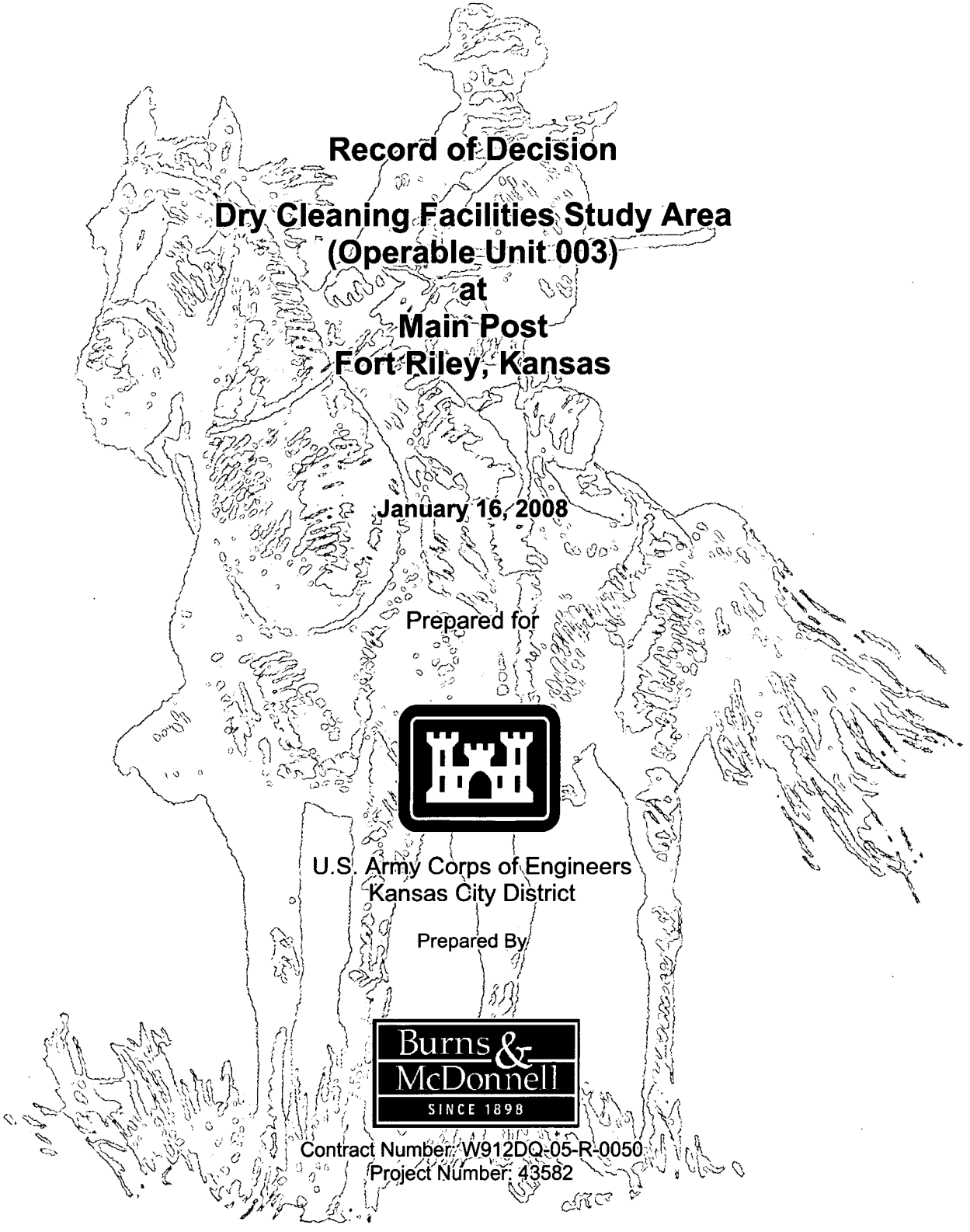

Record of Decision

Dry Cleaning Facilities Study Area
(Operable Unit 003)
at
Main Post
Fort Riley, Kansas

January 16, 2008

Prepared for

U.S. Army Corps of Engineers
Kansas City District

Prepared By

Burns & McDonnell
SINCE 1898

Contract Number: W912DQ-05-R-0050
Project Number: 43582

DCF_7_1_001

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List of Acronyms and Abbreviations

AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
BER	Bureau of Environmental Remediation
bgs	below ground surface
BMcD	Burns & McDonnell Engineering Company, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
cm^2	square centimeters
CO_2	Carbon Dioxide
COC	Chemical of Concern
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CSM	Conceptual Site Model
DA	Department of the Army
cis-1,2-DCE	cis-1,2-Dichloroethene
DCF	Dry Cleaning Facility
DCFA	Dry Cleaning Facilities Area
DO	Dissolved Oxygen
DSR	Data Summary Report
EAB	Enhanced Anaerobic Bioremediation
FFA	Federal Facility Agreement
FS	Feasibility Study
FSA	Feasibility Study Addendum
Ft	Foot
HEAST	USEPA Health Effects Assessment Summary Tables
HHBRA	Human Health Baseline Risk Assessment
H_2O	Water
HPGL	High Pressure Gas Line
HQ	Hazard Quotient
HRS	Hazard Ranking System
IC	Institutional Control
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
ISCO	In-Situ Chemical Oxidation
KAR	Kansas Administrative Record
KDHE	Kansas Department of Health and Environment
kg	kilograms
Law	Law Environmental, Inc.

List of Acronyms and Abbreviations (Continued)

LBA	Louis Berger & Associates
m^3 of air/hr	cubic meters of air per hour
MCL	Maximum Contaminant Level
mg	milligram
mg/day	milligrams per day
MH	Manhole
MNA	Monitored Natural Attenuation
MPEO	Master Plan Environmental Overlay
msl	Mean Sea Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operation and Maintenance
ORNL	Oak Ridge National Laboratories
ORP	Oxidation-Reduction Potential
OSHA	Occupation Health and Safety Administration
OU	Operable Unit
PA	Preliminary Assessment
PCE	Tetrachloroethene
PRG	Preliminary Remediation Goal
PSR	Pilot Study Report
PWE	Directorate of Public Works – Environmental Division
RAB	Restoration Advisory Board
RIAMER	Remedial Investigation Addendum Monitoring Expansion Report
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action Plan
RI	Remedial Investigation
RIA	Remedial Investigation Addendum
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RPMP	Real Property Master Plan
RSK	Kansas Risk Based Standard
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SI	Site Investigation
TA2	Training Area 2
TBC	To-Be-Considered
TCE	Trichloroethene
TOC	Total Organic Carbon

List of Acronyms and Abbreviations (Continued)

UCL	Upper Confidence Limit
UPRR	Union Pacific Railroad
USAEHA	United States Army Environmental Hygiene Agency
USC	United States Code
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VC	Vinyl Chloride
VOC	Volatile Organic Compound
µg/L	micrograms per Liter

* * * * *

1.0 DECLARATION

1.1 SITE NAME AND LOCATION

SITE NAME:	Dry Cleaning Facilities (DCF) Study Area, Main Post (Figure 1-1)
USEPA IDENTIFICATION NUMBER:	KS6214020756; Federal Facility Agreement (FFA) Docket Number VII-90-F-0015
LOCATION:	Fort Riley, Kansas
SITE TYPE:	Federal Facility
LEAD AGENCY:	The United States Department of the Army (DA), Fort Riley
SUPPORTING AGENCIES:	The United States Environmental Protection Agency (USEPA), Region VII and the State of Kansas, Kansas Department of Health and Environment (KDHE), Bureau of Environmental Remediation (BER)
OPERABLE UNIT:	Operable Unit (OU) 003

1.2 STATEMENT OF BASIS AND PURPOSE

This document is published as a Record of Decision (ROD) for the Fort Riley, Kansas, KS6214020756, DCF Study Area OU 003 under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), 42 United States Code (USC) § 9601 et seq. The term "DCF Study Area" is used in this report to refer to the Dry Cleaning Facilities Study Area in its entirety which includes the following components: the Dry Cleaning Facility Area (DCFA), which was the original site, the Transition Zone, the Island, the Horse Corral, and Training Area 2 (see Figure 1-2). The remedy for the DCF Study Area was chosen in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practical, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulation (CFR) Part 300. The remedy was selected based upon the Administrative Record file for the DCF Study Area. This ROD is consistent with previous RODs for other OUs at Fort Riley discussed in Section 2.4 and is expected to be in agreement with the Final Comprehensive ROD for the entire Fort Riley Site. Documents supporting this ROD are identified in Section 4.0.

This remedy was selected by the DA, Fort Riley, in consultation with the USEPA Region VII and the KDHE. The State of Kansas and the USEPA concur with the selected remedy.

1.3 ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. The principal threat pertains to potential future use of site-impacted groundwater. Groundwater is the primary source of drinking water and water used for non-domestic purposes (e.g., livestock and irrigation) for Fort Riley and many of the surrounding communities. Alluvial sand and gravel deposits in the Kansas and Republican River valley areas are excellent aquifers and bedrock in the upland areas is also tapped as a source of water (Burns & McDonnell [BMcD], 2004a), however, neither the Kansas and Republican River valley aquifers, the terrace aquifers, or the upland bedrock aquifers at or downgradient of the DCF Study Area are currently used or will be used in the future by Fort Riley as a water source. The source of water for Fort Riley is located several miles upgradient of the DCF Study Area and Fort Riley possesses sufficient excess capacity from the existing supply wells to provide potable water for any foreseeable expansion of the military post. The current water supply system is served by eight wells with a combined total capacity of 8,400,000 gallons per day. This represents less than half of the available capacity.

1.4 DESCRIPTION OF THE SELECTED REMEDY

The Fort Riley National Priorities List (NPL) site currently encompasses five OUs located at the post. The OUs have been designated by the DA, Fort Riley based on the results of prior investigations. The five OUs include: the Southwest Funston Landfill site (OU 001); the Pesticides Storage Facility site (OU 002); the DCF Study Area site (OU 003); the Former Fire Training Area - Marshall Army Airfield site (OU 004); and the 354 Area Solvent Detections site (OU 005).

The selected remedy for the DCF Study Area at Fort Riley is Monitored Natural Attenuation (MNA) with Institutional Controls (ICs). This alternative reflects the long-term site management plan for the DCF Study Area in that the remedy relies on natural degradation processes already occurring at the DCF Study Area to further reduce contaminant concentrations to levels below the maximum contaminant levels (MCLs) at the Kansas River and uses ICs to restrict usage at the DCF Study Area. MNA is currently being conducted as part of post-performance monitoring of source removal interim actions conducted at the DCF Study Area in fall 2005 through fall 2007. ICs currently in place at the DCF Study Area are controlled by the environmental overlay of the Fort Riley Real Property Master Plan (RPMP). The RPMP is the means

through which the post authorities will control and limit development and other activities on the post. This includes overall controls on land use, the issuing of excavation permits that will define and limit potential exposure for utility and grounds workers, and tactical dig permits that control potential exposure for soldiers.

With this alternative, progress at the DCF Study Area will be monitored through groundwater sampling, and ICs will be implemented to restrict groundwater usage until remediation is complete. The Remedial Design/Remedial Action Plan (RD/RA) for the DCF Study Area will be completed upon ROD approval. The RD/RA will include more details of ICs and the monitoring to be conducted under the MNA approach. The primary IC implemented will be restricting the installation and use of groundwater supply wells at and downgradient of the DCF Study Area through the RPMP.

The soil and groundwater contamination at the DCF Study Area included tetrachloroethylene (PCE) and the degradation products trichloroethylene (TCE), *cis*-1,2-dichloroethylene (cis-1,2-DCE), and vinyl chloride (VC). The source of contamination in soil was reduced to concentrations below the Kansas Risk Based Standard (RSK) soil-to-groundwater protection pathway levels (KDHE, 2003)(ECC/BMcD, 2007b). RSK levels are levels determined by the KDHE that would prevent further leaching of contaminants from soil to groundwater. The source reduction at the DCF Study Area occurred in fall 2005 and spring 2006 and involved a source removal pilot study using in-situ treatment of soil with sodium permanganate, ex-situ soil excavation with treatment, and removal of shallow soils to 12-feet (ft) below ground surface (bgs).

Groundwater was also treated in the source area by using potassium permanganate to reduce contaminant concentration mass and by using enhanced anaerobic bioremediation (EAB) to enhance the natural attenuation processes already occurring at the DCF Study Area (ECC/BMcD, 2007b). Natural attenuation, combined with the in-situ and ex-situ source removal treatment has been responsible for the continuing decrease of contaminant levels in groundwater as shown for Monitoring Well DCF93-13, which is located in the source area near former Buildings 180/181 (see Table 1-1). The well location is shown on Figure 1-3 and the temporal concentration trend for Monitoring Well DCF93-13 is shown on Figure 1-3. In general, concentration trends for monitoring wells at the DCF Study Area have shown a temporal reduction in PCE concentration mass since 1993 [Data Summary Report (DSR), BMcD, 2000b] ((Remedial Investigation Addendum (RIA) BMcD, 2004a)) and (Pilot Study Report (PSR) ECC/BMcD, 2007b).

The following key elements of the selected remedy will be implemented:

- Monitoring the natural attenuation of the contamination within the aquifers;
- Restricting the installation and use of on-site groundwater wells at and downgradient of the DCF Study Area until contaminant concentrations are below MCLs and satisfy the KDHE Anti-Degradation Policy through the use of ICs; and
- Conducting a review/evaluation in accordance with CERCLA Section 121 and the NCP 40 CFR Section 300.430(f)(4)(ii) as necessary every five years until groundwater concentrations do not exceed MCLs and satisfy the KDHE Anti-Degradation Policy to determine if the selected remedy is still operational and functional, if the original assumptions are still valid, and if additional corrective measures are required.

The remediation goal is to restore the groundwater to its beneficial use, which may include drinking water or non-domestic uses such as agricultural (livestock or irrigation). Groundwater at the DCF Study Area will be sampled annually for three years in 2008, 2009, and 2010, followed by 5-Year Review sampling as necessary. The 2008, 2009, and 2010 sampling will monitor contaminant concentrations and to make sure that the Pilot Study activities did not disrupt the monitored natural attenuation. Once the alluvial wells are below MCLs, the DCF Study Area will be recommended for site closeout. Five-Year Review sampling may still be required for Terrace, Transition Zone, and Horse Corral wells.

1.5 STATUTORY DETERMINATIONS

The DA, USEPA, and KDHE have determined that the selected remedy meets the requirements of CERCLA Section 121, and, to the extent practical, the NCP. The selected remedy was chosen over the other alternative because it provides risk reduction through degradation of contaminants in the groundwater and provides measures to prevent future exposure to currently contaminated groundwater. Based on the information available at this time, the DA, USEPA, and KDHE believe the selected remedy will be protective of human health and the environment, will comply with applicable or relevant and appropriate requirements (ARARs), will be cost-effective, and will utilize permanent solutions to the maximum extent practicable.

The selected remedy (MNA) relies on natural degradation processes already occurring at the DCF Study Area. These processes further reduce contaminant concentrations to levels below the MCLs. The selected remedy (MNA) does not involve engineered treatment because this portion of the remedies identified

during the Feasibility Study Addendum (FSA) were conducted as part of an interim action (see PSR, ECC/BMcD, 2007b). The three Areas of Concern (AOCs) include AOC 1 soils, AOC 2 groundwater, and AOC 3 groundwater (see Figure 1-4). Each remedy selected for each AOC contained MNA and IC as part of a remedial package. The engineered remedies selected and applied at each AOC is discussed in detail in the DCF PSR (ECC/BMcD, 2007b) and summarized in the Proposed Plan (BMcD, 2007).

Evidence of natural degradation processes at the Site, as per the USEPA MNA guidance document (USEPA, 1999a) includes: 1) decreasing contaminant concentration trend, and 2) supporting geochemical data measurements. The source of contamination in the soil was successfully treated by both in-situ sodium permanganate injection and ex-situ soil excavation and removal in fall 2005 through fall 2007. These treatments reduced concentrations of volatile organic compounds (VOCs) in soil to below levels that would continually leach to groundwater. As a result, the known contamination source areas were effectively removed. In addition, the groundwater treatment with potassium permanganate and EAB coupled with natural attenuation/degradation of the VOCs plume(s) is effectively reducing the contamination based on available data. The selection of MNA as the Selected Remedy is based upon current and reasonably projected land use and exposures. The Site is currently designated as an open area under Fort Riley's Master Plan. Open areas have building restrictions and are used for safety areas, utility clearances and easements, conservation areas, and buffer zones. However, hazardous substances, pollutants, or contaminants may remain at the DCF Study Area above levels that would allow for unlimited use and unrestricted exposure.

The rationale for choosing this remedy is based on the fact that no source materials (such as liquids, areas contaminated with high concentrations of toxic compounds, or highly mobile materials) constituting principal threat wastes that require further treatment or removal likely exist at the DCF Study Area and that the total excess lifetime cancer risks for on-post populations were below the USEPA's generally acceptable risk range.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining at the DCF Study Area above levels that allow for unlimited use and unrestricted exposure, a review in accordance with CERCLA and the NCP will be conducted as necessary no less often than every five years based on the review schedule already in place at Fort Riley to ensure that the remedy is, or will be, protective of human health and the environment. The first five-year review of the selected remedy will include consideration of the following factors:

- the performance of MNA in achieving cleanup levels (MCLs and satisfaction of the KDHE Anti-Degradation Policy);
- the continuation of ICs that restrict use of groundwater on the property to ensure that groundwater with contamination above cleanup levels (MCLs) is not used; and
- Groundwater at the DCF Study Area will be sampled annually for three years in 2008, 2009, and 2010, followed by 5-Year Review sampling as necessary. The 2008, 2009, and 2010 sampling will monitor contaminant concentrations. Once the alluvial wells are below MCLs, the DCF Study Area will be recommended for site closeout. Five-Year Review sampling may still be required for Terrace, Transition Zone, and Horse Corral wells.

1.6 ROD DATA CERTIFICATION CHECKLIST

In accordance with *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (USEPA, 1999b), the following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for the DCF Study Area.

- Chemicals of concern (COCs) and their respective concentrations (Section 2.7.1)
- Baseline risk represented by the COCs (Section 2.7.1)
- Cleanup levels established for COCs and the basis for these levels (Section 2.8)
- How source materials constituting principal threats are addressed (Section 2.11)
- Current and reasonably-anticipated, future, land-use assumptions and current and potential, future, beneficial uses of groundwater as defined in the baseline risk assessment and ROD (Section 2.6)
- Potential land (Section 2.6.1) and groundwater (Section 2.6.2) use that will be available at the DCF Study Area as a result of the selected remedy
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 2.12.3 and Tables 2-18 through 2-21)
- Key factors that led to selecting the remedy (i.e., describe how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (Section 2.12.1)

1.7 AUTHORIZING SIGNATURES

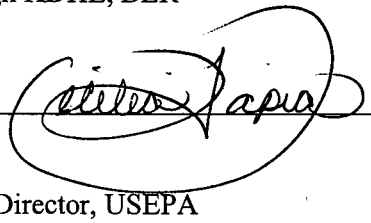
On the basis of the RIA/FSA performed at the DCF Study Area, the selected remedy, MNA with ICs, meets the requirements for remedial action set forth in CERCLA, as confirmed by the following signature pages.

Lead and Support Agency Acceptance of the ROD

Fort Riley Army Installation

DCF Study Area, OU 003

Signature sheet to the ROD for the DCF Study Area (OU 003) final action at the Fort Riley Installation between the United States Army, Fort Riley and the USEPA, Region VII, with concurrence by the State of Kansas acting through KDHE, BER



2/21/08

Cecilia Tapia — Date

Superfund Division Director, USEPA

Lead and Support Agency Acceptance of the ROD

Fort Riley Army Installation

DCF Study Area, OU 003

Signature sheet to the ROD for the DCF Study Area (OU 003) final action at the Fort Riley Installation between the United States Army, Fort Riley and the USEPA, Region VII, with concurrence by the State of Kansas acting through KDHE, BER

3/18/08
Date

Richard G. Piscal
COL, Armor
Garrison Commander

* * * * *

2.0 DECISION SUMMARY

This Decision Summary provides an overview of the groundwater conditions at the DCF Study Area, the remedial alternatives evaluated, and the analysis of those options. In addition, this section explains the rationale for the remedy selection and describes how the selected remedy satisfies statutory requirements.

2.1 SITE NAME, LOCATION, AND DESCRIPTION

The Fort Riley, Kansas, DCF Study Area is located in the Main Post cantonment area of the Fort Riley Military Installation, located in Geary and Riley Counties, near Junction City. Main Post is in the southern region of Fort Riley, north of the Kansas River (Figure1-1). The term "DCF Study Area" is used in this report to refer to the entire Dry Cleaning Facilities Site (OU 003).

Fort Riley is identified by the USEPA as Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) site KS6214020756. This document is issued by the DA, the lead agency for the activities at Fort Riley, in consultation with the USEPA and KDHE, the support agencies. Cleanup work at the DCF Study Area has been funded by the DA (Fort Riley) through the Installation Restoration Program (IRP).

The DCF Study Area is situated both north and south of the Kansas River and consisted of five main investigative areas (see Figure 1-2). The original area of investigation was the location of the former dry cleaning operation buildings. During the investigative period, four additional areas were added to the original area. These five areas are described as follows:

- The **Dry Cleaning Facilities Area (DCFA-original study area)** consists of two areas located on an alluvial terrace: the former Buildings 180/181 Area and the former Buildings 183/184 Area. Dry cleaning operations were conducted at both of these locations. 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 181. The axis of the channel runs northeast/southwest, slopes to the southwest, and extends through the Transition Zone into the Island. Sand is present at depth within the bedrock erosional channel.

- The **Transition Zone** separates the DCFA terraces from the Island and the Horse Corral river alluvial deposits. The Transition Zone is where the geology "transitions" from the upper terrace system beneath the DCFA to the point bars of the alluvial system of the Island and the Horse Corral. 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. The Union Pacific Railroad (UPRR) tracks lie within the Transition Zone.

- The **Island** consists of a point bar formed by the Kansas River. This area is located between the DCFA and the Kansas River. The Island consists of approximately 40 heavily-wooded acres that are undeveloped and currently serve as a winter roosting area for bald eagles. The Island is a U.S. Fish and Wildlife Service designated critical habitat for Bald and Golden Eagles (16 U.S.C. 668-668d) and is under the protection of federal and state protected species laws. The Island is 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. Subsurface lithologies in this area represent an upward-fining sequence typical of alluvial point bar and floodplain sediments.

- The **Horse Corral** is the western portion of a point bar located downstream of the Island, and is located southeast of the DCF Study Area. This area is located immediately west and is adjacent to the 354 Area Solvent Detections Site (OU 005). The Horse Corral is bounded by Henry Drive to the east, the Kansas River to the west and south, and the UPRR tracks to the north. The point bar is currently used for pasturing and training of Fort Riley's horses. Portions of the Horse Corral are also designated as a critical habitat for Bald and Golden Eagles and are under the federal and state protected species law. The Horse Corral is underlain by Kansas River alluvium. The Kansas River alluvium is composed of Kansas River flood deposits and erosional deposits from the upland and terrace area. Subsurface lithologies in this areas represents an upward-fining sequence typical of alluvial point bar and floodplain sediments.

- **Training Area 2 (TA2)** consists of the Kansas River floodplain located along the south side of the Kansas River directly across from the Island. TA2 is heavily wooded and is used by Fort Riley for

military exercises. It is undeveloped and is also a winter roosting area for bald eagles. Portions of the TA2 area are also designated as a critical habitat for Bald and Golden Eagles and are under the protection of federal and state protected species law. The TA2 area is underlain by Kansas River alluvium. The Kansas River alluvium is composed of Kansas River flood deposits. Subsurface lithologies in this areas represents an upward-fining sequence typical of alluvial point bar and floodplain sediments.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The original investigation area (DCFA) contained the former dry cleaning operations and support buildings (see Figure 1-2). The former Buildings 180/181 Area was located south of Custer Road. Buildings 180/181 were the location of the original dry cleaning (1930 to 1983) and laundry (1915 to 1983) operations before these operations were transferred to Building 183. Building 182 was a storage building. Buildings 180/181 and 182, and the surrounding parking lots and sidewalks were demolished in the summer 2000. Buildings 183 and 184 were located north of Custer Road. The former Building 183 contained the more recent dry cleaning operations that consisted of dry cleaning (1983 to 2002) and laundry facilities (1941 to 2002). A steam generating plant was present at Building 184. Buildings 183 and 184, and most surrounding structures were demolished in fall 2002. The locations where Buildings 180/181, 182, 183, and 184 once stood are now empty grassy lots.

The Transition Zone is a moderately-wooded area that contains the UPRR. The Island, and TA2 are heavily-wooded undeveloped areas. The Horse Corral area is a moderately-wooded area that contains a few barns and inner corral fencing for housing, pasturing, and training horses.

Environmental investigations and sampling events were performed at Fort Riley during the 1970s and 1980s. These investigations identified activities and facilities where hazardous substances had been released or had the potential to be released to the environment. Potential sources of contamination included landfills; printing, dry cleaning, furniture shops; and pesticide storage facilities (BMcD, 2004a).

Effective June 1991, the DA entered into a FFA, Docket No. VII-90-F-0015, with the State of Kansas KDHE and USEPA Region VII to address environmental pollution subject to CERCLA, the NCP, and/or the Resource Conservation and Recovery Act (RCRA) (USEPA, 1991). The Hazard Ranking System (HRS) ranking was performed in 1988 by the USEPA based on the aggregation of two individual areas of the Fort Riley Superfund site, the Southwest Funston Landfill and the Pesticide Storage Facility. It was

noted that other potentially contaminated areas exist at Fort Riley (e.g. burn pits, fire training areas, and dry cleaner operations). These sites received a comprehensive score of 33.79. As a result, on July 14, 1989, the USEPA proposed inclusion of Fort Riley on the NPL pursuant to CERCLA.

The FFA specifically required that a preliminary assessment (PA) be performed for the DCF Study Area. Site investigation field activities began in October 1991. A Draft PA/Site Investigation (SI) was finalized with USEPA, KDHE, and Army comments attached to the PA/SI document in October 1992 (Law Environmental (Law), 1992). In accordance with the NCP, a remedial investigation (RI) was subsequently performed for the DCF Study Area. The Draft Final RI Report (Louis Berger & Associates (LBA), 1995) was submitted in March 1995 to the USEPA and KDHE for review and acceptance. Based upon the results of the RI, a Draft Feasibility Study (FS) was prepared and submitted to KDHE and USEPA in April 1995. The Draft FS was not finalized due to comments from KDHE requesting that further information be obtained with regard to the groundwater contamination on the Island. As a result, the *Work Plan for Monitoring Network Expansion Including Additional Characterization of the Island* (LBA, 1996a) was prepared in May 1996. Conditional upon completion of the additional groundwater sampling and analysis in the Work Plan, KDHE approved the RI in April 1996. After the planned work was completed, the *Remedial Investigation Addendum Monitoring Expansion Report* (RIAMER) (LBA, 1998a) was prepared and submitted in March 1998. KDHE approved the RIAMER in April 1998. The *Revised Feasibility Study for the Dry Cleaning Facilities Study Area, Fort Riley, Kansas* (LBA, 1998b) was submitted to USEPA and KDHE for review in March 1998. KDHE approved the Revised FS in April 1998. During this time, groundwater monitoring was continued at the DCF Study Area.

In 2000, the USEPA conducted a review of the removal actions conducted at the DCF Study Area. The results of the review were transmitted to Fort Riley in a letter dated April 26, 2000 entitled *Technical Review of Removal Action Activities at the Former Dry Cleaning Facility Operable Unit No.3, Fort Riley, Kansas* (USEPA, 2000b). The USEPA review had determined that the soil vapor extraction contaminant removal action/pilot study, conducted in the latter part of 1994 and early 1995, "had no effect on the significantly higher concentrations of chlorinated compounds observed in well DCF93-13. Additional source area(s) appear to be present." Based upon this correspondence, Fort Riley voluntarily conducted an additional source screening in October 2000. The results of the Potential Source Area Investigation were presented in the *Technical Memorandum Report, Potential Source Area and Sewer Line Field Screening, Dry Cleaning Facilities Area (OU 003) at Fort Riley, Kansas* (BMcD, 2002c). Based upon the results of the technical report, Fort Riley decided to conduct additional field investigations at the DCF Study Area and to present the findings as an addendum to the original RI Report. The *Remedial*

Investigation/Feasibility Study Addendum Work Plan for the Dry Cleaning Facilities Area (Operable Unit 003) at Fort Riley (BMcD, 2002b) was submitted to USEPA and KDHE in March 2002. Following approval by these agencies, field investigation activities for the RI Addendum began in April 2002. Based on the results of groundwater screening on the Island during this investigation, the *Technical Memorandum for the Monitoring Well Placement, Dry Cleaning Facilities Area (Operable Unit 003) at Fort Riley, Kansas, (*BMcD, 2003a) was presented by Fort Riley to the USEPA and KDHE for approval of monitoring well locations on the Island and the Transition Zone. Following agency approval, field investigation activities for the RI Addendum resumed in September 2002 and continued throughout 2003. After demolition of Buildings 183 and 184, it was decided that surface soil sampling was needed in the area of these former buildings. KDHE also requested that an additional well cluster was needed along the Kansas River in the northern portion of TA2. This additional work was detailed in the *Work Plan Addendum for the Dry Cleaning Study Area at Fort Riley, Kansas* (BMcD, 2003d). The surface soil at former Building 183 was sampled and Monitoring Well Cluster DCF03-50a/c was installed at TA2 in the summer 2003 (see Figure 1-2).

