

**DRAFT**

**Remedial Action Completion Report**

**Dry Cleaning Facilities Study Area**

**(Operable Unit 003)**

**at**

**Main Post**

**Fort Riley, Kansas**

Prepared for  
U.S. Army  
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## List of Acronyms and Abbreviations

AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
cis-1,2- DCE	cis-1,2 Dichloroethene
COC	Chemical of concern
COPC	Chemical of potential concern
DCFA	Dry Cleaning Facilities Study Area
EPA	U.S. Environmental Protection Agency
FTRI	Fort Riley
HGL	HydroGeoLogic, Inc.
IC	Institutional Control
KDHE	Kansas Department of Health and Environment
LTM	Long-Term Monitoring
LUCP	Land Use Control Plan
MAROS	Monitoring and Remediation Optimization System
MCL	Maximum Contaminant Level
µg/L	Micrograms Per Liter
MNA	Monitored Natural Attenuation
OU	Operable Unit
PCE	Tetrachloroethene
PWE	Directorate of Public Works – Environmental Division
RAO	Remedial Action Objective
RA	Remedial Action
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision

## **List of Acronyms and Abbreviations (Continued)**

RSKs	Risk-Based Standards for Kansas
RPMP	Real Property Master Plan
USACE KC	U.S. Army Corps of Engineers, Kansas City District
TA2	Training Area 2
TCE	Trichloroethene
VC	Vinyl Chloride
VOC	Volatile Organic Compound

# 1. Background

## 1.1 Site Location and History

The Fort Riley, Kansas, Dry Cleaning Facilities Study Area (DCFA), Operable Unit 003 (OU 003) is located on the Main Post cantonment area of the Fort Riley Military Installation, near Junction City, Kansas (Figure 1). The term DCFA used in this document is defined as the entire OU 003 which consists of five areas; the original study area and four additional areas added during the investigative period (Figure 2). These five areas are described as follows:

- The original dry cleaning facilities area which 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 these locations.
- The Transition Zone
- The Island
- The Horse Corral
- Training Area 2 (TA2)

Dry cleaning operations were conducted at former Buildings 180/181 and 183. Former Buildings 180/181 operated as a laundry facility from 1915 to 1983 and as a dry cleaning facility from 1930 to 1983. From 1983 until 2000, former Buildings 180/181 were used for general storage. Former Building 183 was initially used as a laundry facility from construction in 1941 until 2002, and as a dry cleaning facility from 1983 to 2002.

Stoddard solvent, a petroleum distillate mixture, was used as the dry cleaning solution from 1944 until 1966. From 1966 until dry cleaning operations ceased, tetrachloroethene (PCE) was used as the cleaning solution. Buildings 180/181 and the surrounding structure, parking lots and sidewalks were demolished in summer 2000. Building 183 and the surrounding structures were demolished in fall 2002. These locations are now empty grassy lots.

Site investigation activities began in 1991. During the investigative phase, prior to the ROD, several areas of concern (AOCs) were addressed by removal action/pilot studies approved by Fort Riley with the concurrence of U.S. Environmental Protection Agency (EPA) and Kansas Department of Health and Environment (KDHE). The AOCs are listed in the ROD as follows:

- AOC 1 - Soils in the vicinity of the former DCFA Buildings 180/181
- AOC 2 - Groundwater in the vicinity of the former DCFA Buildings 180/181
- AOC 3 – Soil and Groundwater in an area which included portions of the Transition Zone and the Island

In addition to the above AOCs, groundwater at three additional areas identified as Other Areas (one on the Island and two at the Horse Corral) were treated as part of the removal action/pilot studies.

Soil concentrations of tetrachloroethene (PCE) above the Risk-Based Standards for Kansas (RSKs) were detected at two shallow soil source areas to a maximum depth of twelve feet at AOC 1. These soil sources were removed during a Pilot Study and soil (AOC 1) is no longer a medium of concern.

Following the various Pilot Studies, only groundwater at AOC 2 and AOC 3 remain a medium of concern. PCE, trichloroethene (TCE), cis-1,2-Dichloroethene (cis-1,2-DCE), and vinyl chloride (VC) are the chemicals of concern (COCs).

