00098892

FINAL
RECORD OF DECISION
LHAAP-50, FORMER SUMP WATER TANK, GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Prepared for

U.S. Army Corps of Engineers
Tulsa District
1645 South 101st Avenue
Tulsa, Oklahoma

Prepared by

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
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Acronyms and Abbreviations

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
ARARs	applicable or relevant and appropriate requirements
AST	aboveground storage tank
AT123D	Analytical Transient One-, Two-, Three-Dimensional
BERA	baseline ecological risk assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COC	chemicals of concern
COPC	chemical of potential concern
CWA	Clean Water Act
DCA	dichloroethane
DCE	dichloroethene
ECOP	Environmental Condition of Property
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FR	Federal Register
FS	Feasibility Study
GW-Ind	TCEQ groundwater MSC for industrial use
GW-Res	TCEQ groundwater MSC for residential use
GWP-Ind	TCEQ soil MSC for industrial use based on groundwater protection
HI	hazard index
HQ	hazard quotient
Jacobs	Jacobs Engineering Group, Inc.
LHAAP	Longhorn Army Ammunition Plant
LTM	long-term monitoring
LUC	land use control
MCL	maximum contaminant level
mg/kg-day	milligrams per kilogram per day
MNA	monitored natural attenuation
MOA	Memorandum of Agreement
MSC	medium-specific concentration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List

Acronyms and Abbreviations (continued)

O&M	operations and maintenance
Plexus	Plexus Scientific Corporation
PCE	tetrachloroethene
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RFA	RCRA Facility Assessment
RfD	reference dose
ROD	Record of Decision
RRS	Risk Reduction Standard
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
Shaw	Shaw Environmental, Inc.
STEP	Solutions to Environmental Problems
TAC	Texas Administrative Code
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TNT	trinitrotoluene
U.S. Army	U.S. Department of the Army
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Material Agency
USC	U.S. Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VC	vinyl chloride
VOC	volatile organic compounds

1.0 Declaration

1.1 Site Name and Location

LHAAP-50, Former Sump Water Tank, Group 4.

Longhorn Army Ammunition Plant
Karnack, Texas

Comprehensive Environmental Response, Compensation, and Liability Information System, U.S. Environmental Protection Agency (USEPA) Identification Number: TX6213820529.

1.2 Statement of Basis and Purpose

This decision document presents the selected final remedy for LHAAP-50, Former Sump Water Tank, Group 4, located at the Longhorn Army Ammunition Plant (LHAAP) in Karnack, Texas. The remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Code of Federal Regulations (CFR) Title 40 §300.

The remedy selection was based on the Administrative Record for this site, including the Remedial Investigation (Jacobs Engineering Group, Inc. [Jacobs] 2002), Baseline Human Health Risk Assessment (BHHRA) (Jacobs, 2003), Installation-Wide Baseline Ecological Risk Assessment (BERA) (Shaw Environmental, Inc. [Shaw], 2007a), Feasibility Study (FS) (Shaw, 2009), Proposed Plan (U.S. Department of the Army [U.S. Army], 2010), and other related documents contained in the Administrative Record for LHAAP-50.

This document is issued by the U.S. Army, the lead agency for this installation. USEPA (Region 6) and the Texas Commission on Environmental Quality (TCEQ) are the regulatory agencies providing technical support, project review and comment, and oversight of the U.S. Army cleanup program. The USEPA and TCEQ concur with the selected remedy.

1.3 Assessment of the Site

The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment.

1.4 Description of the Selected Remedy

The selected remedy protects human health and the environment by preventing human exposure to perchlorate and volatile organic compounds (VOCs) including tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethene (DCE), 1,2-dichloroethane (DCA), cis-1,2-DCE, and vinyl chloride (VC) in the shallow groundwater. No principal threat source material has been identified at LHAAP-50. The remedy for LHAAP-50 includes:

- Excavation and off-site disposal of perchlorate-contaminated soil
  - Sampling for perchlorate at Goose Prairie Creek near LHAAP-50
- Monitored natural attenuation (MNA) of groundwater
  - MNA to return groundwater to its beneficial use
  - Calculated cleanup time is approximately 50 years
  - Performance objectives to evaluate MNA remedy performance after two years
  - Contingency remedy to enhance MNA if MNA is found to be ineffective
  - Long term monitoring to evaluate remedy performance and plume conditions, initiated after two years and will continue until cleanup levels are met
- Land use control (LUC) to restrict the use of groundwater to environmental monitoring and testing only until cleanup levels are met

Soil

Risk evaluation conducted for LHAAP-50 determined that the soil does not pose a hazard or risk for nonresidential use. An additional evaluation was conducted of the soil as potential soil-to-surface water and soil-to-groundwater pathways for the emerging contaminant perchlorate. Because this evaluation indicated some potential for migration of perchlorate from soil-to-groundwater, soil contaminated with perchlorate will be excavated and disposed in an off-site landfill.

Groundwater

Due to the risk posed by perchlorate and VOCs in groundwater, LUC is needed in the impacted area to ensure the protection of human health and the environment by preventing human exposure to the contaminated groundwater. The selected LUC will prevent human exposure to contaminated groundwater through the restriction of groundwater use. The LUC will remain in place until the cleanup levels are met.

MNA will be implemented to verify that the plume is stable and that the natural attenuation processes are occurring. Performance objectives will be evaluated after two years of MNA. During those two years, monitoring will be quarterly. If MNA is found to be ineffective, a contingency remedy to enhance MNA will be implemented. If MNA is found to be effective, it will be continued, and monitoring will be semiannual for three years. In subsequent years, monitoring will be annual until the next five-year review. The monitoring and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue every five years until cleanup levels are achieved.

Based on examination of existing concentration trends, groundwater cleanup levels are expected to be met through natural attenuation in approximately 50 years. Estimated cleanup times based on first order kinetics are presented in the natural attenuation evaluation in the FS, Appendix A (Shaw, 2009). The estimated cleanup times for perchlorate, PCE, TCE, cis-1,2-DCE, VC, and 1,2-DCA are 5.5, 3.7, 47.7, 12.9, 7.9, and 6.6 years, respectively. Considering the lithologic variability, particularly the lateral and vertical change from sand to clay, the times to achieve cleanup levels may range up to an order of magnitude greater for some constituents. In the course of the remedy, the additional monitoring results will allow more accurate time estimates. The need to continue the LUC to restrict groundwater use and MNA will be reviewed every five years, beginning with the first five-year review.

The specific LUC and implementation details will be included in the remedial design (RD). The MNA performance monitoring plan will also be presented in the RD. Within 90 days of the signing of the ROD, the U.S. Army will prepare and submit the RD to USEPA consistent with the schedule of Section XVI of the Federal Facility Agreement (FFA). The U.S. Army, USEPA, and the Texas Water Commission (currently known as TCEQ) entered into the FFA for the remedial activities at LHAAP on December 30, 1991. The U.S. Army will be responsible for implementation, maintenance, periodic inspection, and enforcement of LUC in accordance with the RD. Although the U.S. Army may transfer these responsibilities to another party through property transfer agreement or other means, the U.S. Army will remain responsible for: (1) CERCLA §121(c) five-year reviews; (2) notification of the appropriate regulators of any known LUC deficiencies or violations; (3) access to the property to conduct any necessary response; (4) reservation of the authority to change, modify, or terminate LUC and any related transfer or lease provisions; and (5) ensuring that the LUC objectives are met to protect the integrity of the selected remedy.

U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of a LUC objective at this site after it has been transferred. U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or significant modification of a LUC, or land use change inconsistent with the LUC objectives and use assumptions of the remedy. In the event that TCEQ and/or USEPA and the U.S. Army agree with respect to any modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the FFA and 40 CFR 300.435(c)(2) and 40 CFR 300.430(f)(4)(iii).

The management strategy at LHAAP is to approach each site separately to address human health issues and to approach the sites by sub-area to address ecological risk. Thus, the implementation of this remedy at LHAAP-50 is independent of any other remedial action at LHAAP to address human health issues. To address ecological risk, LHAAP-50 was grouped with several other sites as part of the Industrial Sub-Area. No chemicals exceeded ecological thresholds of concern in the Industrial Sub-Area. Thus, no action is needed at LHAAP-50 to address ecological risk (Shaw, 2007a).

1.5 Statutory Determinations

The selected remedy does not satisfy the statutory preference for treatment as a principle element of the remedy. Although the final selected remedy is not intended to address the statutory preference for treatment to the maximum extent practicable, the final selected remedy offers, within a reasonable time frame and at a lower cost, a similar level of protection to human health and the environment than those remedy alternatives which satisfy the preference for treatment. In addition, no source materials constituting principle threats will be addressed within the scope of this action. In addition, the remedy offers long-term effectiveness through the implementation of LUC, which would minimize the potential risk posed by the contaminated groundwater. Further, evaluation of MNA including routine monitoring of the attenuation until cleanup levels are met would document the effectiveness of the selected remedy. The selected remedies are easily and immediately implementable and cost less than the other alternatives considered for LHAAP-50, with the exception of Alternative 1 (No Action).

The selected remedy of excavation and MNA would reduce the toxicity, mobility, or volume of contaminants in the soil with an active remedial action, and in the groundwater through a passive remedial action. There is no known principal threat material or contaminant source in the LHAAP-50 groundwater.

Because hazardous substances, pollutants, or contaminants may remain at the site above levels that allow for unlimited use and unrestricted exposure, a five-year review will be conducted every five years to ensure protection of human health and the environment under CERCLA §121(c), U.S. Code (USC) Title 42 §9621(c). In accordance with Texas Administrative Code (TAC) Title 30 §335.566, a notification will be recorded in the Harrison County records stating that the site is only suitable for nonresidential use and that a restriction of groundwater use to environmental monitoring and testing only is in place until the cleanup levels are achieved. Although the U.S. Army may later pass these procedural responsibilities to the transferee by property transfer agreement, the U.S. Army shall retain ultimate responsibility for remedy integrity, per the FFA and CERCLA §121.

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD.

- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater as identified in the baseline risk assessment and ROD (**Section 2.6**).

- Potential land and groundwater use that will be available at the site as a result of the selected remedy (**Section 2.6**).
- Chemicals of concern (COCs) and their respective concentrations (**Section 2.7**).
- Baseline risk represented by the COCs (**Section 2.7**).
- Cleanup levels established for COCs and the basis for these levels (**Section 2.7**).
- No principal threat source materials identified (**Section 2.11**).
- Key factors that led to selecting the remedy (**Section 2.12**).
- 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**).

Additional information can be found in the Administrative Record file for this site.

1.7 Authorizing Signatures

As the lead agency, the United States Army issues this ROD for LHAAP-50 which documents the selected remedy. The undersigned is the appropriate approval authority for this decision.

Thomas E. Lederle 23 Sep 2010
(Name) (Date)

Thomas E. Lederle
Industrial Branch Chief
Base Realignment and Closure Division
United States Army

The United States Environmental Protection Agency approves the selected remedy as provided in the ROD for LHAAP-50.

9-30-10
(Name) (Date)

for Samuel Coleman, P.E.
Director
Superfund Division
United States Environmental Protection Agency
Region 6

2.0 Decision Summary

2.1 Site Name, Location, and Description

LHAAP-50, Former Sump Water Tank, Group 4

Longhorn Army Ammunition Plant
Karnack, Texas

Comprehensive Environmental Response, Compensation, and Liability Information System USEPA Identification Number: TX6213820529

Lead Agency: U.S. Army, Department of Defense
Support Agencies: USEPA Region 6, TCEQ

Source of Cleanup Money: U.S. Army, Department of Defense
Site type: Industrial facility

The former LHAAP is an inactive, government-owned, formerly contractor operated and maintained Department of Defense facility located in central east Texas (see **Figure 2-1**) in the northeast corner of Harrison County. LHAAP is approximately 14 miles northeast of Marshall, Texas, and approximately 40 miles west of Shreveport, Louisiana. The former U.S. Army installation occupied 8,416 acres between State Highway 43 at Karnack, Texas, and the southwestern shore of Caddo Lake. The facility can be accessed via State Highways 43 and 134.

LHAAP was placed on the Superfund National Priorities List (NPL) on August 9, 1990. Activities to remediate contamination began in 1990. After its listing on the NPL, the U.S. Army, the USEPA, and the Texas Water Commission (currently known as the TCEQ) entered into a CERCLA §120 FFA for remedial activities at LHAAP. The FFA became effective December 30, 1991. LHAAP operated until 1997 when it was placed on inactive status and classified by the U.S. Army Armament, Munitions, and Chemical Command as excess property. The majority of LHAAP has been transferred by the U.S. Army to the U.S. Fish and Wildlife Service (USFWS) for management as the Caddo Lake National Wildlife Refuge.

The site addressed in this ROD, LHAAP-50, known as the former sump water tank, is located in the north-central portion of LHAAP and covers approximately 1 acre as shown in **Figure 2-2**. Historically, LHAAP-50 contained an aboveground storage tank (AST) which received industrial wastewater from various industrial waste production sumps throughout LHAAP from 1955 to 1988 (Plexus Scientific Corporation [Plexus], 2005). The wastewater was transported to the AST at LHAAP-50. The AST has been removed.

2.2 Site History and Enforcement Activities

2.2.1 History of Site Activities

LHAAP was established in December 1941 with the primary mission of manufacturing trinitrotoluene (TNT). Production of TNT began at Plant 1 in October 1942 and continued through World War II until August 1945, when the facility was placed on standby status until February 1952. Plant 2 was reactivated and production of pyrotechnic ammunition, such as photoflash bombs, simulators, hand signals, and tracers for 40 mm ammunition continued through 1956.

In December 1954, a third facility, Plant 3, began production of solid-fuel rocket motors for tactical missiles. Rocket motor production at Plant 3 continued to be the primary operation at LHAAP until 1965 when Plant 2 was again reactivated for the production of pyrotechnic and illuminating ammunition. In the years following the Vietnam conflict, LHAAP continued to produce flares and other basic pyrotechnic or illuminating items for the U.S. Department of Defense inventory. From September 1988 to May 1991, LHAAP was also used for the static firing and elimination of Pershing I and II rocket motors in compliance with the Intermediate-Range Nuclear Forces Treaty in effect between the United States and the former Union of Soviet Socialist Republics. LHAAP operated until 1997 when it was placed on inactive status and classified by the U.S. Army Armament, Munitions, and Chemical Command as excess property.

LHAAP-50 contained a 47,000 gallon capacity AST which received industrial wastewater from various industrial waste production sumps throughout LHAAP from 1955 to 1988. After the solids were filtered, discharges from the storage tank were made upstream of the bridge on Crockett Avenue, south of 51st Street into Goose Prairie Creek. The flow in the creek was sufficient to dilute the water to safe levels (Jacobs, 2002). If natural flow in the creek was considered insufficient, clean water was apparently pumped into the creek to dilute the contents. Because the storage tank was described as holding industrial wastewater, it is possible hazardous wastes may have been released by these activities. The AST has been removed.

2.2.2 History of Investigative Activities

As part of the Installation Restoration Program, the U.S. Army began an environmental investigation in 1976 at LHAAP followed by installation-wide assessments/investigations that included the following:

- In 1980, U.S. Army Toxic and Hazardous Material Agency (USATHAMA) conducted a record search to assess the impact of the LHAAP installation activities including usage, storage, treatment, and disposal of toxic and hazardous materials on the environment, and defined conditions that may have adversely affected human health and the environment (USATHAMA, 1980).

- Contamination Survey – In 1982, as part of the LHAAP contamination survey, Environmental Protection Systems collected six groundwater samples for laboratory analyses. Subsequently, in 1987, as part of the Resource Conservation and Recovery Act (RCRA) permit application process, and as a continuation of the contamination survey, U.S. Army Environmental Hygiene Agency (USAEHA) identified, described, and evaluated all solid waste management units at LHAAP (USAEHA, 1987). Units requiring further sampling, investigation, and corrective action were delineated.
- RCRA Facility Assessment (RFA) – In 1988, a preliminary RFA was conducted by the U.S. Army (Maley, 1988). Waste at the various sites was characterized, but no samples were collected.

In addition to the installation wide investigations, site-specific investigations were conducted for LHAAP-50 and included the following:

Between 1992 and 2008, numerous investigations were conducted in a phased approach to determine the nature and extent of contamination at LHAAP-50. Beginning in 1995, an initial site investigation was conducted at LHAAP-50 where sediments and soils were sampled to assess whether industrial wastewater that had been stored in the AST had impacted the site. Phase II and III investigations were conducted that included the collection of soil, sediment, surface water, and groundwater samples (Jacobs, 2002). Additional investigations were conducted, including the installation of several wells and soil borings from 2000 through 2002 (Solutions to Environmental Problems [STEP], 2005), a site assessment in 2003 (Plexus, 2005), and further sampling from 2004 through 2008 (Shaw, 2007b; Shaw, 2009), to determine the nature and extent of contamination at LHAAP-50. Media investigated included soil, sediment, surface water, and groundwater. The Final BERA was based on investigations conducted from 1993 through 2006 (Shaw, 2007a). The Final BHHRA (Jacobs, 2003) used data from the investigations conducted through 2001. The additional data collected since the BHHRA was evaluated in the FS to determine if the outcome of the risk assessment would change. The additional data collected did not change the outcome of the risk assessment as discussed in **Section 2.7**.

2.2.3 History of CERCLA Enforcement Activities

Due to the releases of chemicals from facility operations, the USEPA placed LHAAP on the Superfund NPL on August 9, 1990. Activities to remediate contamination associated with the listing of LHAAP as a Superfund site began in 1990. After the listing on the NPL, the U.S. Army, the USEPA, and the Texas Water Commission (currently known as the TCEQ) entered into a CERCLA §120 FFA for remedial activities at LHAAP. The FFA became effective December 30, 1991.

The FS for LHAAP-50 (Shaw, 2009) was issued in December 2009, and the Proposed Plan (U.S. Army, 2010) was issued in January 2010. This ROD follows that Proposed Plan and precedes the more detailed RD.

2.3 Community Participation

The U.S. Army, USEPA, TCEQ and the LHAAP Restoration Advisory Board (RAB) have provided public outreach to the surrounding community concerning LHAAP-50 and other environmental sites at LHAAP. The outreach program has included fact sheets, media interviews, site visits, invitations to attend quarterly RAB and regulatory review meetings, and public meetings consistent with its public participation responsibilities under Sections 113(k)(2)(B), 117(a), and 121(f)(1)(G) of CERCLA.

The Final Proposed Plan (U.S. Army, 2010) for the selection of the remedy for LHAAP-50 was released to the Administrative Record file and made available to the public for review and comment on January 25, 2010. A media release was sent to radio stations KTBS, KSLA and KETK on January 18, 2010. The initial notice of availability of the Proposed Plan and other related documents in the Administrative Record file was published in *The Shreveport Times* and the *Marshall News Messenger* on both January 17 and 24, 2010. An extension to the public review period was requested. A notice for the 30-day extension and a second public meeting was published in *The Shreveport Times* on February 22 and 28, 2010, and in the *Marshall News Messenger* on February 21 and 28, 2010. The newspaper and media notices for the meetings are provided in **Appendix A**. The public comment period for the Proposed Plan began on January 25, 2010 and ended March 25, 2010. Public meetings were held on January 26, 2010 in an open forum style with informal comments, questions, and discussions, and on March 9, 2010 with a more formal format and a court reporter. The transcript for the meeting on March 9, 2010 is part of the Administrative Record. The significant comments (oral or written) are addressed in the Responsiveness Summary, which is included in this ROD in **Section 3.0**.

The Administrative Record may be found locally at the information repository maintained at the following location:

Location:	Marshall Public Library 300 S. Alamo Marshall, Texas 75670
Business Hours:	Monday – Thursday 10:00 a.m. – 8:00 p.m. Friday – Saturday 10:00 a.m. – 5:00 p.m.