The results for the field work conducted in support of the RI Addendum was reported in the *Remedial Investigation Addendum (RIA) for the Dry Cleaning Facilities Area (Operable Unit 003) at Fort Riley Kansas* (BMcD, 2004a) and was submitted and approved by KDHE and USEPA in April 2004. The *Feasibility Study Addendum for the Dry Cleaning Facilities Area (Operable Unit 003) Fort Riley, Kansas* (BMcD, 2005b) was submitted and approved by KDHE and USEPA in March 2005. Following completion of the FSA, Fort Riley implemented a removal action/pilot study to address soil and groundwater contamination at the DCF Study Area. The removal action/pilot study incorporated the engineered portions of the remedial alternatives selected for each AOC that were approved for the FSA by the KDHE and USEPA. The *Work Plan Pilot Study for Soil and Groundwater Remediation DCF Study Area (Operable Unit 003) Main Post, Fort Riley, Kansas* (BMcD, 2005c) was approved by Fort Riley in August 2005 with concurrence from KDHE and USEPA. The main areas addressed by the removal action/pilot study included surface soil, subsurface soil, and utility corridors at AOC 1 located at the former DCFA Buildings 180/181, groundwater at AOC 2 located at the former DCFA Buildings 180/181, and soil and groundwater at AOC 3 which included portions of the Transition Zone and the Island (Figure 1-4). Field work in support of the removal action/pilot study commenced in November 2005 and was concluded in September 2007. Following completion of the removal action/pilot study field work, the results of the removal action/pilot study were presented to Fort Riley in the *Pilot Study Report for the DCF Study Area (Operable Unit 003) Main Post, Fort Riley, Kansas* (ECC/BMcD, 2007b-PSR) in January 2008.

The monitoring wells associated with the DCF Study Area have been sampled as part of the groundwater monitoring program at Fort Riley. The results of these sampling events are provided in the Data Summary Report (DSRs) for each event (LBA, 1996b, 1998c, and 1999; and BMcD, 1999a, 1999b, 1999c, 2000b, 2001a, 2001b, 2001c, 2002a, 2002d, 2002e, 2003b, 2003e, 2003f, 2004b, 2004c, 2005a, 2006a) and the Quality Control Summary Reports for the PSR (ECC/BMcD 2006a, 2006b, and 2007a).

Following the submittal of the removal action/pilot study report, the *Proposed Plan for the DCF Study Area (Operable Unit 003) Main Post Fort Riley, Kansas* (BMcD, 2007) was issued in October 2007 to inform the public of Fort Riley's, USEPA's, and KDHE's preferred remedy based on information included in the Administrative Record. The intention was to solicit public comments pertaining to the remedial alternatives evaluated, including the preferred alternative. Submitted on October 11, 2007, the Draft Final Proposed Plan was accepted by the KDHE and USEPA, as presented in the Responsiveness Summary (Section 3.0 of this document).

2.3 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The RI/FS process was conducted in accordance with CERCLA requirements to document the comprehensive remedial activities and proposed remedial plan for the DCFA Site. Primary documents developed during the RI/FS process included the original RI and FS reports, the updated RIA (with the human health baseline risk assessment [HHBRA]), FSA report, and PP for the DCFA Site. These reports were released to the public between November 2003 and May 2007, and have been made available for public review as part of the Administrative Record file at the Fort Riley Directorate of Public Works – Environmental Division (PWE), formerly known as the Directorate of Environment and Safety. The Administrative Record is the set of supporting information used to determine the preferred alternative. These reports were also made available to potentially affected persons and the public in the Dorothy Bramlage Public Library (Junction City) and Manhattan Public Library. The PP can be viewed electronically by conducting a search at the following website: http://www.riley.army.mil/Services.

Notices of availability of these documents and the notice for the public meeting to discuss the PP were published in the *Manhattan Mercury* and the *Junction City Daily Union* on October 21, 2007. A public comment period for the Proposed Plan was declared from October 21, 2007 through November 20, 2007 to provide a reasonable opportunity for comment and to disseminate information regarding the document. No comments were received from the public.

A public meeting was held at the PWE, Building 407 Pershing Court, Fort Riley, Kansas at 7:00 pm local time on October 30, 2007 in conjunction with the Restoration Advisory Board (RAB) meeting to discuss the Proposed Plan. At this meeting, representatives for the DA, KDHE, and USEPA were available to inform the public about the DCF Study Area and remedial options under consideration. The official transcript for the public meeting was recorded by SGT Flores, court reporter. There were no comments made by the public during the meeting.

2.4 SCOPE AND ROLE OF OPERABLE UNIT

As with many superfund sites, the problems at Fort Riley are complex and are site-specific in nature. As a result, USEPA has organized the work into separate operable units. Fort Riley currently encompasses five OUs located at the post. The OUs have been designated by the DA, Fort Riley based on the results of prior investigations. The five OUs include: the Southwest Funston Landfill site (OU 001), the Pesticide Storage Facility site (OU 002); the DCF Study Area site (OU 003); the Former Fire Training Area - Marshall Army Airfield site (OU 004); and the 354 Area Solvent Detections site (OU 005). The remedy selected by USEPA for each site includes landfill capping for the Southwest Funston Landfill site (OU 001); capping, soil excavation and removal for the Pesticide Storage Facility site (OU 002); MNA and ICs for the Former Fire Training Area - Marshall Army Airfield Site (OU 004) following a soil vapor extraction pilot study; and MNA and ICs for the 354 Area Solvent Detections site (OU 005) following an in-situ chemical oxidation pilot study.

The DCF Study Area, the subject of this ROD, addresses groundwater contamination. The DCF Study Area is a discrete area of contamination that does not affect or is not affected by the other four OUs at the Fort Riley NPL site. Ingestion of water extracted from the Kansas River alluvial aquifer in the vicinity and downgradient of the DCF Study Area poses a current and potential risk to human health because the concentrations of contaminants are greater than the MCL for drinking water (as specified in the Safe Drinking Water Act (SDWA)). This should be the final response action for the DCF Study Area because the principal threat areas have been treated during the removal action/pilot study conducted in 2005 through 2007 at the site and groundwater contaminant concentrations will continue to degrade based on the post-performance monitoring results. The selected response action addresses the remedial action objectives (RAOs) established for the DCF Study. Refer to Section 2.8 for more information on RAOs and cleanup levels.

2.5 SITE CHARACTERISTICS

The conceptual site model (CSM); site overview; summary of surface and subsurface features; sampling strategy; known or suspected sources, types, and location of contamination; and nature and extent of contamination are discussed below. Additional details regarding the DCF Study Area characteristics are provided in the RIA report (BMcD, 2004a).

2.5.1 Conceptual Site Model

Figure 2-2 presents the human health CSM. Reasonable exposure scenarios were developed based on how the DCFA Site is currently used and assumptions about its future use and physical site features.

2.5.2 Site Overview

SOIL

The DCF Study Area is located at the Main Post cantonment area, in the southern region of Fort Riley (Figure 1-2). Contamination in soil was located beneath the former Building 180/181 foot print; in the bedding and soil in the utility corridor which included portions of the sanitary sewer lines, portions of the high pressure abandoned gas line (HPGL), in the soil in and around several sewer manholes (MH), and in the vadose zone near Monitoring Well DCF02-42. Figure 1-4 provides a visual summary of the treatment areas for the DCF Study Area. The contaminated soil source beneath the former Building 180/181 foot print was removed during the removal action/pilot study conducted in 2005 through 2007 by the excavation and removal of the upper 8 to 12-feet of soil with PCE concentrations above the KDHE RSK levels. The total area excavated was approximately 133 ft by 183 ft or 24,339 square feet. The excavated soils were transported to a landfarm treatment cell for further treatment. Following removal of approximately 2,400 cubic yards of contaminated soil, the excavations at AOC 1 were backfilled with clean high-clay content borrow. Portions of the bedding and soil within the utility corridor were excavated, exposed, sampled, and treated with a sodium permanganate oxidant to eliminate contamination in these areas. For further information on the treatment, refer to the PSR (ECC/BMcD, 2007b). Based on soil removal and treatment in AOC 1, soil in this area is no longer a medium of concern and has been removed from further discussion in this ROD.

The vadose zone soils around Monitoring Well DCF02-42 were also sampled and treated with injections of sodium permanganate. The vadose treatment area was approximately 15 ft by 25 ft or 375 square feet. For further information on the treatment, refer to the PSR (ECC/BMcD, 2007b). The vadose zone treatment of this area will prevent the leaching of contaminants from the vadose zone to the saturated zone. Although

the soil in this area was not identified as a medium of concern in the FSA and contained analytical concentrations below the KDHE RSK levels, Fort Riley decided to proactively address this area during the removal action/pilot study. Based on the low soil analytical concentrations below the KDHE RSK levels and the soil treatment in this area, soil in AOC 3 is not a medium of concern and has been removed from further discussion in this ROD.

GROUNDWATER

There are currently two groundwater plumes at the DCF Study Area that are designated as the eastern and western plume (Figure 1-4). The eastern plume (containing AOC 1 and AOC 2) originates from beneath the former Buildings 180/181 foot print and extends through the transition zone into the Kansas River alluvium on the Island. The western plume (containing AOC 3) originates in the area around Monitoring Well DCF02-42 and extends through the transition zone into the Kansas River alluvium on the Island (see Figures 2-3 through 2-9 and Table 2-1).

The source for both plumes was leaking sanitary sewer lines. For the eastern plume, contaminated subsurface soil at and adjacent to former Buildings 180/181 also contributed to groundwater contamination. The source area for the eastern plume was treated by removal of contaminated subsurface soil and in-situ oxidation treatment of the sanitary sewer lines and MHs. For groundwater, the eastern plume is naturally attenuating to concentrations below the MCL for PCE, TCE, cis-1,2- DCE and VC by the time the plume reaches Monitoring Well DCF96-27. Monitoring Well DCF96-27 is located at the southern end of a buried bedrock erosional channel in the Kansas River Alluvium. This channel extends from beneath the former Building 180/181 foot print to the Kansas River alluvium. During the pilot study, EAB in the form of a non-emulsified (neat) vegetable oil was injected into the saturated zone in the bedrock erosional channel north of the UPRR to enhance the ongoing biodegradation that is occurring in this area as well as to reduce the contaminant mass monitoring time (see Figure 2-10). Total area for EAB injection was 290 ft by 120 ft or 34,800 square ft. Based on groundwater treatment, natural degradation of groundwater in AOC 2, and reduction of concentrations below MCLs once the plume reaches the end of the erosional channel, groundwater in this area is no longer a medium of concern and will be removed from further discussion in this ROD. However, monitoring wells installed within this AOC are part of the monitoring well network for the DCF Study Area and will be monitored on an annual basis as part of the monitoring plan.

The western plume originates near Monitoring Well DCF02-42 and extends into the Kansas River alluvium on the Island. This plume is also attenuating, but to a lesser degree than the eastern plume.

During the pilot study, the vadose zone soil adjacent to Monitoring Well DCF02-42 (see Figure 2-11) was treated with sodium permanganate oxidant and the saturated zone between Monitoring Wells DCF02-42 and DCF06-25, where the bulk of the groundwater contaminant mass was located, was injected with a potassium permanganate oxidant to reduce the contaminant mass and the groundwater concentrations (see Figure 2-12). Total area for potassium permanganate injection was 160 ft by 60 ft or 13,050 square ft. Additional groundwater treatment on the Island included upgradient treatment of Monitoring Well DCF02-49c with EAB in the form of a non-emulsified (neat) vegetable oil to enhance the ongoing biodegradation that is occurring in this area (See Figures 2-13 and 2-14). Total area for EAB injection was approximately 30 ft by 270 ft or 8,100 square ft. Although the groundwater in this area was not identified as a separate AOC in the FSA, the groundwater in this area contained PCE and TCE analytical concentrations above the MCL, therefore, Fort Riley decided to proactively address this area during the pilot study. Although recent groundwater analytical results have shown a reduction in contaminant concentrations due to treatment with potassium permanganate and EAB as well as natural attenuation (ECC/BMcD, 2007b), concentrations of PCE, TCE, and cis-1,2-DCE above the MCLs are still present in AOC 3, therefore, groundwater in AOC 3 and the Island is still a medium of concern and will be addressed further in this ROD.

There are also minor intermittent amounts of contaminant PCE concentrations in groundwater (less than 15 µg/L) at two areas in the Horse Corral which are the result of a leaking sanitary sewer line located immediately north of the Horse Corral. The sanitary sewer line is no longer in service. Although these two areas were removed from further consideration during development of the FSA with KDHE and USEPA approval, Fort Riley decided to proactively address these areas during the pilot study. EAB in the form of a non-emulsified (neat) vegetable oil was injected into the saturated zone upgradient of Monitoring Well DCF97-37c and B354-99-11c to enhance the ongoing biodegradation that is occurring in this area (see Figures 2-13, 2-15, and 2-16). Total area for EAB injection was approximately 30 ft by 270 ft or 8,100 square ft for DCF97-37c and approximately 30 ft by 270 ft or 8,100 square ft for B354-99-11c. Because these two areas were removed from further consideration during the FSA, groundwater at the Horse Corral is not a medium of concern and will be removed from further discussion in this ROD.

2.5.3 Surface and Subsurface Features

The topography across the DCF Study Area is dominated by alluvial terraces (DCFA), a soil Transition Zone, point bars (the Island and the Horse Corral Area) of the Kansas River, and the Kansas River floodplain (TA2) (Figure 1-2).

The portion of the DCF Study Area located north of the UPRR grade 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 Study Area, 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 above mean sea level (msl) along the UPRR grade in the Transition Zone to approximately 1,126 feet above msl north of former Building 183.

A soil Transition Zone separates the upland terraces north of the UPRR grade from the point bars located south of the UPRR grade (Figure 1-2). The Transition Zone is composed of Kansas River alluvium 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 in the transition zone vary in the north/south direction between 1,046 feet above msl at the base of the UPRR grade to approximately 1,066 feet above msl on the UPRR track. Elevations vary in the east/west direction between about 1,064 feet above msl at the UPRR tracks at Henry River Bridge to 1069 feet above msl at the UPRR train trestle located immediately south of former Buildings 180/181.

The Island, Horse Corral, and TA2 are composed of 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 (Figure 1-2), while TA2 lies south of the Kansas River, west of Henry Drive bridge. All three areas are of low relief, with ground surface elevations generally between 1,046 feet above msl near the Kansas River to 1,060 feet above msl at TA2 and 1,065 feet above msl on the Island.

A more detailed description of the geology and hydrogeology of the DCF Study Area are presented in Section 3.0 of the RIA Report (BMcD, 2004a).

2.5.4 Sampling Strategy

Over the operational years of the dry cleaning facilities, dry cleaning related activities have been conducted at the DCF Study Area that resulted in chlorinated solvent soil and groundwater contamination. The activities include the temporary storage, usage, and disposal of new and spent PCE dry cleaning solvent. Specific areas identified as possible source areas include the following:

- Sanitary sewer lines and MHs leading from former Building 183 including MH 367 and MH 365 (see Figure 2-17).
- Sanitary sewer lines and MHs leading from former Buildings 180/181 including MH 363.
- HPGL located between Custer Road and former Buildings 180/181.
- Soil beneath Former Building 180/181 foot print.
- Soil around Manhole 363.
- Soil near Monitoring Well DCF02-42.

A number of field investigations have been conducted at the DCF Study Area. Since 1991, these investigations have included collection and chemical analysis of soil-gas samples, groundwater-screening samples, soil samples, surface soil samples, and groundwater samples. Monitoring wells were also installed and sampled at the DCF Study Area. The data substantiates that chlorinated solvents, including PCE in soil, and PCE, TCE, DCE, and VC concentrations in groundwater were present at the DCF Study Area. Details regarding the historical sampling events are provided in the RIA report and various DSRs.

The United States Geological Survey (USGS) has conducted surface-water sampling of the Kansas River at Fort Riley in order to determine whether contamination from sites adjacent to the river has impacted the river. The USGS conducted surface-water sampling events in March 2000, July 2000, and July 2001. These samples were collected both upstream and downstream of the point where the groundwater plumes enters the river and were analyzed for VOCs. Surface-water samples collected during these sampling events did not contain any detectable VOCs concentrations (BMcD, 2000a, 2000c, and 2001d).

2.5.5 Known or Suspected Sources, Types, and Location of Contamination/Nature and Extent of Contamination

The known or suspected sources, types, and location of contamination/nature and extent of contamination are fully presented in the RIA report (BMcD, 2004a), the FSA report (BMcD, 2005b) and the PSR (ECC/BMcD, 2007b). The major findings are as follows:

- Soil is not a medium of concern at the DCF Study Area. The areas of shallow soil contaminated with PCE, located beneath the former Buildings 180/181 foot print, adjacent to MH 363, within the utility and HPGL corridor, and near Monitoring Well DCF 02-42 were remediated during the pilot study.

- Groundwater is a medium of concern at the DCF Study Area. PCE, TCE, DCE, and VC are COCs. TCE, DCE, and VC are degradation products of the primary PCE contamination at the site.

- Two contamination plumes are present at the DCF Study Area. The eastern plume (AOC 2) originates beneath the former Buildings 180/181 building foot print in the buried bedrock erosional channel and extends to the Kansas River alluvial deposits south of the UPRR. The western plume (AOC 3) originates in the terrace deposits near Monitoring Well DCF02-42 and extends southeastwards into the Kansas River alluvial deposits south of the UPRR.

- There were no detectable VOC concentrations in samples collected from the Kansas River.

- Currently, in-situ treatment of EAB and chemical oxidation as well as natural attenuation of contaminants are the dominant mechanisms for the decrease in contaminant levels in groundwater at this site. Natural attenuation was determined to be occurring at the DCF Study Area based on the presence of PCE degradation products (TCE, cis-1,2-DCE, and VC) and favorable natural attenuation parameters (dissolved oxygen (DO), oxidation reduction potential (ORP), sulfate, methane). Natural attenuation appears to be active mainly in the bedrock erosional channel and the alluvial aquifer of the Kansas River.

- The groundwater plume in AOC 2 is degrading to concentrations below the MCL as the plume exits the bedrock erosional channel into the Kansas River Alluvium. Although groundwater in AOC 2 is not a medium of concern, monitoring wells installed within this area are part of the site monitoring network and will continue to be monitored.

- The groundwater plume in AOC 3 is also degrading but to a lesser extent. Groundwater concentrations for the COCs are above the MCL as the plume approaches the Kansas River. Accordingly, groundwater in AOC 3 is a medium of concern and has been retained for future consideration.

- There is no soil or groundwater contamination at TA2. Therefore, soil and groundwater in TA2 are not media of concern and this area has been removed from future consideration.

- There is no soil contamination at the Horse Corral. There are intermittent concentrations of PCE, TCE, and DCE in two small areas adjacent to the abandoned sanitary sewer line. An investigation of this area (BMcD, 2002c) concluded that there were no soil or groundwater sources in this area and that the sanitary sewer line was the likely source. Because the dry cleaning facilities have been demolished, this portion of the sanitary sewer line is no longer active, and these two areas were treated during the pilot study, the Horse Corral area has been removed from future consideration.

- Those portions of the DCF Study Area that need to be further addressed include the groundwater at AOC 3 and portions of the Island.

The current size of the AOC 2 shallow groundwater plume that exceeded the MCL for PCE is confined to a small area around Monitoring Well DCF06-40 (see Figure 2-3). There were no detections of TCE above the MCL of 5 ug/L. Due to EAB treatment and natural attenuation, concentrations of cis-1,2-DCE exceeds the MCL of 70 ug/L at Monitoring Well DCF02-41 (110 ug/L). VC is currently found only intermittently in bedrock Monitoring Well DCF93-19 and alluvial monitoring well DCF96-27 (see Figure 2-9 and Table 2-1) and are the result of natural attenuation of PCE.

The current size of the AOC 3 shallow groundwater plume that exceeded the MCL for PCE has decreased in size and mass since the pilot study remediation was conducted at the DCF Study Area (Figure 2-18). The size and mass reduction in PCE groundwater contamination in this area was the direct result of potassium permanganate and EAB in-situ treatment. Concentrations for Monitoring Well DCF02-44a decreased from 51.5 (Fall 2005 Baseline) to 13.2 µg/L (Fall 2007) while concentrations for Monitoring Well DCF02-49c also decreased from 26.3 (Fall 2005 Baseline) to 4.0 µg/L (Fall 2007). The analytical results for these two events are presented in Table 4-1 and 4-16 of the PSR (ECC/BMcD, 2007b).

2.6 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

2.6.1 Land Uses

The DCF Study Area is part of the Fort Riley reservation and is not zoned by Geary County. North and east of the UPRR grade is a built-up area (Main Post), with building and road development. Buildings include offices, barracks, family housing units, warehouses, and maintenance facilities. South and east of the UPRR grade are several point bars of the Kansas River. This area is covered with forest and vegetation. South of the Kansas River lies the TA2 area, which is also covered with forest and vegetation.

East of the TA2 area lies Henry Drive, the main entrance to the post from Interstate 70, and Marshall Army Airfield. West of the study area are open grassy fields.

In 2000 and 2002, Buildings 180/181 and 183/184 and their associated structures were demolished. The Fort Riley Master Plan currently designates these areas, as well as the Transition Zone, the Island, Horse Corral, and TA2, as Open Areas, in which future development for residential or commercial industrial use would not be allowed (Parsons/Harland, Bartholomew, and Associates, 2000). Open areas have building restrictions and are used only for safety areas, utility clearances and easements, conservation areas, and buffer zones. It is anticipated that land use activities within the DCF Study Area will remain unchanged into the foreseeable future based on these building restrictions.

Additionally, a portion of the DCF Study Area lies within the active flood plain of the Kansas River where land uses must be in compliance with Executive Order 11988 – Floodplain Management. This order restricts and places requirements on actions that occur within a floodplain. The Fort Riley Master Plan restricts building in the flood plain and current as well as future construction in these areas is not anticipated. Furthermore, no significant changes in current or future land use is foreseen since a portion of the DCF Study Area, which includes all of the Island, lies within the 100 meter buffer zone established on both sides of the Kansas River as a U.S. Fish and Wildlife Service designated critical wildlife habitat for bald eagles that winter at Fort Riley. This critical habitat area for Bald and Golden Eagles is under the protection of federal and state protected species laws.

2.6.2 Water Uses

Groundwater is the primary source of drinking water for Fort Riley and many of the surrounding communities. Alluvial sand and gravel deposits in the Kansas and Republican River valleys are excellent aquifers. Potential users of the Kansas River are identified in this section. Fort Riley, Morris County Rural Water District, and the communities of Junction City and Ogden rely on groundwater withdrawn from alluvial materials for their drinking water supplies. Fort Riley has eight active wells, Junction City has nine active wells, Ogden has three active wells (United States Army Environmental Hygiene Agency [USAEHA], 1992), and Morris County Rural Water District has three active wells. The Fort Riley well field is not currently operating at full capacity. Ogden also provides water to a rural water district in Riley County. The wells for Ogden and Junction City are more than four miles from the DCF Study Area and the Morris County Rural Water District wells withdraw water from the Clarks Creek alluvium which is hydraulically separated from the Kansas River alluvium.

At the DCF Study Area, there are no known water supply wells completed in the terrace or Kansas River alluvial aquifers. For the alluvial aquifer, the Fort Riley water supply wells are located approximately three miles upgradient (west) of the DCF Study Area near Camp Forsyth. The nearest water supply well (used as a backup well) is located at Marshall Army Airfield, approximately one mile east of the TA2 portion of the DCF Study Area and south of the Kansas River. The purpose for this well is to service the airfield in the event of an emergency affecting the Fort Riley water distribution system.

For the terrace aquifer, the transmissivity is quite low. This is due to the limited saturated thickness, which is generally no greater than ten feet, and usually less than this depth. Because of the prolific supply available from the Kansas River alluvial aquifer, there is no reason for water supply wells to be completed in the terrace aquifer. There are no reasonably anticipated changes in water use at the DCF Study Area currently or in the near future. Implementation of ICs will ensure that water supply wells are not completed in the terrace or alluvial aquifers at the DCF Study Area until remediation or attenuation of groundwater contamination is complete. For more information regarding water uses and hydrogeology at the DCF Study Area, refer to the RIA report (BMcD, 2004a).

2.7 SUMMARY OF SITE RISKS

The baseline risk assessment (human health and ecological) that was completed for the DCF Study Area in 2004 found that the estimated risks to human health and the environment were within or below the USEPA acceptable levels. The DA (Fort Riley's) remedy decision is based on the presence of current site-related contaminants at the DCF Study Area in the terrace and alluvial aquifer at levels exceeding drinking water standards (MCLs), which are identified as an ARAR. Since no specific groundwater use restrictions are in place, concern remains that future development and groundwater use may occur, although the likelihood is remote. Therefore, even though contaminant concentrations are decreasing due to natural attenuation and engineered remedial efforts, and despite the absence of human health or ecological risks before implementation of the engineered portions of the alternative selected for each AOC in the FSA, the current exceedances of MCLs in groundwater at AOC 3 provides the basis for action at the DCF Study Area.

Although additional sampling of groundwater has occurred since 2004, the soil sources in AOC 1 were removed in fall 2005 and spring 2006, and the groundwater in AOC 2 and AOC 3 were treated in the spring/fall 2006, the HHBRA presented in the RIA was not updated for this ROD. The HHBRA may be found in the Administrative Record file for the DCF Study Area. Although the results of the HHBRA are not the basis for remedial action at the DCF Study Area because the estimated risks to human health and

the environment were within or below the USEPA acceptable levels before the pilot study was conducted, a brief discussion of the contaminants and exposures that were evaluated is appropriate. Because the pilot study addressed each of the problem areas in each AOC, the baseline risk assessment should currently be considered extremely conservative. The following subsections of the ROD summarize the human health and ecological risk assessments that were conducted as part of the RIA at the DCF Study Area.

2.7.1 Summary of Human Health Risk Assessment

This subsection provides a brief summary of the four primary components of the human health risk assessment: identification of chemicals of potential concern (COPCs), the exposure assessment, the toxicity assessment, and the risk characterization. Details regarding each of these components can be found in Section 6 of the RIA report (BMcD, 2004a).

Buildings 180/181 and 182 and the surrounding parking lots and sidewalks were demolished in summer 2000. After demolition, the site was graded and is now an open grassed field. Building 183 continued to function as a dry cleaners and laundry until 2001. In October 2002, Buildings 183, 184, and associated structures were demolished and removed. After demolition, the site was graded and is now an open grassy field. The RPMP establishes the DCF Study Area as Open Areas not designated for future development of any kind (Parsons/Harland, Bartholomew, and Associates, 2000).

Identification of Chemicals of Potential Concern

COPCs include those site-related chemicals detected at the DCF Study Area which have the potential to impact human health. For this risk assessment, COPCs were generally identified as those constituents that were detected in one or more samples from a given data set. The following paragraphs identify the COPCs for each medium evaluated in this risk assessment.

The only COPC for surface soil was PCE as it was the only chemical detected. Similarly, PCE was the only chemical detected in subsurface soil samples from 0 – 13 ft bgs; therefore, PCE is the only COPC for subsurface soil. Both TCE and DCE were detected in one sample collected from 38 – 39 feet bgs. This depth interval is often below the water table; thus, it is likely that these two detections are associated with groundwater rather than soil. Therefore, TCE and cis-1,2-DCE were not identified as COPCs in subsurface soil. It is important to note that soil sources were removed during the pilot study conducted in the fall 2005 and spring 2006 and that soil is no longer a medium of concern.

The COPCs selected for the groundwater in the Buildings 180/181 Area (AOC 2) include cis-1,2-DCE, isopropylbenzene, tert-butylbenzene, PCE, trans-1,2-DCE, TCE, trichloromethane, and VC. Diesel and kerosene were both detected in groundwater samples collected from DCF03-19. The chemical characteristics of both petroleum groups indicate that they are nonvolatile, and groundwater is approximately 38 - 40 feet bgs, a depth at which direct contact is unlikely to occur. As described earlier, groundwater is not considered a potential source of potable water. Given the lack of completed exposure pathways, neither diesel nor kerosene was identified as COPCs in groundwater. It is important to note that since groundwater in AOC 2 is degrading to concentrations below the MCL on the Island, groundwater in AOC 2 is no longer a medium of concern.