**Table 1 - Chronology of Site Activities Leading up to the ROD**

Year	Activity
1991	Site investigation field activities were conducted.
1992	Preliminary Assessment was conducted, including monitoring well installation, PCE, TCE, DCE, and VC detected in soil and groundwater at DCFA.
1994	Remedial Investigation (RI) conducted to identify the types, quantities, and distribution of contaminants.
1994/1995	Soil vapor extraction contaminant removal action and pilot study conducted.
1995	Feasibility Study prepared and submitted.
1998	After completion of additional sampling, KDHE approved the RI.
2000	EPA reviewed the removal actions conducted in 1994 and 1995.
	FTRI conducted additional source screening.
2002	Additional groundwater investigations conducted. Soil sampling conducted after demolition of Buildings 183 and 184.
2004	RI Addendum prepared summarizing additional soil and groundwater investigations conducted in 2002, submitted and approved.
2005 to 2007	AOC 1 and AOC 2: Pilot study for soil and groundwater remediation conducted, involving treatment and removal of 2,400 cubic yards of soil, injection of 3,692 gallons of 10 percent sodium permanganate solution and 8,200 pounds of CAP18™.

Year	Activity
2005 to 2007 cont'd	AOC 3: Pilot study involving vadose zone injection of approximately 7,400 pounds of sodium permanganate aqueous solution. Pilot study involving saturated zone injection of 21,755 pounds of potassium permanganate.
	Other Areas: Pilot study involving injection of 5,530 pounds of CAP18™.

## 1.2 Record of Decision Requirements

The selected remedy for the DCFA at Fort Riley, as stated in the ROD dated January 16, 2008, and approved on March 18, 2008, is Monitored Natural Attenuation (MNA) with Institutional Controls (ICs) (Alternative 2).

MNA relies on natural degradation processes already demonstrated to be occurring at the DCFA to further reduce contaminant concentration to or below the Maximum Contaminant Levels (MCLs). Monitoring is to be conducted to follow the effectiveness and progress of natural attenuation. ICs are to be utilized to prevent exposure of receptors to contaminated groundwater.

For the MNA program, the objectives are to:

- Monitor groundwater contaminant concentrations and reduce contaminant levels, to the extent practicable and appropriate through natural attenuation processes, and
- Monitor geochemical parameters to determine if conditions favorable to MNA are present.

The purpose of ICs for the DCFA at Fort Riley is to restrict the use of groundwater in accordance with the ROD and Applicable or Relevant and Appropriate Requirements (ARARs).

## 1.3 Remedial Action Objectives

The remedial action objectives (RAOs) for the DCFA are to:

- Prevent further degradation in groundwater in the Kansas River alluvium and off-site migration in groundwater of Chemicals of Potential Concern (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 clean-up levels for the DCFA are as follows:

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

## **1.4 Remedial Design**

In accordance with Section 1.5 of the Remedial Design (RD)/Remedial Action (RA) Plan issued on June 26, 2008, the key elements of the selected remedy to be implemented are:

- Periodic sampling of the 25 monitoring wells,
- Conducting annual inspections and periodic maintenance and repair of the 25 monitoring wells,
- Restricting site access and the installation and use of groundwater wells at the DCFA and downgradient,
- Conducting a review in accordance with Section 121 (c) of CERCLA no less often than every five years after initiation. The first five-year review of the selected remedy will include consideration of the following factors:
  - The performance of MNA in achieving clean-up levels (MCLs),
  - Use of the property above the groundwater plume to ensure that groundwater with contamination above clean-up levels (MCLs) is not used, and
  - If no Island alluvial wells exceed groundwater cleanup levels (MCLs) for the COPCs at the end of the three years of sampling (2008, 2009, 2010) or during the 5-year review sampling, a recommendation for discontinuing sampling and site close out will be made as part of the five-year review. Otherwise, sampling will continue as discussed in the RD/RA Plan.

In accordance with the RD/RA Plan, samples obtained from the monitoring wells are to be sampled for Target Compound List Volatile Organic Compounds (VOCs), natural attenuation parameters (methane, ethane, ethene, alkalinity, total organic carbon, nitrate, nitrite, sulfide, sulfate, dissolved oxygen, oxidation-reduction potential, and ferrous iron), and general water quality parameters (temperature, pH, turbidity, and specific conductivity). Groundwater level measurements are also to be taken to determine groundwater flow direction.