2.4 Scope and Role of Response Action

The recommended action at LHAAP-50 will prevent potential risks associated with exposure to contaminated groundwater. Although groundwater at Longhorn is not currently being used as drinking water, nor may it be used in the future based on its reasonably anticipated use as a national wildlife refuge, when establishing the remedial action objectives (RAOs) for this response action, the U.S. Army has considered the NCP's expectation to return usable groundwaters to their potential beneficial uses wherever practicable and has also considered the State of Texas designation of all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 TAC 335.563(h)(1). The Army intends to return the contaminated shallow groundwater zone at LHAAP-50 to its potential beneficial uses, which for the purposes of this ROD is considered to be attainment of the Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C). If an MCL is not available for a chemical, the promulgated TCEQ groundwater medium-specific concentration (MSC) for industrial use (GW-Ind) will be used. If a return to potential beneficial uses is not practicable, the NCP expectation is to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction.

The remedial action will remove soil that may act as a residual source to groundwater and surface water.

The preferred remedial action will also ensure containment of the plume to prevent potential impact to surface water. The potential exists for contaminated shallow groundwater to migrate to surface water, which could ultimately affect Caddo Lake, a source of drinking water.

In addition, the preferred action will include groundwater monitoring to demonstrate that the plume is not migrating at levels that present a potential impact to nearby surface water bodies and to verify that contaminant levels are being reduced to drinking water standards (MCLs or GW-Ind if no MCL is available) when the LUC may be terminated.

2.5 Site Characteristics

This section of the ROD presents an overview of LHAAP-50 site characteristics with respect to physical site features, known or suspected sources of contamination, types of contamination, and affected media. Known or potential routes of contaminant migration are also discussed.

2.5.1 Conceptual Site Model

Figure 2-3 illustrates the overall conceptual site model for LHAAP-50. The model presents those pathways that are being considered for remediation. Those pathways that are likely to be incomplete or have negligible impact are not being considered for remediation as discussed below.

The AST was the most likely source of contaminants being released into the environment. Since the AST has been removed, there is no longer a potential release mechanism for leaks or spills.

Perchlorate and VOCs were probably released via overflows, spills, and discharges to the soil and adjacent surface water. Sufficient perchlorate levels remain in the soil to act as an ongoing source of groundwater contamination or to be potentially released into surface waters during storm events. The area of perchlorate contamination in the soil is very small, and the concentrations of perchlorate do not pose an unacceptable risk to human health (hypothetical future maintenance worker) or ecological receptor.

Goose Prairie Creek runs on the north side of LHAAP-50 and the south side of LHAAP-47, and both sites may be contributing to detections of perchlorate in the surface water. However, perchlorate results for the surface water are below the contact recreation value of 395 micrograms per liter (µg/L) (TCEQ, 2007). Since the creek discharges into nearby Caddo Lake, a drinking water source, the concentrations in Goose Prairie Creek may also be compared to the TCEQ groundwater MSC for residential use (GW-Res) value of 26 µg/L (TCEQ, 2006). The concentrations of perchlorate in the surface water during quarterly sampling from May 2007 to June 2010 were also below the GW-Res, except the March 2008 result of 27 µg/L at GWP-1. Even though the concentrations in the creek are acceptable, detection of perchlorate in the creek water indicates that there could be a potential pathway from the contaminated surface soil at LHAAP-50 to the surface water. Thus, the soil pathways considered for remediation are the potential migration to surface water and leaching into the groundwater.

The groundwater at LHAAP-50 may pose a risk for the hypothetical future maintenance workers. Groundwater modeling concluded that there was no impact to surface water from VOCs and perchlorate in groundwater (Shaw, 2007c), and recent surface water samples collected and analyzed for perchlorate were below Texas water quality standard levels. Thus, the pathways considered for remediation are soil-to-groundwater, soil-to-surface water, and future industrial groundwater use.

2.5.2 Overview of Site

LHAAP-50 is approximately 1 acre. The northeastern half of LHAAP-50 is an open area of grass and brush that is bounded by South Crocket Avenue to the northeast. The southwestern half of the site is an area of heavy timber bounded by a drainage ditch to the west, a railroad spur to the south, and Goose Prairie Creek to the north. Runoff from the northeastern half of the site is generally toward the northeast. Runoff is collected by a drainage ditch to the northeast that runs parallel to South Crockett Avenue and eventually joins Goose Prairie Creek. Runoff from the southwestern portion of the site is collected to the west by a drainage ditch that carries the runoff north into Goose Prairie Creek. Goose Prairie Creek eventually empties into Caddo Lake, a source of drinking water for several neighboring communities in Louisiana. LHAAP-50 has no known areas of archaeological or historical importance.

2.5.3 Geology and Hydrology

Groundwater at the site was encountered approximately 20 feet below ground surface (bgs) in the shallow groundwater zone and approximately 55 feet bgs in the intermediate zone. The predominant groundwater flow in the shallow zone at the site is generally to the east as shown on **Figure 2-4**. Rising head slug tests were performed on all wells at LHAAP-50 to calculate hydraulic conductivity values using the Bouwer-Rice method. The hydraulic conductivity values for the shallow saturated zone at LHAAP-50 ranged from 5.5×10^{-5} centimeters per second (cm/sec) at well 50WW04 to 1.9×10^{-4} cm/sec at well 50WW03 (Jacobs, 2002).

General soil and geologic maps indicate that the site is situated on the outcrop of the Wilcox Group. The Wilcox Group materials at the site generally consist of a few feet of residually derived soils overlying silts and clays. Surficial soils range from 0 to 2 feet thick and are composed of brown, silty sand grading into gray silt. This material is underlain by yellowish-brown to gray silt and clay with alternating layers of sandy clays and silty clays. The alternating layers are present from 8 to 11 feet bgs in borings to the south and up to 18 feet bgs at boring 50WW01 to the north. At 50WW02, a fine grain sand was observed where the well was screened. A cross-section of the site is shown in **Figure 2-5**.

Contamination was found in the soil and groundwater. However, no principal threat source material was identified at LHAAP-50. The groundwater elevation is currently below the creek bed elevation as shown in **Figure 2-5** (Shaw, 2009). Historic data prior to 2002 indicates at times the groundwater elevation has been higher than the creek bed elevation. However, groundwater flow direction is to the east or parallel to the creek, therefore, no impact to surface water from the contaminated groundwater is expected.

2.5.4 Sampling Strategy

Several sampling events were conducted at LHAAP-50 from 1992 to 2008, as outlined in **Section 2.2.2** on site investigations. In the early investigations, soil samples were collected from throughout the site to determine the areas of contamination. Subsequent investigations focused on the areas where contamination was found, performing additional soil, groundwater, and sediment sampling and installing monitoring wells to delineate the contamination. Samples were analyzed for various analytes including VOCs, semivolatile organic compounds, metals, explosives, perchlorate, pesticides, and dioxins/furans. In the area of the contaminant plume, groundwater samples were also analyzed for indicators of conditions that promote natural attenuation (biodegradation), such as sulfide, methane, and chloride.

2.5.5 Nature and Extent of Contamination

Chemicals in the groundwater at LHAAP-50 pose an unacceptable risk to human health. Evaluation of data generated after the risk assessment did not identify any additional COCs with risks exceeding the USEPA target risk level of 1×10^{-4} or a hazard quotient (HQ) greater than 0.1. Chemicals in the soil do not pose an unacceptable risk or hazard to human health.

Shallow zone groundwater COCs include perchlorate and VOCs including PCE, TCE, 1,1- DCE, 1,2-DCA, cis-1,2-DCE, and VC. The shallow groundwater plume is shown on **Figure 2-6** and is approximately 5.5 million gallons.

Should current conditions change, the potential exists for contaminated groundwater to migrate toward and discharge into Goose Prairie Creek and then subsequently into Caddo Lake, a drinking water supply. Although results of plume migration modeling indicate that contaminants will not adversely affect Goose Prairie Creek surface water (Shaw, 2007c), there are uncertainties associated with calibration and literature based degradation rates used in the migration modeling. However, the groundwater elevation is currently below the creek bed elevation and has been since 2002 (Shaw, 2009); therefore, no impact to surface water from the contaminated groundwater is expected. The results were obtained by using the transport model Analytical Transient One-, Two-, and Three-Dimensional Simulation of Waste Transport in the Aquifer System (AT123D). AT123D assumes the aquifer to be homogeneous and isotropic. It accounted for advection, dispersion, adsorption, and chemical degradation.

The soil-to-surface water pathway may exist since surface water samples collected from Goose Prairie Creek have detected perchlorate. The perchlorate concentrations in the creek are currently below the residential MSC for groundwater. The residential level was used for comparison because Goose Prairie Creek discharges into Caddo Lake, a drinking water supply.

Perchlorate is an emerging contaminant that is soluble and has the potential to migrate to groundwater. An area of perchlorate contaminated soil was identified within the perchlorate groundwater plume footprint. The contaminated soil area is approximately 4,000 square feet in area and 1 foot in depth, for a volume of approximately 150 cubic yards. The contaminated soil area is shown on **Figure 2-7**.

2.6 Current and Potential Future Site and Resource Uses

2.6.1 Current and Future Land Uses

LHAAP is located near the unincorporated community of Karnack, Texas. Karnack is a rural community with a population of 775 people. The incorporated community of Uncertain, Texas, population 205, is located to the northeast of LHAAP on the edge of Caddo Lake and is a resort area and an access point to Caddo Lake. The industries in the surrounding area consist of agriculture, timber, oil and natural gas production, and recreation.

LHAAP has been an industrial facility since 1942. Production activities and associated waste management activities continued until the facility was determined to be in excess of the U.S. Army's needs in 1997. The plant area has been relatively dormant since that time. LHAAP is surrounded by a fence (except on the border with Caddo Lake), and current security measures at the LHAAP preclude unlimited public access to areas within the fence. The fence now represents the Refuge boundary. Approved access for hunters is very limited.

The reasonably anticipated future use of LHAAP-50 is as a national wildlife refuge. This anticipated future use is based on a Memorandum of Agreement (MOA) (U.S. Army, 2004) between the USFWS and the U.S. Army. That MOA documents the transfer process of the LHAAP acreage to USFWS to become the Caddo Lake National Wildlife Refuge. Presently the Caddo Lake National Wildlife Refuge occupies approximately 7,000 acres of the 8,416-acre former installation. In accordance with the National Wildlife Refuge System Administration Act of 1966 and its amendments (USC, Title 16 §668dd), the land will remain as a national wildlife refuge unless there is a change brought about by an act of Congress, or the land is part of an exchange authorized by the Secretary of the Interior.

2.6.2 Current and Future Surface Water Uses

Streams on LHAAP currently support wildlife and aquatic life. While humans may have limited access to some streams during annual hunts, there is no routine human use of streams on LHAAP. The streams do not carry adequate numbers and size of fish to support either sport or subsistence fishing. During the summer months, the streams cease flowing and/or dry up. The streams discharge into Caddo Lake. Caddo Lake is a large recreational area that covers 51 square miles and has a mean depth of 6 feet. The watershed of the lake encompasses approximately 2,700 square miles. It is used extensively for fishing and boating. Caddo Lake is a drinking water supply for multiple cities in Louisiana including Vivian, Oil City, Mooringsport, South Shore, Blanchard, Shreveport, and Bossier City.

The anticipated future uses of the streams and lake are the same as the current uses.

2.6.3 Current and Future Groundwater Uses

Groundwater in the deep aquifer (250-430 feet bgs) near LHAAP is currently used as a drinking water source. There are five active water supply wells near LHAAP. One well is located in and owned by Caddo Lake State Park. The well is completed to a depth of 315 feet and has been in use since 1935. A second well owned by the Karnack Water Supply Corporation services the town of Karnack and is located approximately 2 miles southeast of town. This well is approximately 430 feet deep and has been in use since 1942. The Caddo Lake Water Supply Corporation has three wells located both north and northwest of LHAAP. These wells are identified as Caddo Lake Water Supply Corporation Wells 1, 2, and 3 and are all hydraulically upgradient of LHAAP (Jacobs, 2002). These wells are completed deeper than the deepest zone of contamination at LHAAP. Because of this and the large distance between these wells and LHAAP, water removal from these wells is not expected to affect groundwater flow at the site.

In addition, there are several livestock and domestic wells located in the vicinity of LHAAP with depths averaging approximately 250 feet.

Three water supply wells are located within the boundary of LHAAP itself. One well is located at the Fire Station; the second well is located approximately 0.35 miles southwest of the Fire Station. The third well is located north of the USFWS administration building for the Caddo Lake National Wildlife Refuge administration building, near the main entrance to LHAAP. The distances from these wells to LHAAP-50 are approximately 0.68 mile, 0.80 mile, and 1.6 miles, respectively. All three water supply wells were completed within a deeper groundwater zone not comparable to the deep wells installed and described at LHAAP. Two additional wells previously supplied water to the installation, but these have been plugged and abandoned. None of these three wells are currently used for drinking water at LHAAP, although they may supply water for non-potable uses.

Although the anticipated future use of the facility as a wildlife refuge may not include the use of the groundwater at LHAAP-50 as a drinking water source, the State of Texas designates all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 TAC 335.563(h)(1). To be conservative, a hypothetical industrial use scenario was evaluated for risk. The future industrial scenario for LHAAP assumes limited use of groundwater as a drinking water source.

2.7 Summary of Site Risks

The BHHRA and BERA estimate the risks posed by the site if no action were taken. These assessments provide the basis for taking action and identify the contaminants and exposure pathways that need to be addressed by the remedial action.

2.7.1 Summary of Human Health Risk Assessment

This section is based on the conclusions presented in the *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites* (Jacobs, 2003), in the *Data Gaps Investigations* (Shaw, 2007b), and in additional data collected in preparation of the *Final Feasibility Study, LHAAP-50* (Shaw, 2009). The risk assessment used data from the investigations conducted through 2001 including the plant-wide perchlorate investigation. Results from the later investigations did not change the overall outcome of the risk assessment. During the risk assessment, soil and groundwater data were used to calculate the aggregate risk, which was then compared to the USEPA target risk range of 1×10^{-4} to 1×10^{-6} for the excess lifetime carcinogenic risk and to a hazard index (HI) of 1 for non-carcinogenic hazards. If there is no unacceptable risk associated with a medium, and a cleanup level is not exceeded, then the medium is not identified in this ROD for remediation. The conceptual site model that is associated with the risk assessment was introduced in **Section 2.5.1**, and is presented as **Figure 2-3**.

2.7.1.1 Identification of Chemicals of Potential Concern

The BHHRA identified chemicals of potential concern (COPCs) for LHAAP-50 and evaluated the carcinogenic risk and non-carcinogenic hazard for each. **Table 2-1** summarizes the risk assessment data for the COPCs, including minimum and maximum detected concentrations, frequency of detection, and exposure point concentrations. Analytical results for various congeners of dioxins and furans are expressed as toxic equivalents of 2,3,7,8-tetrachlorodibenzo-p-dioxin.

2.7.1.2 Exposure Assessment

The Jacobs risk assessment (Jacobs, 2003) presented the human health risks and hazards to a hypothetical future maintenance worker under an industrial scenario for soil and groundwater.

For soil, reasonable exposure pathways according to the conceptual site model are: incidental ingestion of the surface soil (0 to 0.5 feet bgs), dermal contact with the surface soil, inhalation of particulates, and inhalation of VOCs from the soil (0 to 7 feet bgs). The BHHRA found VOC levels in the soil at 0 to 7 feet bgs to be non-detect; this exposure pathway did not add to carcinogenic risk or non-carcinogenic hazard. Therefore, it was not added to the summary tables in the ROD.

For groundwater, reasonable exposure pathways are ingestion of groundwater, dermal contact while showering with contaminated groundwater, and inhalation of VOCs while showering with contaminated groundwater.

2.7.1.3 Toxicity Assessment

The carcinogenic and non-carcinogenic toxicity assessments from the BHHRA are summarized in **Tables 2-2** and **2-3**, respectively. The toxicity data assumes that exposure would be chronic to be conservative. Sources for the data include the Integrated Risk Information System and Health Effects Assessment Summary Tables.

2.7.1.4 Risk Characterization

Characterization of the carcinogenic risk and non-carcinogenic hazard are summarized in **Tables 2-4** and **2-5**, respectively. For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime carcinogenic risk is calculated from the following equation:

$$\text{Risk} = \text{CDI} \times \text{SF}$$

where: risk = unitless probability of an individual developing cancer
CDI = chronic daily intake averaged over 70 years, expressed as milligrams per kilogram per day (mg/kg-day)
SF = slope factor, expressed as $(mg/kg\text{-}day)^{-1}$

These risks are probabilities that usually are expressed in scientific notation. An excess lifetime carcinogenic risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime carcinogenic risk" because it would be in addition to the risks of cancer that individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. USEPA's generally acceptable risk range for site-related exposures is 1×10^{-4} to 1×10^{-6}.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called an HQ. An HQ < 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The HI is the sum of all HQs and is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI < 1 indicates that toxic non-carcinogenic effects from all contaminants are unlikely. An HI > 1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

Non-carcinogenic HQ = CDI/RfD

Where: CDI = chronic daily intake
RfD = reference dose

CDI and RfD are expressed in the same units and represent the same exposure period (e.g., chronic, subchronic, or short-term).

The carcinogenic risks for soil and groundwater are 5.8×10^{-7} and 5.5×10^{-3}, respectively (Jacobs, 2003). The soil is in the acceptable range while the groundwater is not. The hazard indices for soil and groundwater are 0.035 and 305, respectively. Again, the soil is acceptable while the groundwater is not. Therefore, the remedial action focuses on the groundwater. The primary contributor to carcinogenic risk for the groundwater at LHAAP-50 is TCE; other significant contributors are VC, 1,1-DCE, and 1,2-DCA. The chemicals in groundwater with the highest HQs are perchlorate and TCE, with values of 200 and 84, respectively. Other chemicals with high HQs include cis-1,2-DCE, and 1,1-DCA.

Even though the risk assessment did not conclude that exposure to soil would cause risk, additional evaluation was conducted of the soil as potential soil-to-surface water and soil-to-groundwater pathways for the emerging contaminant perchlorate. The maximum concentration of perchlorate in the surface soil between 0 to 0.5 feet bgs was detected at 45,600 micrograms per kilogram (µg/kg) which exceeds the TCEQ soil MSC for industrial use based on groundwater protection (GWP-Ind) for perchlorate of 7,200 µg/kg (TCEQ, 2006). Thus, perchlorate in soil poses unacceptable risk to groundwater. Based on protection of groundwater, perchlorate was identified as a COC in soil at LHAAP-50 (**Table 2-6**).

The BHHRA included an uncertainty analysis which identified factors that would cause values used in the risk assessment to be over- or underestimated. The analysis concluded that the risks and HIs are overestimated, making the BHHRA a conservative evaluation. The analysis listed eight factors that would lead to overestimations, four that would lead to underestimations, and five that could lead to either over- or underestimations.

2.7.2 Summary of Ecological Risk Assessment

The ecological risk for LHAAP-50 was addressed in the installation-wide BERA (Shaw, 2007a). The BERA provides a process that evaluates the likelihood that adverse ecological effects may occur, or are occurring, as a result of exposure to one or more stressors. A stressor is any physical, chemical, or biological entity that can induce an adverse ecological response. The BERA for LHAAP focuses only on chemical stressors.

Ecological risk does not exist unless:

- The stressor has the inherent ability to cause adverse effects
- It co-occurs with or contacts an ecological component (i.e., organism, population, community, or ecosystem) long enough and at sufficient intensity to elicit an adverse effect

For the BERA, the entire installation was divided into three large sub-areas (i.e., the Industrial Sub-Area, Waste Sub-Area, and Low Impact Sub-Area) for the terrestrial evaluation. Each of the individual sites at LHAAP was grouped into one of these sub-areas, based on commonalities of historic use, habitat type, and spatial proximity to each other. Conclusions for individual sites and the potential for detected chemicals to adversely affect the environment are made in the context of the overall conclusions of the sub-area in which the site falls.

LHAAP-50 lies within the Industrial Sub-Area, and the BERA concluded that no chemicals exceeded ecological thresholds of concern in the Industrial Sub-Area (Shaw, 2007a). Thus, there are no chemicals of ecological concern at LHAAP-50. As such, no action is needed at LHAAP-50 for the protection of ecological receptors.