The COPCs in groundwater in the Transition Zone/Island Area (AOC 3) include cis-1,2-DCE, PCE, toluene, trans-1,2-DCE, TCE, and VC. For the purpose of this risk assessment, groundwater near the Kansas River was used as a surrogate medium for sediment pore water in the river. The COPCs selected for groundwater within the Kansas River Area are cis-1,2-DCE, PCE, and TCE. Groundwater in AOC 3 is a medium of concern.

Exposure Assessment

Health risks may occur when there is contact with a chemical by a receptor population. Exposed populations must then either ingest, inhale, or dermally absorb COPCs to complete an exposure pathway and possibly experience a health risk, as shown in the human health CSM, presented in Figure 2-2. The risk assessment evaluated potential exposures to current groundskeeper workers, future utility workers, and current youth trespassers. It is important to note that soil sources were removed during the pilot study conducted in the fall 2005 through fall 2007 and that soil is no longer a medium of concern. Based on the human health CSM, the potentially completed exposure pathways evaluated for each population as presented in the RIA are as follows:

- Current Groundskeeper - Since groundskeeping activities typically involve mowing, direct contact with surface soil is likely to occur. Direct contact with surface soil could lead to incidental ingestion of and chemical absorption through dermal contact with surface soil.

- Future Utility Workers - Since utility activities typically involve excavation of soil, utility workers could directly contact contaminated surface and shallow subsurface soils. Direct contact with surface and subsurface soil could lead to incidental ingestion of soil and chemical absorption

through dermal contact with soil. Chemical vapors from VOCs detected in surface and subsurface soil are likely to be present in the breathing zone of a utility worker. Since VOCs were detected in the groundwater, inhalation of vapor phase chemicals is considered a potentially completed pathway.

- Current Youth trespassers - Could directly contact contaminated surface soils. Direct contact with surface soil could lead to incidental ingestion and chemical absorption through dermal contact. Chemical vapors from VOCs present in surface and subsurface soil could migrate through soils and be present in the breathing zone of a youth trespasser. Chemical vapors from VOCs detected in surface and subsurface soil are likely to be present in the breathing zone of a utility worker. Since VOCs were detected in the groundwater, inhalation of vapor phase chemicals is considered a potentially completed pathway. Exposure to sediment was evaluated and the calculated risk levels were below the USEPA acceptable levels.

The potential for human health risk due to exposure to chemicals at the DCF Study Area was considered for soil, groundwater, and air media.

USEPA's *Supplemental Guidance to RAGS, Calculating the Concentration Term* (USEPA, 1992) specifies that the reasonable maximum exposure (RME) concentration for a receptor population be calculated using the 95 percent upper confidence limit (UCL) of the arithmetic mean of chemical concentrations. These values were calculated assuming a log-normal distribution of the data. However, there are instances where the 95 percent UCL can be greater that the maximum detected value, such as when there are elevated detection limits or small sample sizes with great variability. In these situations, USEPA recommends that the maximum detected concentration be used.

The maximum detected concentrations and the 95 percent UCLs are shown in Tables 2-2 through 2-6, with the values used in calculations specified. Exposure concentrations were based on actual data from the DCF Study Area. Intake assumptions were based on USEPA guidance and are described in detail in the RIA report (BMcD, 2004a). Major assumptions used to calculate intake are presented below:

- *Current Groundskeeper* – Ingestion of chemicals in soil, dermal contact with chemicals in soil, inhalation of chemicals in dust, inhalation of vapor phase chemicals from soil; and inhalation of vapor phase chemicals from groundwater.

- Weight – 70 kilograms (kg)
- Exposed Skin Area – 3,600 square centimeters (cm^2)
- Soil to Skin Adherence Factor – 0.20 milligram (mg)/cm^2
- Inhalation Intake – 1.5 cubic meters of air per hour ($m^3$of air/hr)
- Soil Ingestion Intake – 100 milligrams per day (mg/day)
- Variable Fraction of Soil Ingested from Contaminated Source – 1
- Exposure Time, Frequency, and Duration – Groundskeeper mows a given area for 0.5 hours a day, 31 days per year, for 25 years

- *Future Utility Excavation Workers* – Ingestion of chemicals in soil, dermal contact with chemicals in soil, inhalation of chemicals in dust, inhalation of vapor phase chemicals from soil; and inhalation of vapor phase chemicals from groundwater.
  - Weight – 70 kg
  - Exposed Skin Area – 3,600 cm^2
  - Soil to Skin Adherence Factor – 0.20 mg/cm^2
  - Inhalation Intake – 2.5 m^3 of air/hr
  - Soil Ingestion Intake – 330 mg/day
  - Variable Fraction of Soil Ingested from Contaminated Source - 1
  - Exposure Time, Frequency, and Duration – Workers conduct excavation work in the Fort Riley area for 8 hours a day, 6 days per year, for 25 years

- *Current Youth Trespasser* – Ingestion of chemicals in soil, dermal contact with chemicals in soil, inhalation of chemicals in dust, inhalation of vapor phase chemicals from soil gas; inhalation of vapor phase chemicals from groundwater.
  - Weight (0 – 6 years old) – 43.3 kg
  - Exposed Skin Area – 8,048 cm^2
  - Soil to Skin Adherence Factor – 0.20 mg/cm^2
  - Inhalation Intake – 1.2 m^3 of air/hr
  - Variable Fraction of Soil Ingested from Contaminated Source - 1
  - Soil Ingestion Intake – 100 mg/day
  - Exposure Time, Frequency, and Duration – Child spends 4 hours a day, 23 days per year, for 3 years

Toxicity Assessment

In a risk assessment, toxicity of COPCs is evaluated for both carcinogenic potential and noncarcinogenic adverse health effects. Data regarding health effects are then used to derive numerical toxicity values. Toxicity values used in the risk assessment were obtained from the following sources:

- Integrated Risk Information System (IRIS) (USEPA, 2003),
- Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997a), and
- The USEPA National Center for Environmental Assessment Superfund Technical Support Center (USEPA, 1999c).

Risk Characterization

The non-carcinogenic risk value, the hazard quotient (HQ), represents the ratio of the chemical-specific intake rate to the toxicity value for that chemical. HQs are summed within each pathway and then for all pathways for a total hazard index. If the total hazard index is one or less, it is unlikely for even sensitive populations to experience adverse health effects within the described scenario. Tables 2-7 through 2-9 show the intakes, reference values, and HQs for the current groundskeeper, future utility excavation worker, and current youth trespasser. The values presented in these tables are in scientific notation (i.e., 2E-03 instead of 0.002). Please note that the tables show that the non-carcinogenic hazard indices did not exceed the USEPA acceptable level for the exposure scenarios evaluated even before the engineered portions of the remedial alternatives presented in the FSA were conducted during the pilot study.

Carcinogenic risk represents the probability of developing cancer as a result of exposure to a given chemical. The chemical-specific risks are summed within each pathway and then for all pathways to yield total excess cancer risk posed by a site. This represents the probability of developing cancer that is solely attributable to exposure from the site and is in excess of the general background risk. USEPA has established the risk range of one in 10,000 to one in a million (1E-04 to 1E-06 in scientific notation) as a commonly-accepted, remediation goal. An excess, lifetime, cancer risk greater than one in 10,000 would generally be considered unacceptably high, while risks within the range would be acceptable depending upon site use. Risks of one in a million or less are generally considered insignificant. Tables 2-10 through 2-12 show the intakes, slope factors, and the excess, lifetime, cancer risk associated with chemical exposure for the current groundskeeper, future utility excavation worker, and current youth trespasser. The values presented in these tables are in scientific notation (i.e., 2E-03 instead of 0.002). Please note that the tables show that the carcinogenic risk values did not exceed the USEPA acceptable range for the scenarios

evaluated even before the engineered portions of the remedial alternatives presented in the FSA were conducted during the pilot study.

Uncertainties

Conducting a risk assessment requires making a number of assumptions that serve to introduce degrees of uncertainty in the final result. Uncertainties are inherent in the chemical identification, toxicity assessment, and exposure assessment processes. However, the cumulative effect is generally that risk has been overestimated, not underestimated. Section 6.7 of the RIA report (BMcD, 2004a) provides a detailed discussion of the uncertainties and their potential effect on the risk assessment.

2.7.2 Summary of Ecological Risk Assessment

The purpose of the ecological evaluation was to assess possible adverse effects to ecological receptors that may come in contact with contaminated media. Qualitative observations, calculated exposure estimates, and best professional judgement were used to determine whether further evaluation of ecological risk is necessary (BMcD, 2004a).

Chemicals that may elicit adverse effects to ecological receptors are considered chemicals of potential ecological concern (COPECs).

The following chemicals were detected in soil samples and selected as preliminary COPECs for soils (soil sources were removed during the pilot study conducted in the fall 2005 through fall 2007):

- PCE

The following chemicals were detected in groundwater samples and selected as preliminary COPECs for groundwater:

- PCE
- TCE
- DCE
- VC

Preliminary COPECs were further evaluated and compared to toxicological benchmarks in the preliminary semi-quantitative screening.

The DCF Study Area was evaluated for the presence of completed ecological exposure pathways. The areas determined to have completed exposure pathways were the original DCFA (see Figure 1-2) and the

benthic habitats of the Kansas River. Based upon observed conditions at the DCFA, it was concluded that flora and fauna could be exposed to site-related chemicals through direct contact and/or ingestion of soil. Similarly, conditions along the northern bank of the Kansas River indicated that benthic organisms could be exposed to site-related chemicals through direct contact and/or ingestion of groundwater as sediment pore water. These areas were evaluated both qualitatively and quantitatively to assess risk to ecological receptors. All other areas were determined to have incomplete exposure pathways.

Based on the available habitat at the DCF Study Area, wildlife receptors potentially present were identified and compared to a list of species for which benchmarks have been established (see Table 2-13 and 2-14). Terrestrial receptors selected as representative species included the little brown bat, short-tailed shrew, white-footed mouse, meadow vole (close relative and surrogate for the prairie vole), mink, eastern cottontail rabbit, red fox, and white-tailed deer. The source of the benchmarks was the Oak Ridge National Laboratories' (ORNL) *Toxicological Benchmarks for Wildlife: 1996 Revision* (ORNL, 1996). Natural history characteristics used to calculate exposure were obtained from the *Wildlife Exposure Factors Handbook Vol. I & II* (USEPA, 1993b), *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson et. al., 1997), *Toxicological Benchmarks for Wildlife: 1996 Revision* (ORNL, 1996), and *The Wild Mammals of Missouri* (Schwartz and Schwartz, 1981).

The potential for ecological risk from exposure to chemicals at the DCF Study Area was considered for soils at the DCFA and for groundwater along the Kansas River. Preliminary COPECs identified included PCE in soils and groundwater and TCE and cis-1,2-DCE in groundwater. For the areas of the DCF Study Area that were assessed in the Ecological Evaluation, ecological receptors (occurring or potentially occurring) were identified and the exposure pathways were described. As part of the semi-quantitative evaluation, analytical data were compared to chemical- and receptor-specific benchmarks obtained from literature. The results of the semi-quantitative evaluation were combined with a qualitative (observable) assessment to determine if the potential for significant risk to ecological receptors existed due to site-related chemicals.

The impacts of the preliminary COPECs upon potential receptors were assessed qualitatively and by a quantitative screening. The preliminary screening did not provide any indications of adverse ecological effect to plants (see Table 2-15) and animals from exposure to soil contamination. All other terrestrial receptors, including soil organisms, were qualitatively assessed and determined to exhibit no adverse effects. The qualitative risk characterization was based on the lack of any visible adverse effects within the plant and animal communities at the DCF Study Area. Ecological clues such as areas devoid of

vegetation, notable overpopulation of a particular species, and/or accumulation of detritus were not observed at the DCFA and Island areas of the DCF Study Area. Based on the results of the semi-quantitative and qualitative evaluations of soil contaminants, ecological risk to terrestrial flora and fauna inhabiting the DCF Study Area is expected to be insignificant. Additionally, protected species (See Table 2-16) are unlikely to experience adverse effects due to incidental contact with contaminated soil or consumption of prey inhabiting the site of the former DCFA buildings. The presence of any protected species in the contaminated areas in the vicinity of the former DCFA buildings is likely to be transitory. Potential for risk to benthic organisms (See Table 2-17) inhabiting the Kansas River was assessed semi-quantitatively. Existing chemical concentrations in groundwater near the Kansas River (as measured in samples collected from Island monitoring wells along the Kansas River) were compared to benchmark values for benthic organisms. The maximum detected concentrations of PCE, TCE, and DCE in groundwater near the Kansas River were below the benchmarks used for this evaluation. Therefore, current concentrations in groundwater assumed to be representative of concentrations in sediment pore water are unlikely to pose appreciable risk to benthic organisms in the Kansas River.

As stated in Section 7.2.1 of the RIA, critical habitat for the bald eagle, piping plover, and interior least tern occurs along the Kansas River at the southern edge of the DCF Study Area. Bald eagles are migratory and known to winter on the Island. Both the piping plover and the interior least tern are seasonal inhabitants along the Kansas River. Although the food gathered along the Kansas River may make up a significant dietary component of wintering bald eagles, nesting piping plovers, and interior least terns, the approximate one-mile stretch of the Kansas River within the DCF Study Area would only account for approximately one-quarter to one-half of each species' foraging range. Only minimal exposure to PCE, TCE, and cis-1,2-DCE would be expected due to the short amount of time these species spend along the Kansas River at the DCF Study Area and the insignificant concentrations to which they would potentially be exposed.

Secondary exposures may result from the bioaccumulation and bioconcentration of chemicals through the food chain. Predators (e.g., bald eagles) and other species near the top of the food chain are potentially the most vulnerable to effects of bioaccumulation. PCE, TCE, and cis-1,2-DCE all have low to negligible potential for bioaccumulations. Considering also the exceedingly low concentrations in soils and groundwater along the Kansas River and the propensity of PCE, TCE, and cis-1,2-DCE to volatilize, it is unlikely that contaminants at the DCF Study Area present a significant exposure potential to bald eagles or other higher species in the food chain. Therefore, the risk to bald eagles, piping plovers, and interior least

terns in the vicinity of the DCF Study Area is most likely insignificant. Risks to other state and federally listed species known to occur in Riley County are also likely to be insignificant.

2.7.3 Basis for Action

The baseline risk assessment (human health and ecological) that was completed for DCF Study Area found that the estimated risks to human health and the environment were within or below the USEPA acceptable levels. Soil sources in AOC 1 that were identified in the RIA (BMcD, 2004a) were removed during the pilot study conducted in the fall 2005 through fall 2007 (ECC/BMcD, 2007b) and are no longer a medium of concern. Groundwater in AOC 2 is degrading to concentrations below the MCL based on natural attenuation and EAB remedial treatment and is no longer considered a medium of concern. The presence of site-related contaminants in the Kansas River alluvial aquifer at levels exceeding drinking water standards (MCLs, identified as an ARAR) in AOC 3 provides the basis for remedial action.

2.8 REMEDIAL ACTION OBJECTIVES

As identified in the USEPA guidance *Rules of Thumb for Superfund Remedy Selection* (USEPA, 1997b), a remedial action is generally warranted if one or more of the following conditions apply:

- Cumulative excess carcinogenic risk to an individual exceeds 10^{-4}.
- Non-carcinogenic hazard index is greater than one.
- Site contaminants cause adverse environmental impacts.
- Chemical-specific standards (i.e., ARARs) or other measures that define acceptable levels are exceeded and exposure to contaminants above these levels is predicted for the RME identified in the risk assessment.

For the DCF Study Area, only the last listed item above applies, in that chemical-specific ARARs are being exceeded. The drinking water standard (i.e., MCL) is exceeded in the groundwater, which is impacting the Kansas River alluvial aquifer at multiple monitoring wells installed on the Island in AOC 3.

RAOs provide a general description of what the remedial action is anticipated to accomplish. RAOs are developed based on protection of human health and the environment including consideration of the goals of the CERCLA program. The current goal for long-term groundwater cleanup is summarized in the NCP:

> "USEPA expects to return usable groundwaters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site. When restoration of groundwater to beneficial uses is not technically practicable, USEPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction."

RAOs are developed in this section considering the 1) current and future use at the DCF Study Area; 2) beneficial use of groundwater at the DCF Study Area; 3) results of the risk assessment; and 4) anticipated fate and transport of contaminants beneath the DCF Study Area. Current land use, risk assessment (including media of interest, COPCs, and exposure pathways), and anticipated fate and transport are summarized in previous sections of this report with details provided in the RIA Report (BMcD, 2004a). RAOs and clean-up levels should reflect current and potential, future, groundwater uses and exposure scenarios that are consistent with those uses. As identified in the risk assessment, groundwater at the DCF Study Area is not currently used as a drinking water source, nor is such use anticipated in the foreseeable future. Fort Riley possesses sufficient excess capacity from the existing supply well field to provide potable water for any foreseeable expansion on the post. Additionally, the evaluation of environmental risk concluded that there is no detrimental exposure to environmental receptors at the DCF Study Area.

The Kansas River reach flowing through Fort Riley is a major classified river under the Kansas State Water Plan. This reach of the river has multiple designated uses, one of which is domestic supply (KDHE, 2002). Because of this designated use, the Kansas River and its associated alluvial aquifer fall under the Kansas Antidegradation Policy. This policy applies in those situations where either an intentional or unintentional release of pollutants from a point source results in contamination or potential contamination of an alluvial aquifer that threatens to preclude attainment of the designated use of the alluvial aquifer or its associated surface water.

Although there is virtually no prospect for additional water supply wells to be installed within the terrace and Kansas River alluvial aquifers on the Island, groundwater does discharge from the alluvial aquifer on the Island to the Kansas River. Additionally, although water samples collected from the Kansas River were non-detect for the COPCs (RIA, 2004a), the beneficial use of the groundwater from the alluvial aquifer would be a potential source of domestic supply once it discharges to and enters the surface-water system of the Kansas River. Therefore, RAO and clean-up level development should reflect this.

Based on the human health and ecological risk assessments, the preliminary ARARs, the media of interest, the COPCs in groundwater at the DCF Study Area, and the anticipated land and beneficial groundwater use, the RAOs for the DCF Study Area is to:

- Prevent further degradation in groundwater in the Kansas River alluvium and off-site migration in groundwater of COPCs that exceed cleanup goals.
- Achieve cleanup goals of MCLs for COPCs in groundwater in the Kansas River alluvium through the use of natural and/or active remedial processes.

The RAOs are listed in the general sequence in which they should be addressed (USEPA, 1997b). These RAOs were used in the development and evaluation of remedial alternatives.

Generally, drinking water standards are relevant and appropriate as clean-up levels for groundwater that is determined to be a current or potential future source of drinking water. As indicated previously, groundwater at the DCF Study Area is considered to have a potential beneficial use as a drinking water source due to its hydraulic connection to the Kansas River; therefore, the clean-up levels are defined as the MCLs. This site specific definition for the clean-up levels for the DCF Study Area is adopted even though samples collected from the Kansas River Reach were non-detect for the COPCs. The clean-up levels for the DCF Study Area are as follows:

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

The current site conditions at the DCF Study Area are discussed in Section 2.5.5 of this document.

2.9 DESCRIPTION OF REMEDIATION ALTERNATIVES

The following remedial alternatives were considered in the FSA for each of the following AOCs:

AOC 1 (Shallow subsurface soil at former Building 180/181)

- No Action
- Excavation and landfarming at a pre-existing treatment cell and ICs

- Excavation and landfarming at new treatment cell and IC
- Excavation and off-site incineration and IC

AOC 2 (East Plume - Groundwater in subsurface bedrock erosional channel near Monitoring Wells DCF93-13 and DCF06-40)

- No Action
- EAB, MNA, and ICs
- In-Situ Chemical Oxidation (ISCO), MNA, and ICs

AOC 3 (West Plume - Groundwater near Monitoring Wells DCF02-42 and DCF06-25)

- No Action
- EAB, MNA, and ICs
- ISCO, MNA, and ICs

The DA, in consultation with the KDHE and the USEPA, selected a remedy for each AOC. The remedies selected for each AOC are as follows:

- AOC 1 - Excavation and landfarming at a pre-existing treatment cell and ICs
- AOC 2 – EAB with MNA, and ICs
- AOC 3 – ISCO with MNA, and ICs. Fort Riley added EAB to three additional areas as shown in Figure 2-1.

As part of Fort Riley's continuing effort to protect the human health and the environment by proactively addressing identified environmental problems at the post, the DA, in consultation with the KDHE and the USEPA, conducted a pilot study in the 2005 through 2007 to address soil and groundwater contamination identified at the three AOCs. The removal action was based on a Pilot Study Work Plan (BMcD, 2005d) that was reviewed and approved by the DA, the KDHE, and the USEPA. The pilot study addressed the engineered portion of the selected remedy for each AOC.

For AOC 1, the removal action selected by the DA with concurrence from the KDHE and the USEPA was the excavation and removal of shallow subsurface soil to a depth of 12 feet bgs (see PSR, ECC/BMcD, 2007b). All soil above the KDHE RSK value of 180 µg/kg for the soil to groundwater protection pathway was excavated and transported to a treatment cell located at Camp Funston for treatment and disposal.

Additionally at AOC 1, selected sanitary sewer lines, the soil and bedding material adjacent to selected sanitary sewer lines, the HPGL, the soil and bedding material adjacent to the HPGL, the sanitary sewer MHs 363, 365, and 367 [MH 363 was identified in the RI as the source of the drycleaning process wastewater leak (LBA-1995)] were treated in-situ with 3,692 gallons of a 10 percent (%) sodium permanganate solution. All excavations were backfilled with clean borrow soil.

At AOC 2, the removal action selected by the DA with concurrence from the KDHE and the USEPA was the injection of an EAB substrate (CAP 18™, a neat vegetable oil) into the saturated zone located within the buried bedrock erosional channel. EAB was selected over chemical oxidation because biodegradation was already occurring in this area and CAP 18™ would enhance the ongoing natural attenuation; CAP 18™ has a longer residence time than ISCO, and CAP 18™ would reduce the monitoring time for this AOC. Approximately 8,200 pounds of CAP 18™ vegetable oil was injected into the bedrock erosional channel at 72 locations.

At AOC 3, the removal action selected by the DA with concurrence from the KDHE and the USEPA was injection of a sodium permanganate solution into the vadose zone soil around Monitoring Well DCF02-42 and the injection of a potassium permanganate solution into the saturated zone in the area between Monitoring Well DCF02-42 and Monitoring Well DCF06-25 to oxidize and reduce the contaminant mass in this area. EAB was not selected for this area for groundwater treatment because of the amount and areal extent of groundwater contamination and the aggressiveness of contaminant reduction of chemical oxidation over EAB. In the vadose zone around Monitoring Well DCF02-42, approximately 7,400 gallons of a 10 % sodium permanganate solution was injected at 23 locations. In the saturated zone, 21,755 pounds of potassium permanganate was injected at 44 locations.

Additional areas were also targeted during the pilot study that included three separate areas; one on the Island (Monitoring Well DCF02-49c) and two at the Horse Corral (DCF99-37c and B354-99-11c). Monitoring Well DCF02-49c was targeted since this monitoring well was located at the toe of the plume as it approached the Kansas River. Monitoring Wells DCF99-37c and B354-99-11c were targeted because these wells have minor amounts of PCE in the groundwater. These areas were injected with approximately 5,530 pounds of CAP 18™ at 37 injection points to enhance the natural biodegradation in these areas.

Following completion of the removal actions and post treatment monitoring, the results of the pilot study were presented and discussed in the Proposed Plan (BMcD, 2007). The pilot study undertaken by Fort Riley is presented in detail in the PSR (ECC/BMcD, 2007b).

A site-wide remedial alternative approach will replace the three AOC alternative approaches previously defined based on the completion of the engineered components of each alternative for each AOC during the pilot study as shown below:

- AOC 1 - Excavation and landfarming
- AOC 2 – EAB
- AOC 3 – ISCO and EAB

The new site wide approach will replace the original approach because the engineered portion of the selected remedy for each AOC has been successfully completed. Therefore, the site-wide approach will contain only the remaining portions of the previously defined and accepted remediation alternatives and will include MNA and ICs as a single combined alternative. This single combined alternative will be evaluated in this section against the No Action Alternative as presented below to determine the proper remedy for the DCF Study Area:

- Alternative 1 – No Action
- Alternative 2 – MNA with IC

2.9.1 Description of Remedy Components

Following the remedy selection by the DA, the KDHE, and the USEPA and the successful completion of the engineered portions of those remedies in the pilot study, the DA (Fort Riley) evaluated the remaining portions of the previously defined alternatives for consideration at the DCF Study Area. The alternatives are discussed in the following paragraphs.

2.9.1.1 Alternative 1 – No Action

This alternative is the "no action" alternative, a requirement of the NCP, which provides a baseline for comparison of other remedial alternatives developed for the DCF Study Area. Under the no action alternative, ICs are not implemented and monitoring of the groundwater contamination is not conducted.

By definition, this alternative requires that the current monitoring program be discontinued. At a minimum, CERCLA requires administrative re-assessments every five years, if the site is not open for unrestricted use, whenever contaminants are left in place. Therefore, with no ICs in place with this alternative, the possibility for the public's use of the affected aquifer for a drinking water source remains.

Groundwater sampling results, up to and including the spring 2007 sampling round, indicate that although groundwater concentrations for one of the COPCs (PCE) decreased, the preliminary chemical-specific ARARs (i.e., MCLs) were exceeded for the western plume of the alluvial aquifer as the plume approaches the Kansas River.

Under the "no action" alternative there is no groundwater monitoring to determine concentration trends for the western plume. Therefore, under the "no action" alternative the evaluation assumes that contaminant concentrations remain essentially unchanged. However, natural attenuation processes active within the aquifer are reducing contaminant concentrations. Without monitoring, the evolution of concentrations remains an unknown and, for the purposes of this evaluation, the assumption will be made that under the "no action" alternative that MCLs will continue to be slightly exceeded. No credit is given for the in-situ groundwater treatments using EAB (CAP 18™) and chemical oxidation (potassium permanganate); excavation and removal of the shallow soil source zones; treatment of the vadose zone near Monitoring Well DCF02-42 with sodium permanganate; treatment of the sanitary sewer lines and the HPGL with sodium permanganate; and the current indications of stable to declining trends. Even under these very conservative constraints, the MCL exceedances are localized, are not exceeded at the Kansas River, and do not impact a drinking water supply.

2.9.1.2 Alternative 2 – MNA with ICs

This alternative includes MNA and ICs. The term MNA refers to the reliance on natural attenuation processes (within the context of a controlled and monitored, site-cleanup approach) to achieve site-specific, remediation objectives within a time frame that is reasonable compared to those time frames offered by other more active methods (KDHE, 2001). MNA relies on natural subsurface processes to reduce contaminant concentrations. Some of these natural processes that appear to be occurring at the DCF Study Area are dilution, dispersion, volatilization, biodegradation, and sorption (BMcD, 2004a).

Natural attenuation is sometimes perceived as equivalent to "no action." However, MNA differs from the "no action" alternative in that the site is actively monitored and evaluated to reduce the risk of exposure and to evaluate potential further degradation of the aquifer. Typical performance parameters monitored for natural attenuation can include: temperature, pH, methane, ethane, ethene, alkalinity, nitrate, sulfate, sulfide, chloride, total organic carbon (TOC), DO, ORP, ferrous iron, and contaminant concentrations. However, these parameters can be significantly reduced at those sites where the efficacy of reductive dechlorination has been demonstrated by an extended record of sampling results. System components of

MNA are usually composed of groundwater wells. Contaminant concentrations will be monitored periodically to evaluate if the natural attenuation processes are reducing contaminant concentrations to chemical-specific ARARs (MCLs). Although the monitoring network for the DCF Study Area is in place, details regarding the system components of MNA at the DCFA Site will be included in the RD/RA.

Selection of this option as a sole remedy required the collection of groundwater quality information and evaluation of contaminant degradation rates and pathways. Evidence of natural degradation processes at the DCF Study Area, as per the USEPA MNA guidance document (USEPA, 1999a), included: 1) decreasing contaminant concentration trends over time, and 2) supporting geochemical data measurements as previously outline in the preceding paragraph. A risk assessment was used to evaluate whether MNA was likely to be protective of human health and the environment (BMcD, 2004a). It is important to note here that the HHBRA for the DCF Study Area (RIA, 2004a) concluded that there was no human or ecological risk at the site even before the engineered portions of the remedial alternatives selected in the FSA for each AOC was conducted.

For MNA to be considered a stand-alone, remedial alternative for the DCF Study Area, the criteria outlined in the following guidance documents must be met: *Monitored Natural Attenuation, Bureau of Environmental Remediation/Remedial Section Policy*, BER Policy # BER RS 042 (KDHE, 2001); and *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (USEPA, 1999a).