## **2. Remedial Action Implementation (Construction Activities)**

### **2.1 Monitored Natural Attenuation**

Existing groundwater monitoring wells were utilized for monitoring COCs and natural attenuation parameters in accordance with the RD/RA Plan. Approved Sampling Plans were followed for each sampling event. Following each sampling event, Annual Long-Term Monitoring (LTM) Reports were submitted to the Army, EPA and KDHE for review. These reports documented field activities performed (static water level measurements, monitoring well and pump inspections, sampling), analytical results of contaminants, analysis of natural attenuation parameters, and pilot study performance review. Quality Control Summary Reports also were issued.



## 2.2 Additional Treatment of Groundwater at AOC 2 (Pilot Study)

In February of 2010, at AOC 2, approximately 2,500 pounds of CAP 18™ was injected into the deepest portion of the bedrock erosions to enhance the degradation of the chlorinated VOC in the area. This bottom up injection, starting at bedrock, augmented the initial 2006 AOC 2 top down injection which did not treat the deepest portion of the erosional trench. The CAP 18™ was injected through 10 injection points along the axis of the bedrock erosional channel in the area surrounding monitoring wells DCF06-40, DCF93-03, and DCF93-13 (CTI, 2012).

## 2.3 Institutional Controls

ICs were incorporated into the Fort Riley Real Property Master Plan (RPMP) restricting building construction and demolition, digging and trenching, and installation of drinking water wells at the DCFA.

## 3. Chronology of Events

**Table 2 - Chronology of Site Activities Following the ROD**

Year	Activity
2008	ROD approved with selected remedy of MNA and ICs.
2009	RD/RA Plan approved
2008 and 2009	Annual groundwater monitoring conducted as part of MNA.
2010	AOC 2: Treatment of groundwater with 2,500 pounds of CAP18™.
2010 and 2011	Groundwater monitoring conducted semi-annually
2012	Installation-wide Five Year Review conducted and concluded biodegradation is contributing to a decrease in PCE concentration.
2012 to present	Annual groundwater monitoring conducted as part of MNA.
2015	Microcosm/Bench-scale Study
2017	Installation-wide Five Year Review conducted and concluded bioremediation continues to effectively reduce PCE concentrations.

Following the ROD, groundwater sampling events were conducted annually in 2008 and 2009 in accordance with the RD/RA Plan. Groundwater sampling occurred twice in 2010 following the CAP 18™ injection at AOC 2.

Since VOCs continued to be detected above MCLs, two additional groundwater sampling events were conducted in 2011 and annual groundwater sampling events resumed in 2012.

## **4. Performance Evaluation**

### **4.1 FTRI Five Year Review 2012**

In 2012, the DCFA was included in the Fort Riley Five-Year Review. The Review concluded MNA with ICs are functioning as intended. It stated seventeen wells are currently sampled to evaluate the site, with six of those wells showing no exceedances of MCL for any COCs within the past five years. Of the remaining eleven wells, six show statistically significant downward trends of PCE contamination. The presence of degradation daughter products, cis-1,2-DCE and VC in small amounts indicated that bio-degradation is contributing to the decline of PCE concentrations.

The 2012 Five-Year Review also stated ICs are implemented through the RPMP and Land Use Control Plan (LUCP). ICs included restricting land use, limiting public access, prohibiting installation of drinking water wells and groundwater use in the area, and involving the Fort Riley Directorate of Public Works – Environmental Division (PWE) personnel in proposed future plans for the site. The RPMP restricts residential development at the site and prohibits digging and trenching. The LUCP dated July 2012, addressed internal PWE procedures on annual inspection and integration with the National Environmental Protection Act review process. The site visit revealed no evidence of development or excavation activities. The Review concluded the current implementation of the RPMP and LUCP requirements are effective in preventing exposure to potential receptors.

### **4.2 Microcosm/Bench Scale Study**

In 2015, a bench-scale microcosm study was conducted at OU3 to determine whether biodegradation using native microorganisms to address PCE could be stimulated in situ. The report concluded that biodegradation is occurring. Although biodegradation could be enhanced by stimulation with soybean oil emulsion, Fort Riley concluded that further treatment was not warranted based on physical site conditions and access limitations at source areas (2017 Five-Year Review).