2.7.3 Basis of Action

The remedial 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, pollutants, or contaminants into the environment. The conclusion reached by the FS investigation and subsequent investigations is that the COCs for groundwater at LHAAP-50 are perchlorate, PCE, TCE, cis-1,2-DCE, 1,1,-DCE, 1,2-DCA, and VC. The COC in soil is perchlorate. **Table 2-6** presents the cleanup levels for the COCs. Except for perchlorate, the SDWA MCL has been determined for each of the COCs, therefore these MCLs will be used as the cleanup levels. For perchlorate in groundwater, the GW-Ind is used as the cleanup level since no MCL exists (TCEQ, 2006). For perchlorate in soil, the GWP-Ind value is used as the cleanup level (TCEQ, 2006).

The human health risk assessment, which was based on the reasonably anticipated future use as a national wildlife refuge, does not address unrestricted use. Although not part of the remedy, limited monitoring in the form of five-year reviews will be conducted to certify proper land use and, in accordance with 30 TAC 335.566, a notification will be recorded in the Harrison County records stating that the site is suitable for nonresidential use.

2.8 Remedial Action Objectives

The RAOs for LHAAP-50, which address contamination associated with the media at the site and take into account the future uses of LHAAP streams, land, and groundwater, are:

- Protection of human health by preventing human exposure to the contaminated groundwater;
- Protection of human health by preventing further potential degradation of groundwater and surface water from contaminated soil;
- Protection of human health and the environment by preventing contaminated groundwater from migrating into nearby surface water; and
- Return of groundwater to its potential beneficial uses as drinking water, wherever practicable.

The above RAO recognizes USEPA's policy to return all groundwater to beneficial uses, based on the non-binding programmatic expectation in the NCP and is consistent with the NCP regulations requiring the lead agency, the U.S. Army in this case, to establish RAOs specifying contaminants and media of concern, potential exposure pathways, and remediation goals.

2.9 Description of Alternatives

Three alternatives (including No Action) are proposed. This section introduces the remedy components, identifies the common elements and distinguishing features of each alternative, and describes the expected outcomes of each.

2.9.1 Description of Remedy Components

Alternative 1 – No Action Alternative

As required by the NCP, the no action alternative provides a comparative baseline against which the action alternatives can be evaluated. Under this alternative, the soil and groundwater would be left "as is" without implementing any additional monitoring, containment, removal, treatment, or other mitigating actions. No actions would be implemented to reduce existing or potential future exposure to human receptors, although natural attenuation would be ongoing. Also, no action would be implemented to remove contaminated soil that may continue to contaminate the groundwater and surface water.

Estimated Capital Present Worth Cost: $0
Estimated O&M Present Worth Cost: $0
Cost Estimate Duration: --
Estimated Total Present Worth Cost: $0

Alternative 2 – Excavation, MNA, LUC

The major components of this alternative include the following:

- Excavation and off-site disposal of perchlorate contaminated soil from LHAAP-50, thereby eliminating the soil-to-groundwater and soil-to-surface water pathways
- MNA to return groundwater to its potential beneficial use, wherever practicable
  - Performance objectives to evaluate the MNA remedy performance after two years
  - A contingency remedy to enhance MNA to reach the RAOs if MNA is found to be ineffective
  - Long-term monitoring (LTM) semiannually for three years, annually until the next five-year review, then once every five years to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen until cleanup levels are reached
- LUC to restrict access to the contaminated groundwater until the cleanup levels are reached

Estimated Capital Present Worth Cost: $215,000
Estimated O&M Present Worth Cost: $424,000
Cost Estimate Duration: 30 years
Estimated Total Present Worth Cost: $639,000

Alternative 3 – Excavation, In Situ Bioremediation, MNA, LUC

The major components of this alternative include the following:

- Excavation and off-site disposal of perchlorate contaminated soil from LHAAP-50, thereby eliminating the soil-to-groundwater and soil-to-surface water pathways
- In situ bioremediation in a target area that has the highest contaminant concentrations
- MNA to reduce groundwater contamination to cleanup levels
- LUC and LTM until the cleanup levels are achieved

Estimated Capital Present Worth Cost: $402,000
Estimated O&M Present Worth Cost: $512,000
Cost Estimate Duration: 30 years
Estimated Total Present Worth Cost: $914,000

2.9.2 Common Elements and Distinguishing Features of Each Alternative

Common Elements of Alternative 2 and 3

Soil excavation, MNA, LUC and inspection/LTM are common elements to Alternatives 2 and 3.

Soil Excavation **–** Soil contamination would be excavated at LHAAP-50 under both Alternatives 2 and 3 and will eliminate the soil-to-groundwater pathway and soil-to-surface water pathway for perchlorate contaminated soil.

MNA **–** MNA is a passive remedial action that relies on natural biological, chemical, and physical processes to reduce the mass and concentrations of groundwater COCs under favorable conditions. The natural attenuation evaluation indicates that MNA is a feasible technology for the groundwater at LHAAP-50 (Shaw, 2009). Monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume.

MNA performance monitoring will be performed quarterly for the first two years. After eight quarterly sampling events, MNA will be evaluated. The analytical program will consist of VOCs, including chlorinated compounds and degradation products, methane, ethene, and ethane. Initially, the following geochemical parameters will also be included in the analytical program, dissolved oxygen (field), redox potential (field), sulfate, nitrate, nitrites, alkalinity, total organic carbon, and ferrous iron (field).

LUC **–** The LUC would be implemented to support the RAOs. The U.S. Army would be responsible for long-term implementation, maintenance, inspection, reporting, and enforcement of the LUC. The U.S. Army will provide details of the LUC long-term implementation and long term maintenance actions in the RD for the site. The LUC would prevent human exposure to residual groundwater contamination presenting an unacceptable risk to human health and ensure that there is no withdrawal or use of groundwater beneath the sites for anything other than environmental monitoring and testing. The groundwater restriction LUC would be maintained until the concentrations of contaminants and by-product (daughter) contaminants in groundwater had been reduced to levels below their respective cleanup levels. In addition, the Texas Department of Licensing and Regulation responsible for notifying well drillers of groundwater restrictions would be notified and a notification of LUC with the Harrison County Courthouse would include a map showing the areas of groundwater restriction at the site in accordance with 30 TAC 335.566.

In order to transfer this property (LHAAP-50), an Environmental Condition of Property (ECOP) document would be prepared and the Environmental Protection Provisions from the ECOP would be attached to the letter of transfer. The ECOP would include LUC for groundwater as part of the Environmental Protection Provisions. The property would be transferred subject to the LUC identified in the ECOP. These restrictions would prohibit or restrict property uses that might result in exposure to the contaminated groundwater (e.g., drilling restrictions, drinking water well restrictions). The U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of a LUC objective at this site after it has been transferred. The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or significant modification of a LUC, or land use change inconsistent with the LUC objectives and use assumptions of the remedy. In the event that TCEQ and/or EPA and the U.S. Army agree with respect to any modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the FFA and 40 CFR 300.435(c)(2) and 40 CFR 300.430(f)(4)(iii).

Inspection/Long-Term Groundwater Monitoring **–** Alternatives 2 and 3 include inspection and long-term groundwater monitoring activities. Monitoring would be continued as required to demonstrate effectiveness of the remedy, to demonstrate compliance with applicable or relevant and appropriate requirements (ARARs) and RAOs, and to support CERCLA five-year reviews.

Distinguishing features of Alternative 3

The distinguishing feature of Alternative 3 compared to Alternative 2 is the inclusion of in situ bioremediation action. The components of this action are described below.

Defining the target area – Currently shallow monitoring wells 50WW02 and 50WW05 are impacted. Shallow groundwater is present in thin (3 to 5 foot) discontinuous sand lenses which occur in a formation consisting primarily of clay to silty clay. At 50WW02, fine-grained sand was observed in the silty clay over the 10-foot interval that was screened. In situ bioremediation is proposed around 50WW02. To define the target area for treatment, a direct push investigation will be performed. The purpose of this investigation is: 1) to better delineate the target area (sand lenses or fine-grained sands [seams] impacted), 2) determine the concentration of VOCs and obtain geochemistry information prior to treatment, and 3) identify the treatment zone (laterally and vertically). This study is necessary to identify the types and amounts of substances required to stimulate optimum contaminant degradation and specify geologic and geochemistry information for project design. Some of the parameters that are important to consider include the mix of contaminants in the plume; soil type and properties; pH; salinity; competing electron acceptors (e.g., sulfates, nitrates); and the presence or absence of inhibitory substances.

Installing temporary wells for injection – Chlorinated solvents often require nutrients and other growth-stimulating additives/materials specific to the contaminants' metabolic degradation process. The wells would be used to inject these materials to accelerate microbial degradation of the plumes.

Injecting microbial cultures and nutrients into the subsurface at a predetermined location – Bacteria present in the groundwater can use chlorinated solvents as electron acceptors. Electron donors may include a wide variety of nutrients: sugars (molasses), alcohols (methanol, ethanol), volatile acids (acetate, lactate), and/or wastes (food processing, manure). The COCs at LHAAP-50 can degrade under anaerobic conditions, but microorganisms, mechanisms, and redox requirements differ. Based on results of an initial study during the RD, appropriate nutrients and other materials would be injected into the subsurface. It is assumed that a bioaugmentation will be used at the site. This form of bioremediation combines the injection of microbial cultures capable of degrading the contaminants with a carbon source to provide adequate conditions for the proliferation of the dechlorinating organisms. For costing purposes, it is assumed that application would be over a 50-foot square area at the area of highest concentrations, with five injection points at the four corners and at the center of the square. Injection points would be installed using direct-push technology. It is anticipated that the material would be injected twice, and that the injection would occur in the shallow zone, at approximately 20 feet bgs.

Monitoring wells – Current well locations are shown on **Figure 2-4**. The effectiveness of the treatment will be monitored using the monitoring well 50WW02, which is assumed to be located just downgradient of the treated area.

Sampling wells to monitor effectiveness – Monitoring for contaminants would be performed to assess the effectiveness of the treatment. Anticipated remediation times may be short in the target area with appropriate contact. MNA will be implemented in the untreated areas and will be initiated in the first year. Assuming first order anaerobic degradation rates and reasonable half-lives for the COCs, the COCs could be reduced to their respective cleanup levels in approximately two years directly in the target area. However, due to the discontinuous nature of the shallow groundwater, it is anticipated that residuals will be present downgradient, and possibly in the clay material directly overlying the saturated zone. For cost estimating purposes, it is assumed sampling will be performed quarterly for the first year, semiannually for the next three years, annually until the next five-year review, then every five years. The estimated time for the RAO to be achieved is approximately 50 years. The continued MNA monitoring is included in the five-year reviews beyond Year 10. The analytical program will consist of perchlorate, and VOCs, including chlorinated compounds and their degradation products, methane, ethene, and ethane. The following geochemical parameters will also be included in the analytical program, dissolved oxygen (field), redox potential (field), sulfate, nitrate, nitrites, alkalinity, total organic carbon, and ferrous iron (field).

Reporting – Annual reports will be prepared to document the effectiveness of the treatment. The first year annual report will include a review of the four quarters of data and provide an evaluation of the effectiveness of the bioremediation alternative.

2.9.3 Expected Outcomes of Each Alternative

Alternative 1 would allow the site to remain a hazard to human health, since it simply leaves the site as is. Alternatives 2 and 3 have very similar outcomes, and the main difference is in the time required to reach the cleanup levels, which is anticipated to occur in 50 years for Alternative 2 and less time for Alternative 3. The similar outcomes are considered to be attainment of the SDWA MCLs to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C). For perchlorate, no MCL has been promulgated, so the GW-Ind is used in place of the MCL, in accordance with 30 TAC 335. In addition, the monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume. Until that time, LUC will restrict the use of the site’s groundwater to environmental monitoring and testing.

2.10 Summary of Comparative Analysis of Alternatives

Nine criteria identified in the NCP §300.430(e)(9)(iii), are used to evaluate the different remediation alternatives individually and against each other in order to select a remedy. This section profiles the relative performance of each alternative against the nine criteria, noting how it compares to the other options under consideration. The nine evaluation criteria are discussed below. **Table 2-7** summarizes the comparative analysis of the alternatives.

2.10.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

The three alternatives provide varying levels of human health protection. Alternative 1, no action, does not confirm achievement of the RAO for the return of groundwater to its potential beneficial use as a drinking water since there is no monitoring involved. Alternative 1 also provides the least protection of all the alternatives; it provides no reduction in risks to human health or the environment because no measures would be implemented to eliminate the pathway for human exposure to the groundwater contamination.

Alternatives 2 and 3 both satisfy the RAOs for LHAAP-50. Alternatives 2 and 3 provide confirmation that human health and the environment will be protected because contaminated soil will be removed and disposed off-site and monitoring will be conducted to ensure that MNA is returning the contaminated shallow groundwater zone at LHAAP-50 to its potential beneficial uses as a drinking water, wherever practicable, and to document that the plumes are contained and prevented from impacting surface water at levels that could present a risk to human health and the environment. Furthermore, the LUC would protect human health by preventing access to the contaminated groundwater until contaminants in the groundwater attain the cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) for all contaminants above the cleanup levels and attain the cleanup levels for all contaminant by-products (daughter contaminants) above the cleanup levels.

2.10.2 Compliance with ARARs

Section 121(d) of CERCLA and NCP §300.430(f)(1)(ii)(B) requires that remedial actions at CERCLA sites 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). The ARARs that pertain to this ROD are discussed in **Section 2.13.2**.

Because contaminated groundwater has the potential to discharge to surface water features that flow to Caddo Lake, a drinking water supply, chemical-specific ARARs for surface water consumption are appropriate and relevant. Specifically, Texas surface water quality standards are set forth in 30 TAC 307.6(d)(1) for PCE (5 µg/L), TCE (5 µg/L), 1,2-DCA (5 µg/L), 1,1-DCE (7 µg/L), and VC (2 µg/L) for LHAAP-50. These standards are equivalent to the MCLs. For contaminants that are not listed in 30 TAC 307.6(d)(1), the GW-Res (MCL) for cis-1,2-DCE (70 µg/L), and the GW-Res (non-MCL) for perchlorate (26 µg/L) apply.

Alternative 1 does not comply with chemical-specific ARARs because no additional remedial action would be implemented. Alternatives 2 and 3 return the contaminated shallow groundwater zone at LHAAP-50 to its potential beneficial use as drinking water, wherever practicable, which for the purposes of this ROD is considered to be attainment of the relevant and appropriate cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C) and 30 TAC 335. If a return to potential beneficial uses is not practicable, these alternatives would still meet the NCP expectation to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. Alternative 2 does comply with surface water ARARs because modeling results indicate that MNA will reduce PCE and 1,2-DCE concentrations in groundwater to the cleanup levels prior to discharge as base flow into surface water, and that mixing and dilution would reduce TCE, VC and perchlorate concentrations to the cleanup levels at the point of entry into surface water; monitoring would be used to confirm it. Alternative 3 also complies with surface water chemical specific ARARs because active remedial processes will reduce contaminant levels in groundwater to levels below water quality standards prior to discharge as base flow into surface water.

Location-specific and action-specific ARARs would not apply to Alternative 1 since no remedial activities would be conducted. Alternatives 2 and 3 comply with all location-specific and action-specific ARARs.

2.10.3 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 cleanup 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.

For Alternative 1, contaminant removal would occur by natural attenuation processes, but the long-term effectiveness and permanence would be unknown because of the absence of monitoring. No measures would be implemented to control exposure risks posed by contaminated site groundwater. Alternative 1 would also be the least effective and permanent for the risk posed to human health from the soil-to-groundwater and soil-to-surface water pathways since no removal would be conducted.

The potential long-term risk from soil would be permanently removed for Alternatives 2 and 3 since the soil will be excavated and placed in a permitted landfill with the necessary facilities and long-term maintenance to control risks from the perchlorate contaminated soil. MNA processes at LHAAP-50 are controlling plume migration and have stabilized the size of the areas exhibiting COC concentrations exceeding cleanup levels. Monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume. Alternative 3 would reduce contaminant levels quicker than Alternative 2 through in situ bioremediation.

2.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternative 1 has the potential to reduce the mass and concentration of contaminants through natural attenuation processes, although the progress would be unmonitored and undocumented. Alternative 2 would use MNA and excavation to permanently reduce the mass and concentration of contaminants and, therefore, the volume, toxicity and mobility of the contaminants. Alternative 3 would use in situ bioremediation and excavation to achieve the same reductions in contamination that are expected from Alternative 2. MNA is a passive remedial action, and bioremediation is an active treatment process.

Biological activity would generate daughter products that may temporarily increase toxicity or mobility of the contaminant plume. Alternatives 2 and 3 include monitoring so that daughter products would be quantified, documented, and evaluated. The same biological activities would also consume the daughter products, and it is anticipated that these concentrations would be reduced to levels below their associated MCLs to return groundwater to its potential beneficial use as drinking water, wherever practicable.

Achievement of cleanup levels in groundwater would be expedited by implementing in situ bioremediation in areas of highest contaminant concentrations for Alternative 3. Monitoring for contaminants would be performed to assess the effectiveness of the treatment. It is also anticipated that COCs will remain in the plume outside the treated areas and will continue to attenuate to cleanup levels over time.

The soil excavation in Alternatives 2 and 3 provides a reduction of mobility because perchlorate is removed from the site and placed in a permitted disposal facility. Toxicity and volume are not reduced by the excavation portion of the alternative as the form and quantity of the perchlorate is not altered.

2.10.5 Short-Term Effectiveness

Short term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

Alternative 1 does not involve any remedial measures; therefore, no short-term risk to workers, the community or the environment would exist. The activities associated with Alternatives 2 and 3 are protective to the surrounding community from short-term risks except for minimal potential short-term risks during transport (possible accident when soil is transported offsite) of perchlorate-contaminated soil and negligible risks to workers associated with the exposure to contaminants during groundwater monitoring activities.

Alternatives 2 and 3 involve potential short-term risks to workers associated with exposure to contaminated groundwater and soil during operation of drilling/construction equipment. Alternatives 2 and 3 contain LUC as an element of their remedies and would provide almost immediate protection through the LUC that prohibits installation of wells for any purposes other than environmental monitoring and testing. The time period to achieve groundwater cleanup levels is the most significant difference between Alternative 1 versus Alternatives 2 and 3. Alternative 3 is expected to take less time to achieve RAOs.

2.10.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Under the no action alternative, no remedial action would be taken. Therefore, no difficulties or uncertainties would be associated with its implementation. Alternatives 2 and 3 are easily implemented from a technical standpoint as all required equipment, materials, and services are readily available. The U.S. Army would be responsible for long-term maintenance and enforcement of the LUC, long-term evaluation of MNA, long-term sampling; and long-term maintenance and operation of sampling equipment.

Alternative 3 would be somewhat more difficult to implement than Alternative 2 from a technical standpoint due to the specialized expertise required for design and construction of the in situ bioremediation treatment.

Administratively, all of the alternatives are implementable.

2.10.7 Cost

Cost estimates are used in the CERCLA FS process to eliminate those remedial alternatives that are significantly more expensive than competing alternatives without offering commensurate increases in performance or overall protection of human health or the environment. The cost estimates are preliminary estimates with an intended accuracy range of -30 to +50 percent. Final costs will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final scope, final schedule, final engineering design, and other variables.

The costs estimates include capital costs (including fixed-price remedial construction) and long-term O&M costs (post-remediation). Overall present worth costs are developed for each alternative assuming a discount rate of 2.8 percent. The duration used for the estimates is a 30-year period.

The progression of present worth costs from the least expensive alternative to the most expensive alternative is as follows: Alternative 1, Alternative 2, and Alternative 3. No costs are associated with Alternative 1 because no remedial activities would be conducted. Alternative 2 has the lower present worth and capital costs of the remedial alternatives other than no action. The higher capital cost associated with Alternative 3 is primarily due to the activities associated with the injection phase of in situ bioremediation.