Site geochemical and contaminant concentrations and results from USEPA reductive dechlorination screening protocol (USEPA, 1998) indicated that there is strong evidence for reductive dechlorination (and thus natural attenuation) of chlorinated solvents at the DCF Study Area (BMcD, 2004a). Groundwater at the DCF Study Area will be sampled annually for three years in 2008, 2009, and 2010, followed by 5-Year Review sampling as necessary. The 2008, 2009, and 2010 sampling will monitor contaminant concentrations. Once the alluvial wells are below MCLs, the DCF Study Area will be recommended for site closeout. Five-Year Review sampling may still be required for Terrace, Transition Zone, and Horse Corral wells. At a minimum, CERCLA requires administrative re-assessments every five years, if the DCF Study Area is not open for unrestricted use, whenever contaminants are left in place.

The pilot study substantially eliminated the shallow soil and groundwater contamination located in the following areas:

- Beneath the former Building 180/181 by excavation and removal down to a depth of 12 feet bgs,

- In the vadose zone around Monitoring Well DCF02-42 by injecting sodium permanganate,
- In the soil and bedding material in and adjacent to the sanitary sewer lines, MHs, and the HPGL by injecting sodium permanganate,
- Into the sanitary sewer lines and MHs by injection of sodium permanganate,
- Into the saturated zone of the eastern plume in the buried bedrock erosional channel by injection of EAB,
- Into the saturated zone in the Kansas River alluvium near the leading edge of the western plume by injection of EAB, and
- Into the saturated zone in the Kansas River alluvium near the source area of the western plume by injection of potassium permanganate.

These treatments ensure that there is no re-mobilization of chlorinated solvent contamination from the shallow soils and groundwater in these areas. The results show decreasing concentrations of contaminants in groundwater both within the terrace aquifer and the Kansas River alluvial aquifer; therefore, credit was given for the pilot study when evaluating Alternative 2.

Institutional Controls

The primary control for the Main Post portion of the DCF Study Area will be to restrict use through the environmental overlay of the RPMP. Master planning for Army installations is required by Army Regulation 210-20 which establishes a relationship between environmental planning and real property master planning to ensure that environmental factors are included in planning decisions and land use. The long-range component of the RPMP consists of narratives and supporting graphics that include a Master Plan Environmental Overlay (MPEO) to reflect operational and environmental constraints. The DCF Study Area will be designated as restricted land use in the RPMP.

The category directs the RPMP user to the MPEO that subsequently identifies the restrictions. Restrictions will limit exposure at the DCF Study Area by:

- Restricting use to non-residential,
- Limiting public access,
- Prohibiting installation of drinking water wells and groundwater use in the area, and
- Involving PWE personnel in proposed future plans for the DCF Study Area.

The federal ownership of an active military base limits the layering of other proprietary or government controls. The only additional controls that will be implemented at the DCF Study Area are informational controls (KDHE Identified Site List and community awareness through the RAB).

As with Alternative 2, a review will be conducted no less often than every five years after initiation. This alternative is anticipated to meet preliminary chemical-specific ARARs (i.e., MCLs). Groundwater monitoring will provide data for the continuing evaluation of progress. It is anticipated that ICs could also be relaxed at the time RAOs are achieved across the DCF Study Area. The elimination of the soil source areas and groundwater treatment under the pilot test program should also assist in meeting chemical-specific ARARs.

Preliminary location-specific ARARs for Alternative 2 mainly concern protected species. Location-specific ARARs will be met by coordinating remedial activities with the Fort Riley Conservation & Restoration Branch personnel to minimize or eliminate adverse impact to wildlife. Preliminary action-specific ARARs include CERCLA, Occupational Safety and Health Administration (OSHA) regulations, and water-well construction and abandonment regulations. It is anticipated that there would be no difficulties complying with all of these.

In addition to ARARs, Alternative 2 is anticipated to comply with the to-be-considered (TBCs) discussed in *Monitored Natural Attenuation, Bureau of Environmental Remediation/Remedial Section Policy* (KDHE, 2001), and *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (USEPA, 1999a). MNA is not anticipated to pose an unacceptable risk to human health because the risk estimates for current and future RME scenarios do not currently exceed the USEPA accepted risk levels (BMcD, 2004a). The RME scenarios are considered conservative because they do not include the engineered portions of the remedial alternatives that were conducted during the pilot study. MNA is not anticipated to allow continued degradation of groundwater quality, because the contaminant levels at the DCF Study Area are continuing to decrease. Samples collected from the Kansas River indicate that the western plume is not impacting the river.

2.9.2 Common Elements and Distinguishing Features of Each Alternative

All of the engineered portions of the remedial alternative selected in the FSA for each AOC to address soil and groundwater contamination for the DCF Study Area were performed during the pilot study conducted by Fort Riley in 2005 through 2007. The remaining portion for each alternative for each AOC that was not

addressed in the pilot study was the No Action Alternative and MNA with ICs. By definition, under the no action alternative, ICs are not implemented and monitoring of the groundwater contamination is not conducted. Therefore, there are relatively few common elements between the two remaining alternatives. The following describes the distinguishing features and common elements that do exist among the two alternatives.

ARARs

Applicable ARARS for both alternatives include chemical-specific ARARs (i.e., MCLs).

The chemical-specific ARARs for the DCF Study Area are:

- Kansas Surface Water Quality Standards (Kansas Administrative Record [KAR] § 28.16.28b)
- Kansas Water Pollution Control, Antidegradation Policy (KAR § 28.16.28c(a))
- Safe Drinking Water Act (SDWA), National Primary Drinking Water Regulations (40 CFR § 141, Subpart A,C,D,F, and G; and 142 Subparts A-G)
- Kansas Drinking Water Standards (KAR § 28.15)

The location-specific ARARs for the DCF Study Area are:

- Endangered Species Act of 1973 (7 USC § 136 and 16 USC § 460 et seq.)
- Fish and Wildlife Conservation Act (16 USC § 2901 and 2911)
- Flood Control Act of 1944 (16 USC § 460)
- Non-Game, Threatened or Endangered Species (KAR § 115-15)
- Bald and Golden Eagle Protection Act (16 USC 668-668d)

The action-specific ARARs for the DCF Study Area are:

- Clean Water Act (33 USC, Chapter 26, Subchapter 1, § 1251 et seq.)
- CERCLA of 1980 (42 USC § 9601-9675, et seq. as amended by the SARA of 1986)
- OSHA of 1970 (29 USC § 651 et seq.). Includes both workplace standards (29 CFR 1910) and construction standards (29 CFR 1926)
- Ambient Air Quality Standards and Air Pollution Control (KAR § 28-19)
- Water Well Contractor's License; Water Well Construction and Abandonment (KAR § 28-30)
- Kansas Board of Technical Professions (KAR § 66-6 through 66-14)

Long-Term Reliability of the Remedy

Under the No Action alternative, ICs are not implemented and monitoring of the groundwater contamination is not conducted. Therefore, with no ICs in place for Alternative 1, the possibility remains, however remote, for the public's use of the affected aquifer for a drinking water source, which provides an indication of the unreliability of the No Action alternative. Under the MNA with ICs alternative, the site is actively monitored and evaluated to reduce the risk of exposure and to evaluate potential further degradation of the aquifer.

Waste Management

Under the no action alternative, ICs are not implemented and monitoring of the groundwater contamination is not conducted. Therefore, there is no waste generated with this alternative. Waste generated with the MNA with ICs alternative involves purge water removed from the aquifer during periodic groundwater sampling events. Purge water generated during these events are disposed of according to the guidelines set forth in the *Installation-Wide Investigative Derived Waste Management Plan for Environmental Investigations at Fort Riley, Kansas* (BMcD, 2003c). These guidelines stipulate that IDW generated from the purging of monitoring wells be disposed of in the wastewater treatment system under Fort Riley's National Pollutant Discharge Elimination System (NPDES) Permit (permit # F-KS97-P001). Based on the current groundwater concentration trends for PCE, TCE, DCE, and VC, the degree of hazard is minimal.

Temporal Estimation for Design, Construction, and Achievement of Remediation Goals

Under the no action alternative, there is no design, construction, or achievement of remediation goals. The site will remain "as is." For MNA with ICs, the monitoring well network as well as the ICs using the RPMP is already in place at the DCF Study Area. The temporal estimation for achieving the remediation goals for the DCF Study Area, which include the chemical-specific ARARs (i.e., MCLs) for groundwater, are characterized as an intermediate to long-term alternative not to exceed 20 years of annual operation and monitoring.

Alternative Cost

The total project cost for the No Action Alternative (see Tables 2-18 and 2-19) based on 5-year reviews until site closure, estimated at 20 years, is approximately $500,000.00 with a Total Present Value Project Cost at 3.2% of approximately $330,000.00. It is assumed that each 5-year review will require groundwater sampling. The discount rate of 3.2% follows USEPA guidelines (USEPA, 1993a and 2000a) and is based on the difference between the return rate on an annuity investment minus the inflation rate. The rate of return was based on a 30-year treasury bill of 5.2% and an inflation rate of 2 %. This resulted

in a discount rate of 3.2%. The Total Project Cost for MNA with IC (see Tables 2-20 and 2-21) based on 20 years with 5-year reviews and monitoring until closure is approximately $1,500,000 with a Total Present Value Project Cost at 3.2% of approximately $1,200,000.00.

2.10 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Nine criteria are used to evaluate the remediation alternatives individually and against each other in order to select a remedy. This section of the ROD profiles the relative performance of each alternative against the nine criteria, noting how it compares to the other option under consideration. The nine evaluation criteria are defined below in Section 2.10.1. The evaluation methodology is described in Section 2.10.2, and a comparison of the alternatives to each criterion is provided in Section 2.10.3. Table 2-21 summarizes the comparative evaluation.

2.10.1 Evaluation Criteria for CERCLA Remedial Alternatives

The first two criteria are the "threshold" factors. Any alternative that does not satisfy both of the following criteria is dropped from further consideration in the remedy selection process:

- Overall Protectiveness of Human Health and the Environment
- Compliance with ARARs

Five "primary balancing" criteria are then used to make comparisons and to identify the major trade-offs between the remedial alternatives. Alternatives that satisfy the threshold criteria are therefore evaluated using the following balancing criteria:

- Long-term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment
- Short-term Effectiveness
- Implementability
- Cost

The remaining two criteria are "modifying" factors and are to be evaluated in the ROD. The evaluation of these two factors can only be complete after the Proposed Plan is published for comment and the public comment period is completed. These modifying factors are:

- State/Support Agency Acceptance
- Community Acceptance

2.10.2 Evaluation Method

Because the engineered portion of each of the selected remedial alternatives for each AOC were completed during the pilot study conducted in 2005 through 2007, and the only portion of each alternative that remains for a comparative analysis is Alternative 1 (No Action) and Alternative 2 (MNA with ICs), these two alternatives were combined to form the two remaining site-wide remedial alternatives left for consideration in the ROD. The two alternatives were scored on a pass/fail basis for the two threshold criteria (protection of human health and environment, and compliance with ARARs). The alternative passing the threshold criteria was then evaluated for the five balancing criteria on the basis of whether the selected alternative satisfies each of the five balancing criteria. The final two modifying criteria were then evaluated for the selected remedy.

2.10.3 Comparative Analysis

This section of the ROD compares the alternatives against the nine criteria. The nine criteria include the threshold criteria, balancing criteria, and modifying criteria.

2.10.3.1 Overall Protection of Human Health and the Environment

Overall protectiveness of human health and the environment determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through ICs, engineering controls, or treatment. This is a pass/fail criterion. Based on the risk assessments (human health and ecological) performed in the RIA Report (BMcD, 2004a), both of the alternatives are protective of human health and the environment because the risk estimates for current and future RME scenarios do not exceed the USEPA accepted risk levels.

2.10.3.2 Compliance with ARARs

Section 121(d) of CERCLA and NCP § 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental, or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental, or facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

Compliance with ARARs evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that pertain to a site, or whether a waiver is justified. This is a pass/fail criterion. Of the two remedial alternatives, Alternative 2 (MNA with ICs), is anticipated to comply with preliminary chemical-specific ARARs (KDHE Anti-Degradation Policy and Clean Water Act MCLs). Additionally, it appears that possible location- and action-specific ARARs will not be a factor. Alternative 1 (No Action) does not comply with chemical-specific ARARs (i.e., MCLs) because contaminant levels are currently above MCLs and this alternative takes no action to address the ARAR. It is probable that Alternative 1 would eventually meet preliminary chemical-specific ARARs as a result of natural attenuation processes active within the aquifers. However, Alternative 1 provides no mechanism to ensure that ARARs have been met. Therefore, Alternative 1 was dropped from further consideration because it does not meet one of the threshold criteria (i.e., compliance with ARARs).

2.10.3.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls. Because the baseline risk assessment (human health and ecological) that was completed for DCF Study Area found that the estimated risks to human health and the environment were within or below the USEPA acceptable levels, and that the presence of site-related contaminants in the terrace and Kansas River alluvial aquifers at levels exceeding drinking

water standards (MCLs, identified as an ARAR) provides the basis for remedial action, Alternative 2 (MNA with ICs) can be expected to maintain reliable protection of the human health and environment once the site remediation goals (MCLs) have been achieved. Since there is no remaining source at the DCF Study Area, Alternative 2 – (MNA with ICs) is anticipated to be able to provide long term effectiveness and permanence.

2.10.3.4 Reduction of Toxicity, Mobility, or Volume

Reduction of toxicity, mobility, or volume of contaminants through treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present. Current concentration trends for monitoring wells in the terrace and alluvial aquifers indicate that natural attenuation destructive and nondestructive mechanisms will reduce the principal contaminants to levels at or below their respective MCLs. Nondestructive mechanisms include dispersion, diffusion, dilution, volatilization, and sorption. Destructive mechanisms include abiotic and biotic degradation processes. Natural attenuation mechanisms at the site coupled with the soil source removal, vadose zone and utility corridor treatment with sodium permanganate, and groundwater treatment with potassium permanganate and EAB conducted during the pilot study is anticipated to provide reduction in toxicity, mobility, and volume of the principal contaminants at the DCF Study Area. ICs are anticipated to be in place to limit or prevent exposure to contaminated groundwater.

2.10.3.5 Short-Term Effectiveness

Short-term effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation until cleanup levels are achieved. For Alternative 2 (MNA with ICs), the monitoring well network as well as the ICs using the RPMP are already in place at the DCF Study Area. Because the baseline risk assessment (human health and ecological) that was completed for DCF Study Area found that the estimated risks to human health and the environment were within or below the USEPA acceptable levels, the risks Alternative 2 (MNA with ICs) poses to workers, residents, and the environment are minimal. ICs will also address potential receptors during MNA by limiting or preventing exposure to contaminated groundwater.

2.10.3.6 Implementability

Implementability addresses the technical and administrative feasibility of a design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and

coordination with other government entities are also considered. For Alternative 2 (MNA with ICs), the monitoring well network as well as the ICs using the RPMP has already been established at the DCF Study Area and an annual groundwater monitoring program is already in place. Fort Riley is currently presenting the groundwater concentration results for the DCF Study Area annually in a report format to the KDHE and the USEPA. Based on these factors, the technical and administrative implementation of Alternative 2 (MNA with ICs) is feasible.

2.10.3.7 Cost

Cost includes estimated capital, periodic, and annual O&M costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent. The total project cost for MNA with ICs based on 20 years with 5-year reviews and monitoring until closure is approximately $1,500,000.00 (rounded) with a total present value project cost of $1,200,000.00 with a 3.2% discount rate.

2.10.3.8 State/Support Agency Acceptance

State/support agency acceptance considers whether the State agrees with DA's analyses and recommendations, as described in the RIA and FSA reports (BMcD, 2004a and 2005b) and the Proposed Plan (BMcD, 2007). The KDHE supports the selected remedy presented in the Proposed Plan for the DCF Study Area.

2.10.3.9 Community Acceptance

Community acceptance considers whether the local community agrees with DA's analyses and preferred alternative. No comments were received on the Proposed Plan (BMcD, 2007b) which is an important indicator of community acceptance. Based on the lack of comments from the public on the Proposed Plan (BMcD, 2007), the selected remedy for the DCF Study Area is acceptable to the community.

2.10.4 Summary of Comparative Analysis

The alternatives were first evaluated as either compliant or non-compliant with the threshold criteria (Protection of Human Health and the Environment, and Compliance with ARARs). Of the two alternatives, the No Action alternative did not comply with the threshold criteria (non-compliant with ARARs) and it was removed from further consideration in the ranking of alternatives. Alternative 2 (MNA with ICs) met the threshold criteria and was then compared using the five balancing criteria. The

preferred Alternative 2 (MNA with ICs) was assigned a favorable status. Discussions of the results are presented below.

The favorable status assigned for Alternative 2 (MNA with ICs) was due to the ease of implementation (no physical systems required except for monitoring), effectiveness of the process (reduces contaminants at the DCF Study Area to MCLs through natural attenuation), and low costs (monitoring and evaluation costs).

2.11 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable. Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile which cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Contaminated groundwater is not considered to be a source material and is, therefore, not generally considered to be a principal threat waste (USEPA, 1998).

The source of contamination in soil was reduced to concentrations below the KDHE RSK soil-to-groundwater protection pathway concentrations (ECC/BMcD, 2007b). The source reduction occurred through a pilot study (using in-situ treatment and ex-situ excavation and removal) and was completed in 2005 through 2007. Therefore, there are no known principal threat wastes at the DCF Study Area. Only the groundwater remains contaminated with VOCs above MCLs. Because there are no known principal threat wastes at the DCF Study Area, the selected remedy will rely on natural processes to address the western groundwater plume.

On March 8, 1999, EPA issued a position letter in which they identified the Antidegradation provisions of K.A.R. 28-16-28c(a) as a prospective requirement at the Dry Cleaning site. That is, the Remedial Action for the DCF Study Area must maintain levels of water quality necessary to protect existing and designated uses in uncontaminated areas of surface water (including associated alluvial groundwater). The following contingency would be triggered if the PCE levels in the alluvial wells exceed their historical maximum concentrations in accordance with the March 8, 1999 EPA letter.

- Quarterly sampling for PCE, TCE, cis-1,2-DCE, and VC for one year
- Monitoring Wells to be sampled will include DCF06-40, DCF92-05, DCF93-13, DCF02-42, DCF02-41, DCF06-25, DCF02-44c, and DCF02-49c

- Submittal of a quarterly QCSR for each sampling event for KDHE and USEPA review
- Submittal of an annual DSR that will contain a summary of the analytical results and a statistical trend analysis using the reported PCE concentrations to determine if the PCE analytical results are a true indication of increasing concentration trends or if the PCE analytical results are the product of temporal variation.

If the statistical trend analysis does not indicate increasing PCE concentration trends that will exceed the historical maximum concentrations identified in the March 8, 1999 EPA letter, then the Site will return to the ROD sampling - 2008, 2009, or 2010 annual sampling, or 5-year review sampling - as previously scheduled.

2.12 SELECTED REMEDY

Alternative 2 (MNA with ICs), the selected remedy for the DCF Study Area, will address the contaminated groundwater. Alternative 2 will use ICs to prevent exposure of receptors to contaminated groundwater. MNA relies on natural degradation processes already demonstrated to be occurring at the DCF Study Area to further reduce contaminant concentrations to or below the MCLs. Monitoring will be conducted to follow the effectiveness and progress of natural attenuation.

2.12.1 Summary of the Rationale for the Selected Remedy

This section provides a discussion of the principal factors upon which the remedy selection decision was based. The principal factors influencing the DA (Fort Riley) in its selection of Alternative 2 (MNA with ICs) are presented as follows:

- Shallow soil contamination to a depth of 12 feet bgs (2,400 cubic yards) was excavated and removed during a pilot study conducted in 2005 through 2007. The soil was removed to levels determined by KDHE to prevent further leaching to groundwater.
- Vadose zone contamination to a depth of 30 feet bgs near Monitoring Well DCF02-42 was treated by injection of 7,400 pounds of sodium permanganate into the subsurface.
- The bedding and soil in and around the HPGL corridor and the sanitary sewer lines and MHs were treated with 3,692 gallons of sodium permanganate.
- The groundwater in the buried bedrock erosional channel (eastern plume) was treated with 8,200 pounds of CAP 18™ (a neat vegetable oil) for EAB.
- The groundwater in the alluvial aquifer (western plume) was treated with 21,755 pounds of potassium permanganate to reduce contaminant mass at the source area.
- The leading edge of the western plume was treated with 2,680 pounds of CAP 18™ (a neat vegetable oil) for EAB.

- The Horse Corral was treated with 2,850 pounds of CAP 18™ (a neat vegetable oil) for EAB.
- Current monitoring data indicate no evidence of principal threat waste.
- Natural attenuation combined with soil and groundwater remediation treatment has resulted in a continuing decrease in contaminant concentrations in groundwater.
- The selected remedy is expected to continue to provide risk reduction through degradation of contaminants in the groundwater.
- The selected remedy provides measures to prevent future exposure to currently contaminated groundwater.
- DA, USEPA, KDHE, and the public believe the selected remedy would be protective of human health and the environment, would comply with ARARs, would be cost effective, and would utilize permanent solutions to the maximum extent practicable.

2.12.2 Description of the Selected Remedy

The selected remedy for remediation of the groundwater contamination at the DCF Study Area is Alternative 2 (MNA with ICs). This alternative relies on natural degradation processes already occurring at the DCF Study Area to further reduce contaminant concentrations to levels below the MCLs. This section will provide a detailed description of the selected remedy.

MNA

The term MNA refers to the reliance on natural attenuation processes (within the context of a controlled and monitored, site-cleanup approach) to achieve site-specific, remediation objectives within a time frame that is reasonable compared to those time frames offered by other more active methods (KDHE, 2001). MNA relies on natural subsurface processes to reduce contaminant concentrations. Natural attenuation is composed of destructive and nondestructive mechanisms for reducing the principal contaminants to levels at or below their respective MCLs.

Nondestructive mechanisms include dispersion, diffusion, dilution, volatilization, and sorption. Dispersion, typically referred to as mechanical dispersion, is the process by which a contaminant plume spreads or disperses as it moves downgradient. Contaminated groundwater mixes with uncontaminated groundwater and produces a dilution of the plume along the leading edge (Fetter, 1999). Diffusion is the process by which contaminants move from an area of greater concentration toward an area of lesser concentration (Fetter, 1999). Diffusion processes are more pronounced in groundwater systems with very slow flow velocities. The faster the flow velocity, the less likely there will be a noticeable effect due to diffusion processes.

Dilution is the process by which contaminant levels are reduced by introducing clean water into an area of contaminated groundwater. The clean water mixes with the contaminated water and reduces the contaminant concentrations through dilution. Volatilization is the process by which groundwater concentrations of chlorinated solvents are reduced through mass transfer between liquid and gaseous phases. Contaminants that come in contact with air molecules may transfer from a liquid to gaseous phase and enter the air, thus decreasing the concentration in groundwater.

Adsorption is the process by which contaminants adhere to the solid surface of minerals or organic carbon present in the aquifer. These contaminants may later desorb from the solid surface and continue to flow along with the moving groundwater. This process of adsorption and desorption is generally referred to as sorption and is responsible for slowing the transport of contaminants relative to the transport of groundwater.

Destructive mechanisms include abiotic and biotic degradation processes. Abiotic degradation includes processes such as dechlorination of chlorinated aliphatic hydrocarbons through chemical reactions with ferrous iron. Biotic degradation includes degradation through mechanisms such as electron acceptor reactions, electron donor reactions, and co-metabolism. An important process of natural biodegradation of chlorinated solvents in groundwater is through reductive dechlorination (an electron acceptor reaction) (Wiedemeier and Chapelle, 1998). The reductive dechlorination pathway for PCE is as follows:

$$\text{PCE} \rightarrow \text{TCE} \rightarrow \text{cis or trans-1,2-DCE} \rightarrow \text{VC} \rightarrow \text{Ethene} \rightarrow \text{Carbon Dioxide } (CO_2) + \text{water } (H_2O).$$

Implementation of MNA involves actively monitoring and evaluating the site to reduce the risk of exposure and to evaluate potential further degradation of the aquifer. Typical performance parameters monitored for natural attenuation include: temperature, pH, methane, ethane, ethene, alkalinity, nitrate, sulfate, sulfide, chloride, TOC, DO, ORP, ferrous iron, and contaminant concentrations. For the DCF Study Area, the MNA system components are groundwater wells. Contaminant concentrations will be monitored periodically to evaluate if the natural attenuation processes are reducing contaminant concentrations to below chemical-specific ARARs (MCLs).

Site geochemical and contaminant concentrations and results from USEPA reductive dechlorination screening protocol (USEPA, 1998) indicated that there is evidence for reductive dechlorination (and thus natural attenuation) of chlorinated solvents at the DCF Study Area (BMcD, 2004a). Samples are collected, analyzed, and evaluated on a periodic basis. Groundwater at the DCF Study Area will be sampled

annually for three years in 2008, 2009, and 2010, followed by 5-Year Review sampling as necessary. The 2008, 2009, and 2010 sampling will monitor contaminant concentrations and to make sure that the Pilot Study activities did not disrupt the monitored natural attenuation. Once the alluvial wells are below MCLs, the DCF Study Area will be recommended for site closeout. Five-Year Review sampling may still be required for Terrace, Transition Zone, and Horse Corral wells.

Institutional Controls

The primary control for the on-post portion of the DCF Study Area will be to restrict use through the environmental overlay of the RPMP. Master planning for Army installations is required by Army Regulation 210-20 which establishes a relationship between environmental planning and real property master planning to ensure that environmental factors are included in planning decisions and land use. The long-range component of the RPMP consists of narratives and supporting graphics that include a MPEO to reflect operational and environmental constraints. The DCF Study Area will be designated as restricted land use in the RPMP. The category directs the RPMP user to the MPEO that subsequently identifies the restrictions. Restrictions will limit exposure at the DCF Study Area by:

- Restricting use to non-residential
- Limiting public access
- Prohibiting installation of drinking water wells and groundwater use in the area
- Involving PWE personnel in proposed future plans for the DCFA Site

The federal ownership of an active military base limits the layering of other proprietary or government controls. The only additional controls that will be implemented at the DCF Study Area are informational controls (KDHE Identified Site List and community awareness through the RAB).

2.12.3 Summary of the Estimated Remedy Costs

The approximate costs for the selected remedy of MNA with ICs are summarized below:

Present Worth Cost:	$1,200,000
Capital Cost:	$50,000
Total Operation &Maintenance (O&M) Cost:	$1,400,000
Periodic Costs:	$110,000
Total Project Cost:	$1,500,000

Details regarding the costs for the selected remedy are presented in Tables 2-20 and 2-21. Costs provided above have been rounded. For the cost estimation process, data were gathered from actual cost for the current periodic sampling events, vendor quotations, prior expenses, and professional judgement. The Present Worth Cost is based on the discount rate of 3.2% following USEPA guidelines (USEPA, 1993a and 2000a). The discount rate is based on the difference between the return rate on an annuity investment minus the inflation rate. The rate of return was based on a 30-year treasury bill of 5.2% and an inflation rate of 2%. This resulted in a discount rate of 3.2%. Capital cost includes cost for implementing ICs such as groundwater restrictions and access easements.

Total O&M costs are based on annual natural attenuation/ groundwater monitoring and include groundwater sampling, laboratory analyses, quality control reporting, data summary reporting, electronic data submittals, and project administration. Periodic costs include five-year review reports and closure reports.

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during operation and further design of the selected remedy. Major changes may be documented in the form of a memorandum in the Administrative Record file, an Explanation of Significant Differences, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

2.12.4 Expected Outcomes of the Selected Remedy

The selected remedy relies on natural degradation processes already occurring at the DCF Study Area to further reduce contaminant concentrations to levels below the MCLs. With this alternative, the DCF Study Area will undergo groundwater sampling to monitor progress, and ICs are in place to prevent exposure of receptors where MCLs are exceeded. The USEPA and KDHE will provide oversight and will have the opportunity to collect split samples to confirm the results that will be used to evaluate the effectiveness of the selected remedy.

Currently, there is no human exposure to the contaminated groundwater and concentrations of contaminants in groundwater in the terrace and alluvial aquifers are showing decreasing trends for the COCs based on the most recent groundwater sampling results produced in spring 2007. The selected

remedy will be considered complete when the following COCs are below their respective MCLs for three consecutive years:

- PCE (MCL is 5 µg/L)
- TCE (MCL is 5 µg/L)
- cis-1,2-DCE (MCL is 70 µg/L)
- VC (MCL is 2 µg/L)

Groundwater at the DCF Study Area will be sampled annually for three years in 2008, 2009, and 2010, followed by 5-Year Review sampling as necessary. The 2008, 2009, and 2010 sampling will monitor contaminant concentrations and to make sure that the Pilot Study activities did not disrupt the monitored natural attenuation. Once the alluvial wells are below MCLs, the DCF Study Area will be recommended for site closeout. Five-Year Review sampling may still be required for Terrace, Transition Zone, and Horse Corral wells.