### **4.3 FTRI Five Year Review 2017**

Another Five-Year Review was conducted at Fort Riley in 2017. The 2017 Five -Year Review concluded the remedy is functioning as intended. The Review stated the groundwater monitoring data from the last five years suggests that MNA continues to be effective in meeting the RAOs for the DCFA and that the ranges of MNA parameters also indicated favorable conditions for bioremediation. The Review further stated statistical trend analyses generally indicated decreasing and stable trends for PCE trends across the DCFA. An increasing trend was noted in one well located side-gradient from the treatment area at AOCs 1 and 2, which may

indicate that PCE has migrated from the potential source area. However, the source area has been remediated and the PCE trend is likely to reverse in time (note: this side gradient well DCF93-20 has not exceeded the MCL for PCE since 2013). Increasing trends for cis-1,2-DCE and VC were noted in one well in the source area in AOCs 1 and 2. The increase in breakdown products is expected where MNA is occurring.

The 2017 Five-Year Review also concluded ICs continue to be effective. The Fort Riley RPMP restricts building construction and demolition, digging and trenching, and installation of drinking water wells at the DCFA. The ICs have been enforced through annual inspections and the dig permitting processes that are monitored by the PWE personnel. In addition, a LUCP was prepared in 2015 to ensure that current and future activities are compatible with land use restrictions by identifying several processes such as the “Site Approval Process” used for reviewing and approving excavation and construction projects, as well as other land use changes on the installation. The Five-Year Review has also documented that the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection are still valid and that no other information has come to light that could call into question the protectiveness of the remedy.

#### **4.4 Continued Annual Monitoring Events**

Since the 2012 Five-Year Review, annual groundwater monitoring events have occurred. Groundwater flow direction has consistently been reported as southwest towards the Kansas River. As more data became available, statistical trend analyses utilizing the Mann Kendall test and optimization evaluations utilizing MAROS (Monitoring and Remediation Optimization System) were conducted. Since the ROD, between 24 and 18 wells were monitored during each sampling event; the numbers of wells sampled varied due to damage, insufficient water levels, inaccessibility, or concurrence by the regulators to reduce sampling at wells where contaminants have not been detected for years. Overall, contamination decreased steadily through the years with some fluctuations potentially caused by either rebounding following the pilot studies or high groundwater/river levels.

### **5. Ongoing Activities**

While monitored natural attenuation is effective, annual groundwater monitoring will continue at the DCFA until all COCs are below the MCLs. The estimated time of remediation was initially calculated in the 1998 Revised FS as being between ten and thirty years (fast and slow flush respectively). In the Five-Year Review conducted in 2012, following the 2010 pilot study, it was estimated that DCE levels in monitoring well DCF02-41 at AOC 2 were projected to drop below the MCL in 2013 and the PCE levels in monitoring well DCF06-25 at AOC 3 were projected to drop below the MCL in 2017. To date, cleanup goals have not been met, however, statistical trends will continue to be analyzed during each sampling event and future Five-Year Reviews.

ICs will continue to be implemented and will be evaluated during Five-Year Reviews. Five-Year Reviews of the DCFA will continue to be a part of the installation wide Fort Riley Five-Year Review as appropriate.

## **6. Exit Strategy**

The Army will utilize EPA's August 2014 Recommended Approach for Evaluating Completion of Groundwater Restoration Remedial Actions at a Groundwater Monitoring Well (OSWER 9283.1-44) in conjunction with the July 2014 Groundwater Statistics Tool User's Guide (OSWER 9283.1-46) to achieve closeout. Specifically, groundwater monitoring will cease when the detections of all COCs or the 95% Upper Confidence Levels are below their MCLs and demonstrate a decreasing or stable statistical trend for eight consecutive sampling events at all monitoring wells. Groundwater monitoring may be switched from annual to semiannual or quarterly when all COCs detections approach the MCLs. All changes to groundwater monitoring will be approved by EPA and KDHE. Once groundwater monitoring is no longer required, the DCFA will be recommended for closeout.