2.10.8 State/Support Agency Acceptance

The USEPA and TCEQ have reviewed the Proposed Plan, which presented Alternative 2 as the preferred alternative. Comments received from the USEPA and TCEQ during the Proposed Plan development have been incorporated. Both agencies concur with the selected remedial action.

2.10.9 Community Acceptance

Community acceptance is an important consideration in the final evaluation of the selected remedy. Public comments were received during the 60-day public comment period, including written comments sent to the U.S. Army and verbal comments made at the January 26, 2010 and March 9, 2010, public meetings. Two sets of comments were submitted by the public. Questions included: the timeframe to achieve MCLs, potential for contamination of surface water by groundwater, and adequacy of monitoring wells for determining the plume extent. Comment responses were provided and incorporated into the ROD, including U.S. Army's intention to consider additional monitoring wells in the RD, clarification of times to restoration, and surface water-groundwater interaction. Significant comments are discussed in the Responsiveness Summary (**Section 3.0**). Responses to written comments have been filed in the Administrative Record.

2.11 Principal Threat Wastes

Contamination was found in the soil and groundwater. However, no principal threat source material was identified at LHAAP-50.

2.12 The Selected Remedy

2.12.1 Summary of Rationale for the Selected Remedy

Alternative 2 is the selected remedy for LHAAP-50 and is consistent with the intended future use of the site as a national wildlife refuge. This alternative is selected because it satisfies the RAOs for the site through contaminated soil removal with off-site disposal by eliminating the soil-to-groundwater and soil-to-surface water pathways, and through groundwater use restriction LUC that will ensure protection of human health by preventing human exposure to contaminated groundwater until cleanup levels are met. The monitoring and reporting associated with the MNA remedy will continue until cleanup levels are attained. Based on groundwater modeling, groundwater cleanup levels are expected to be met through natural attenuation in approximately 50 years for TCE. Considering the lithologic variability, particularly the lateral and vertical change from sand to clay, the calculated times to reach cleanup levels may range up to an order of magnitude greater for some constituents. Based on the groundwater flow rates and predictive modeling, no adverse impact to the surface water is expected during the time it would take natural attenuation to reduce contaminant concentrations to cleanup levels. The selected alternative offers a high degree of long-term effectiveness, can be easily and immediately implemented, and costs less than Alternative 3.

The performance of MNA will be evaluated after two years of performance monitoring using data from eight quarterly sampling events and from historical sampling events of the prior ten years. The performance objectives will be included in the RD. If it is found that the performance objectives for that two year period are not being met, a contingency remedy such as in situ bioremediation (see Alternative 3 description for basic elements) will be implemented, after approval of the RD for the contingency remedy. If MNA is found to be effective, the monitoring program will be continued as follows: three years of semiannual monitoring, then annual monitoring until the next five-year review, and finally LTM every five years until the cleanup levels are reached.

Based on the information currently available, the U.S. Army believes that the preferred alternative provides the best balance of tradeoffs among the other alternatives with respect to the CERCLA §121(b) criteria used to evaluate remedial alternatives. The preferred alternative will: 1) be protective of human health and the environment; 2) comply with ARARs; 3) be cost-effective; 4) utilize a permanent solution; and 5) not utilize an active treatment as a principal element.

Although the selected remedy is not intended to address the statutory preference for treatment to the maximum extent possible, the selected remedy offers, within a time frame reasonable for its anticipated use and at a lower cost, a similar level of protection to human health and the environment than the remedy alternative which satisfies the preference for treatment. In addition, no source materials constituting principle threats have been indentified at the site; therefore none will be addressed within the scope of this action.

The U.S. Army will present details of the LUC implementation plan, the groundwater monitoring plan, and the MNA remedy implementation in a RD for LHAAP-50.

Five-year reviews will be performed to document that the remedy remains protective of human health and the environment.

2.12.2 Description of Selected Remedy

The selected remedy, Alternative 2, was outlined in **Section 2.9**; that description is expanded in the following discussion. The remedy may change somewhat as a result of the RD and construction processes. Changes to the remedy described in the ROD will be documented using a technical memorandum in the Administrative Record, an Explanation of Significant Differences (ESD), or a ROD amendment.

The major components of the MNA remedy with a contingency remedy for the impacted groundwater include:

- Excavation of the contaminated soil and disposal in a RCRA-permitted landfill will remove soil that is considered to be a contaminant source to groundwater, thereby, protecting groundwater. The estimated volume of soil to be removed is 150 cubic yards and is based on the conservative TCEQ GWP-Ind of 7,200 µg/kg for perchlorate in soil. The approximate limits of excavation are shown on **Figure 2-7**. The removal of soil contamination will be verified by collecting confirmation samples from the walls and floors of the excavation area and submitting them for laboratory analysis for perchlorate.

- Semi-annual performance monitoring of Goose Prairie Creek adjacent to the LHAAP-50 will be conducted at two locations after excavation of the contaminated perchlorate pathway. Evaluation of this data will be included in the annual reports. The frequency and locations of sampling may be modified after evaluation of data. If perchlorate levels in the creek are consistently above the GW-Res after two years of monitoring, then additional evaluation will be conducted and any proposed actions will be included in the annual evaluation report to be submitted after year 2. The need to continue creek sampling will be evaluated during the five-year reviews.

- *MNA to return groundwater to its potential beneficial use, wherever practicable.* Historic data suggest that natural attenuation of COCs is occurring at the site; however, additional data collection is necessary to fully evaluate natural attenuation. Monitoring wells will be sampled for eight consecutive quarters to evaluate and confirm the occurrence of natural attenuation in conjunction with historical data. Data from the eight quarterly events will be combined with historic data to evaluate the effectiveness of various natural physical, chemical, and biological processes in reducing contaminant concentrations.

- *Performance objectives to evaluate the MNA remedy performance after two years.* Each of the general performance objectives must be met as indicated below. If the criteria are not met to illustrate that MNA is an effective remedy, a contingency action would be initiated. If MNA is effective, a baseline will be established from the data to this point in time. Specific evaluation criteria will be developed in the RD. The MNA evaluation will be based on the USEPA lines of evidence (USEPA, 1999) and the anaerobic screening (USEPA, 1998) as follows:

  – MNA potential based on evaluating biodegradation screening scores using USEPA guidance

  – Plume stability (i.e., the plume concentrations are decreasing in the majority of performance wells, and the plume is not expanding in area as demonstrated with compliance wells).

  – MNA Process Evaluation demonstrated based on an attenuation rate calculated with empirical performance monitoring data, and MNA Process Demonstration based on the presence of daughter products and bacterial culture counts.

- *A contingency remedy to enhance MNA to reach the RAOs if MNA is found to be ineffective.* The contingency remedy will use elements from other active remedial alternatives included in this ROD to address the ineffective aspects of MNA. The area and the elements of the contingency remedy would be selected based on the entire data set available. If a contingency remedy is implemented, it will be documented in an ESD.

- *Initiate LTM.* If MNA is determined to be effective, monitoring will be conducted to evaluate the remedy performance and determine if the plume conditions remain constant, improve or worsen after the baseline is established. Monitoring will continue after the initial eight quarters at a frequency of semiannual for three years, then annually until the next five-year review. The performance monitoring plan will be developed in the RD and will be based on USEPA guidance (USEPA, 2004).

- *Continue LTM every five years to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen.* The baseline of the plume for future five-year reviews will be established as part of the MNA evaluation program. The initial LTM plan will be developed during RD.

- *LUC to restrict access to the contaminated groundwater to environmental monitoring and testing only until cleanup levels are reached.* LUC implementation details will be included in the RD. The recordation notification for the site which will be filed with Harrison County will include a description of the LUC. The boundary of the LUC would enclose the site boundaries and the plume boundaries shown on **Figure 2-6**.

The U.S. Army would be responsible for implementation, maintenance, inspection, reporting, and enforcement of the LUC. Although the U.S. Army may later pass these procedural responsibilities to the transferee by property transfer agreement, the U.S. Army shall retain ultimate responsibility for: (1) CERCLA §121(c) five-year reviews; (2) notification of the appropriate regulators of any known LUC deficiencies or violations; (3) access to the property to conduct any necessary response; (4) reservation of the authority to change, modify or terminate LUCs and any related transfer or lease provisions; and (5) ensuring that the LUC objectives are met to protect the integrity of the selected remedy. In the event that TCEQ and/or EPA and the Army agree with respect to any modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the FFA and 40 CFR 300.435(c)(2) and 40 CFR 300.430(f)(4)(iii).

LUC implementation and maintenance actions would be described in the RD for LHAAP-50. The selected LUC will prevent human exposure to groundwater contaminated with chlorinated solvents and perchlorate through the restriction of groundwater use. The groundwater restriction LUC shall be maintained until the concentrations of contaminants and by-product (daughter) contaminants have been reduced to below their respective cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) to allow unlimited use and unrestricted exposure at LHAAP-50. The LUC would be included in the property transfer documents. In addition, the Texas Department of Licensing and Regulation responsible for notifying well drillers of groundwater restrictions would be notified and a recordation of the area of groundwater restriction would be filed in the Harrison County Courthouse.

Monitoring activities associated with the LUC and MNA would be undertaken to ensure that groundwater is not being used, and to demonstrate containment of the plume and the eventual reduction of contaminates to levels below cleanup levels.

Long-term operational requirements under this alternative would include maintenance of the LUC. The need for continued monitoring will be evaluated every five years during the reviews. Sampling frequency and analytical requirements will be presented in the RD for LHAAP-50.

2.12.3 Cost Estimate of the Selected Remedy

Table 2-8 presents the present worth analysis of the cost for the selected remedy, Alternative 2. The information in the table is based on the best available information regarding the anticipated scope of the remedial alternative. The quantities used in the estimate are for estimating purposes only. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within -30 to +50 percent of the actual project cost.

The total project present worth cost of this alternative is approximately $639,000, using a discount rate of 2.8%. The capital cost is estimated at $215,000. The total O&M present value cost is estimated at approximately $424,000. The O&M cost includes evaluation of MNA, maintenance of LUC, and LTM through Year 30. The LTM would support the required CERCLA five-year reviews.

2.12.4 Expected Outcomes of the Selected Remedy

The purpose of this response action is to attain the RAOs stated in **Section 2.8** of this document. **Table 2-6** presents the cleanup levels. The cleanup levels for the VOCs in the groundwater are the Federal SDWA MCLs. The cleanup levels for perchlorate in the soil and groundwater are the MSCs for industrial use, GWP-Ind and GW-Ind, respectively (TCEQ, 2006).

The expected outcome of the selected remedy is that the VOC and perchlorate plumes in the groundwater would be reduced to the cleanup levels. Achievement of the cleanup levels is anticipated to be completed in 50 years. When the groundwater is satisfactory, the LUC will be removed. In the short-term (prior to the groundwater achieving cleanup levels), the site will be made part of a national wildlife refuge operated by USFWS, and will continue as such in the long-term (after the groundwater achieves cleanup levels).

In addition, the monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume. Until that time, the LUC will restrict the use of the site’s groundwater to environmental monitoring and testing.

2.13 Statutory Determinations

Under CERCLA §121 and the NCP, the U.S. Army 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 practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets the statutory requirements.

2.13.1 Protection of Human Health and the Environment

The selected remedy, Alternative 2, will protect human health and the environment, and achieve the RAOs for LHAAP-50. Although this alternative does not provide for human intervention to remediate groundwater, the alternative is a passive subsurface remedial action conducted by natural processes and mechanisms. The contaminated groundwater will be reduced to protective ARAR levels, and the soil above protective ARAR levels will be removed. LUC would prevent human exposure to the contaminated groundwater by prohibiting the construction of potable wells within the LUC boundaries. Surface water monitoring of the creek will verify that the soil removal effectively mitigated the soil-to-groundwater pathway. The monitoring activities associated with MNA will ensure that COCs and by-product (daughter) contaminants in groundwater do not discharge to nearby surface water bodies at such levels that ARARs are exceeded.

There are no short-term threats associated with the selected remedy that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the selected remedy.

2.13.2 Compliance with ARARs

The selected remedy complies with all ARARs. The ARARs are presented below and in **Table 2-9**.

Chemical-Specific ARARs

- **Soil**: There are no Federal promulgated chemical-specific ARARs for soil. The TCEQ Texas Risk Reduction Rules are promulgated State standards for this site. It is anticipated that removal of perchlorate-contaminated soils above the TCEQ GWP-Ind of 7,200 μg/kg will prevent contamination of the groundwater at the site.

- **Surface water**: Section 121(d)(2) of CERCLA states that every remedial action shall require a level of control which at least attains surface water quality criteria established under Sections 304 or 303 of the Clean Water Act of 1972 (CWA). Therefore, surface water quality criteria are ARARs if there is a remedial action that affects surface water, and measures will be implemented during construction to prevent off-site migration of contaminants to surface waters. In the event of remedy failure resulting in or potentially resulting in a release to surface water, 40 CFR 122, 125, 129, 130, and 131 and 30 TAC 307.1, 307.2, 307.3, 307.4, 307.5(a) and (b), 307.6, 307.7, 307.8 and 307.9 are considered potential future ARARs.

- **Groundwater**: Cleanup levels are presented in **Table 2-6**. LHAAP is being addressed using the Risk Reduction Standards (RRS) (30 TAC 335.551 through 335.569). The RRS were provided to ensure adequate protection of human health and the environment from potential exposure to contaminants associated with releases from solid waste management facilities or other areas. There are three sets of RRS that provide cleanup levels ranging from closure/remediation to site background (RRS 1) to closure/remediation with controls (RRS 3). A baseline risk assessment under RRS 3 was completed for LHAAP-50 which identified COCs in groundwater that potentially pose carcinogenic risk and hazard to the hypothetical future maintenance worker. These identified COCs, with the exception of perchlorate, have MCLs. Thus, the cleanup goal for groundwater will be the MCLs which meet health-based standards and criteria, and the MSCs provided under Texas Risk Reduction Rules (30 TAC 335.551 through 335.569) where MCLs are not available, i.e., perchlorate. This alternative will return the contaminated shallow groundwater zone at LHAAP-50 to its potential beneficial use as drinking water, wherever practicable, which for the purposes of this ROD is considered to be attainment of the relevant and appropriate cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C) and 30 TAC 335. If a return to potential beneficial uses is not practicable, this alternative would still meet the NCP expectation to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. Because modeling results indicate that maximum concentrations of COCs would be below their respective cleanup levels in the nearby surface water bodies where groundwater discharges, nearby surface water bodies will be protected from ARAR exceedances.

Location-Specific ARARs

- **Floodplain management**: LHAAP-50 may include areas classified as part of a floodplain.

- **Wetlands**: The USACE has not made a determination that jurisdictional wetlands exist at LHAAP-50, and none are identified on the USFWS database; therefore, protection of wetlands is not considered a potential location-specific ARAR for this site.

Action-Specific ARARs

The selected remedy has potential action-specific ARARs related to the following activities: waste generation, characterization, management, storage, and disposal activities; and well construction.

- **Waste and disposal activities**: The processes of monitoring, intercepting, or treating contaminated groundwater may generate a variety of primary and secondary waste streams (e.g., soil, personal protective equipment, and dewatering and decontamination fluids). These waste streams are expected to be non-hazardous waste. All solid waste (defined as any solid, liquid, semisolid, or contained gaseous material intended for discard [40 CFR 261.2]) generated during remedial activities must be appropriately characterized to determine whether it contains RCRA hazardous waste (40 CFR 262.11; 30 TAC 335.62; 30 TAC 335.503[a][4]; 30 TAC 335.504). All wastes must be managed, stored, treated (if necessary), and disposed of in accordance with the ARARs for waste management listed in **Table 2-9** for the particular type of waste stream or contaminants in the waste.

- **Well construction**: The remedial action may involve the placement, use, or eventual plugging and abandonment of some type of groundwater monitoring, injection, and/or extraction wells, either for in situ treatment of the contaminated groundwater or for LTM of the groundwater. Available standards for well construction and plugging/abandonment would provide ARARs for such actions and include 30 TAC 331, Subchapters A, C, and H. Texas has promulgated technical requirements in Chapter 76 of Title 16 of the TAC applicable to construction, operation, and plugging/abandonment of water wells. In particular, 16 TAC 76.1000 (*Locations and*

Standards of Completion for Wells), 16 TAC 76.1002 (*Standards for Wells Producing Undesirable Water or Constituents*) (LHAAP-50 contaminated groundwater could be considered "undesirable water" defined pursuant to Section 76.10[36] as "water that is injurious to human health and the environment or water that can cause pollution to land or other waters"), 16 TAC 76.1004 (*Standards for Capping and Plugging of Wells and Plugging Wells that Penetrate Undesirable Water or Constituent Zones*), and 16 TAC 76.1008 (*Pump Installation*) may provide ARARs for the placement, construction, and eventual plugging/abandonment of groundwater injection or extraction wells or the placement and long-term operation of groundwater monitoring wells for proposed groundwater remedial strategies.

- **Water Treatment**: Contaminated groundwater and wastewaters collected during well drilling or decontamination activities could be transported to the groundwater treatment plant at LHAAP-18/24 for processing, and would subsequently be discharged in compliance with the effluent limits for that plant. Such waters would be characterized, as required, before transport and managed accordingly in compliance with requirements for the type of waste contaminating the water. To assure compliance with the groundwater treatment plant's discharge limits, the incoming water must meet the waste acceptance criteria for the facility. On-site wastewater treatment units (as defined in 40 CFR 260.10) that are part of a wastewater treatment facility that is subject to regulation under Section 402 or Section 307(b) of the CWA are not subject to RCRA Subtitle C hazardous waste management standards (40 CFR 270.1[c][2][v]; 40 CFR 264.1[g][6]; 30 TAC 335.42[d][1]). The USEPA has clarified that this exemption applies to all tanks, conveyance systems, and ancillary equipment, including piping and transfer trucks, associated with the wastewater treatment unit (Federal Register [FR] Title 53, 34079, September 2, 1988).

2.13.3 Cost Effectiveness

Alternative 2 has the lowest present worth and capital costs of the remedial alternatives other than no action. The present worth cost of Alternative 2 is significantly lower than that of Alternative 3 primarily due to the costs of in situ bioremediation included under Alternative 3. Alternative 2 offers a high degree of long-term effectiveness, and costs less than Alternative 3.

Table 2-8 is the cost estimate summary table for the selected remedy. **Table 2-7** compares the cost and effectiveness of each alternative.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

The selected remedy addresses the issue of permanent solution through disposal with the excavation of the contaminated soil, but does not address the issue of a permanent solution for groundwater through disposal, treatment, or recovery of contaminants. The selected remedy provides the best balance of trade offs in terms of five balancing criteria and considering State and community acceptance. Alternative 2 would document effectiveness through the confirmation of MNA and the routine monitoring of the attenuation and migration of the contaminants in groundwater. Natural attenuation effectively controls plume migration and has stabilized the size of the area exhibiting COC and by-product (daughter) contaminant concentrations exceeding cleanup levels. Natural biodegradation is an irreversible treatment process that would reduce the mass and concentration of contaminants. Alternative 2 would provide almost immediate protection because the LUC would be implemented relatively quickly. Maintenance of these controls would be required until natural attenuation processes reduce COC and by-product (daughter) contaminant concentrations to below cleanup levels. Alternative 2 is easily implemented from a technical standpoint; it requires soil excavation, routine maintenance of the LUC, evaluation of MNA, and sampling. Alternative 2 has the lowest present worth and capital costs of the remedial alternatives.

2.13.5 Preference for Treatment as a Principle Element

The selected remedy does not satisfy the statutory preference for treatment as a principle element of the remedy. Although the selected remedy is not intended to address the statutory preference for treatment to the maximum extent practicable, the selected remedy offers, within a reasonable time frame and at a lower cost, a similar level of protection to human health and the environment than those remedy alternatives which satisfy the preference for treatment. Because no source materials constituting principle threats are present at the site, they not will be addressed within the scope of this action.