2.13 STATUTORY DETERMINATIONS

Under CERCLA §121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practical. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous waste as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

2.13.1 Protection of Human Health and the Environment

The selected remedy, Alternative 2 (MNA with ICs) will protect human health and the environment based on the baseline risk assessment (human health and ecological) that was completed for DCF Study Area. The baseline risk assessment found that the estimated risks to human health and the environment were within or below the USEPA acceptable levels before the engineered portions of the remedial alternatives selected for each AOC were implemented, and that Alternative 2 (MNA with ICs) can be expected to maintain reliable protection of the human, health, and environment. The selected remedy includes monitoring of groundwater and restriction of groundwater use through the use of ICs to ensure receptors are not exposed to contaminant levels above MCLs. The monitoring ensures that contaminant levels that

could cause risk will be detected in time to take remedial action. The selected remedy relies on natural degradation processes already occurring at the DCF Study Area to further reduce contaminant concentrations to levels below the MCLs.

2.13.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedy MNA with ICs must meet the federal and state environmental statutes, regulations, and other requirements that regulate the DCF Study Area. These criteria are known as ARARs and are placed into three categories: chemical-specific, location-specific, and action-specific.

The KDHE list of potential ARARs was evaluated according to each statutory program and the regulations specific to each program. The ARAR evaluation was conducted in accordance with the *CERCLA Compliance with Other Laws Manual, Parts I and II* (USEPA, 1989a and 1989b). Following the ARAR evaluation process, chemical-, location-, and action-specific ARARs for the DCF Study Area were identified and are summarized below.

The chemical-specific ARARs for the DCF Study Area are:

- Kansas Surface Water Quality Standards (KAR § 28.16.28b)
- Kansas Water Pollution Control, Antidegradation Policy (KAR § 28.16.28c(a))
- SDWA, National Primary Drinking Water Regulations (40 CFR § 141 and 142)
- Kansas Drinking Water Standards (KAR § 28.15)

The location-specific ARARs for the DCF Study Area are:

- Endangered Species Act of 1973 (7 USC § 136 and 16 USC § 460 et seq.)
- Fish and Wildlife Conservation Act (16 USC § 2901 and 2911)
- Flood Control Act of 1944 (16 USC § 460)
- Non-Game, Threatened or Endangered Species (KAR § 115-15)
- Bald and Golden Eagle Protection Act (16 USC 668-668d)

The action-specific ARARs for the DCF Study Area are:

- Clean Water Act (33 USC § 1251 et seq.)
- CERCLA of 1980 (42 USC § 9601 et seq. as amended by the SARA of 1986)
- OSHA of 1970 (29 USC § 651 et seq.). Includes both workplace standards (29 CFR 1910) and construction standards (29 CFR 1926)

- Water Well Contractor's License; Water Well Construction and Abandonment (KAR § 28-30)
- Kansas Board of Technical Professions (KAR § 66-6 through 66-14)

Based on groundwater data collected from the monitoring well network following the pilot study, groundwater is the only environmental medium at the DCF Study Area that has constituent levels above their corresponding chemical-specific ARARs (KDHE Anti-Degradation Policy and MCLs). The selected remedy will eventually achieve compliance with the chemical-specific ARAR (MCLs) through the natural attenuation process. ICs will prevent exposure to groundwater with contamination levels in excess of MCLs until groundwater quality for unrestricted use is achieved. Because there are no major construction activities associated with the selected remedy and no hazardous wastes produced by the remediation, the selected remedy is in compliance with both action-and location-specific ARARs, including endangered and/or threatened species, floodplain, historical, or RCRA ARARs.

2.13.3 Cost Effectiveness

In the DA's judgment, the Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its cost are proportional to its overall effectiveness" (NCP §300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to cost to determine cost-effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its cost and hence this alternative represents a reasonable value for the money to be spent.

The estimated present worth cost of the Selected Remedy is approximately $1,200,000.00 while the total project cost is approximately $1,500,000.00. Although the cost for Alternative 2 (MNA with ICs) is approximately $700,000.00 higher than Alternative 1 (No Action), Alternative 1 was removed from consideration because it did not satisfy one of the threshold criteria (ARAR-compliant).

2.13.4 Use of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The DA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at this site. Because only one

alternative provided protection of human health and the environment and is ARAR-compliant, the DA has determined that the Selected Remedy does provide the best balance of trade-offs in terms of the five balancing criteria while also considering the statutory preference for treatment as a principal element and bias against off-site treatment and disposal, and by considering State and community acceptance.

With the Selected Remedy, the DCF Study Area will undergo groundwater sampling to monitor progress, and ICs are in place to eliminate or minimize the chance of a receptor being exposed to the contaminated groundwater below and downgradient of the DCF Study Area. Once RAOs are achieved at the DCF Study Area, groundwater contaminant levels are anticipated to remain below MCLs because there is likely no on-going source at the DCF Study Area. Therefore, the magnitude of risk to human health and the environment is anticipated to be less than current potential risk conditions, which are already within the USEPA accepted limits at the DCF Study Area. ICs will serve to limit exposure to present and future users of the groundwater.

2.13.5 Preference for Treatment as a Principal Element

The Selected Remedy does not address principal threats posed by the site through the use of treatment technologies, but instead relies on natural degradation processes already occurring at the DCF Study Area to further reduce contaminant concentrations to levels below the MCLs.

The source of contamination in soil and concentrations of the COPCs in groundwater were reduced following the pilot study conducted by Fort Riley in 2005 through 2007. Treatment performed during this pilot study, including the excavation and removal of shallow soil sources beneath the former Building 180/181 foot print; treatment of the vadose zone near Monitoring Well DCF02-42 with sodium permanganate; treatment of the utility corridor adjacent to former Buildings 180/181 and 183 with sodium permanganate; groundwater treatment with EAB in the buried bedrock erosional channel beneath former Buildings 180/181; potassium permanganate treatment for contaminant mass reduction in the alluvial aquifer on the Island; groundwater treatment with EAB at the leading edge of the western plume, and groundwater treatment with EAB at the Horse Corral. These treatments have had a beneficial effect for Alternative 2 (MNA with ICs). The soil treatments have reduced the COC concentrations to levels below the KDHE RSKs for the soil-to-groundwater protection pathway. Natural attenuation combined with the groundwater treatment has been responsible for the continuing decrease of contaminant levels in groundwater. The selected remedy was chosen because it is expected to continue to provide risk reduction through degradation of contaminants in the groundwater and provides measures to prevent future exposure

to currently contaminated groundwater. The selected remedy did not lend itself to the use of active treatment as the principal element because the active treatment (engineered) portions of the remedial alternative selected for each AOC had been previously conducted.

2.13.6 Five-Year Review Requirements

The purpose of this section is to explain the determinations for five-year reviews. The NCP states that the ROD must describe whether a five-year review is required (statutory review). Section 121 of CERCLA and NCP §300.430(f)(5)(iii)(C) provide the statutory and legal bases for conducting five-year reviews. The structure and content of the five-year review is the same for both statutory and policy reviews. If there are any hazardous substances, pollutants, or contaminants remaining at the site above levels that would not allow for unlimited use and unrestricted exposure, a review of remedial action no less often than five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented is required.

The ROD should also discuss whether the site is likely to undergo any discretionary policy reviews. The policy reviews are triggered by construction completion. Policy reviews are conducted at sites based on the following:

- A post-SARA remedial action will allow for unlimited use and unrestrictive exposure after completion of the remedial action, but where attainment of remedial action objectives and cleanup levels will take longer than five years to complete.
- Pre-SARA sites at which the remedy, upon attainment of the remedial action objectives and cleanup levels, will not allow unlimited use and unrestricted exposure.
- NPL removal-only sites where hazardous substances, pollutants, or contaminants are left on-site above levels that allow unlimited use and unrestricted exposure and where no remedial action has taken place

Once clean-up levels are achieved at the DCF Study Area, groundwater contaminant levels are anticipated to remain below MCLs because there is no known on-going source at the DCF Study Area. The magnitude of risk to human health and the environment is anticipated to be less than current risk conditions, which are already within the USEPA accepted limits at the DCF Study Area. Contaminants sorbed to the aquifer matrix may serve as a low-level source after remediation is completed, but natural

attenuation will continue to reduce these concentrations. ICs are anticipated to limit exposure to present and future users of the groundwater.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining at the DCF Study Area above levels that allow for unlimited use and unrestricted exposure, a review in accordance with the NCP will be conducted no less often than every five years after initiation of the selected remedial action to ensure that the remedy continues to be protective of human health and the environment. The first five-year review of the selected remedy will include consideration of the following factors:

- the performance of MNA in achieving cleanup levels (MCLs);
- the use of property above the groundwater plume to ensure that groundwater with contamination above cleanup levels (MCLs) is not used; and
- Annual sampling of groundwater at the DCF Study Area for three years in 2008, 2009, and 2010. The 2008, 2009, and 2010 sampling will monitor contaminant concentrations and to make sure that the Pilot Study activities did not disrupt the monitored natural attenuation.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

The revised (Draft Final) Proposed Plan was submitted to the DA, USEPA and KDHE on October 11, 2007 and was available to the public at the Fort Riley IRP administrative library located at 407 Pershing Court, Fort Riley, Kansas, the Dorothy Bramlage Public Library located at 230 West Seventh Street, Junction City, Kansas, and the Manhattan Public Library located at 629 Poyntz Avenue, Manhattan, Kansas. The Proposed Plan was released to the public on October 21, 2007. The public comment period was from October 21, 2007 through November 22, 2007, which included the October 30, 2007 public meeting held concurrently with the public RAB meeting. Announcements regarding the Site were published in the *Junction City Daily Union* and the *Manhattan Mercury* newspapers. The Proposed Plan identified Alternative 2 (MNA with ICs) as the preferred remedy. Fort Riley received no public comments on the Proposed Plan during the designated public comment period. No significant changes to the remedy as it was originally identified in the Proposed Plan are necessary.

* * * * *

3.0 RESPONSIVENESS SUMMARY

3.1 STAKEHOLDER COMMENTS AND LEAD AGENCY RESPONSES

During the public comment period from October 21, 2007 through November 22, 2007 for the Proposed Plan (BMcD, 2007), no public comments regarding the selected remedy for the DCF Study Area (OU 003) were received. No comments were conveyed at the public meeting held on October 30, 2007. Because there was no public response to the selected remedy of the Proposed Plan, this Responsiveness Summary contains no comments.

3.2 TECHNICAL AND LEGAL ISSUES

3.2.1 Technical Issues

There are no outstanding technical issues at the DCF Study Area.

3.2.2 Legal Issues

There are no outstanding legal issues at the DCF Study Area. The DA, Fort Riley will continue to coordinate with the USEPA and the State of Kansas acting through the KDHE regarding implementation of appropriate ICs to prevent use of the groundwater until concentrations decrease to at or below the MCLs for a consecutive period of three years. At this point, a recommendation for discontinuing sampling and site close out will be made.

* * * * *

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Tables

Table 1-1
Monitoring Well DCF93-13
Temporal Concentration Trend
DCF Study Area
Record of Decision
Fort Riley, Kansas

Date of Sample Round	Contaminants of Concern (µg/L)		
	PCE	TCE	DCE
May-96	130	38	12
Oct-96	160	93	19.7
Feb-97	130	98	30.7
May-97	130	64	19.9
Sep-97	320	260	62.9
Dec-97	140	120	47.7
Mar-98	150	130	38.8
Jun-98	152	229	41
Oct-98	90.9	97	26.3
May-99	120	61.1	11.3
Sep-99	124	87.8	18.8
Feb-00	83.8	83.4	27.3
Jul-00	89.7	152	47
Oct-00	76.1	54.5	21.1
Mar-01	49	31.7	11.1
Oct-01	67	50.1	16.4
Mar-02	61.5	56.5	15.9
Jul-02	72.8	ND	64.5
Apr-03	44.5	18.9	8.5
Jul-03	63.2	76.1	19.7
Oct-03	30.9	10	10.3
Apr-04	36.3	13.4	4
Aug-04	33.2	66.7	24.1
Apr-05	26.7	5.8	2
Oct-05	26.5	20.6	9.9
Mar-06	28.7	6.7	2
Oct-06	9.6	1.4	ND
Jan-07	6.5	0.9	0.9
Apr-07	2.6	1.9	3.7
Sep-07	ND	1.3	3.7

µg/L - micrograms per liter
PCE - Tetrachloroethylene
TCE - Trichloroethylene
DCE - *cis*-1,2-Dichloroethylene

NS - Not Sampled
ND - Not Detected

Table 2-1
Positive Detections
April 2007 Groundwater Sampling Event
Record of Decision
DCF Study Area
Fort Riley, Kansas

Sample Point: / Date Sampled: / Laboratory Number:		KDHE RSK/MCL	DCF92-01/01 4/23/2007 07041513	DCF92-05/01 4/20/2007 07041490	DCF93-13/01 4/20/2007 07041491	DCF93-19/01 4/23/2007 07041511	DCF93-19/11 4/23/2007 07041510 Duplicate	DCF93-20/01 4/20/2007 07074192
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	0.5 U	***4.6***	***3.7***	***6.2***	***6.2***	***13.7***
Tetrachloroethylene	ug/L	5	1.1U	***2.1***	***2.6***	1.1U	1.1U	***2.5***
Trichloroethylene	ug/L	5	0.6U	***0.9***	***1.9***	0.6U	0.6U	***4.6***
Vinyl Chloride	ug/L	2	0.8U	0.5 U	0.8U	***2.5***	***2.5***	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 2-1
Positive Detections
April 2007 Groundwater Sampling Event
Record of Decision
DCF Study Area
Fort Riley, Kansas

Sample Point: / Date Sampled: / Laboratory Number:		KDHE RSK/MCL	DCF06-25/01	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	DCF99-37c/11 4/18/2007 07041193 Duplicate
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	NA	***8***	***1.4***	0.5 U	***10.1***	***10.4***
Tetrachloroethylene	ug/L	5	NA	***1.6***	1.1U	1.1U	1.1U	1.1U
Trichloroethylene	ug/L	5	NA	0.6U	0.6U	0.6U	***1***	***0.8***
Vinyl Chloride	ug/L	2	NA	***1.4***	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 2-1
Positive Detections
April 2007 Groundwater Sampling Event
Record of Decision
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF99-38c/01	DCF06-40/01	DCF02-41/01	DCF02-41/11	DCF02-43/01	DCF02-44a/01
Date Sampled:		RSK/MCL	4/18/2007	4/20/2007	4/23/2007	4/23/2007	4/20/2007	4/19/2007
Laboratory Number:			07041195	07041489	07041509	07041508 Duplicate	07041488	07041396
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	0.5U	***2.0***	***110***	***109***	0.5 U	***9.1***
Tetrachloroethylene	ug/L	5	1.1U	***65.8***	1.1U	1.1U	1.1U	***56.4***
Trichloroethylene	ug/L	5	0.6U	0.6U	***1.3***	***1.2***	0.6U	***8.4***
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 2-1
Positive Detections
April 2007 Groundwater Sampling Event
Record of Decision
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF02-44c/01	DCF02-46a/01	DCF02-46c/01	DCF02-47a/01	DCF02-47c/01	DCF02-48a/01
Date Sampled:		RSK/MCL	4/19/2007	4/19/2007	4/19/2007	4/19/2007	4/19/2007	4/20/2007
Laboratory Number:			07041395	07041398	07041397	07041394	07041393	07041446
Volatiles	**Units**							
cis-1,2-Dichloroethylene	ug/L	70	***7.9***	***0.6***	0.5 U	***5.5***	0.5 U	***7.4***
Tetrachloroethylene	ug/L	5	***56.4***	1.1U	1.1U	***1.5***	1.1U	1.1U
Trichloroethylene	ug/L	5	***7.1***	0.6U	0.6U	***1.1***	0.6U	***1.7***
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 2-1
Positive Detections
April 2007 Groundwater Sampling Event
Record of Decision
DCF Study Area
Fort Riley, Kansas

Sample Point:		KDHE	DCF02-48c/01	DCF02-49c/01	DCF03-50c/01	B354-99-11c/01
Date Sampled:		RSK/MCL	4/20/2007	4/20/2007	4/18/2007	4/18/2007
Laboratory Number:			05091899	07041445	07041197	07041196
Volatiles	**Units**					
cis-1,2-Dichloroethylene	ug/L	70	0.5U	***8.3***	0.5U	***2.3***
Tetrachloroethylene	ug/L	5	***5.1***	***17.2***	1.1U	***8.7***
Trichloroethylene	ug/L	5	0.6U	***6.3***	0.6U	***1.6***
Vinyl Chloride	ug/L	2	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 2-2
Exposure Concentrations in Surface Soil
DCF Study Area
Record Of Decision
Fort Riley, Kansas

Parameter	Maximum Detected Concentration (mg/kg)	95 Percent Upper Confidence Limit (UCL) (mg/kg)	Exposure Concentration Used in HHBRA (mg/kg)
Volatiles			
Tetrachloroethylene	2.01E-01	1.64E-02	1.64E-02

Notes:
Concentration used in HHBRA represents the lower of the 95 percent UCL or maximum detected concentration (USEPA, 1992).
One-half of the detection limit was used as a proxy concentration for results that were nondetect.
The 95 percent UCLs were calculated assuming a lognormal distribution.
HHBRA - Human Health Baseline Risk Assessment
mg/kg - milligrams per kilogram

Table 2-3
Exposure Concentrations in Shallow Subsurface Soil
DCF Study Area
Record of Decision
Fort Riley, Kansas

Parameter	Maximum Detected Concentration (mg/kg)	95 Percent Upper Confidence Limit (UCL) (mg/kg)	Exposure Concentration Used in HHBRA (mg/kg)
Volatiles			
Tetrachloroethylene	5.13E-01	6.93E-02	6.93E-02

Notes:
Concentration used in HHBRA represents the lower of the 95 percent UCL or maximum detected concentration (USEPA, 1992).
One-half of the detection limit was used as a proxy concentration for results that were nondetect.
The 95 percent UCLs were calculated assuming a lognormal distribution.
HHBRA - Human Health Baseline Risk Assessment
mg/kg - milligrams per kilogram

Table 2-4
Exposure Concentrations in Groundwater
Buildings 180/181 Area
DCF Study Area
Record of Decision
Fort Riley, Kansas

Parameter	Maximum Detected Concentration (mg/L)	95 Percent Upper Confidence Limit (UCL) (mg/L)	Exposure Concentration Used in HHBRA (mg/L)
Volatiles			
cis-1,2-Dichloroethylene	5.84E-02	1.69E+00	5.84E-02
Isopropylbenzene	1.30E-03	1.31E-02	1.30E-03
tert-Butylbenzene	1.80E-03	2.99E-03	1.80E-03
Tetrachloroethylene	1.69E-01	1.33E-01	1.33E-01
trans-1,2-Dichloroethylene	6.80E-03	3.99E-03	3.99E-03
Trichloroethylene	2.56E-01	1.32E+02	2.56E-01
Trichloromethane	9.00E-04	9.61E-04	9.00E-04
Vinyl chloride	1.40E-03	1.39E-03	1.39E-03

Notes:

Concentration used in HHBRA represents the lower of the 95 percent UCL or maximum detected concentration (USEPA, 1992).

One-half of the detection limit was used as a proxy concentration for results that were nondetect.

The 95 percent UCLs were calculated assuming a lognormal distribution.

HHBRA - Human Health Baseline Risk Assessment

mg/L - milligrams per Liter

Table 2-5
Exposure Concentrations in Groundwater
Transition Zone/Island Area
DCF Study Area
Record of Decision
Fort Riley, Kansas

Parameter	Maximum Detected Concentration (mg/L)	95 Percent Upper Confidence Limit (UCL) (mg/L)	Exposure Concentration Used in HHBRA (mg/L)
Volatiles			
cis-1,2-Dichloroethylene	5.76E-02	3.37E-02	3.37E-02
Tetrachloroethylene	7.70E-02	2.67E-01	7.70E-02
Toluene	1.90E-03	5.92E+03	1.90E-03
trans-1,2-Dichloroethylene	9.00E-04	3.85E-04	3.85E-04
Trichloroethylene	3.95E-02	4.39E-02	3.95E-02
Vinyl chloride	2.40E-03	2.68E-03	2.40E-03

Notes:
Concentration used in HHBRA represents the lower of the 95 percent UCL or maximum detected concentration (USEPA, 1992).
One-half of the detection limit was used as a proxy concentration for results that were non-detect.
The 95 percent UCLs were calculated assuming a lognormal distribution.
HHBRA - Human Health Baseline Risk Assessment
mg/L - milligrams per Liter

Table 2-6
Exposure Concentrations in Groundwater
Kansas River Area
DCF Study Area
Record of Decision
Fort Riley, Kansas

Parameter	Maximum Detected Concentration (mg/L)	95 Percent Upper Confidence Limit (UCL) (mg/L)	Exposure Concentration Used in HHBRA (mg/L)
Volatiles			
cis-1,2-Dichloroethylene	3.66E-02	4.07E-02	3.66E-02
Tetrachloroethylene	2.75E-02	2.17E-02	2.17E-02
Trichloroethylene	5.90E-03	6.90E-03	5.90E-03

Notes:

Concentration used in HHBRA represents the lower of the 95 percent UCL or maximum detected concentration (USEPA, 1992).

One-half of the detection limit was used as a proxy concentration for results that were nondetect.

The 95 percent UCLs were calculated assuming a lognormal distribution.

HHBRA - Human Health Baseline Risk Assessment

mg/L - milligrams per Liter

Table 2-7
Hazard Index Estimates for
Current Groundskeeper Scenario
DCF Study Area
Record of Decision
Fort Riley, Kansas

Chemical	Daily Intake (mg/kg/day)	RfD (mg/kg/day)	Hazard Quotient	Pathway Hazard Index	Total Hazard Index
Exposure Pathway: Incidental ingestion of chemicals in surface soil					
Volatiles					
Tetrachloroethylene	2.0E-09	1E-02	2E-07		
				2E-07	
Exposure Pathway: Dermal contact with chemicals in surface soil					
Volatiles					
Tetrachloroethylene	0.0E+00	1E-02	NAp		
				NAp	
Exposure Pathway: Inhalation of chemical vapors					
Volatiles					
cis-1,2-Dichloroethylene	1.1E-10	NAv	NAp		
Isopropylbenzene	0.0E+00	1E-01	NAp		
tert-Butlybenzene	0.0E+00	NAv	NAp		
Tetrachloroethylene	5.9E-09	2E-01	3E-08		
trans-1,2-Dichloroethylene	1.5E-11	NAv	NAp		
Trichloroethylene	1.1E-09	NAv	NAp		
Trichloromethane	2.0E-12	NAv	NAp		
Vinyl chloride	1.9E-11	3E-02	6E-10		
				3E-08	
					2E-07

Notes:

NAv - Not available

NAp - Not applicable

RfD - Reference Dose

mg/kg/day - milligrams per kilogram per day

Table 2-8
Hazard Index Estimates for
Future Utility Worker Scenario
DCF Study Area
Record of Decision
Fort Riley, Kansas

Chemical	Daily Intake (mg/kg/day)	RfD (mg/kg/day)	Hazard Quotient	Pathway Hazard Index	Total Hazard Index
Exposure Pathway: Incidental ingestion of chemicals in soil					
Volatiles					
Tetrachloroethylene	5.4E-09	1E-02	5E-07		
				5E-07	
Exposure Pathway: Dermal contact with chemicals in soil					
Volatiles					
Tetrachloroethylene	0.0E+00	1E-02	NAp		
				NAp	
Exposure Pathway: Inhalation of chemical vapors					
Volatiles					
cis-1,2-Dichloroethylene	5.7E-10	NAv	NAp		
Isopropylbenzene	0.0E+00	1E-01	NAp		
tert-Butylbenzene	0.0E+00	NAv	NAp		
Tetrachloroethylene	3.1E-08	2E-01	2E-07		
trans-1,2-Dichloroethylene	8.1E-11	NAv	NAp		
Trichloroethylene	6.2E-09	NAv	NAp		
Trichloromethane	1.1E-11	NAv	NAp		
Vinyl chloride	1.1E-10	3E-02	4E-09		
				2E-07	
					7E-07

Notes:

NAv - Not available

NAp - Not applicable

RfD - Reference Dose

mg/kg/day - milligrams per kilogram per day

Table 2-9
Hazard Index Estimates for
Current Youth Trespasser Scenario
DCF Study Area
Record of Decision
Fort Riley, Kansas

Chemical	Daily Intake (mg/kg/day)	RfD (mg/kg/day)	Hazard Quotient	Pathway Hazard Index	Total Hazard Index
Exposure Pathway: Incidental ingestion of chemicals in surface soil					
Volatiles					
Tetrachloroethylene	2.4E-09	1E-02	2E-07		
				2E-07	
Exposure Pathway: Dermal contact with chemicals in surface soil					
Volatiles					
Tetrachloroethylene	0.0E+00	1E-02	NAp		
				NAp	
Exposure Pathway: Inhalation of chemical vapors on the Building 180/181 Area					
Volatiles					
cis-1,2-Dicholorethylene	9E-10	NAv	NAp		
Isopropylbenzene	0E+00	1E-01	NAp		
tert-Butylbenzene	0E+00	NAv	NAp		
Tetrachloroethylene	1E-07	2E-01	7E-07		
trans-1,2-Dichloroethylene	1E-10	NAv	NAp		
Trichloroethylene	9E-09	NAv	NAp		
Trichloromethane	2E-11	NAv	NAp		
Vinyl chloride	2E-10	3E-02	5E-09		
				7E-07	
Exposure Pathway: Inhalation of chemical vapors from groundwater on the Transition Zone/Island Area					
Volatiles					
cis-1,2-Dicholorethylene	5E-09	NAv	NAp		
Tetrachloroethylene	4E-08	2E-01	2E-07		
Toluene	4E-10	1E-01	4E-09		
trans-1,2-Dichloroethylene	1E-10	NAv	NAp		
Trichloroethylene	1E-08	NAv	NAp		
Vinyl chloride	2E-09	3E-02	8E-08		
				3E-07	
Exposure Pathway: Dermal contact with chemicals in sediment pore water					
Volatiles					
cis-1,2-Dicholorethylene	4E-06	1E-02	4E-04		
Tetrachloroethylene	1E-05	1E-02	1E-03		
Trichloroethylene	1E-06	6E-03	2E-04		
				2E-03	
					2E-03

Notes:

NAv - Not available

NAp - Not applicable

RfD - Reference Dose

mg/kg/day - milligrams per kilogram per day

Table 2-10
Excess Lifetime Cancer Risk Estimate for
Current Groundskeeper Scenario
DCF Study Area
Record of Decision
fort Riley, Kansas

Chemical	Daily Intake (mg/kg/day)	Slope Factor (mg/kg/day)$^{-1}$	Excess Cancer Risk	Pathway Cancer Risk	Total Cancer Risk
Exposure Pathway: Incidental ingestion of chemicals in surface soil					
Volatile					
Tetrachloroethylene	7.1E-10	5.2E-02	4E-11		
				4E-11	
Exposure Pathway: Dermal contact with chemicals in surface soil					
Volatile					
Tetrachloroethylene	0.0E+00	5.2E-02	NAp		
				NAp	
Exposure Pathway: Inhalation of chemical vapors					
Volatiles					
Tetrachloroethylene	2.1E-09	1.1E-02	2E-11		
trans-1,2-Dichloroethylene	5.3E-12	NAv	NAp		
Trichloroethylene	4.0E-10	6.0E-03	2E-12		
Trichloromethane	7.1E-13	8.1E-02	6E-14		
Vinyl chloride	6.9E-12	1.5E-02	1E-13		
				2E-11	
					6E-11

Notes:

NAv - Not available

NAp - Not applicable

mg/kg/day - milligrams per kilogram per day

Table 2-11
Excess Lifetime Cancer Risk Estimate for
Future Utility Worker Scenario
DCF Study Area
Record of Decision
Fort Riley, Kansas

Chemical	Daily Intake (mg/kg/day)	Slope Factor $(mg/kg/day)^{-1}$	Excess Cancer Risk	Pathway Cancer Risk	Total Cancer Risk
Exposure Pathway: Incidental ingestion of chemicals in soil					
Volatiles					
Tetrachloroethylene	1.9E-09	5.2E-02	1E-10		
				1E-10	
Exposure Pathway: Dermal contact with chemicals in soil					
Volatiles					
Tetrachloroethylene	0.0E+00	5.2E-02	NAp		
				NAp	
Exposure Pathway: Inhalation of chemical vapors					
Volatiles					
Tetrachloroethylene	1.1E-08	1.1E-02	1E-10		
trans-1,2-Dichloroethylene	2.9E-11	NAv	NAp		
Trichloroethylene	2.2E-09	6.0E-03	1E-11		
Trichloromethane	3.9E-12	8.1E-02	3E-13		
Vinyl chloride	3.9E-11	1.5E-02	6E-13		
				1E-10	
					2E-10