## **7. Summary**

This Remedial Action Completion Report summarizes the remedial activities completed at the FTRI OU 003, DCFA, Fort Riley, Kansas. The selected remedy of monitored natural attenuation and institutional controls are effective in achieving the remedial action objectives to:

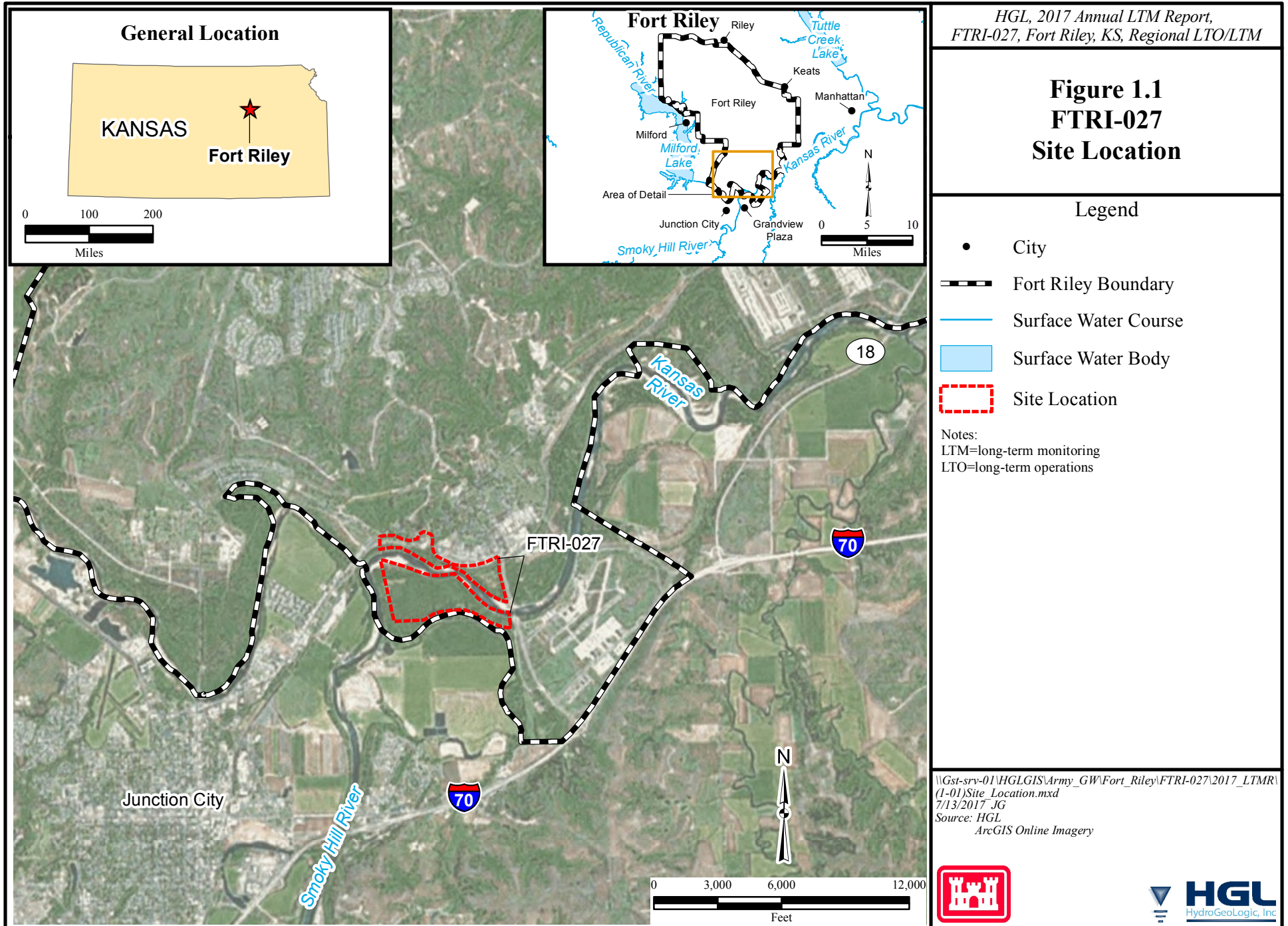
- Prevent further degradation in groundwater in the Kansas River alluvium and off-site migration of COPCs that exceed cleanup goals; and
- Achieve cleanup goals of MCLs for COPCs in groundwater in the Kansas River alluvium through the use of natural and/or active remedial processes.