2.13.6 Five-Year Review Requirements

Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(C) provide the statutory and legal bases for conducting five-year reviews. Because the selected remedy will result in contaminants that remain on site above levels that allow unlimited use and unrestricted exposure, a review will be conducted every five years to ensure that the remedy continues to provide adequate protection of human health and the environment.

2.14 Significant Changes from the Proposed Plan

The Proposed Plan for LHAAP-50 was released for public comment in January 2010. The Proposed Plan identified Alternative 2 (Excavation, MNA, LUC) as the Preferred Alternative for groundwater remediation. The U.S. Army reviewed all written and verbal comments submitted during the public comment period. After careful consideration of the comments, it was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

Table 2-1
Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

Scenario Timeframe: Current
Medium: Soil
Exposure Medium: Soil (0 to 0.5 feet below ground surface)

Exposure Point	Chemical	Concentration Detected[1] (mg/kg)		Frequency of Detection	Exposure Point Concentration (mg/kg)	Statistical Measure
		Minimum	Maximum			
Incidental ingestion, inhalation of particulates, dermal contact	*Dioxin/Furan*					
	2,3,7,8-TCDD	2.64E-07	7.96E-06	---	7.96E-06	Maximum
	Metals					
	Vanadium	3.30E+00	7.10E+01	13/13	7.10E+01	Maximum
	Non-Metallic Anion					
	Perchlorate	3.00E-02	3.00E-02	1/2	3.61E-02	Maximum

Scenario Timeframe: Current
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical	Concentration Detected[1] (µg/L)		Frequency of Detection	Exposure Point Concentration (µg/L)	Statistical Measure
		Minimum	Maximum			
Incidental ingestion, inhalation of particulates, dermal contact	*Dioxin/Furan*					
	2,3,7,8-TCDD	2.93E-06	7.31E-06	---	7.31E-06	Maximum
	Metals					
	Aluminum	2.40E+03	9.90E+03	5/5	9.90E+03	Maximum
	Antimony	9.00E+00	1.40E+01	4/5	1.40E+01	Maximum
	Chromium	3.00E+01	2.00E+02	5/5	2.00E+02	Maximum
	Manganese	9.80E+01	1.11E+03	5/5	1.11E+03	Maximum
	Nickel	6.00E+01	6.90E+02	3/5	6.90E+02	Maximum
	Strontium	2.40E+02	3.40E+03	5/5	3.40E+03	Maximum
	Non-Metallic Anion					
	Perchlorate	1.60E+00	1.80E+04	7/15	1.80E+04	Maximum
	Semi-Volatile Organics					
	Naphthalene	1.30E+00	1.30E+00	1/7	1.30E+00	Maximum
	Volatile Organics					
	1,1,2-Trichloroethane	3.60E+00	3.60E+00	1/7	3.60E+00	Maximum
	1,2,4-trimethylbenzene	3.90E+00	3.90E+00	1/7	3.90E+00	Maximum
	1,1-Dichloroethene	5.00E+01	5.00E+01	1/7	5.00E+01	Maximum
	1,2-Dichloroethane	9.80E+01	9.80E+01	1/7	9.80E+01	Maximum
	Acetone	6.70E+01	6.70E+01	1/7	6.70E+01	Maximum
	Benzene	2.20E+00	2.20E+00	1/7	2.20E+00	Maximum
	Chloroform	6.30E-01	2.50E+01	2/7	2.50E+01	Maximum
	cis-1,2-Dichloroethene	6.40E-01	4.40E+03	4/7	4.40E+03	Maximum
	trans-1,2-Dichloroethene	1.50E+01	1.50E+01	1/7	1.50E+01	Maximum
	Tetrachloroethene	3.50E+01	3.50E+01	1/7	3.50E+01	Maximum
	Trichloroethene	5.70E-01	2.20E+04	6/7	2.20E+04	Maximum
	Vinyl Chloride	1.00E+02	1.00E+02	1/7	1.00E+02	maximum

Table 2-1 *(continued)*
Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

Notes

[1] Minimum/maximum detected concentration above the reporting limit
---: No information available
µg/L: micrograms per liter
mg/kg: milligrams per kilogram
TCDD: tetrachlorodibenzo-p-dioxin

References

Jacobs Engineering Group, Inc. (Jacobs), 2003, *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas*, Final, Oak Ridge, TN, June.

Summary of Chemicals of Potential Concern and Medium-Specific Exposure Point Concentrations

The table presents the chemicals of potential concern (COPCs) and exposure point concentration (EPC) for each (i.e. the concentration used to estimate the exposure and risk from each COPC). The table includes the range of concentrations detected for each COPC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and the statistical measure upon which the EPC was based. The COPCs listed are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003).

Table 2-2
Carcinogenic Toxicity Data Summary

Pathway: Ingestion, Dermal Contact

Chemical of Concern	Oral Cancer Slope Factor (mg/kg-day)	Dermal Cancer Slope Factor (mg/kg-day)	Weight of Evidence/ Carcinogen Guideline Description	Source/Date
Dioxin/Furan				
2,3,7,8-TCDD	1.50E+05	3.00E+05	Not Classified	USEPA-HEAST, 1997
Metals				
Aluminum	NTV	NTV	Not Classified	---
Antimony	NTV	NTV	Not Classified	---
Chromium	NC	NC	Not Classified	---
Manganese	NC	NC	D	USEPA-IRIS, 2001
Nickel	NTV	NTV	A	USEPA-IRIS, 2001
Strontium	NTV	NTV	Not Classified	---
Vanadium	NTV	NTV	Not Classified	---
Non-Metallic Anion				
Perchlorate	NTV	NTV	Not Classified	---
Semi-Volatile Organics				
Naphthalene	NTV	NTV	C	USEPA-IRIS, 2001
Volatile Organics				
1,1,2-Trichloroethane	NC	NC	D	USEPA-IRIS, 2001
1,2,4-trimethylbenzene	NTV	NTV	Not Classified	---
1,1-Dichloroethene	6.00E-01	6.00E-01	C	USEPA-IRIS, 2001
1,2-Dichloroethane	9.10E-02	9.10E-02	B2	USEPA-IRIS, 2001
Acetone	NC	NC	D	USEPA-IRIS, 2001
Benzene	5.50E-02	5.67E-02	A	USEPA-IRIS, 2001
Chloroform	6.10E-03	3.05E-02	B2	USEPA-IRIS, 2001
cis-1,2-Dichloroethene	NC	NC	D	USEPA-IRIS, 2001
trans-1,2-Dichloroethene	NTV	NTV	Not Classified	---
Tetrachloroethene	5.20E-02	5.20E-02	B2	USEPA-NCEA, 2001
Trichloroethene	1.10E-02	1.10E-02	B2	USEPA-NCEA, 2001
Vinyl Chloride	1.50E+00	1.50E+00	A	USEPA-IRIS, 2001

Table 2-2 *(continued)*
Carcinogenic Toxicity Data Summary

Pathway: Inhalation			
Chemical of Concern	Unit Risk Factor $(mg/m^3)^{-1}$	Weight of Evidence/ Carcinogen Guideline Description	Source/Date
Dioxin/Furan			
2,3,7,8-TCDD	3.30E+04	Not Classified	USEPA-HEAST, 1997
Metals			
Aluminum	NTV	Not Classified	---
Antimony	NTV	Not Classified	---
Chromium	NC	Not Classified	---
Manganese	NC	D	USEPA-IRIS, 2001
Nickel	4.80E-01	A	USEPA-IRIS, 2001
Strontium	NTV	Not Classified	---
Vanadium	NTV	Not Classified	---
Non-Metallic Anion			
Perchlorate	NTV	Not Classified	---
Semi-Volatile Organics			
Naphthalene	NC	C	USEPA-IRIS, 2001
Volatile Organics			
1,1,2-Trichloroethane	NC	D	USEPA-IRIS, 2001
1,2,4-trimethylbenzene	NTV	Not Classified	---
1,1-Dichloroethene	5.00E-02	C	USEPA-IRIS, 2001
1,2-Dichloroethane	2.60E-02	B2	USEPA-IRIS, 2001
Acetone	NC	D	USEPA-IRIS, 2001
Benzene	7.80E-06	A	USEPA-IRIS, 2001
Chloroform	2.30E-02	B2	USEPA-IRIS, 2001
cis-1,2-Dichloroethene	NC	D	USEPA-IRIS, 2001
trans-1,2-Dichloroethene	NTV	Not Classified	---
Tetrachloroethene	5.80E-07	B2	USEPA-NCEA, 2001
Trichloroethene	1.70E-03	B2	USEPA-NCEA, 2001
Vinyl Chloride	8.80E-03	A	USEPA-IRIS, 2001

Table 2-2 *(continued)*
Carcinogenic Toxicity Data Summary

Notes

--- : No information available
mg/kg-day: milligrams per kilogram per day
mg/m^3: milligrams per cubic meter
NC: Chemical not classified as a carcinogen
NTV: no toxicity value available
TCDD: tetrachlorodibenzo-p-dioxin

Weight of Evidence/Carcinogen Guideline Description:

- A - Human carcinogen
- B1 - Probable human carcinogen – Indicates that limited human data are available
- B2 - Probable human carcinogen – Indicates sufficient evidence in animals and inadequate or no evidence in humans
- C - Possible human carcinogen
- D - Not classifiable as a human carcinogen

References

Jacobs Engineering Group, Inc. (Jacobs), 2003, *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas*, Final, Oak Ridge, TN, June.

USEPA-HEAST, 1997. Human Health Effects Summary Tables (HEAST). FY-1995, Annual. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R-95-036.

USEPA-IRIS, 2001. Integrated Risk Information System (IRIS). United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 2001.

USEPA-NCEA, 2001. USEPA Region 3 Risk-Based Concentration Tables (5/8/2001). Referenced values from National Center for Environmental Assessment (NCEA).

Summary of Toxicity Assessment

The table provides carcinogenic risk information which is relevant to the contaminants of potential concern soil and ground water. The list of chemicals of concern presented here are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003).

Table 2-3
Non-Carcinogenic Toxicity Data Summary

Pathway: Ingestion, Dermal Contact						
Chemical of Concern	Chronic/ Subchronic	Oral RfD Value (mg/kg-day)	Dermal RfD (mg/kg-day)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source/Date
Dioxin/Furan						
2,3,7,8-TCDD	Chronic	NTV	NTV	---	---	---
Metals						
Aluminum	Chronic	1.00E+00	1.00E-01	NA	NA	USEPA-NCEA, 2001
Antimony	Chronic	4.00E-04	6.00E-05	Longevity, blood glucose, and cholesterol	1000/1	USEPA-IRIS, 2001
Chromium	Chronic	1.50E+00	1.95E-02	NA	100/10	USEPA-IRIS, 2001
Manganese	Chronic	4.70E-02	2.82E-03	CNS	1/1	USEPA-IRIS, 2001
Nickel	Chronic	2.00E-02	8.00E-04	Body weight	300/1	USEPA-IRIS, 2001
Strontium	Chronic	6.00E-01	1.20E-01	Bone	300/1	USEPA-IRIS, 2001
Vanadium	Chronic	7.00E-03	1.82E-04	NA	NA	USEPA-HEAST, 1997
Non-Metallic Anion						
Perchlorate	Chronic	9.00E-04	9.00E-04	NA	NA	USEPA, 1998
Semi-Volatile Organics						
Naphthalene	Chronic	2.00E-02	1.78E-02	Body weight	3000/1	USEPA-IRIS, 2001
Volatile Organics						
1,1,2-Trichloroethane	Chronic	2.80E-01	2.52E-01	NA	NA	USEPA-NCEA, 2001
1,2,4-trimethylbenzene	Chronic	5.00E-02	4.00E-02	NA	NA	USEPA-NCEA, 2001
1,1-Dichloroethene	Chronic	9.00E-03	9.00E-03	Liver	1000/1	USEPA-IRIS, 2001
1,2-Dichloroethane	Chronic	3.00E-02	3.00E-02	NA	NA	USEPA-NCEA, 2001
Acetone	Chronic	1.00E-01	8.30E-02	Liver, kidney	1000/1	USEPA-IRIS, 2001
Benzene	Chronic	3.00E-03	2.91E-03	NA	NA	USEPA-NCEA, 2001
Chloroform	Chronic	1.00E-02	2.00E-03	Liver	1000/1	USEPA-IRIS, 2001
cis-1,2-Dichloroethene	Chronic	1.00E-02	1.00E-02	Blood	3000/1	USEPA-HEAST, 1997
trans-1,2-Dichloroethene	Chronic	2.00E-02	2.00E-02	Blood	1000/1	USEPA-IRIS, 2001
Tetrachloroethene	Chronic	1.00E-02	1.00E-02	Liver	1000/1	USEPA-IRIS, 2001
Trichloroethene	Chronic	6.00E-03	6.00E-03	NA	NA	USEPA-NCEA, 2001
Vinyl Chloride	Chronic	3.00E-03	3.00E-03	Liver	30/1	USEPA-IRIS, 2001

Table 2-3 *(continued)*
Non-Carcinogenic Toxicity Data Summary

Pathway: Inhalation

Chemical of Concern	Chronic/ Subchronic	Inhalation RfC (mg/m³)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source/Date
Dioxin/Furan					
2,3,7,8-TCDD	Chronic	NTV	---	---	---
Metals					
Aluminum	Chronic	0.0035	NA	NA	USEPA-NCEA, 2001
Antimony	Chronic	0.0005	Lungs, GIT	300/1	TCEQ, 2001
Chromium	Chronic	0.0001	NA	NA	TCEQ, 2001
Manganese	Chronic	0.00005	CNS	1000/1	USEPA-IRIS, 2001
Nickel	Chronic	0.0002	Respiratory effects	NA	ATSDR, 1997
Strontium	Chronic	NTV	---	---	---
Vanadium	Chronic	0.00005	NA	NA	TCEQ, 2001
Non-Metallic Anion					
Perchlorate	Chronic	NTV	---	---	---
Semi-Volatile Organics					
Naphthalene	Chronic	0.003	NA	NA	USEPA-IRIS, 2001
Volatile Organics					
1,1,2-Trichloroethane	Chronic	2.205	NA	NA	USEPA-NCEA, 2001
1,2,4-trimethylbenzene	Chronic	0.006	NA	NA	USEPA-NCEA, 2001
1,1-Dichloroethene	Chronic	NTV	---	---	---
1,2-Dichloroethane	Chronic	0.005	NA	NA	USEPA-NCEA, 2001
Acetone	Chronic	0.59	NA	NA	TCEQ, 2001
Benzene	Chronic	0.006	NA	NA	USEPA-NCEA, 2001
Chloroform	Chronic	0.000301	NA	NA	USEPA-NCEA, 2001
cis-1,2-Dichloroethene	Chronic	0.793	NA	NA	TCEQ, 2001
trans-1,2-Dichloroethene	Chronic	0.793	NA	NA	TCEQ, 2001
Tetrachloroethene	Chronic	0.49	NA	NA	USEPA-NCEA, 2001
Trichloroethene	Chronic	NTV	---	---	---
Vinyl Chloride	Chronic	0.1	Liver	30/1	USEPA-IRIS, 2001

Table 2-3 *(continued)*
Non-Carcinogenic Toxicity Data Summary

Notes

---: No information for a compound with no toxicity value (NTV)
CNS: Central nervous system
GIT: Gastrointestinal tract
IRIS: Integrated Risk Information System, USEPA
mg/kg-day: milligrams per kilogram per day
mg/m^3: milligrams per cubic meter
NA: Information not available
NTV: No toxicity value available
RfC: Reference concentration
RfD: Reference dose

References

Agency for Toxic Substances and Disease Registry (ATSDR), 1997, Minimal Risk Levels (MRLs) for Hazardous Substances.

Jacobs Engineering Group, Inc. (Jacobs), 2003, *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas*, Final, Oak Ridge, TN, June.

Texas Commission on Environmental Quality (TCEQ), 2001. Update to 1998 Consistency Memorandum. Toxicity Factors Table, 15 March, 2001.

U.S. Environmental Protection Agency (USEPA), 1998. *Perchlorate Environmental Contamination Toxicological Review and Risk Characterization based on Emergency Information*, Review Draft, Office of Research and Development. NCEA-1-0503, 31 December, 1998.

USEPA-HEAST, 1997. Health Effects Summary Table (HEAST). FY 1995, Annual Office of Emergency and Remedial Response. Washington, D.C. EPA/340/R-95-036.

USEPA-IRIS, 2001. Integrated Risk Information System (IRIS). United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 2001.

USEPA-NCEA, 2001. USEPA Region 3 Risk-Based Concentration Tables (5/8/2001). Referenced values from National Center for Environmental Assessment (NCEA).

Summary of Toxicity Assessment

This table provides non-carcinogenic risk information relevant to the contaminants of concern in both soil and ground water. The list of chemicals of concern presented here are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003). The uncertainty factor and modifying factor are used in the development of a references dose. The uncertainty factor adjusts results from dose-response studies in animals to make them applicable to humans. The modifying factor is used to account for uncertainties in the available toxicity data from which the reference dose is derived. In the risk assessment, the reference doses and concentrations were for the chronic case, to be conservative.

Table 2-4
Risk Characterization Summary – Carcinogens

Scenario Timeframe: Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogen Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 to 0.5 ft)	Soil and particulates	Incidental ingestion, inhalation of particulates, dermal contact	*Dioxin/Furan*				
			2,3,7,8-TCDD	4.2E-07	1.4E-11	1.6E-07	5.8E-07
						Soil risk total =	5.8E-07
Groundwater	Groundwater	Ingestion and exposure while showering	*Dioxin/Furan*				
			2,3,7,8-TCDD	3.8E-06	NE	3.2E-05	3.6E-05
			Volatile Organics				
			1,1,2-Trichloroethane	7.2E-07	3.5E-09	6.5E-07	1.4E-06
			1,1-Dichloroethene	1.0E-04	1.5E-04	1.4E-04	4.0E-04
			1,2-Dichloroethane	3.1E-05	1.6E-04	1.4E-05	2.0E-04
			Benzene	4.2E-07	1.0E-09	3.0E-08	4.5E-07
			Chloroform	5.3E-07	3.5E-05	2.1E-06	3.8E-05
			Tetrachloroethene	6.4E-06	1.2E-09	2.5E-05	3.2E-05
			Trichloroethene	8.5E-04	2.3E-03	1.1E-03	4.3E-03
			Vinyl Chloride	5.2E-04	5.4E-05	NE (Kp<=0.01)	5.8E-04
						Groundwater risk total =	5.5E-03
						Total risk (soil and groundwater) =	5.5E-03

Key

Kp Dermal permeability coefficient
NE Not evaluated through this exposure pathway. Chemical is not identified as a volatile
NE (Kp<=0.01) COPCs with a Kp<=0.01 were not evaluated for dermal contact while showering (USEPA, 1995)
TCDD Tetrachlorodibenzo-p-dioxin

References

U.S. Environmental Protection Agency (USEPA), *National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule, 40 CFR Part 300*, March 8, 1990.

USEPA, *Supplemental Region VI Risk Assessment Guidance, May 5, 1995*.

Summary of Risk Characterization

The table provides risk estimates for the significant routes of exposure at LHAAP-50. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a hypothetical future maintenance worker's exposure to soil and groundwater, as well as the toxicity of the chemicals of concern. The total risk from exposure to contaminated soil and groundwater at this site is estimated to be 5.5E-03. A risk below 10^{-4} is generally considered to be acceptable (USEPA, 1990). The soil risk is acceptable, while the groundwater risk is not. The COC contributing the most to the groundwater risk level is trichloroethene. Other significant contributors are vinyl chloride; 1,1-dichloroethene; and 1,2-dichloroethane. This risk level indicates that if no clean-up action is taken, an individual would have an increased probability of 6 in 1000 of developing cancer as a result of site-related exposure to the chemicals of concern.