Notes:

NAv - Not available

NAp - Not applicable

mg/kg/day - milligrams per kilogram per day

Table 2-12
Excess Lifetime Cancer Risk Estimate for
Current Youth Trespasser Scenario
DCF Study Area
Record of Decision
Fort Riley, Kansas

Chemical	Daily Intake (mg/kg/day)	Slope Factor $(mg/kg/day)^{-1}$	Excess Cancer Risk	Pathway Cancer Risk	Total Cancer Risk
Exposure Pathway: Incidental ingestion of chemicals in surface soil					
Volatiles					
Tetrachloroethylene	1.0E-10	5.2E-02	5E-12		
				5E-12	
Exposure Pathway: Dermal contact with chemicals in surface soil					
Volatiles					
Tetrachloroethylene	0.0E+00	5.2E-02	NAp		
				NAp	
Exposure Pathway: Inhalation of chemical vapors on the Buildings 180/181 Area					
Volatiles					
Tetrachloroethylene	5.7E-09	1.1E-02	6E-11		
trans-1,2-Dichloroethylene	5.2E-12	NAv	NAp		
Trichloroethylene	3.9E-10	6.0E-03	2E-12		
Trichloromethane	6.9E-13	8.1E-02	6E-14		
Vinyl chloride	7.0E-12	1.5E-02	1E-13		
				7E-11	
Exposure Pathway: Inhalation of chemical vapors from groundwater on the Transition Zone/Island Area					
Volatiles					
Tetrachloroethylene	1.6E-09	1.1E-02	2E-11		
trans-1,2-Dichloroethylene	4.4E-12	NAv	NAp		
Trichloroethylene	5.3E-10	6.0E-03	3E-12		
Vinyl chloride	9.8E-11	1.5E-02	1E-12		
				2E-11	
Exposure Pathway: Dermal contact with chemicals in sediment pore water					
Volatiles					
Tetrachloroethylene	4.5E-07	5.2E-02	2E-08		
Trichloroethylene	4.4E-08	1.1E-02	5E-10		
				2E-08	
					2E-08

Notes:

NAv - Not available

NAp - Not applicable

RfD - Reference Dose

mg/kg/day - milligram per kilogram per day

Table 2-13
Preliminary Screening of Soil Analytical Data to Wildlife Benchmarks
DCF Study Area, Record of Decision
Fort Riley, Kansas

Chemical	Representative Wildlife Species	No Observed Adverse Effects Level (NOAEL)[1] (mg/kg/day)	Weight Normalized NOAEL (mg/day)[2]	Consumption Rate of Soil in Diet (kg/day)[3]	Maximum Concentration Detected in Soil (mg/kg)	Dose Received from Soil (mg/day)[4]	Hazard Quotient	Chemical of Potential Ecological Concern[5]
Surface Soil (0 to1 feet below ground surface)								
PCE[6]	Little brown bat	1.98	1.58E-02	8.00E-05	7.03E-02	5.62E-06	3.55E-04	No
	Short-tailed Shrew	1.66	2.49E-02	1.17E-03		8.23E-05	3.30E-03	
	White-footed Mouse	1.51	3.32E-02	6.80E-05		4.78E-06	1.44E-04	
	Meadow Vole	1.27	5.59E-02	1.20E-04		8.44E-06	1.51E-04	
	Mink	0.58	8.12E-01	2.74E-03		1.93E-04	2.37E-04	
	Cottontail Rabbit	0.56	6.72E-01	1.49E-02		1.05E-03	1.56E-03	
	Red Fox	0.40	1.80E+00	1.26E-02		8.86E-04	4.92E-04	
	White-tailed Deer	0.21	1.19E+01	3.50E-02		2.46E-03	2.07E-04	
Subsurface Soil (0 to 4 feet below ground surface)								
PCE[6]	Little brown bat	1.98	1.58E-02	8.00E-05	4.87E-01	3.90E-05	2.46E-03	No
	Short-tailed Shrew	1.66	2.49E-02	1.17E-03		5.70E-04	2.29E-02	
	White-footed Mouse	1.51	3.32E-02	6.80E-05		3.31E-05	9.97E-04	
	Meadow Vole	1.27	5.59E-02	1.20E-04		5.84E-05	1.05E-03	
	Mink	0.58	8.12E-01	2.74E-03		1.33E-03	1.64E-03	
	Cottontail Rabbit	0.56	6.72E-01	1.49E-02		7.26E-03	1.08E-02	
	Red Fox	0.40	1.80E+00	1.26E-02		6.14E-03	3.41E-03	
	White-tailed Deer	0.21	1.19E+01	3.50E-02		1.70E-02	1.44E-03	

Notes:
[1] – ORNL, 1996
[2] – NOAEL x Average Body Weight
[3] – Food Ingestion Rate x Percent of Soil in Diet x Percent of Foraging Range within DCFA (Assumed to be 100%)
[4] – Estimated Value = Consumption Rate of Soil x Maximum Concentration Detected in Soil
[5] – A COPEC was determined by comparing Dose Received from Soil to the Weight-Normalized NOAEL.
[6] – PCE equals Tetrachloroethylene
mg/kg/day - milligrams per kilogram per day
mg/day - milligrams per day
kg/day - kilograms per day
mg/kg - milligrams per kilogram

Table 2-14
Listed and Rare Species Occurring and Potentially Occurring in the Fort Riley Area
DCF Study Area
Record of Decision
Fort Riley, Kansas

Common Name	Scientific Name	Federal Status	State Status
American Burying Beetle	*Nicrophorus americanus*	E	E
Baird's sparrow	*Ammodramus bairdii*	SOC	-
Bald Eagle	*Haliaeetus leucocephalus*	T-PD	T
Black Rail	*Laterallus jamaicensis*	SOC	SINC
Black Tern	*Chlidonias niger*	SOC	SINC
Blue Sucker	*Cycleptus elogatus*	SOC	SINC
Eastern Hognose Snake	*Heterodon platirhinos*	-	SINC
Eastern Spotted Skunk	*Spilogale putorius*	-	T
Eskimo Cerlew	*Numenius borealis*	E	E
False Map Turtle	*Graptemys pseudogeographica*	SOC	-
Ferruginous Hawk	*Buteo regalis*	SOC	SINC
Golden Eagle	*Aquila chrysaetos*	-	SINC
Henslow's Sparrow	*Ammodramus henslowii*	SOC	SINC
Least Tern	*Sterna antillarum*	E	E
Loggerhead Shrike	*Lanius ludovicianus*	SOC	-
Northern Goshawk	*Accipiter gentilis*	SOC	-
Paddlefish	*Polyodon spatula*	SOC	-
Peregrine Falcon	*Falco peregrinus*	E	E
Piping Plover	*Charadrius melodus*	T	T
Plains Minnow	*Hybognathus placitus*	SOC	SINC
Prairie Mole Cricket	*Gryllotalpa major*	SOC	SINC
Red-shouldered Hawk	*Buteo lineatus*	-	SINC
Regal fritillary Butterfly	*Speyeria idalia*	SOC	-
Short-eared owl	*Asio flammeus*	-	SINC
Snowy Plover	*Charadrius alexandrinus*	-	T
Southern Bog Lemming	*Synaptomys copperi*	-	SINC
Sturgeon Chub	*Macrhybopsis gelida*	C	T
Texas Horned Lizard	*Phrynosoma cornutum*	SOC	-
Timber Rattlesnake	*Crotalus horridus*	-	SINC
Topeka Shiner	*Notropis topeka*	E	T
Western Burrowing Owl	*Athene cunicularia*	SOC	-
Western Hognose Snake	*Heterodon nasicus*	-	SINC
Western Prairie Fringed Orchid	*Platanthera praeclara*	T	-
Whip-poor-will	*Caprimulgus vociferus*	-	SINC
White-faced Ibis	*Plegadis chini*	SOC	T
Whooping Crane	*Grus americana*	E	E

C - Candidate
E - Endangered
SINC - Species in Need of Conservation
SOC - Species of Concern
T - Threatened
T-PD - Threatened but Proposed for Delisting

Source: Kansas Department of Wildlife and Parks and U.S. Fish and Wildlife Service

Table 2-15
Preliminary Plant Benchmark Screening for Soil
DCF Study Area, Record of Decision
Fort Riley, Kansas

Chemical	Maximum Concentration Detected in Soils (mg/kg)	Plant Benchmark (mg/kg) [a]	Hazard Quotient [b]	Chemical of Potential Ecological Concern [c]
Surface Soil (0 to1 feet below ground surface)				
Tetrachloroethylene	7.03E-02	>1,000	7.03E-05	No
Subsurface Soil (0 to4 feet below ground surface)				
Tetrachloroethylene	4.87E-01	>1,000	4.87E-04	No

Notes:
[a] – Efroymson, 1997a
[b] – Maximum concentration detected in soil / plant benchmark
[c] – A chemical is considered a potential ecological concern if the hazard quotient is greater than one.
mg/kg - milligrams per kilogram

Table 2-16
Representative Wildlife Species Estimated Consumption Rate of Soil in Diet and Foraging Ranges
DCF Study Area
Record of Decision
Fort Riley, Kansas

Representative Wildlife Species	Average Body Weight (kg)	Food Ingestion Rate (kg/day)	Percent of Soil in Diet	Estimated Consumption Rate of Soil in Diet (kg/day) [e]	Foraging Range (acres) [b]
Little Brown Bat	8.00E-03 [a]	4.00E-03 [c]	2.0 [c]	8.00E-05	640
Short-tailed Shrew	1.50E-02 [b]	9.00E-03 b	13.0 [b]	1.17E-03	0.05
White-footed Mouse	2.20E-02 [b]	3.40E-03 [b]	2.0 [b]	6.80E-05	0.05
Meadow Vole	4.40E-02 [a]	5.00E-03 [d]	2.4 [c]	1.20E-04	0.05
Mink	1.40E+00 [a]	1.37E-01 [c]	2.0 [c]	2.74E-03	1902
Cottontail Rabbit	1.20E+00 [a]	2.37E-01 [d]	6.3 [c]	1.49E-02	12.5
Red Fox	4.50E+00 [b]	4.50E-01 [b]	2.8 [b]	1.26E-02	3768
White-tailed Deer	5.65E+01 [b]	1.74E+00 [b]	2.0 [b]	3.50E-02	640

Notes:
[a] – Schwartz and Schwartz, 1981
[b] – Based on reported body weight, food intake, and soil intake information from Efroymson et al. (1997)
[c] – Estimated fraction of soil or sediment in diet as reported in USEPA, 1993a (The fraction of soil in diet for the jackrabbit was substituted for the cottontail rabbit).
[d] – Based on body weight and food intake information from ORNL (1996).
[e] – Food Ingestion Rate x Percent of Soil in Diet (USEPA, 1993a)
kg - kilograms
kg/day - kilograms per day

Table 2-17
Comparison of Current Concentrations in Groundwater from the River Area to Benthic Organism Benchmarks
DCF Study Area
Record of Decision
Fort Riley, Kansas

Chemical	Maximum Concentration Detected in Groundwater[1] (ug/L)	Benchmark (ug/L)	Source	Ecological Hazard Quotient	Chemical of Potential Ecological Concern
Volatiles					
cis-1,2-Dichloroethylene	36.6	590	USEPA Tier II Secondary Chronic Value	6.20E-02	No
Tetrachloroethylene	27.5	840	KSWQC[2]	3.27E-02	No
Trichloroethylene	5.9	21,900	KSWQC[2]	2.69E-04	No

Notes:
[1] – Groundwater data set consists of samples collected from alluvial wells during sampling events from 7/01 through 7/03.
[2] – Chronic Value for Aquatic Life KSWQC – Kansas Surface Water Quality Criteria
ug/L - micrograms per liter

Table 2-18
Cost Estimate for Alternative 1
DCF Study Area
Record of Decision
Fort Riley, Kansas

No Action

	Description	Quantity	Unit	Unit Cost	Line Cost	Source[1]
Periodic Costs						
1.0	Five-Year Review of Remedial Action[2]	ea	1	$ 20,000.00	$ 20,000	BMcD
1.1	Groundwater Sampling[2]	ea	1	$ 75,000.00	$ 75,000	BMcD
1.2	Closure Report	ls	1	$ 30,000.00	$ 30,000	BMcD

Subtotal Periodic Costs	**$ 125,000**
Contingency (20%)[3]	**$ 25,000**
Total Periodic Costs	**$ 150,000**
Total Project Cost	**$ 492,000**
Total Present Value Project Cost at 3.2%[4]	**$ 331,550**

Notes:

1) BMcD costs represent estimates obtained from similar projects and/or professional experience.

2) It is assumed that five-year reviews performed under the "no action" alternative will require groundwater samples to be collected once every five years. The estimated cost of one round of groundwater sampling is assumed to be the same as described in Alternative 2 .

3) Contingency covers unknowns, unforeseen circumstances, or unanticipated conditions associated with remediation. Twenty percent is an average contingency factor (EPA, 2000a).

4) Total present value based on 20 years with 5-year reviews until closure.

BMcD Burns & McDonnell Engineering Company, Inc.
ea Each
ls Lump Sum

Table 2-19
Present Value Costs for Alternative 1
DCF Study Area
Record of Decision
Fort Riley, Kansas

No Action

Year	Capital Costs	Annual O&M Costs	Periodic Costs[1]	Total Cost	Discount Factor at 3.2%	Total Present Value Cost at 3.2%
0	$ -	$ -	$ -	$ -	1.000	$ -
1	$ -	$ -	$ -	$ -	0.969	$ -
2	$ -	$ -	$ -	$ -	0.939	$ -
3	$ -	$ -	$ -	$ -	0.910	$ -
4	$ -	$ -	$ -	$ -	0.882	$ -
5	$ -	$ -	$ 114,000	$ 114,000	0.854	$ 97,388
6	$ -	$ -	$ -	$ -	0.828	$ -
7	$ -	$ -	$ -	$ -	0.802	$ -
8	$ -	$ -	$ -	$ -	0.777	$ -
9	$ -	$ -	$ -	$ -	0.753	$ -
10	$ -	$ -	$ 114,000	$ 114,000	0.730	$ 83,197
11	$ -	$ -	$ -	$ -	0.707	$ -
12	$ -	$ -	$ -	$ -	0.685	$ -
13	$ -	$ -	$ -	$ -	0.664	$ -
14	$ -	$ -	$ -	$ -	0.643	$ -
15	$ -	$ -	$ 114,000	$ 114,000	0.623	$ 71,074
16	$ -	$ -	$ -	$ -	0.604	$ -
17	$ -	$ -	$ -	$ -	0.585	$ -
18	$ -	$ -	$ -	$ -	0.567	$ -
19	$ -	$ -	$ -	$ -	0.550	$ -
20	$ -	$ -	$ 150,000	$ 150,000	0.533	$ 79,891
Total	**$ -**	**$ -**	**$ 492,000**	**$ 492,000**		**$ 331,550**

Notes:

1. $114,000 includes the cost of a five-year review plus one round of groundwater sampling. $150,000 includes the cost of a five-year review, one round of groundwater sampling, and a closure report.

Table 2-20
Cost Estimate for Alternative 2
DCF Study Area
Record of Decision
Fort Riley, Kansas

Monitored Natural Attenuation with Institutional Controls

	Description	Unit	Quantity	Unit Cost	Line Cost	Source[1]
Capital Costs						
2.1	Institutional Controls: Groundwater Restrictions and Access Easements	ls	1	$ 40,000.00	$ 40,000	BMcD
				Subtotal Capital Costs	**$ 40,000**	
				Contingency (20%)[2]	**$ 8,000**	
				Total Capital Costs	**$ 48,000**	
Annual Operation and Maintenance Costs						
2.2	Annual Natural Attenuation/Groundwater Monitoring[3]					
	Groundwater Sampling	ea	1	$ 20,000.00	$ 20,000	BMcD
	Laboratory Analyses	ea	1	$ 18,000.00	$ 18,000	BMcD
	Quality Control Summary Report (QCSR)	ea	1	$ 11,000.00	$ 11,000	BMcD
	Data Summary Report (DSR)	ea	1	$ 18,000.00	$ 18,000	BMcD
	Electronic Data Submittal	ea	1	$ 5,000.00	$ 5,000	BMcD
	Project Administration	ea	1	$ 3,000.00	$ 3,000	BMcD
				Subtotal Annual O&M	**$ 75,000**	
				Contingency (20%)[2]	**$ 15,000**	
				Total Annual O&M	**$ 90,000**	
Periodic Costs						
2.3	Five-Year Review of Remedial Action	ea	1	$ 20,000.00	$ 20,000	BMcD
2.4	Closure Report	ls	1	$ 30,000.00	$ 30,000	BMcD
				Subtotal Periodic Costs	**$ 50,000**	
				Contingency (20%)[2]	**$ 10,000**	
				Total Periodic Costs	**$ 60,000**	
				Total Project Cost	**$ 1,506,000**	
				Total Present Value Project Cost at 3.2%[4]	**$ 1,182,460**	

Notes:

1) BMcD costs represent estimates obtained from similar projects and/or professional experience.

2) Contingency covers unknowns, unforeseen circumstances, or unanticipated conditions associated with remediation. Twenty percent is an average contingency factor (EPA, 2000a).

3) Monitoring costs are based on current costs per round for the Area 354 monitoring network. Monitoring costs are revised for decreasing existing well network to a focused 16 monitoring well network. Current costs of approximately $104,000 per round for the larger well network are revised to approx. $65,000 per round for the focused network.

4) Total present value based on 15 years with 5-year reviews and monitoring until closure.

BMcD Burns & McDonnell Engineering Company, Inc.
ea Each
ls Lump Sum

Table 2-21
Present Value Costs for Alternative 2
DCF Study Area
Record of Decision
Fort Riley, Kansas

Monitored Natural Attenuation with Institutional Controls

Year	Capital Costs	Annual O&M Costs[1,2]	Periodic Costs[3]	Total Cost	Discount Factor at 3.2%	Total Present Value Cost at 3.2%
0	$ 48,000	$ -	$ -	$ 48,000	1.000	$ 48,000
1	$ -	$ 90,000	$ -	$ 90,000	0.969	$ 87,209
2	$ -	$ 90,000	$ -	$ 90,000	0.939	$ 84,505
3	$ -	$ 90,000	$ -	$ 90,000	0.910	$ 81,885
4	$ -	$ 90,000	$ -	$ 90,000	0.882	$ 79,346
5	$ -	$ 90,000	$ 24,000	$ 114,000	0.854	$ 97,388
6	$ -	$ 90,000	$ -	$ 90,000	0.828	$ 74,501
7	$ -	$ 90,000	$ -	$ 90,000	0.802	$ 72,191
8	$ -	$ 90,000	$ -	$ 90,000	0.777	$ 69,953
9	$ -	$ 90,000	$ -	$ 90,000	0.753	$ 67,784
10	$ -	$ 90,000	$ 24,000	$ 114,000	0.730	$ 83,197
11	$ -	$ 90,000	$ -	$ 90,000	0.707	$ 63,645
12	$ -	$ 90,000	$ -	$ 90,000	0.685	$ 61,672
13	$ -	$ 90,000	$ -	$ 90,000	0.664	$ 59,759
14	$ -	$ 90,000	$ -	$ 90,000	0.643	$ 57,906
15	$ -	$ 90,000	$ 60,000	$ 150,000	0.623	$ 93,518
Total	**$ 48,000**	**$ 1,350,000**	**$ 108,000**	**$ 1,506,000**		**$ 1,182,460**

Notes:

1. Assume 15 years until closure.
2. Assume annual monitoring.
3. $24,000 includes the cost of a five-year review. $60,000 includes the cost of a five-year review and a closure report.

Figures

CUSTER HILL

CAMP FUNSTON

CAMP WHITSIDE

KANSAS RIVER

CAMP FORSYTH

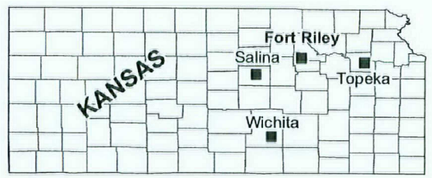
MAIN POST

DCF STUDY AREA

MARSHALL ARMY AIRFIELD

NORTH

3,000 0 3,000 Feet



Not to Scale

Burns & McDonnell

Figure 1-1
GENERAL LOCATION MAP
Record Of Decision
DCF Study Area
Fort Riley, Kansas

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CEMETERY

TRIBUTARY A

CUSTER RD

UNION PACIFIC RAILROAD

DCF02-42

DCFA

DCF92-01

DCF06-40

DCF92-05

DCF93-13

DCF93-20

DCF93-08

DCF93-19

DCF02-43

DCF06-25

DCF02-44a

DCF02-44c

DCF02-41

TRANSITION ZONE

EAGLE BUFFER ZONE

DCF02-46c

THE ISLAND

DCF02-47c

DCF02-47a

DCF96-27

EAGLE ROOST

DCF02-48c

DCF02-48a

TRIBUTARY B

KANSAS RIVER

DCF02-49c

DCF00-34c

CUSTER RD

BEEMAN PL

240

248

252

TRANSITION ZONE

HENRY DRIVE

B354-99-11c

DCF99-37c

HORSE CORRAL

DCF96-36

EAGLE ROOST

DCF03-50c

DCF99-38c

EAGLE BUFFER ZONE

TRAINING AREA 2

ACCESS TRAIL

ACCESS ROAD

HENRY DRIVE BRIDGE

LEGEND

- Monitoring Wells
- Roads with Parking Lots
- Tributary
- Railroad
- Eagle Buffer Zone
- Buildings
- Former Building Locations
- Horse Corral Area
- Island Area
- Transition Zone
- DCF Area
- Training Area 2

NORTH

400 0 400 Feet

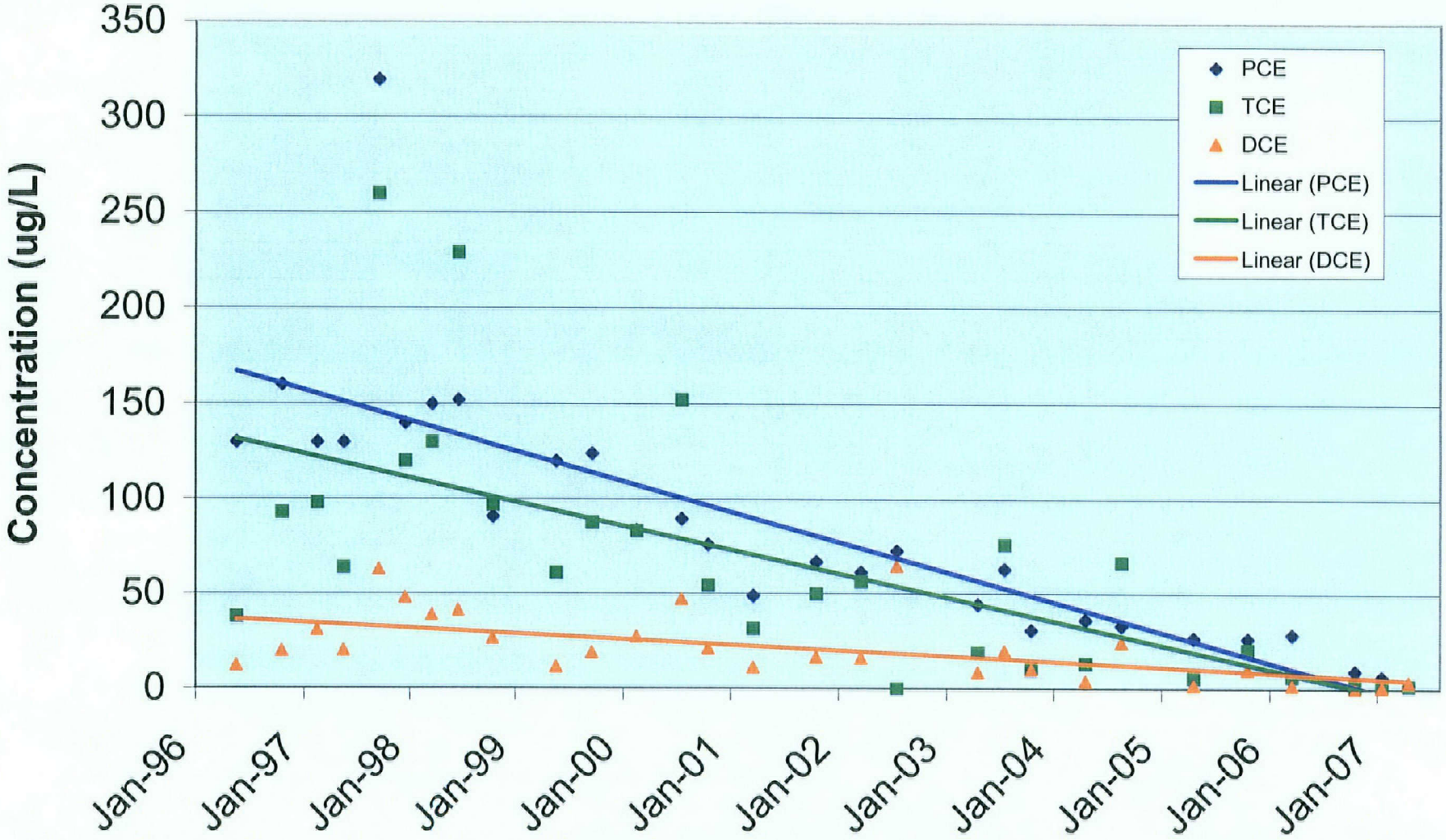
NOTE:

1. River bank based on aerial photography collected on February 8, 1998.
2. AOC - Areas of Concern

K:\ENV\USACE\Site\43582\Deliver\ROD\Draft Rod\Fig1-2 MainInvest\Areas.mxd kme wm 11/1/07 1:2400

Burns & McDonnell SINCE 1898

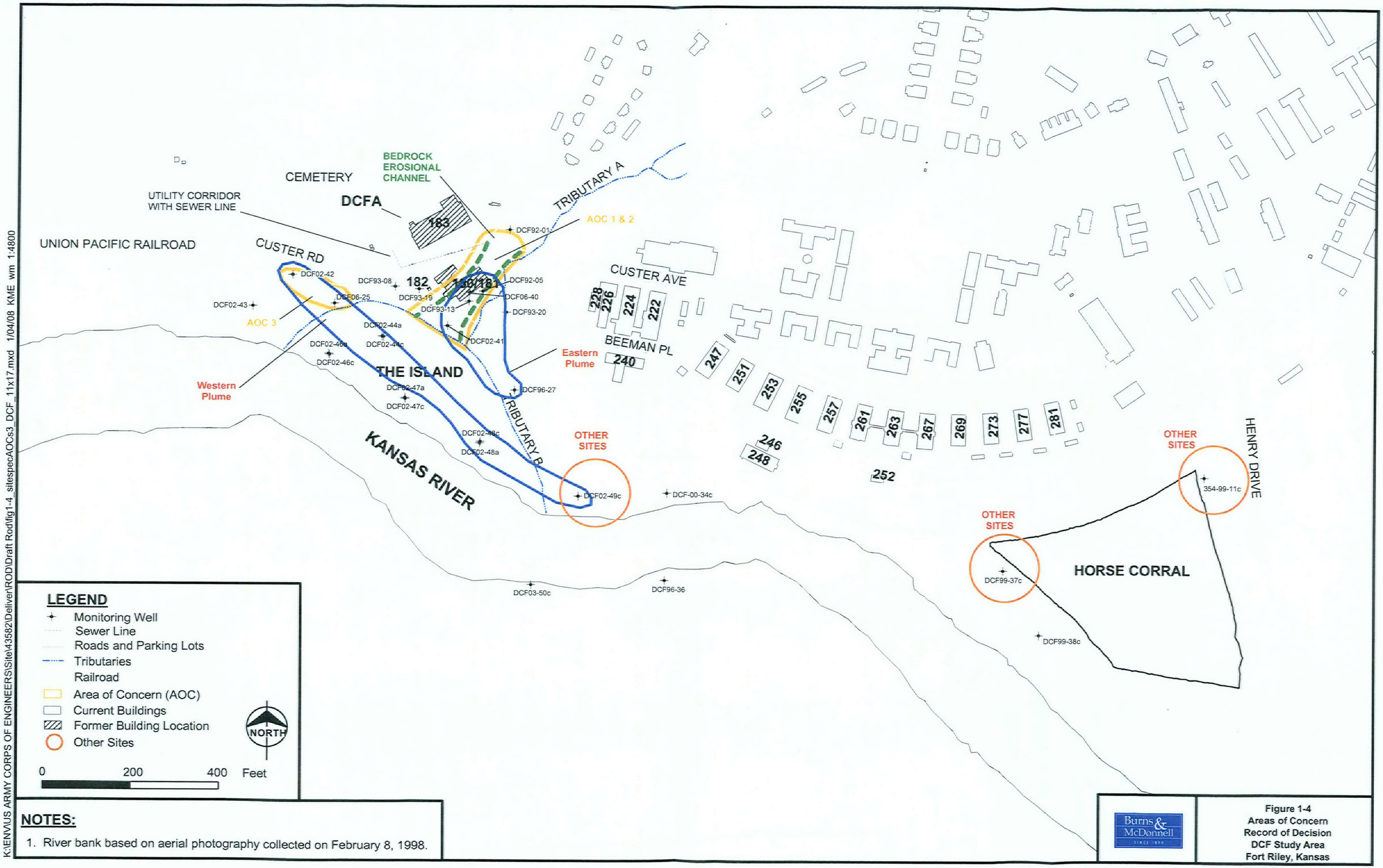
Figure 1-2
MAIN INVESTIGATIVE AREAS
Record Of Decision
DCF Study Area
Fort Riley, Kansas