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## **Figure 1 Site Location Map**

Figure 1. Site Location Map Source: HGL, 2017 Annual LTM Report, FTRI-027, Fort Riley, KS, Regional LTO/LTM

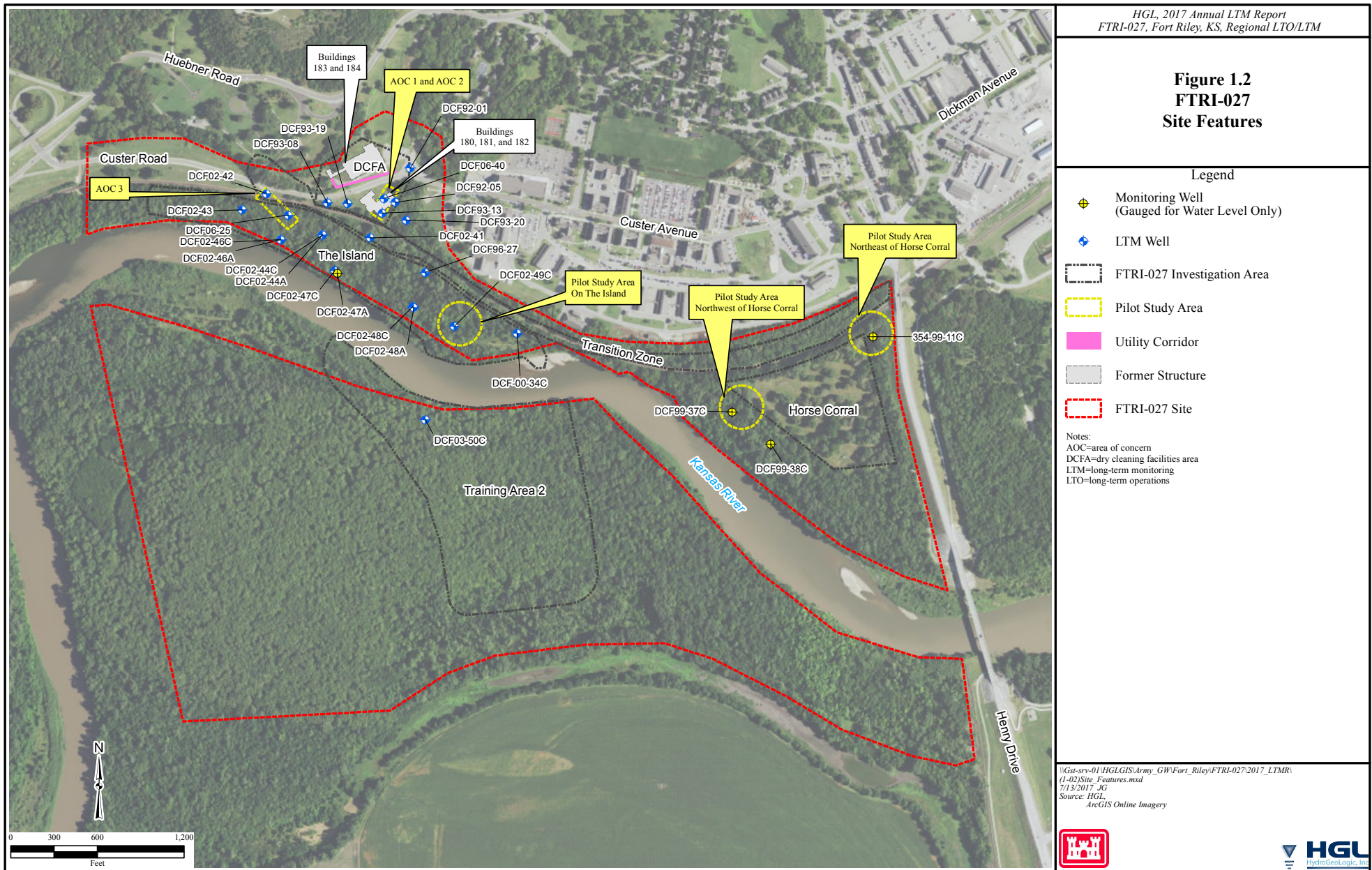


**Figure 2 Dry Cleaning Facilities Area, Areas of Concern and Well Locations**



# Figure 2. Dry Cleaning Facilities Area, Areas of Concern and Well Locations

Source: HGL, 2017 Annual LTM Report, Fort Riley, KS, Regional LTO/LTM



HGL, 2017 Annual LTM Report  
FTRI-027, Fort Riley, KS, Regional LTO/LTM

**Figure 1.2**  
**FTRI-027**  
**Site Features**

**Legend**

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

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

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Source: HGL  
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