Table 2-5
Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 to 0.5 ft)	Soil and particulates	Incidental ingestion, dermal contact, inhalation of particulates	*Metals*					
			Vanadium	NA	9.9E-03	2.1E-04	2.4E-02	3.5E-02
			Non-Metallic Anion					
			Perchlorate	NA	3.9E-05	NTV	2.5E-06	4.2E-05
							Soil Hazard Index Total =	3.5E-02
Ground-water	Ground-water	Ingestion and exposure while showering	*Metals*					
			Aluminum	NA	9.7E-02	NE	NE (Kp<=0.01)	9.7E-02
			Antimony	Blood	3.4E-01	NE	NE (Kp<=0.01)	3.4E-01
			Chromium	Kidney	1.3E-03	NE	NE (Kp<=0.01)	1.3E-03
			Manganese	CNS	2.3E-01	NE	NE (Kp<=0.01)	2.3E-01
			Nickel	Body weight	3.4E-01	NE	NE (Kp<=0.01)	3.4E-01
			Strontium	Bone	5.5E-02	NE	NE (Kp<=0.01)	5.5E-02
			Non-Metallic Anion					
			Perchlorate	NA	2.0E+02	NE	NE (Kp<=0.01)	2.0E+02
			Semi-Volatile Organics					
			Naphthalene	Body weight	6.4E-04	7.4E-02	1.6E-04	7.5E-02
			Volatile Organics					
			1,1,2-Trichloroethane	Blood	8.8E-03	NTV	8.0E-03	1.7E-02
			1,2,4-trimethylbenzene	NA	7.6E-04	1.1E-01	4.1E-04	1.1E-01
			1,1-Dichloroethene	Liver	5.4E-02	NTV	7.3E-02	1.3E-01
			1,2-Dichloroethane	NA	3.2E-02	3.4E+00	1.5E-02	3.4E+00
			Acetone	Liver, kidney	6.6E-03	1.9E-02	NE (Kp<=0.01)	2.6E-02
			Benzene	NA	7.2E-03	6.3E-02	5.1E-04	7.0E-02
			Chloroform	Liver	2.4E-02	1.4E+01	9.6E-02	1.4E+01
			cis-1,2-Dichloroethene	Blood	4.3E+00	9.5E-01	NE (Kp<=0.01)	5.3E+00
			trans-1,2-Dichloroethene	Blood	7.3E-03	3.2E-03	3.7E-04	1.1E-02
			Tetrachloroethene	Liver	3.4E-02	1.2E-02	1.4E-01	1.8E-01
			Trichloroethene	NA	3.6E+01	NTV	4.8E+01	8.4E+01
			Vinyl Chloride	Liver	3.3E-01	1.7E-01	NE (Kp<=0.01)	5.0E-01
							Groundwater Hazard Index Total =	3.0E+02
							Receptor Hazard Index Total (soil and groundwater) =	3.0E+02
							Liver Hazard Index Total =	1.5E+01

Table 2-5 *(continued)*
Risk Characterization Summary – Non-Carcinogens

Key

CNS	Central nervous system
Kp	Dermal permeability coefficient
NA	Information was not available
NE	Not evaluated through this exposure pathway
NE (Kp<=0.01)	Based on USEPA 6 guidance, chemicals of potential concern with a Kp<=0.01 were not evaluated for dermal contact while showering (USEPA, 1995)
NTV	No toxicity value available to quantitatively address this exposure

References

U.S. Environmental Protection Agency (USEPA), 1989, *Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual, (Part A)*, EPA/540/1-89/002, December.

USEPA, *Supplemental Region 6 Risk Assessment Guidance*, May 5, 1995.

Summary of Risk Characterization

The table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure at LHAAP-50. The Risk Assessment Guidance for Superfund (USEPA, 1989) states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse non-carcinogenic effects. The estimated HI of 300 for groundwater indicates that the potential for adverse non-carcinogenic effects could occur from exposure to contamination in that medium. The estimated HI of 0.035 for soil indicates that the hazard of the soil is acceptable.

Table 2-6
Cleanup Levels

COC	ARAR
Groundwater	MCL (µg/L)
1,1-Dichloroethene	7
1,2-Dichloroethane	5
cis-1,2-Dicloroethene	70
Perchlorate	72 a
Tetrachloroethene	5
Trichloroethene	5
Vinyl Chloride	2
Soil	GWP-Ind (µg/kg)
Perchlorate	7,200

Notes and Abbreviations

a Groundwater medium-specific concentration for industrial use for perchlorate since no MCL exists

µg/kg micrograms per kilogram
µg/L micrograms per liter
ARAR applicable or relevant and appropriate requirement
COC chemicals of concern
GWP-Ind soil medium-specific concentration for industrial use based on groundwater protection
MCL maximum contaminant level as established in the Safe Drinking Water Act

Table 2-7
Comparative Analysis of Alternatives

Comparative Analysis of Alternatives Criteria	Alternative 1 No Action	Alternative 2 Excavation, Monitored Natural Attenuation with Land Use Control	Alternative 3 Excavation, In Situ Bioremediation, Land Use Control
Overall protection of human health and the environment	No protection. Does not achieve RAO.	Achieves RAO. Protection of human health and environment provided by maintenance of land use control. MNA activities would demonstrate that degradation of plume is occurring. Land use control in place until cleanup levels are met. Removal of soil with concentrations of perchlorate above cleanup levels would prevent future migration from soil-to-groundwater and -surface water.	Achieves RAO. Protection of human health and environment provided by remediation of groundwater COCs in a target area. Land use control in place until cleanup levels are met. Removal of soil with concentrations of perchlorate above cleanup levels would prevent future migration from soil-to-groundwater and -surface water.
Compliance with ARARs	Does not comply with chemical-specific ARARs or TBC guidance for perchlorate.	Complies with ARARs.	Complies with ARARs.
Long-term effectiveness and permanence	Not effective.	Decrease in COC concentration and presence of degradation products suggests that contaminants are degrading naturally. To be confirmed by MNA sampling following remedy selection. Land use control would be effective and reliable so long as it is maintained. Excavation of soil is effective long-term and permanent as contamination would be removed from the site and placed in a permitted landfill.	Should be effective and permanent; however, uncertainty exists concerning the degree to which the alternative will be effectiveness in enhancing the natural biological processing occurring at the site. Pilot testing may be required prior to implementation. May require multiple treatments. MNA will be implemented in untreated areas of the plume. Land use control would be effective and reliable so long as it is maintained. Excavation of soils is effective long-term and permanent as contamination would be removed from the site and placed in a permitted landfill.
Reduction of TMV through treatment	No active reduction.	No active remediation would be performed for groundwater. However, a reduction in TMV would be provided through natural biodegradation processes that are occurring in the aquifer. In addition, removal of contaminated soils would provide a reduction in the mobility of contaminants in soil.	Provides permanent reduction in TMV in the target area provided conditions are favorable. In addition, removal of contaminated soils would provide a reduction in the mobility of contaminants in soil.

Table 2-7 *(continued)*
Comparative Analysis of Alternatives

Comparative Analysis of Alternatives Criteria	Alternative 1 No Action	Alternative 2 Excavation, Monitored Natural Attenuation with Land Use Control	Alternative 3 Excavation, In Situ Bioremediation, Land Use Control
Short-term effectiveness	No short-term impacts.	Minimal impacts to the community, workers, or the environment from short-term activities. Provides almost immediate protection.	Minimal impacts to the community, workers, or the environment from short-term activities. Provides almost immediate protection.
Implementability	Inherently implementable.	Readily implemented.	Readily implemented. Specialized knowledge required for implementation.
Cost			
• Capital present worth	$0	$215,000	$402,000
• O&M present worth	$0	$424,000	$512,000
• Total present worth	$0	$639,000	$914,000
State Acceptance	Not acceptable	Acceptable	Acceptable
Community Acceptance	Responded to comments		

Notes and Acronyms:

Costs rounded to nearest thousand dollars

ARARs applicable or relevant and appropriate requirements
COCs chemicals of concern
LUC land use control
MNA monitored natural attenuation
O&M operation & maintenance
RAO remedial action objectives
TBC to be considered
TMV toxicity, mobility, or volume

Table 2-8
Remediation Cost Table
Selected Remedy (Alternative 2)

Present Worth Analysis

Year	FY	Capital Costs		Operation & Maintenance Costs			Present Value (NPV)		
		MNA	Excavation	MNA	Monitoring	Total	Discount Rate	Capital	O&M
							2.8%		
1	2010	$81,755	$133,362	$47,416		$47,416	NPV	$215,117	$423,631
2	2011			47,416		47,416			
3	2012				24,064	24,064		Total NPV	$638,748
4	2013				24,064	24,064			
5	2014				66,589	66,589			
6	2015				15,302	15,302			
7	2016				15,302	15,302			
8	2017				15,302	15,302			
9	2018				15,302	15,302			
10	2019				57,827	57,827			
11	2020					0			
12	2021					0			
13	2022					0			
14	2023					0			
15	2024				57,827	57,827			
16	2025					0			
17	2026					0			
18	2027					0			
19	2028					0			
20	2029				57,827	57,827			
21	2030					0			
22	2031					0			
23	2032					0			
24	2033					0			
25	2034				57,827	57,827			
26	2035					0			
27	2036					0			
28	2037					0			
29	2038					0			
30	2039				57,827	57,827			
		$215,117		$94,832	$465,055	$559,887			

Table 2-8 *(continued)*
Remediation Cost Table
Selected Remedy (Alternative 2)

Notes

MNA	monitored natural attenuation
O&M	operation & maintenance
VOC	volatile organic compounds

Major assumptions are as described below. Quantities and assumptions are for cost estimating purposes only.

Capital costs related to MNA include: 1) Allowance for legal fees, administration controls, and documentation; 2) Establishment of a database, licenses, and work plans; 3) Geoprobe installation of additional monitoring wells

Capital costs related to the excavation include these activities: 1) Develop work plans/design, 2) Waste characterization, 3) Mobilization/demobilization, 4) Clear and grub, 5) Soil excavation activities, 6) Transport and disposal, 7) Confirmation sampling (VOCs, perchlorate), 8) Site restoration, 9) Closeout report.

Monitoring costs are based on the assumption that 5 wells are sampled in each sampling event. The frequency of sampling events is in accordance with the frequency described in the Record of Decision. In Years 1 and 2, the samples are analyzed for VOCs, perchlorate, and MNA parameters. Subsequent years are analyzed for VOCs and perchlorate only. Five-year reviews are conducted in Years 5, 10, 15, 20, 25, and 30.

The discount rate of 2.8% is based on the Office of Management and Budget Circular No. A-94, January 2008.

Table 2-9
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
		Groundwater
Federal Safe Drinking Water Act	Applicable to drinking water at a public water system—relevant and appropriate for water that could potentially be used for human consumption	Water designated as a current or potential source of drinking water must not exceed drinking water standard. See Table 2-6 for specific numeric criteria.
State of Texas Risk Reduction Standards 30 TAC 335.558 and 335.559(d)(2) as updated in the Texas Commission on Environmental Quality memorandum July 23, 1998	Applicable to industrial groundwater—relevant and appropriate for potential hypothetical future maintenance worker exposure to groundwater	If no maximum contaminant level has been promulgated, groundwater must not exceed the industrial medium-specific concentration.
		Soil
State of Texas Risk Reduction Standards 30 TAC 335.558 and 335.559(d)(2) as updated in the Texas Commission on Environmental Quality	Relevant and appropriate for potential protection of soil-to-groundwater pathway for hypothetical potential future industrial use of groundwater.	No federal promulgated concentration for perchlorate.
		Floodplain
Requirements for Hazardous Waste Facilities in Floodplains RCRA 40 CFR 264.18(b)	If excavated soil is found to constitute RCRA hazardous waste, these requirements are relevant and appropriate since LHAAP-50 is located within a 100-year floodplain. However, it is not anticipated that the excavated soil will be classified as hazardous.	A hazardous waste treatment, storage, or disposal facility used for remediation waste and located in the 100-year floodplain must be designed, constructed operated, and maintained to prevent washout of such waste by a 100-year flood unless owner/operator show that procedures are in effect to remove waste safely before flood water can reach the facility.

Table 2-9 *(continued)*
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Waste Generation, Management, and Storage		
Characterization of Solid Waste 40 CFR 262.11 30 TAC 335.62 30 TAC 335.504 30 TAC 335.503(a)(4)	Generation of solid waste, as defined in 30 TAC 335.1—**applicable**.	Must determine whether the generated solid waste is RCRA hazardous waste by using prescribed testing methods or applying generator knowledge based on information regarding material or process used. If the waste is determined to be hazardous, it must be managed in accordance with 40 CFR 262–268. After making the hazardous waste determination as required, if the waste is determined to be nonhazardous, the generator shall then classify the waste as Class 1, Class 2, or Class 3 (as defined in Section 335.505 through Section 335.507) using one or more of the methods listed in Section 335.503(a)(4) and Section 335.508 and manage the waste in accordance with the requirements of Chapter 335 of the TAC for industrial solid waste.
Characterization of Hazardous Waste 40 CFR 264.13(a)(1); 40 CFR 268.7 30 TAC 335.504(3) 30 TAC 335.509 30 TAC 335.511	Generation of a RCRA hazardous waste for treatment, storage, or disposal—**applicable** if hazardous waste is generated (e.g., PPE).	Must obtain a detailed chemical and physical analysis of a representative sample of the waste(s) that at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with 40 CFR 264 and 268. Must also determine whether the waste is restricted from land disposal under 40 CFR 268 et seq. by testing in accordance with prescribed methods or use of generator knowledge of waste.
Management of RCRA Hazardous Waters—Wastewater Treatment Unit Exclusion 40 CFR 264.1(g)(6) 40 CFR 270.1(c)(2) 30 TAC 335.41(d)(1)	Treatment/disposal of wastewater containing RCRA hazardous waste—**applicable** to management of contaminated groundwater if it is determined to contain RCRA characteristically hazardous waste.	On-site wastewater treatment units, as defined in 40 CFR 260.10, that are part of a wastewater treatment facility subject to regulation under Section 402 or Section 307(b) of the CWA are excluded from the requirements of RCRA Subtitle C (Note: USEPA has clarified that this exemption applies to all tank systems, conveyance systems, and ancillary equipment, including transfer trucks, associated with the wastewater treatment unit [53 FR 34079, September 2, 1988]).
Requirements for Temporary Storage of Hazardous Waste in Accumulation Areas 40 CFR 262.34(a) and (c)(1) 30 TAC 335.69(a) and (d)	On-site accumulation of 55 gallons or less of RCRA hazardous waste for 90 days or less at or near the point of generation—**applicable** if hazardous waste is generated (e.g., PPE) and stored in an accumulation area.	A generator may accumulate hazardous waste at the facility provided that • Waste is placed in containers that comply with 40 CFR 264.171 to 264.173 (Subpart I); and • Container is marked with the words “hazardous waste”; or • Container may be marked with other words that identify the contents.
Requirements for the Use and Management of Containers 40 CFR 264.171–264.173 30 TAC 335.69(e) 30 TAC 335.152(a)(7)	On-site storage/treatment of RCRA hazardous waste in containers for greater than 90 days—**applicable** if hazardous waste is generated (e.g., PPE) and is stored in containers.	Design and operating standards of 40 CFR 264.175(c) and 40 CFR 264.171, 264.172, and 264.173(a) and (b) must be met for the use and management of hazardous waste in containers.

Table 2-9 *(continued)*
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Well Construction Standards—Monitoring or Injection Wells 16 TAC 76.1000	Construction of water wells—applicable to construction of new monitoring or injection wells, if needed.	Wells shall be completed in accordance with the technical requirements of Section 76.1000, as appropriate.
Class V Injection Wells 30 TAC 331, Subchapter A, C and H	Installation, operation, and closure of injection wells for in situ bioremediation fall in the category of Class V Injection Wells—relevant and appropriate	Injection wells shall be constructed to the required specifications for isolation casing, surface completion, prevention of commingling, and confinement of undesirable groundwater to its zone of origin. Closure shall be accomplished by removing all of the removable casing and the entire well shall be pressure filled via a tremie pipe with cement from bottom to the land surface, or closure shall be performed by the alternative method for Class V Wells completed in zones of undesirable groundwater. Groundwater concentrations at time of well closure will determine the appropriate method of abandonment.
Well Construction Standards—Extraction Wells 16 TAC 76.1000(a) and (c) through (h) 16 TAC 76.1002(a) through (c) 16 TAC 76.1008(a) through (c)	Construction of water wells—applicable to construction of extraction (recovery) wells.	Wells shall be completed in accordance with the technical requirements of Section 76.1000, as appropriate. Water wells completed to produce undesirable water shall be cased to prevent the mixing of water or constituent zones. The annular space between the casing and the wall of the borehole shall be pressure grouted with cement or bentonite grout to the land surface. Bentonite grout may not be used if a water zone contains chloride water above 1500 ppm or if hydrocarbons are present. Wells producing undesirable water or constituents shall be completed in such a manner that will not allow undesirable fluids to flow onto the land surface. During installation of a water well pump, installer shall make a reasonable effort to maintain integrity of groundwater and to prevent contamination by elevating the pump column and fittings, or by other means suitable under the circumstances. Pump shall be constructed so that no unprotected openings into the interior of the pump or well casing exist.

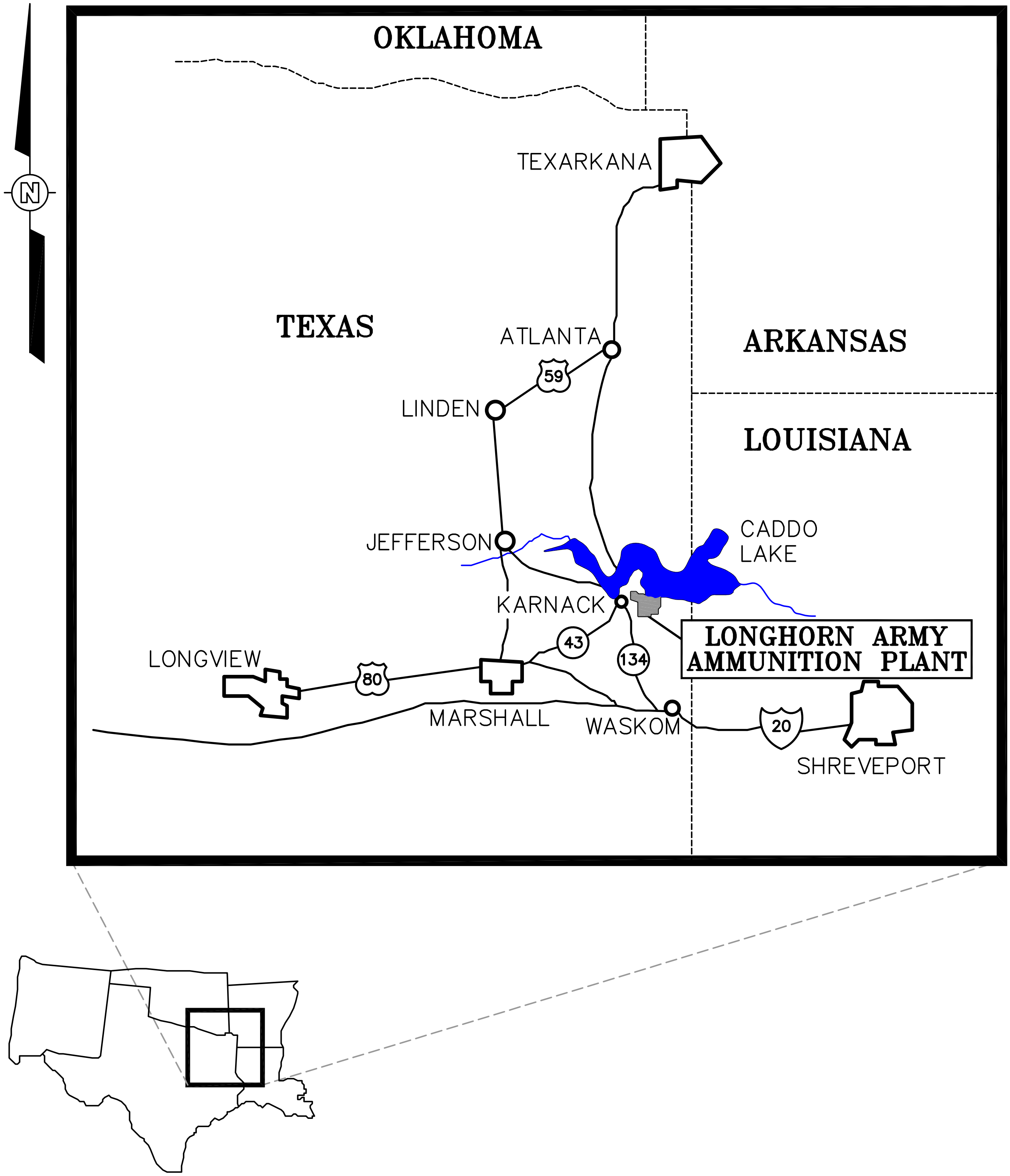
Table 2-9 *(continued)*
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Treatment/Disposal		
Disposal of Wastewater (e.g., contaminated groundwater, dewatering fluids, decontamination liquids) 40 CFR 268.1(c)(4)(i) 30 TAC 335.431(c)	RCRA-restricted characteristically hazardous waste intended for disposal—applicable if extracted groundwater or rinsate from incinerator is determined to be RCRA characteristically hazardous .	Disposal is not prohibited if such wastes are managed in a treatment system subject to regulation under Section 402 of the CWA that subsequently discharges to waters of the United States.
Closure		
Standards for Plugging Wells that Penetrate Undesirable Water or Constituent Zones 16 TAC 76.1004(a) through (c)	Plugging and abandonment of wells—applicable to plugging and closure of monitoring and/or extraction wells.	If a well is abandoned, all removable casing shall be removed and the entire well pressure filled via a tremie pipe with cement from bottom up to the land surface. In lieu of this procedure, the well shall be pressure-filled via a tremie tube with bentonite grout of a minimum 9.1 lb/gal weight followed by a cement plug extending from land surface to a depth of not less than 2 feet. Undesirable water or constituents or the freshwater zone(s) shall be isolated with cement plugs.