Burns & McDonnell
SINCE 1898

Figure 1-3
Temporal Concentration Trends
Monitoring Well DCF93-13
Record of Decision
DCF Study Area, Fort Riley, Kansas

Table 1-1.xls



LEGEND

- Monitoring Well
- Sewer Line
- Roads and Parking Lots
- Tributaries
- Railroad
- Area of Concern (AOC)
- Current Buildings
- Former Building Location
- Other Sites

NORTH

0 200 400 Feet

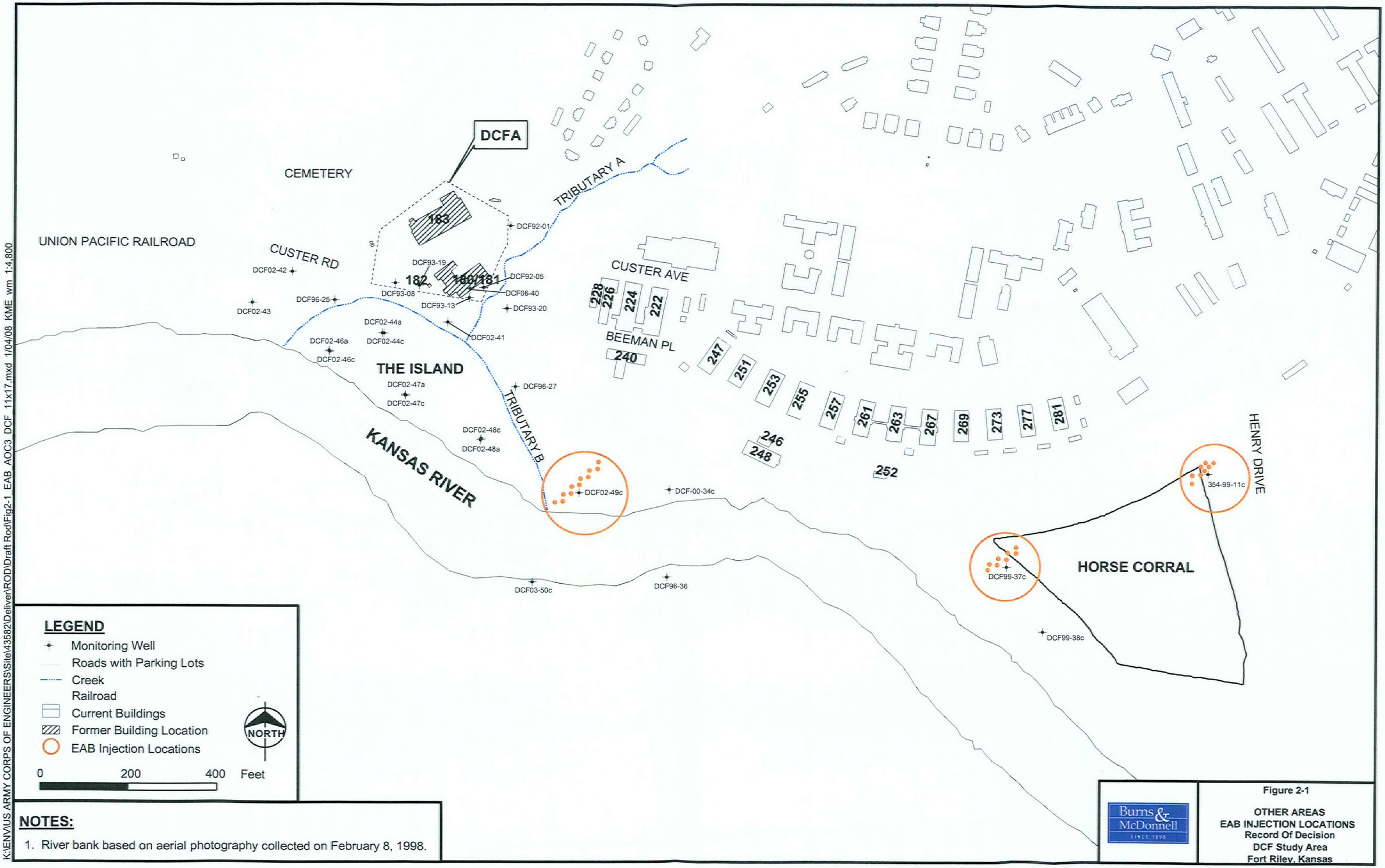
NOTES:

1. River bank based on aerial photography collected on February 8, 1998.

Burns & McDonnell SINCE 1898

Figure 1-4
Areas of Concern
Record of Decision
DCF Study Area
Fort Riley, Kansas

K:\ENV\US ARMY CORPS OF ENGINEERS\Site\43582\Deliver\ROD\Draft Rod\fig1-4_sitespecAOCs3_DCF_11x17.mxd 1/04/08 KME wm 1:4800



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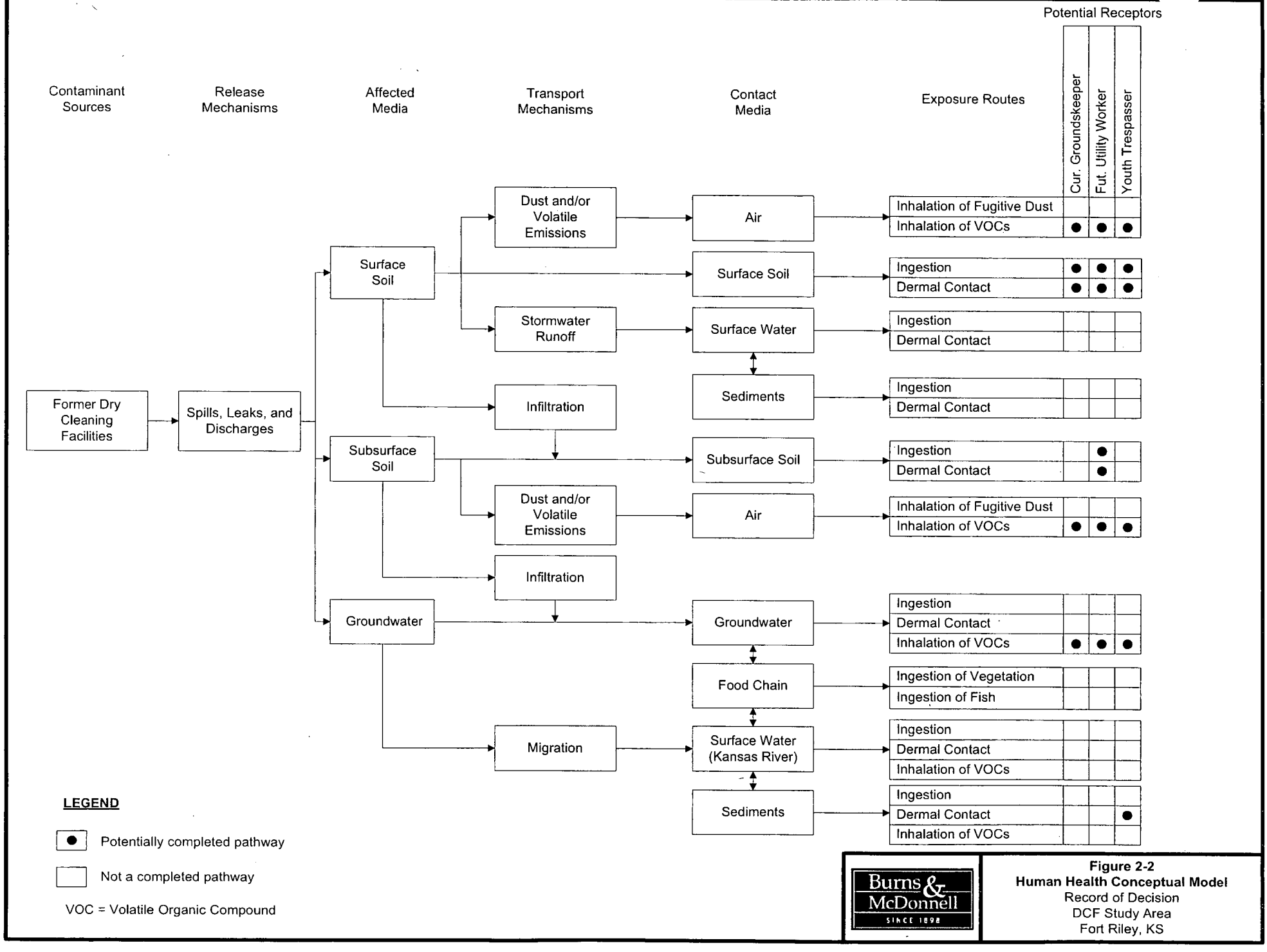

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Burns & McDonnell SINCE 1898

Figure 2-2
Human Health Conceptual Model
Record of Decision
DCF Study Area
Fort Riley, KS

CEMETERY

DCFA

183

TRIBUTARY A

UNION PACIFIC RAILROAD

CUSTER RD

DCF92-01
ND

DCF02-42
NS

DCF93-08
NS

182

180/181

DCF92-05
2.1

DCF96-25
NS

DCF93-19
ND

DCF93-20
2.5

DCF06-40
69.8

DCF93-13
2.6

5

DCF02-44a
56.4

DCF02-41
ND

DCF02-46a
ND

THE ISLAND

DCF02-47a
1.5

DCF96-27
1.6

DCF02-48a
ND

KANSAS RIVER

TRIBUTARY B

CUSTER AVE

228 226 224 222

BEEMAN PL

240

247 251 253 255 257 261 263 267 269 273 277 281

246 248

252

HENRY DRIVE

LEGEND

- Monitoring Well (Sampled)
- Monitoring Well (Not Sampled)
- —5— PCE Isoconcentration Contour (ug/L)
- ----- Study Boundary
- Road or Parking Lot
- Tributaries
- Railroad
- Current Buildings
- Former Building Location

NORTH

400 0 400 Feet

NOTES:

1. All concentrations reported in micrograms per liter (ug/L).
2. 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 isoconcentrations of 5 ug/L (the MCL for PCE).
5. Contours are approximate and dashed where data are insufficient for interpolation between monitoring wells.
6. ND - Not detected above laboratory detection limit.
7. NS - Not sampled.

Burns & McDonnell SINCE 1898

Figure 2-3
PCE RESULTS
TERRACE/SHALLOW ALLUVIAL AQUIFER
SPRING 2007
DCF Study Area
Record of Decision
Fort Riley, Kansas

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CEMETERY

DCFA

183

UNION PACIFIC RAILROAD

CUSTER RD

182

180/181

TRIBUTARY A

CUSTER AVE

228 226 224 222

BEEMAN PL

240

247 251 253 255 257 261 263 267 269 273 277 281

246 248

252

HENRY DRIVE

THE ISLAND

KANSAS RIVER

TRIBUTARY B

DCF02-43
ND

DCF02-46c
ND

DCF02-44c
56.4

DCF02-47c
1.5

DCF02-48c
5.1

DCF02-49c
17.2

DCF00-34c
ND

B354-99-11c
8.7

DCF99-37c
ND

DCF99-38c
ND

DCF03-50c
ND

DCF96-36
ND

LEGEND

- Monitoring Well (Sampled)
- Monitoring Well (Not Sampled)
- –5– PCE Isoconcentration Contour (ug/L)
- Study Boundary
- Road or Parking Lot
- Tributaries
- Railroad
- Current Buildings
- Former Building Location

NORTH

400 0 400 Feet

NOTES:

1. All concentrations reported in micrograms per liter (ug/L).
2. 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 isoconcentrations of 5 ug/L (the MCL for PCE).
5. Contours are approximate and dashed where data are insufficient for interpolation between monitoring wells.
6. ND - Not detected above laboratory detection limit.
7. NS - Not sampled.

Burns & McDonnell SINCE 1898

Figure 2-4
PCE RESULTS
DEEP ALLUVIAL AQUIFER
SPRING 2007
DCF Study Area
Record of Decision
Fort Riley, Kansas

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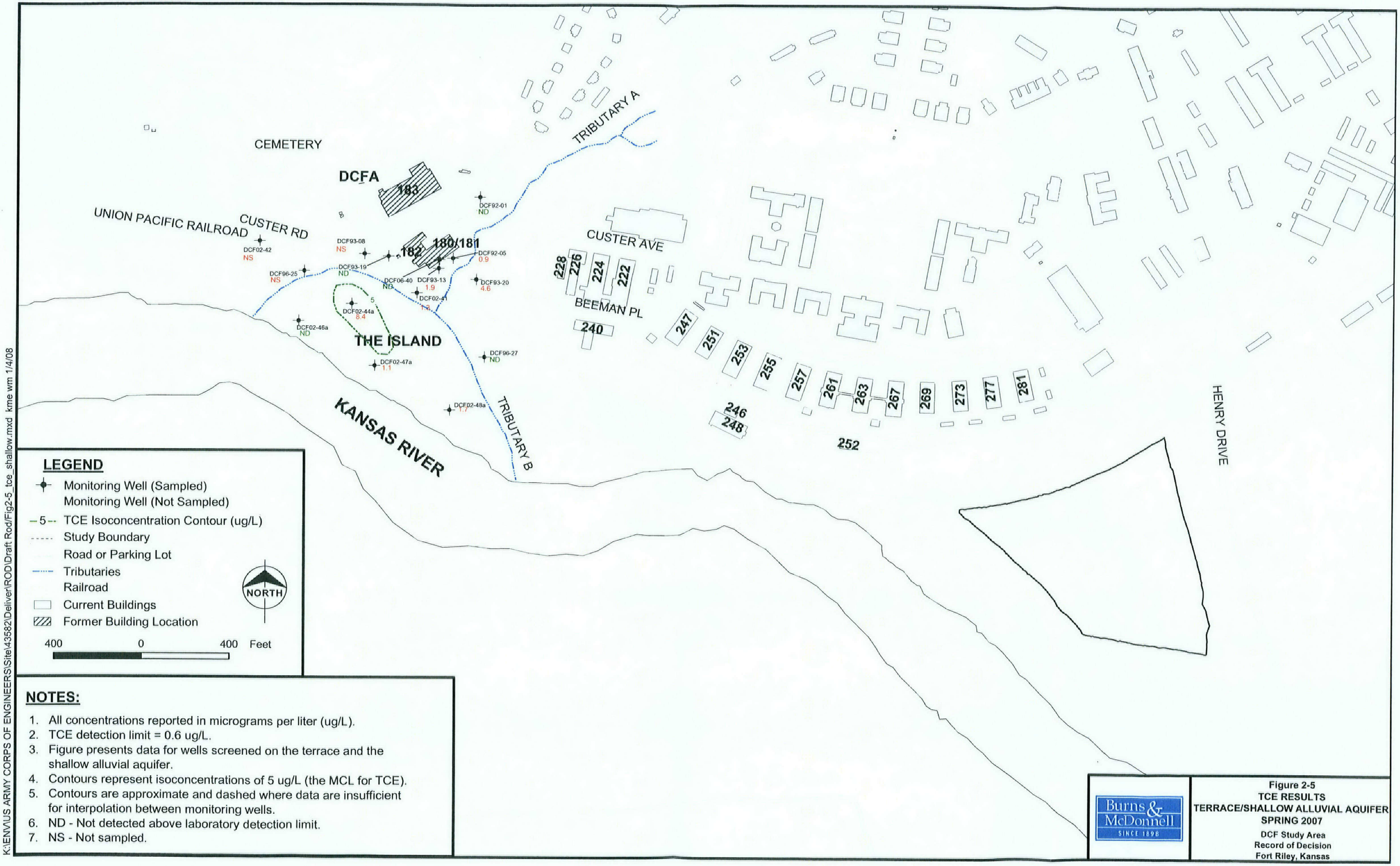

NOTES:

1. All concentrations reported in micrograms per liter (ug/L).
2. TCE detection limit = 0.6 ug/L.
3. Figure presents data for wells screened on the terrace and the shallow alluvial aquifer.
4. Contours represent isoconcentrations of 5 ug/L (the MCL for TCE).
5. Contours are approximate and dashed where data are insufficient for interpolation between monitoring wells.
6. ND - Not detected above laboratory detection limit.
7. NS - Not sampled.

Burns & McDonnell SINCE 1898

Figure 2-5
TCE RESULTS
TERRACE/SHALLOW ALLUVIAL AQUIFER
SPRING 2007
DCF Study Area
Record of Decision
Fort Riley, Kansas

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CEMETERY

DCFA

183

182

180/181

TRIBUTARY A

UNION PACIFIC RAILROAD

CUSTER RD

CUSTER AVE

228 226 224 222

BEEMAN PL

240

247 251 253 255 257 261 263 267 269 273 277 281

246 248

252

HENRY DRIVE

THE ISLAND

KANSAS RIVER

TRIBUTARY B

DCF02-43
ND

DCF02-44c
7.1

DCF02-46c
ND

DCF02-47c
ND

DCF02-48c
ND

DCF02-49c
6.3

DCF00-34c
ND

B354-99-11c
1.6

DCF99-37c
1.0

DCF99-38c
ND

DCF03-50c
ND

DCF96-36
ND

LEGEND

- Monitoring Well (Sampled)
- Monitoring Well (Not Sampled)
- 5 TCE Isoconcentration Contour (ug/L)
- Study Boundary
- Road or Parking Lot
- Tributaries
- Railroad
- Current Buildings
- Former Building Location

NORTH

400 0 400 Feet

NOTES:

1. All concentrations reported in micrograms per liter (ug/L).
2. TCE detection limit = 1.1 ug/L.
3. Figure presents data for wells screened in the deep alluvial aquifer.
4. Contours represent isoconcentrations of 5 ug/L (the MCL for TCE).
5. Contours are approximate and dashed where data are insufficient for interpolation between monitoring wells.
6. ND - Not detected above laboratory detection limit.
7. NS - Not sampled.

Burns & McDonnell SINCE 1898

Figure 2-6
TCE RESULTS
DEEP ALLUVIAL AQUIFER
SPRING 2007
DCF Study Area
Record of Decision
Fort Riley, Kansas

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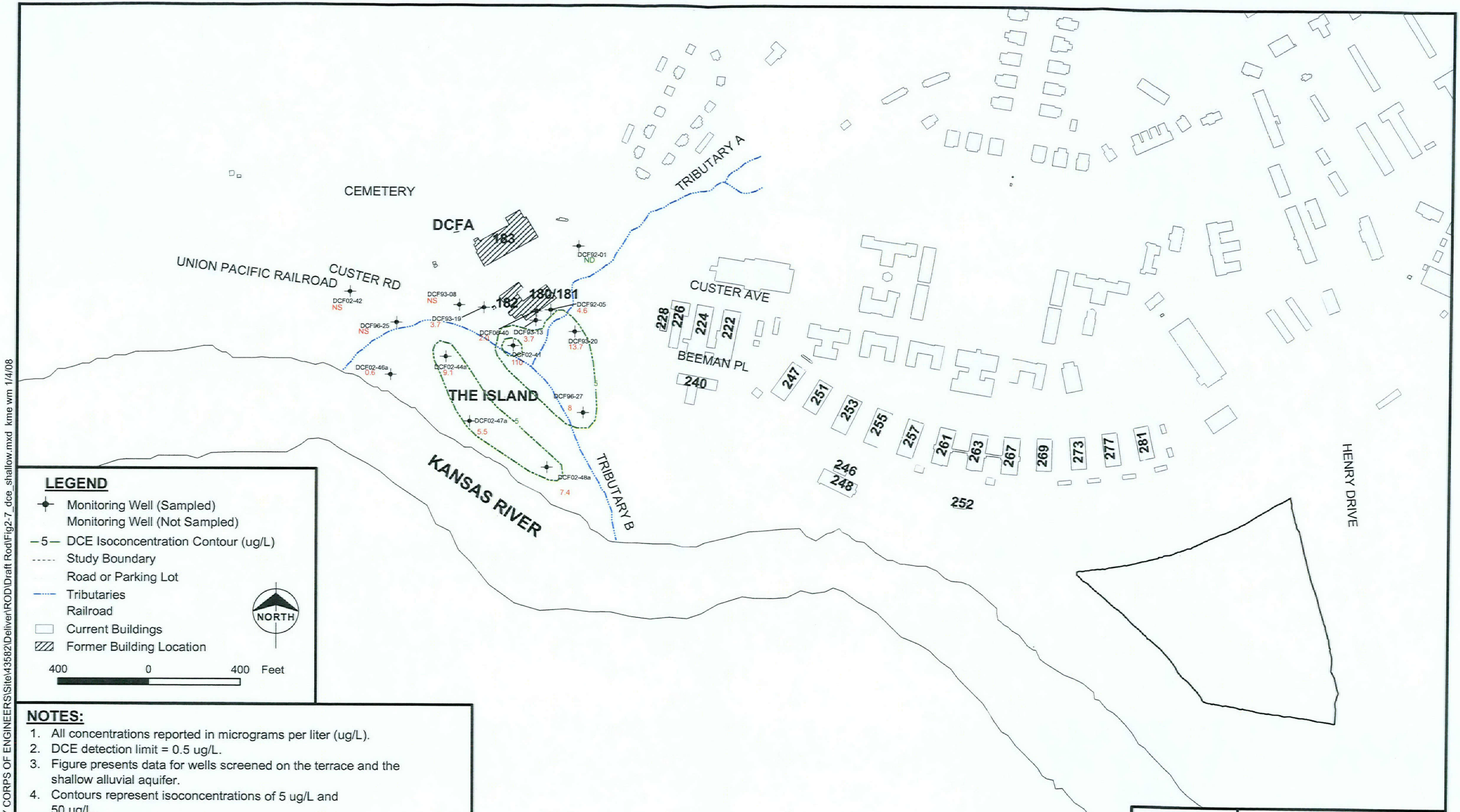

LEGEND

- Monitoring Well (Sampled)
- Monitoring Well (Not Sampled)
- —5— DCE Isoconcentration Contour (ug/L)
- Study Boundary
- Road or Parking Lot
- Tributaries
- Railroad
- Current Buildings
- Former Building Location

NORTH

400 0 400 Feet

NOTES:

1. All concentrations reported in micrograms per liter (ug/L).
2. DCE detection limit = 0.5 ug/L.
3. Figure presents data for wells screened on the terrace and the shallow alluvial aquifer.
4. Contours represent isoconcentrations of 5 ug/L and 50 ug/L.
5. Contours are approximate and dashed where data are insufficient for interpolation between monitoring wells.
6. ND - Not detected above laboratory detection limit.
7. NS - Not sampled.

Burns & McDonnell SINCE 1898

Figure 2-7
DCE RESULTS
TERRACE/SHALLOW ALLUVIAL AQUIFER
SPRING 2007
DCF Study Area
Record of Decision
Fort Riley, Kansas

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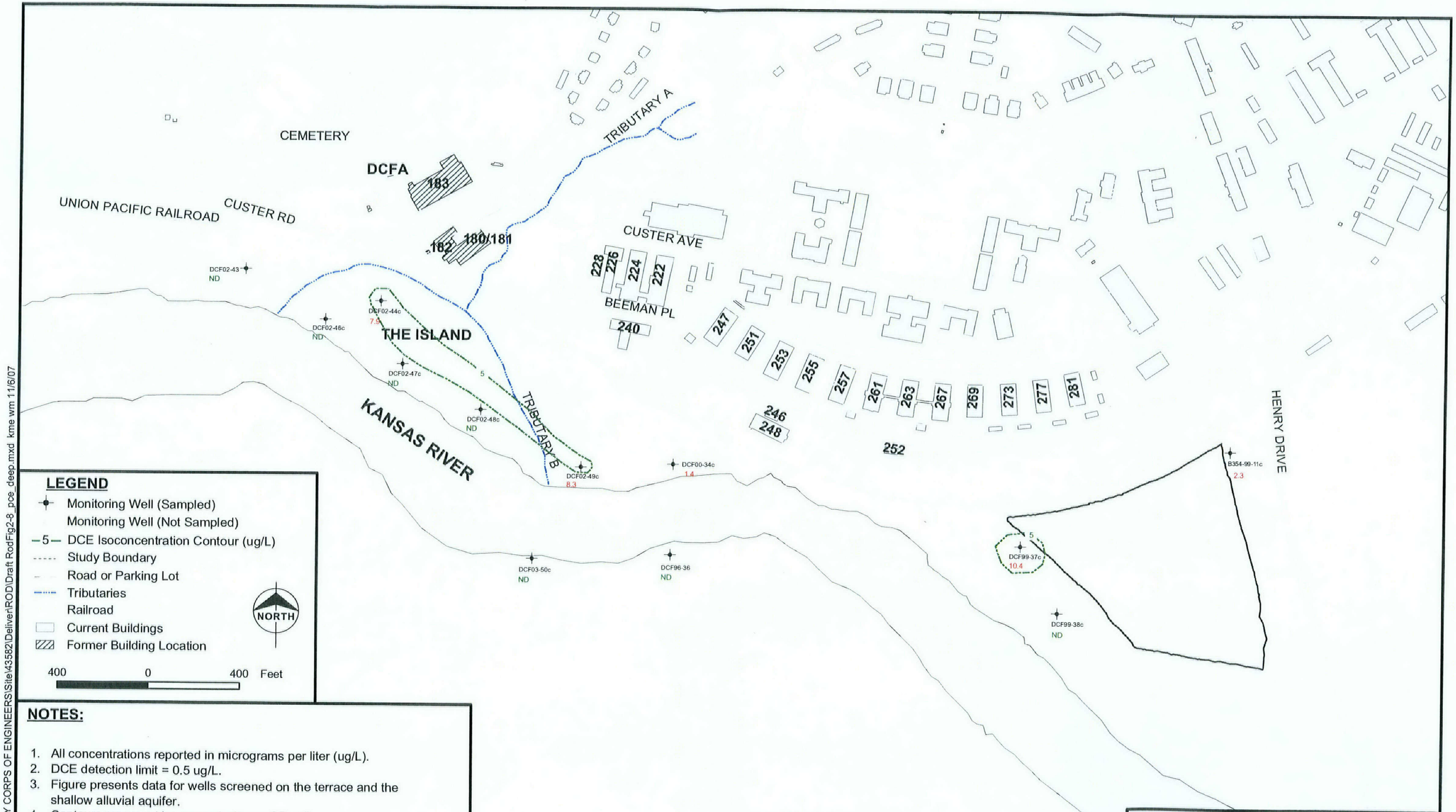


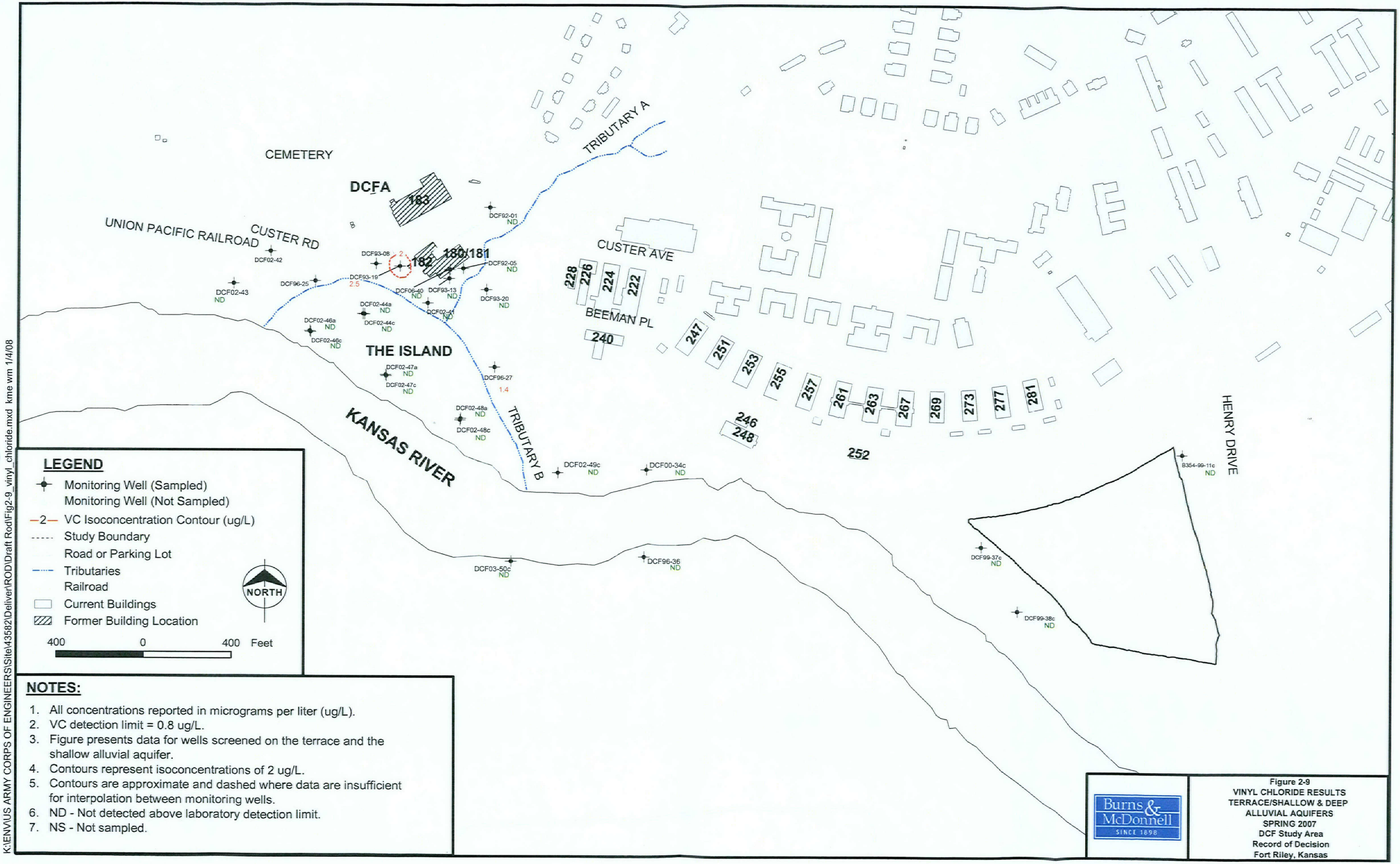
NOTES:

1. All concentrations reported in micrograms per liter (ug/L).
2. DCE detection limit = 0.5 ug/L.
3. Figure presents data for wells screened on the terrace and the shallow alluvial aquifer.
4. Contours represent isoconcentrations of 5 ug/L .
5. Contours are approximate and dashed where data are insufficient for interpolation between monitoring wells.
6. ND - Not detected above laboratory detection limit.
7. NS - Not sampled.

Burns & McDonnell SINCE 1898

Figure 2-8
DCE RESULTS
DEEP ALLUVIAL AQUIFER
SPRING 2007
DCF Study Area
Record of Decision
Fort Riley, Kansas

K:\ENV\US ARMY CORPS OF ENGINEERS\Site\43582\Deliver\RODI\Draft RodFig2-8_poe_deep.mxd kme wm 11/6/07



NOTES:

1. All concentrations reported in micrograms per liter (ug/L).
2. VC detection limit = 0.8 ug/L.
3. Figure presents data for wells screened on the terrace and the shallow alluvial aquifer.
4. Contours represent isoconcentrations of 2 ug/L.
5. Contours are approximate and dashed where data are insufficient for interpolation between monitoring wells.
6. ND - Not detected above laboratory detection limit.
7. NS - Not sampled.

Burns & McDonnell SINCE 1898

Figure 2-9
VINYL CHLORIDE RESULTS
TERRACE/SHALLOW & DEEP ALLUVIAL AQUIFERS
SPRING 2007
DCF Study Area
Record of Decision
Fort Riley, Kansas

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MH 367

MH 369

MH 368E

MH 363

MH 364

BEDROCK
EROSIONAL
CHANNEL

TRIBUTARY A

CUSTER RD

183

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

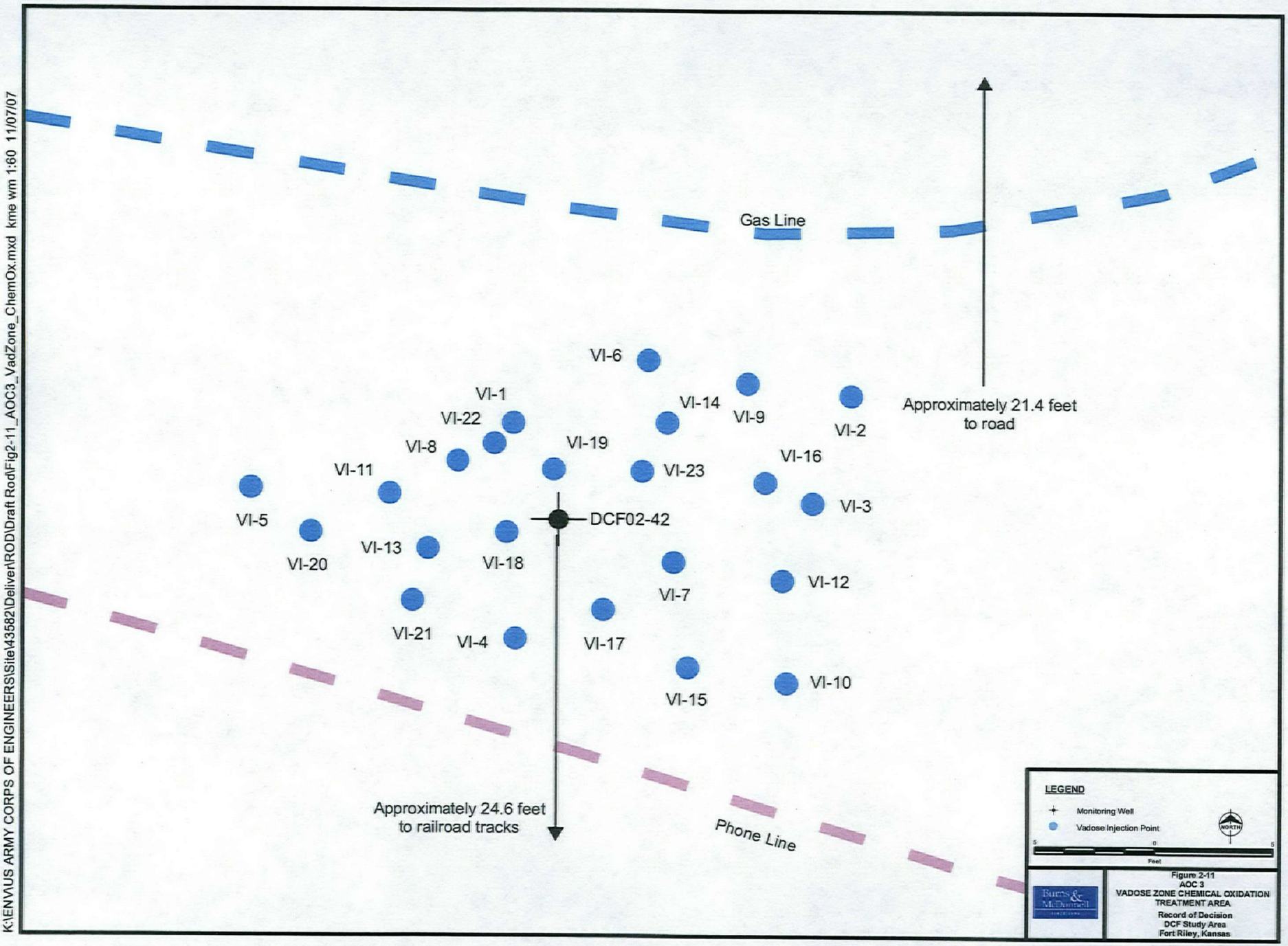
60 0 60 Feet

NOTES:

EAB-Enhanced Anaerobic Bioremediation

Burns & McDonnell SINCE 1898

Figure 2-10
AOC 2
EAB TREATMENT AREA
Record of Decision
DCF Study Area
Fort Riley, Kansas



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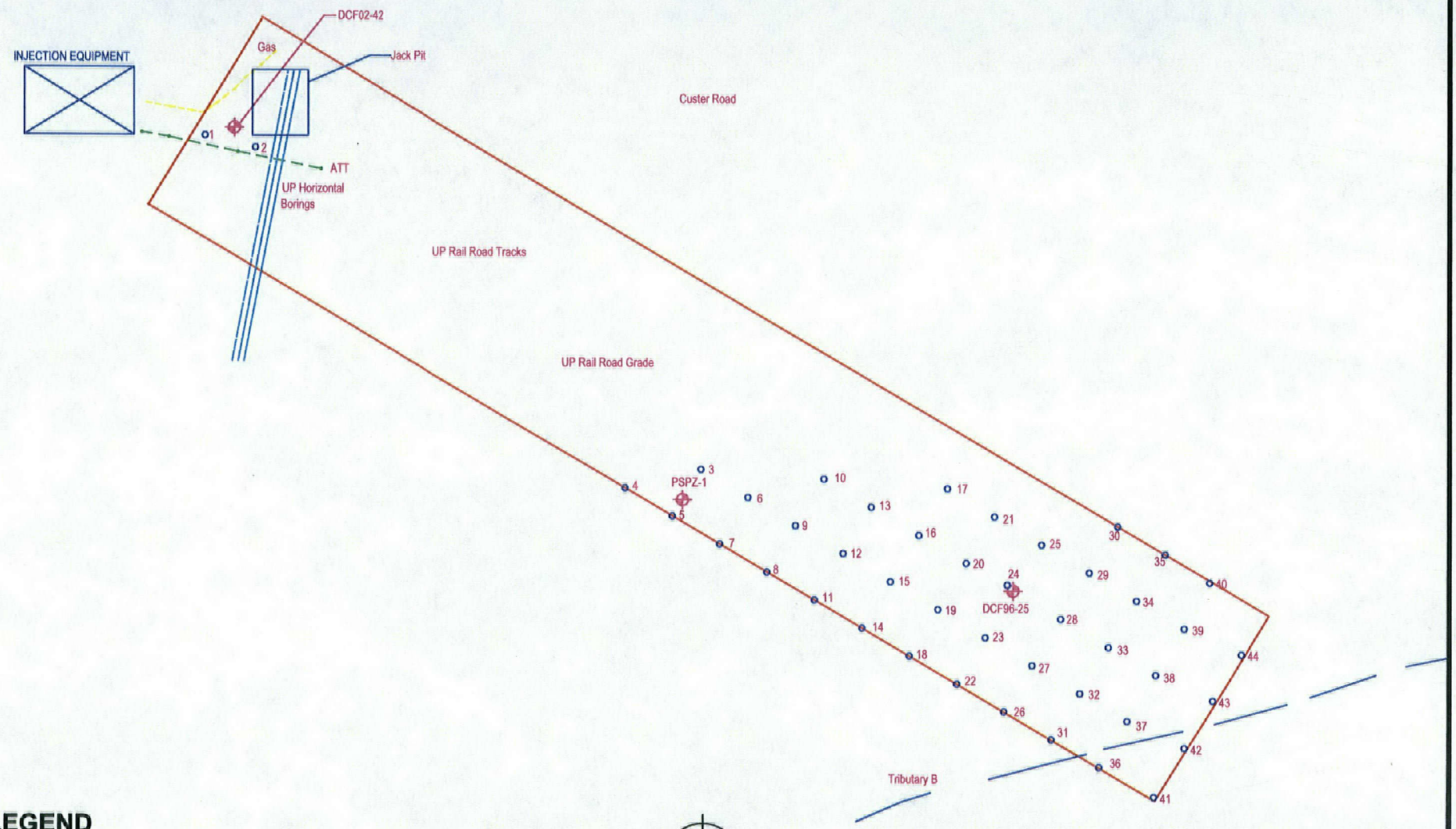

LEGEND

- GAS LINE
- PHONE LINE
- DIRECTIONAL BORING
- INJECTION POINT

N

0 20' 40' 80'

SCALE IN FEET

Burns & McDonnell SINCE 1898

Figure 2-12
AOC 3 Saturated Zone
Chemical Oxidation Application
Record of Decision
DCF Study Area
Fort Riley, Kansas

K:\ENV\US ARMY CORPS OF ENGINEERS\SITE\43582\DELIVER\ROD\DRAFT ROD\FIGURE 2-12.DWG 11-07-2007 13:53 KEVERETT

CEMETERY

DCFA

183

UNION PACIFIC RAILROAD

CUSTER RD

TRIBUTARY A

DCF92-01

DCF93-19

DCF02-42

182

180/181

DCF92-05

DCF93-08

DCF06-40

DCF06-25

DCF93-13

DCF93-20

DCF02-43

DCF02-44a

DCF02-46a

DCF02-44c

DCF02-41

DCF02-46c

THE ISLAND

DCF02-47a

DCF96-27

DCF02-47c

TRIBUTARY B

DCF02-48c

DCF02-48a

KANSAS RIVER

DCF02-49c

DCF-00-34c

DCF03-50c

DCF96-36

CUSTER AVE

228

226

224

222

BEEMAN PL

240

247

251

253

255

257

261

263

267

269

273

277

281

246

248

252

HENRY DRIVE

354-99-11c

DCF99-37c

HORSE CORRAL

DCF99-38c

LEGEND

- Monitoring Well
- Roads with Parking Lots
- Creek
- Railroad
- Current Buildings
- Former Building Location
- EAB Treatment Sites

NORTH

0 200 400 Feet

NOTES:

1. River bank based on aerial photography collected on February 8, 1998.

Burns & McDonnell

Figure 2-13

Island & Horse Corral Treatment Area
Record of Decision
DCF Study Area
Fort Riley, Kansas

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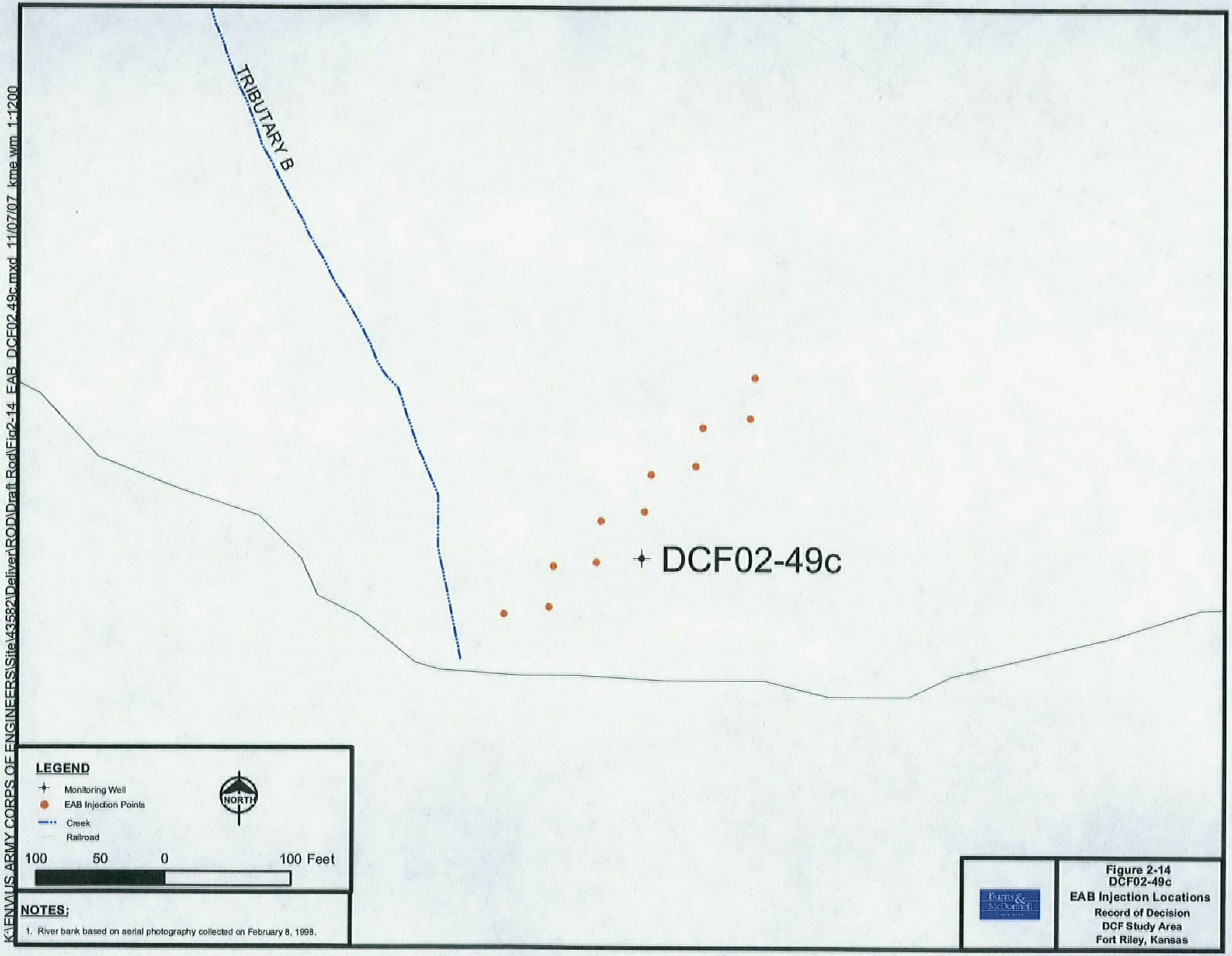
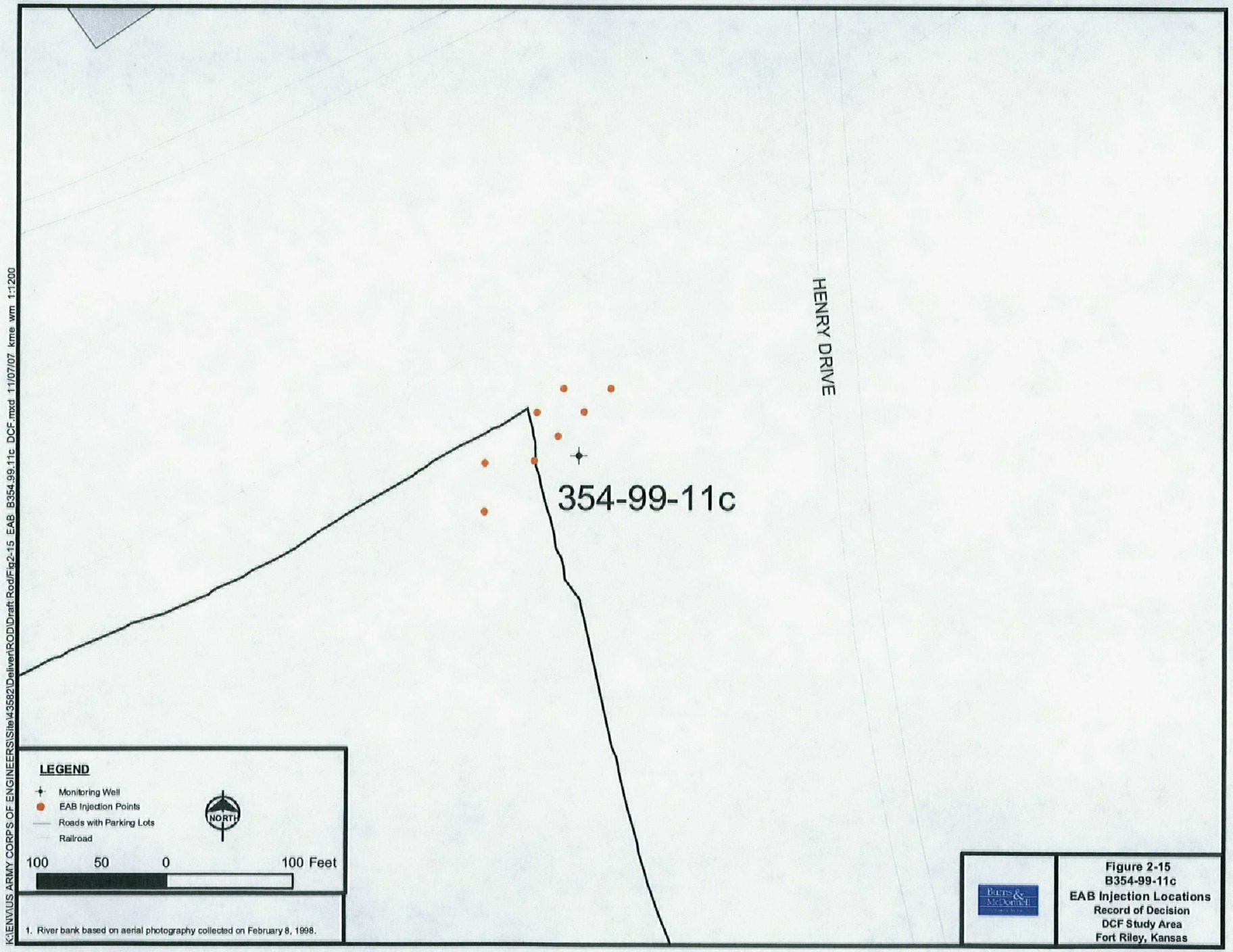
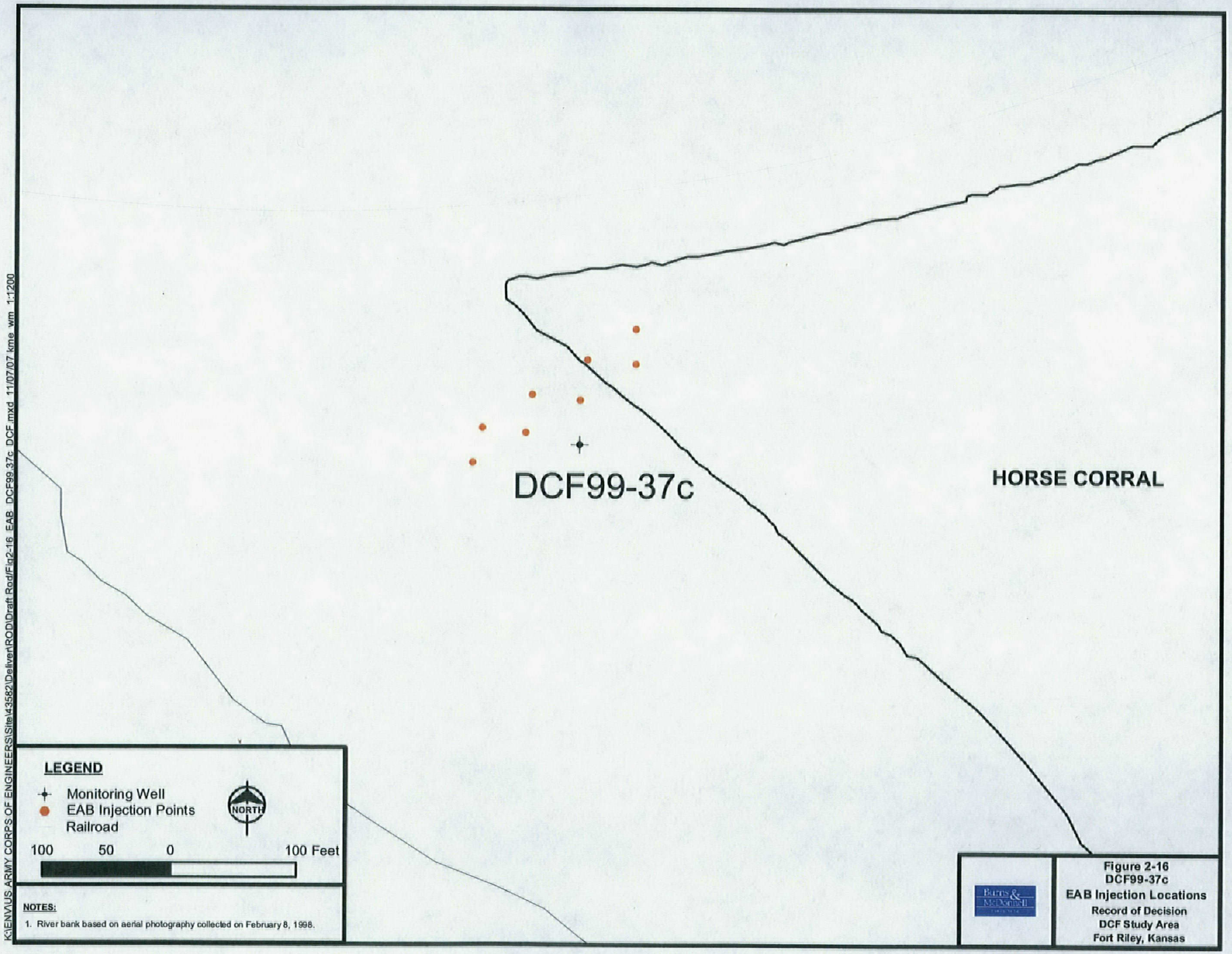

TRIBUTARY B
DCF02-49c
LEGEND
Monitoring Well
EAB Injection Points
Creek
Railroad
NORTH
100 50 0 100 Feet
NOTES:
1. River bank based on aerial photography collected on February 8, 1998.
Figure 2-14
DCF02-49c
EAB Injection Locations
Record of Decision
DCF Study Area
Fort Riley, Kansas
K:\ENV\US ARMY CORPS OF ENGINEERS\Site\43582\Deliver\ROD\Draft Rod\Fig2-14_EAB_DCF02-49c.mxd 11/07/07 kme wm 1:1200


HENRY DRIVE
354-99-11c
LEGEND
Monitoring Well
EAB Injection Points
Roads with Parking Lots
Railroad
NORTH
100 50 0 100 Feet
1. River bank based on aerial photography collected on February 8, 1998.
K:\ENV\US ARMY CORPS OF ENGINEERS\Site\43582\Deliver\ROD\Draft Rod\Fig2-15 EAB B354-99-11c DCF.mxd 11/07/07 kme wm 1:1200
Burns & McDonnell
Figure 2-15
B354-99-11c
EAB Injection Locations
Record of Decision
DCF Study Area
Fort Riley, Kansas


DCF99-37c
HORSE CORRAL
LEGEND
Monitoring Well
EAB Injection Points
Railroad
NORTH
100 50 0 100 Feet
NOTES:
1. River bank based on aerial photography collected on February 8, 1998.
Figure 2-16
DCF99-37c
EAB Injection Locations
Record of Decision
DCF Study Area
Fort Riley, Kansas
K:\ENV\US ARMY CORPS OF ENGINEERS\Site\43582\Deliver\ROD\Draft Rod\Fig2-16_EAB_DCF99-37c_DCF.mxd 11/07/07 kme wm 1:1200

MH 367
MH367 Excavation Area
HPGL
Abandoned In Place Sewerlines and Manholes
MH 365
Active Gas Line
Storm Water Catch Basin
TRIBUTARY A
MH 364
MH 363
AREA #2
408
407
412
423
AREA #1
403
402
418
433
432
431
430
DCF06-40
183
181
182
DCF02-42
CUSTER RD
TRIBUTARY B
UNION PACIFIC RAILROAD

LEGEND

- Monitoring Well Abandoned & Replaced
- Manholes
- High Pressure Gas Line (HPGL)
- Active Gas Line
- Subsurface Soil Sample Locations
- Former Building Locations
- Tributaries
- Railroad
- Roads and Parking Lots
- Former Sanitary Sewer and Manhole with PCE concentrations over KDHE RSK value of 180 ug/kg
- Suspected Soil Source Areas

NORTH

100 0 100 Feet

Burns & McDonnell SINCE 1898

Figure 2-17

Possible Source Areas
Record of Decision
DCF Study Area
Fort Riley, Kansas

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CEMETERY

DCFA

183

UNION PACIFIC RAILROAD

CUSTER RD

TRIBUTARY A

DCF92-01

DCF02-42

DCF93-08

182

180/181

DCF92-05

DCF93-19

DCF96-25

DCF01-40

DCF93-13

DCF93-20

DCF02-41

DCF02-44a

DCF02-46a

THE ISLAND

DCF96-27

DCF02-47a

KANSAS RIVER

DCF02-48a

TRIBUTARY B

DCF02-49c

CUSTER AVE

228 226 224 222

BEEMAN PL

240

247 251 253 255 257 261 263 267 269 273 277 281

246 248

252

HENRY DRIVE

LEGEND

- Monitoring Well (Sampled)
- Monitoring Well (Not Sampled)
- –5– PCE Isoconcentration Contour (ug/L)
- ----- Study Boundary
- Road or Parking Lot
- Tributaries
- Railroad
- Current Buildings
- Former Building Location
- Fall 2007
- Spring 2004

NORTH

400 0 400 Feet

NOTES:

1. All concentrations reported in micrograms per liter (ug/L).
2. 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 isoconcentrations of 5 ug/L (the MCL for PCE).
5. Contours are approximate and dashed where data are insufficient for interpolation between monitoring wells.
6. ND - Not detected above laboratory detection limit.
7. NS - Not sampled.

Burns & McDonnell SINCE 1898

Figure 2-18
AOC 3 PCE Plume Comparison
Fall 2007 / Spring 2007
DCF Study Area
Record of Decision
Fort Riley, Kansas

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