Abbreviations:

µg/L	*micrograms per liter*
ARAR	*applicable or relevant and appropriate requirement*
CFR	*Code of Federal Regulations*
CWA	*Clean Water Act of 1972*
USEPA	*U.S. Environmental Protection Agency*
FR	*Federal Register*
FS	*feasibility study*
lb/gal	*pound per gallon*
LHAAP	*Longhorn Army Ammunition Plant*
%	*percent*
PPE	*personal protective equipment*
ppm	*part per million*
RCRA	*Resource Conservation and Recovery Act of 1976*
TAC	*Texas Administrative Code*

00098958



"DRAWING NOT TO SCALE"

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TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2–1

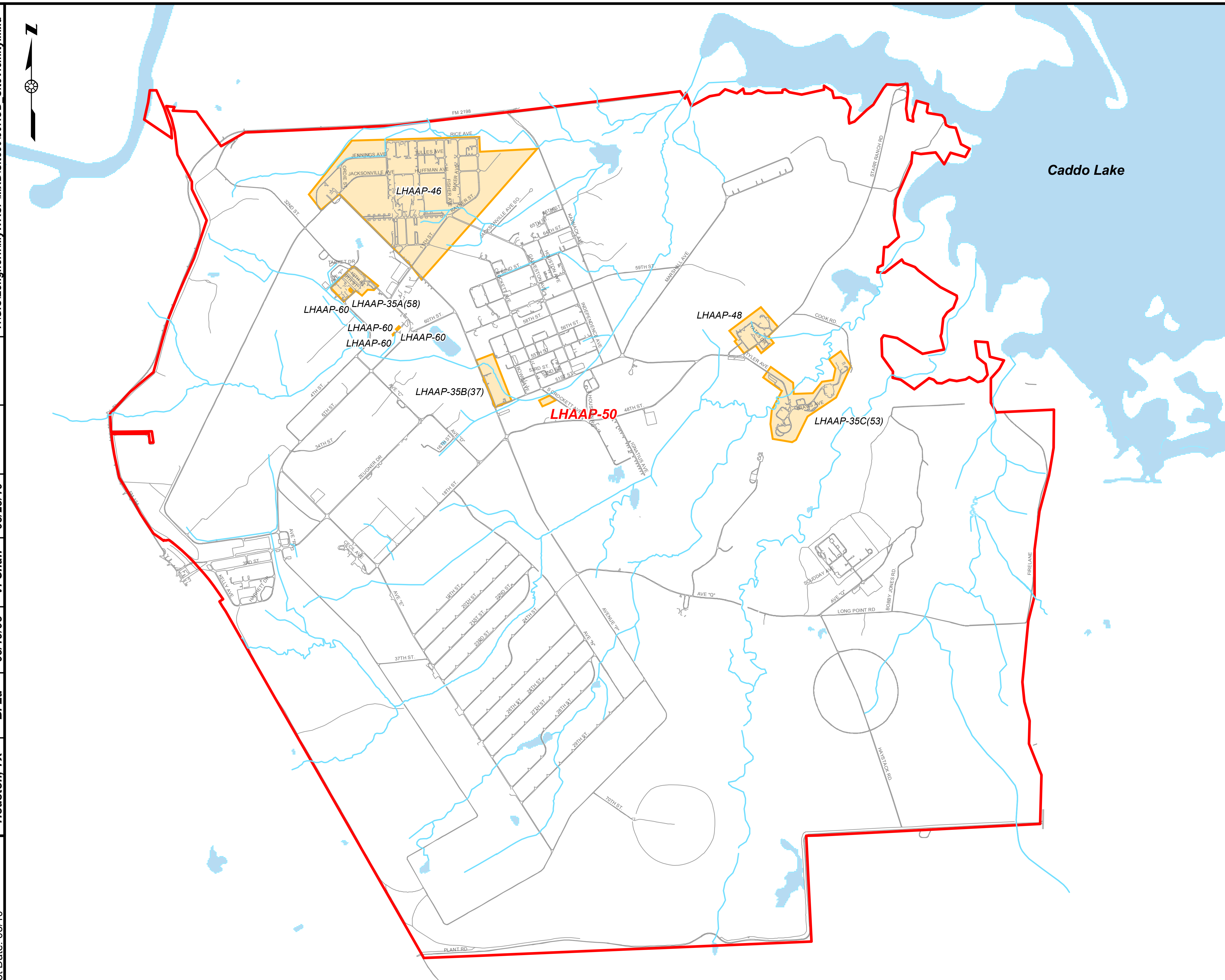
LHAAP LOCATION MAP

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	---	Houston, Texas	L. JONES 12/17/03	G. JONES 10/07/09	P. SRIVASTAV 10/07/09	117591–A55

PLOT DATE: 10/07/09
FORMAT REVISION 3/25/99

00098959



LEGEND

- Stream
- Road
- Site
- Lake
- LHAAP Boundary

0 1,200 2,400 4,800 Feet

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TULSA, OKLAHOMA

FIGURE 2-2

SITE VICINITY MAP
LHAAP-50, GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

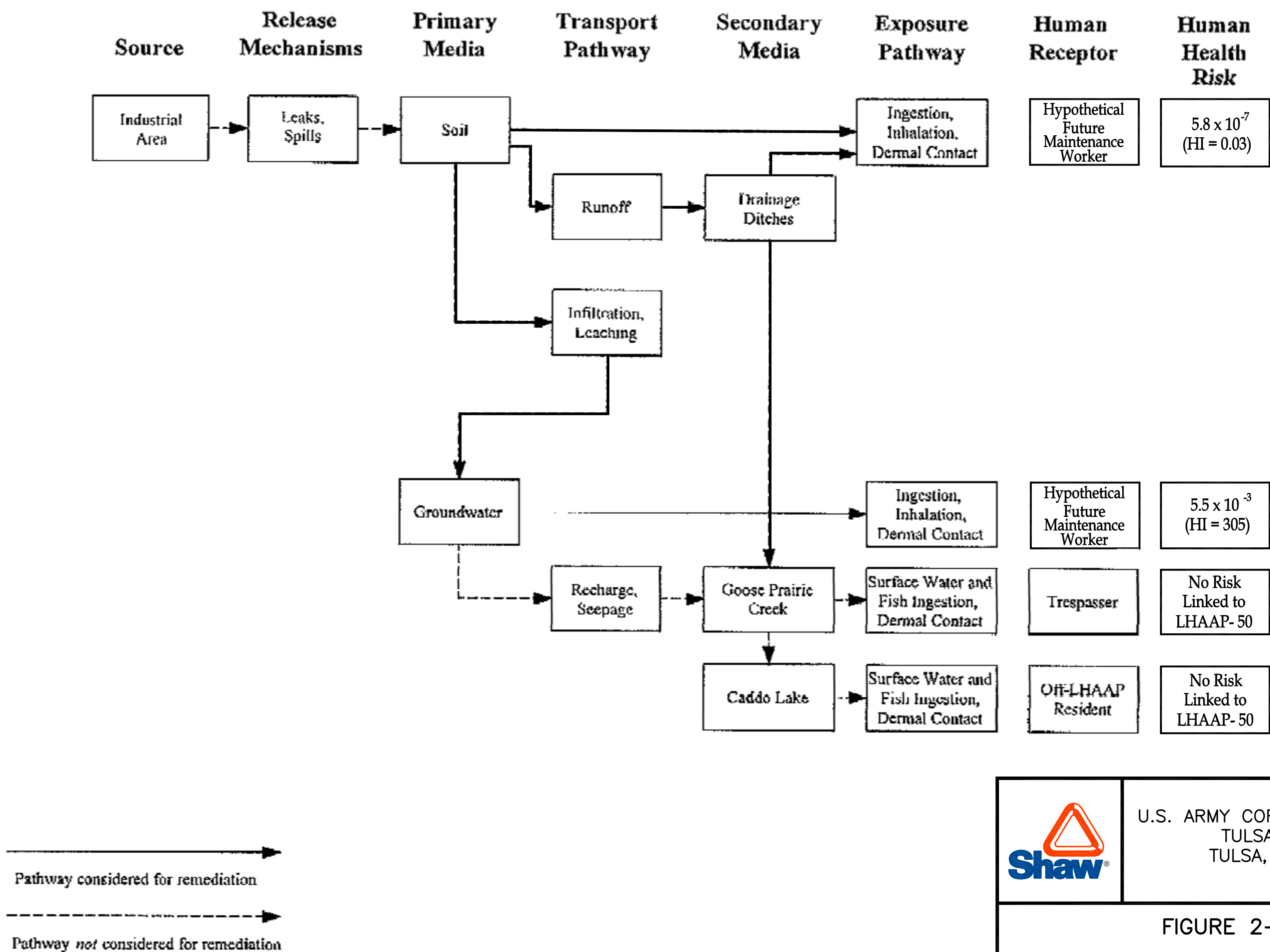
FILE PATH	APPROVED BY	CHECKED BY	DRAWN BY	OFFICE
T:\GIS\Longhorn\MyWKSP\MXD\Site50\50ROD_SiteVicinity.mxd		V. Chan 03/23/10	B. Lu 05/19/08	Houston, TX

Plot Date: 03/10

00098960

PLOT DATE: 04/27/10
FORMAT REVISION 5/13/02

IMAGE	X-REF	OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
site model	---	Houston, Texas	L. JONES	04/27/10	S. WATSON	04/2010	P. SRIVASTAV	04/2010	117591-A68



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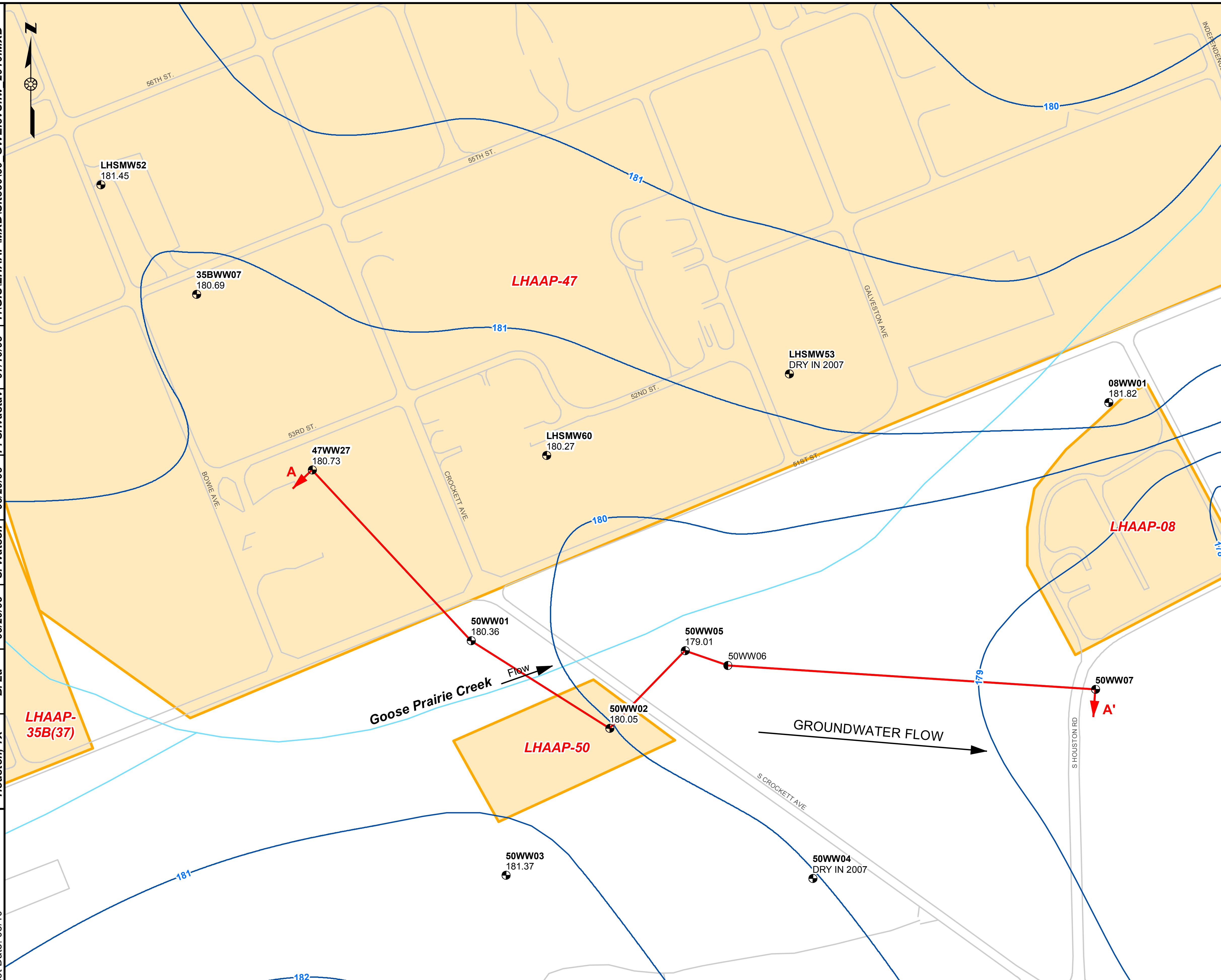
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-3

CONCEPTUAL SITE MODEL
LHAAP-50, GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00098961



LEGEND

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Shallow Groundwater Elevation Contour
- Cross-Section Line
- Stream
- Road
- Site

Note:

Groundwater contour elevations collected in November - December 2007 were reported in feet. 50WW07 was installed in 2008; the groundwater contours were not developed using data from this well.

0 90 180 360 Feet

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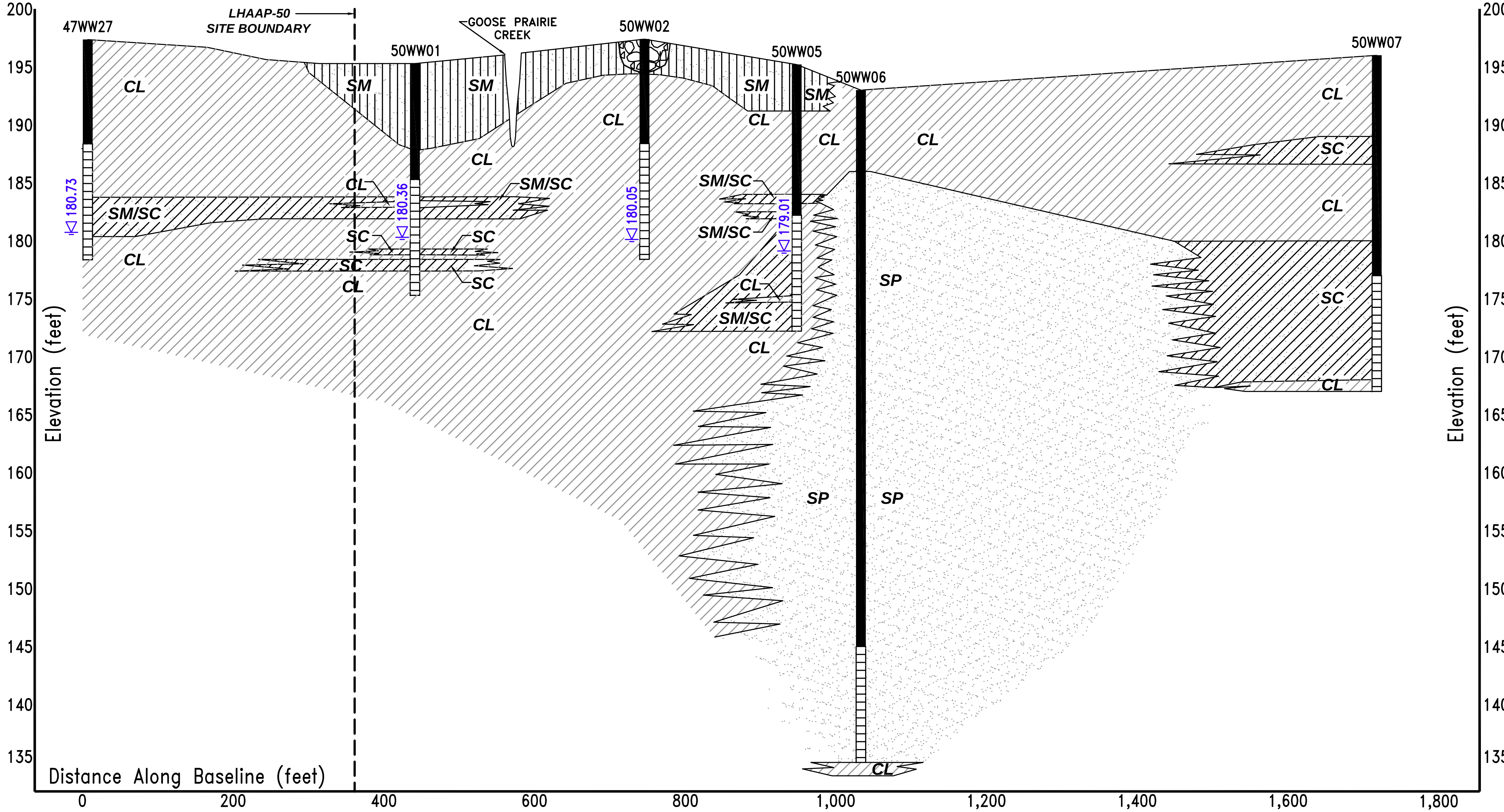
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-4
GROUNDWATER ELEVATION MAP
(SHALLOW ZONE)
LHAAP-50, GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

FILE PATH	T:\GIS\LHAAP\MXD\Site50\50_GWElevShw_2010.MXD
APPROVED BY	P. Srivastav 07/10/08
CHECKED BY	S. Watson 05/20/08
DRAWN BY	B. Lu 05/20/08
OFFICE	Houston, TX

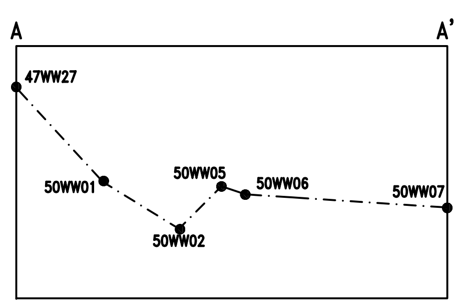
Plot Date: 05/10

00098962



SECTION A–A'

SCALE: AS SHOWN



LEGEND:

- CLAY (CL)
- CLAYEY SAND (SM/SC)
- SILTY SAND (SM)
- WELL SORTED SAND (SP)
- SCREEN
- WATER LEVEL (MSL)

NOTE:

1.) THE FEBRUARY 2008 WATER LEVEL FOR 50WW07 IS 179.55 FEET MEAN SEA LEVEL.

2.) NOV/DEC 2007 WATER LEVEL IN FEET MEAN SEA LEVEL.

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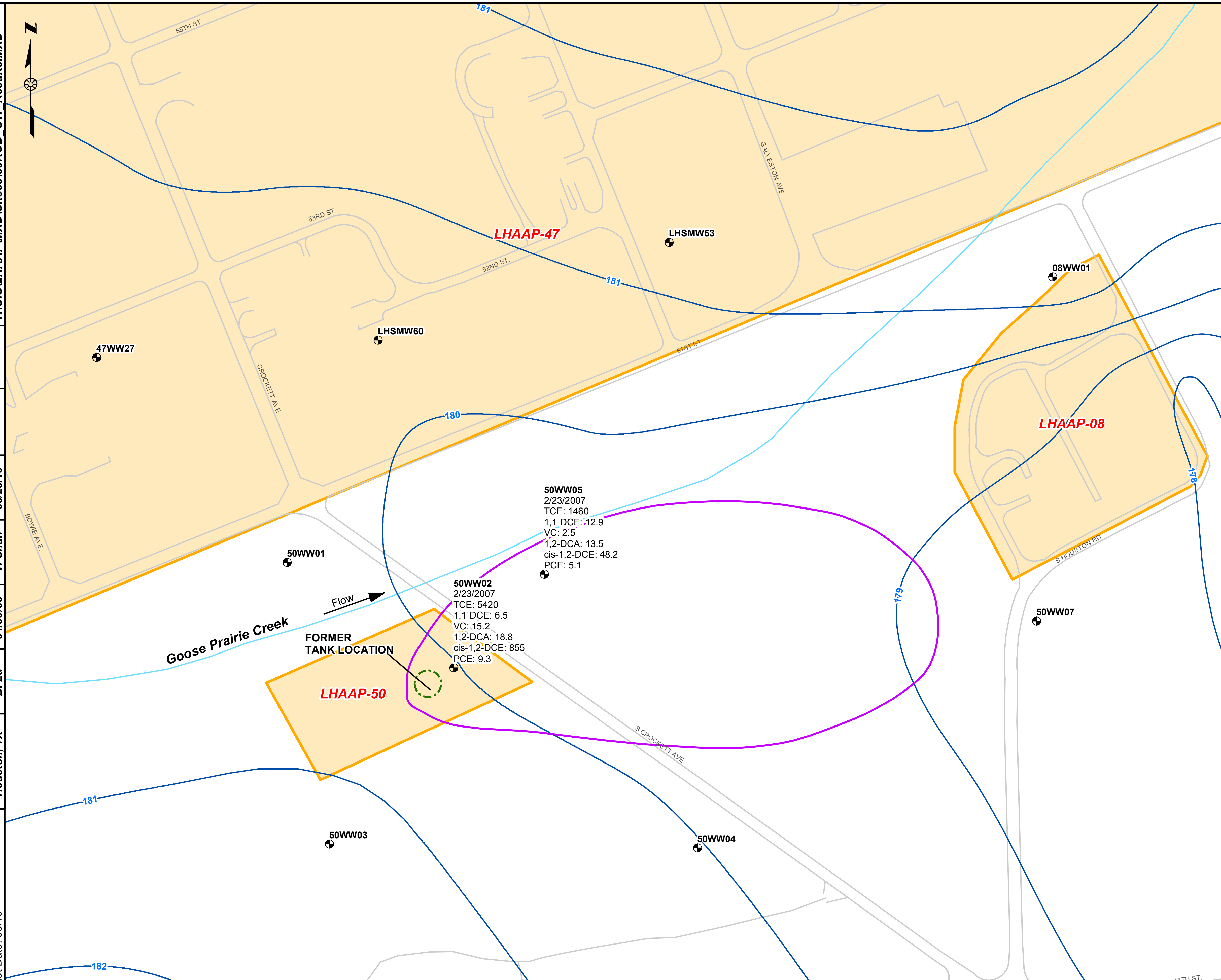
TULSA, OKLAHOMA

FIGURE 2–5
GEOLOGICAL CROSS SECTION A–A'
LHAAP–50, GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

DRAWING NUMBER 117591–B17
APPROVED BY P. SRIVASTAV 04/2010
CHECKED BY A. WILLMORE 04/2010
DRAWN BY L. JONES 04/27/10
OFFICE Houston, Texas
X-REF ---
IMAGE ---

PLOT DATE: 04/27/10
FORMAT REVISION 3/25/99

00098963



LEGEND

- Shallow Monitoring Well
- Groundwater COCs Exceeding Cleanup Levels
- Groundwater Elevation Contour
- Stream
- Road
- Site

Notes:

1. All contours were generated using ArcGIS 9.2.
2. Groundwater contour elevations collected in November - December 2007 were reported in feet.
3. Extents of contaminants are based on MCLs.

0 75 150 300 Feet

FILE PATH T:\GIS\LHAAP\MXD\Site50\50ROD_GW_Results.MXD

APPROVED BY

CHECKED BY V. Chan 03/23/10

DRAWN BY B. Lu 04/30/08

OFFICE Houston, TX

Plot Date: 03/10

Shaw

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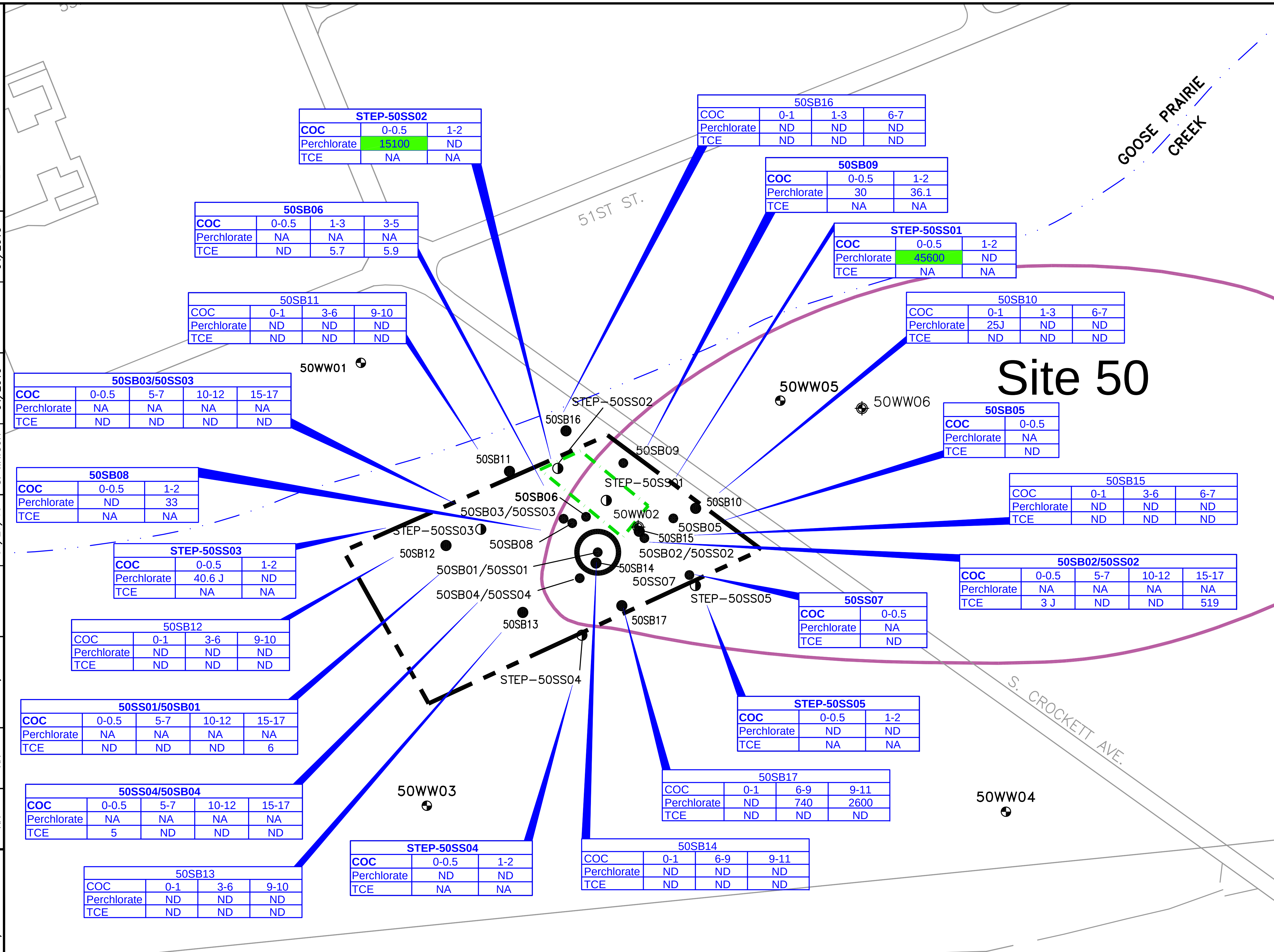
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-6
PLUME OF GROUNDWATER
WITH COCs
LHAAP-50, GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



STEP-50SS02

COC	0-0.5	1-2
Perchlorate	15100	ND
TCE	NA	NA

50SB16

COC	0-1	1-3	6-7
Perchlorate	ND	ND	ND
TCE	ND	ND	ND

50SB09

COC	0-0.5	1-2
Perchlorate	30	36.1
TCE	NA	NA

STEP-50SS01

COC	0-0.5	1-2
Perchlorate	45600	ND
TCE	NA	NA

50SB06

COC	0-0.5	1-3	3-5
Perchlorate	NA	NA	NA
TCE	ND	5.7	5.9

50SB11

COC	0-1	3-6	9-10
Perchlorate	ND	ND	ND
TCE	ND	ND	ND

50SB10

COC	0-1	1-3	6-7
Perchlorate	25J	ND	ND
TCE	ND	ND	ND

50SB03/50SS03

COC	0-0.5	5-7	10-12	15-17
Perchlorate	NA	NA	NA	NA
TCE	ND	ND	ND	ND

50SB05

COC	0-0.5
Perchlorate	NA
TCE	ND

50SB08

COC	0-0.5	1-2
Perchlorate	ND	33
TCE	NA	NA

50SB15

COC	0-1	3-6	6-7
Perchlorate	ND	ND	ND
TCE	ND	ND	ND

STEP-50SS03

COC	0-0.5	1-2
Perchlorate	40.6 J	ND
TCE	NA	NA

50SB02/50SS02

COC	0-0.5	5-7	10-12	15-17
Perchlorate	NA	NA	NA	NA
TCE	3 J	ND	ND	519

50SS07

COC	0-0.5
Perchlorate	NA
TCE	ND

50SB12

COC	0-1	3-6	9-10
Perchlorate	ND	ND	ND
TCE	ND	ND	ND

50SS01/50SB01

COC	0-0.5	5-7	10-12	15-17
Perchlorate	NA	NA	NA	NA
TCE	ND	ND	ND	6

STEP-50SS05

COC	0-0.5	1-2
Perchlorate	ND	ND
TCE	NA	NA

50SB17

COC	0-1	6-9	9-11
Perchlorate	ND	740	2600
TCE	ND	ND	ND

50SS04/50SB04

COC	0-0.5	5-7	10-12	15-17
Perchlorate	NA	NA	NA	NA
TCE	5	ND	ND	ND

STEP-50SS04

COC	0-0.5	1-2
Perchlorate	ND	ND
TCE	NA	NA

50SB14

COC	0-1	6-9	9-11
Perchlorate	ND	ND	ND
TCE	ND	ND	ND

50SB13

COC	0-1	3-6	9-10
Perchlorate	ND	ND	ND
TCE	ND	ND	ND

00098964

LEGEND:

- ATTENUATION MONITORING WELL
- SHALLOW MONITORING WELL
- SURFACE SOIL SAMPLE
- SOIL BORING SAMPLING LOCATION
- SITE BOUNDARY
- FORMER STORAGE TANK LOCATION
- COC — CONSTITUENT OF CONCERN
- ND — NOT DETECTED
- NA — NOT ANALYZED
- AREA OF PERCHLORATE CONTAMINATION FOR SOIL REMOVAL
- PERCHLORATE CONCENTRATIONS GREATER THAN 7,200 ug/kg
- EXTENT OF TCE GROUNDWATER PLUME >5 MICROGRAMS PER LITER

NOTE:
1. CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER KILOGRAM (µg/kg)

SCALE 0 100 200 FEET

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TULSA, OKLAHOMA

FIGURE 2-7
TCE AND PERCHLORATE CONCENTRATIONS IN SOIL LHAAP-50, GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

DRAWING NUMBER 117591-B18
APPROVED BY P. SRIVASTAV 04/2010
CHECKED BY S. WATSON 04/2010
DRAWN BY L. JONES 04/27/10
OFFICE Houston, Texas
X-REF -NA-
IMAGE -NA-
PLOT DATE: 04/27/10
FORMAT REVISION 3/25/99

REFERENCES:
SOLUTIONS TO ENVIRONMENTAL PROBLEMS, INC., MARCH 2003, *DRAFT FINAL PROJECT REPORT PLANT-WIDE PERCHLORATE INVESTIGATION LONGHORN ARMY AMMUNITION PLANT, KARNACK, TEXAS,* FINAL, OAK RIDGE, TN.

JACOBS ENGINEERING GROUP, INC., JANUARY 2002, *FINAL REMEDIAL INVESTIGATIONS REPORT FOR THE GROUP 4 SITES,* OAK RIDGE, TN.

DATA GAP REFERENCE:
SHAW ENVIRONMENTAL, INC. 2007 DATA GAP INVESTIGATION REPORT, LONGHORN ARMY AMMUNITION PLANT, KARNACK, TEXAS, DRAFT FINAL, APRIL.

3.0 Responsiveness Summary

The Responsiveness Summary serves three purposes. First, it provides the U .S. Army, USEPA, and TCEQ with information about community concerns with the preferred alternative at LHAAP-50 as presented in the Proposed Plan. Second, it shows how the public's comments were considered in the decision-making process for selection of the remedy. Third, it provides a formal mechanism for the U.S. Army to respond to public comments.

The U.S. Army, USEPA, and TCEQ provide information regarding LHAAP-50 through public meetings, the Administrative Record file for the facility, and announcements published in the Shreveport Times and Marshall News Messenger newspapers. **Section 2.3** discusses community participation on LHAAP-50, including the dates for the public comment period, the date, location, and time of the public meetings, and the location of the Administrative Record. **Appendix A** presents the announcements for the open house and public meeting on January 26, 2010 and March 9, 2010, respectively, and the extension to the public comment period. The following documents related to community involvement were added to the Administrative Record:

- Transcript of the public meeting on March 9, 2010
- Presentation slides from the March 9, 2010 public meeting
- Written questions and comments from the public during the public comment period, and the U.S. Army response to those comments dated June 4, 2010.

The public questions/comments are summarized in **Section 3.1** below, and a response is provided. No written or verbal comments were received from the regulatory agencies during the public comment period or at the public meeting.

3.1 Stakeholder Issues and Lead Agency Responses

This section summarizes and responds to major issues raised by stakeholders including the public and community groups that were received in written or verbal form. These concerns were addressed by the U.S. Army in the public meetings as much as possible and with the response to comments available in the Administrative Record.

Question/comment: The proposed plan states that contaminant levels will be reduced to MCLs in approximately 50 years. The uncertainty associated with this estimate is an order of magnitude. That is, the time to achieve MCLs could range from 5 years to 500 years. It is not reasonable to propose a plan that could require the maintenance of LUCs for many decades or centuries.

Response: The reasonably anticipated future use of the site is as a wildlife refuge (i.e., Caddo Lake National Wildlife Refuge). Once the property is transferred into the refuge system, the property must be kept as a National Wildlife Refuge unless there is an act of Congress which removes the parcel or the land is exchanged in accordance with the National Wildlife Refuge System Administration Act of 1966 and the National Wildlife Refuge System Act Amendments of 1974. This proposed transfer as a national wildlife refuge, which by its very nature includes physical access and use restrictions, is subject to control and continual inspection by Refuge personnel. Also, the property is intended to remain under ownership and management of a federal government agency. The LUC will restrict access to the groundwater for purposes other than environmental monitoring and testing until cleanup levels are met. Maintenance of the LUC for groundwater use restrictions would require minimal effort and would be reasonable for extended lengths of time. Effectiveness of the LUC will be evaluated as part of the statutory five-year reviews and does not pose additional burden. Additionally, access of groundwater through well installations requires a permit from the Texas Department of Licensing and Regulation or Texas Water District authority. The department will be provided a copy of the county recordation that indicates the location of contaminated groundwater at the site and associated restriction.

Question/comment: The extent of groundwater contamination in the shallow zone has not been determined. The extent of contamination 1) to the north of Goose Prairie Creek (in the vicinity of 50WW05), and 2) to the east of the former wastewater storage tank (between 50WW02 and 50WW07), is unknown. The Army should install monitor wells in these areas to determine the full extent of groundwater contamination in the shallow zone.

Response: The extent of groundwater contamination has been determined. There are wells with results less than the cleanup level up, down and cross gradient to the wells with contamination. To answer 1 and 2: 1) Wells LHSMW60 and LHSMW53 are located north of 50WW05. 2) Well 50WW02 is within the plume and well 50WW07 is outside it providing bounding. The cost estimates for the remedial alternatives evaluated in the FS assumed that two new monitoring wells may be installed. Any additional monitoring wells will be considered in the RD including the locations suggested in the comment.

Question/comment: The extent of groundwater contamination in the intermediate zone has not been determined. Only one intermediate zone monitor well was installed near LHAAP-50. This well is approximately 250 feet downgradient of the contaminant source (former wastewater storage tank). The intermediate zone cannot be adequately characterized with just one well. The Army should install an intermediate zone [sic] at or immediately downgradient of the contaminant source. If contaminants are detected in this new well, additional wells should be installed to determine the full extent of contamination in the intermediate zone. If contaminant concentrations exceed standards, the Army should develop a plan for remediating the intermediate zone.

Response: The intermediate zone well 50WW06 does not contain any current concentrations above the cleanup levels. This well is in an appropriate location to detect contamination of the intermediate zone. Installation of additional wells is thus not considered necessary.

Question/comment: Concentrations of perchlorate in boring 50SB17 increases with depth. Perchlorate concentrations are: non-detect between the surface and a depth of one foot, 740 µg/kg between six and nine feet, and 2600 µg/kg between nine and 11 feet. No samples were taken below 11 feet. The Army should sample soil near 50SB17 all the way down to the water table to determine whether perchlorate at this locations exceeds the TCEQ GWP-Ind limit of 7200 µg/kg. Soils with perchlorate concentrations exceeding this limit should be excavated to protect the underlying groundwater.

Response: Additional sampling of the contaminated area will be conducted to support the RD. Soil samples will be collected to better delineate the contaminated soil as a part of the RD before the excavation. A sample deeper than 11 feet will be collected at 50SB17 to determine if concentrations at depth exceed the clean up goal of 7,200 µg/kg.

Question/comment: The Army intends to monitor Goose Prairie Creek for perchlorate. However, there is a not-insignificant chance that contaminated groundwater will discharge to the creek. Therefore, the creek should also be monitored for groundwater contaminants (i.e., TCE, cis-1,2-DCE).

Response: It is unlikely that the shallow groundwater will reach the creek. The shallow groundwater has been below the creek bottom for the past 8 years. It appears that groundwater discharge to Goose Prairie Creek from LHAAP-50 is unlikely except in very wet periods. Additionally, plotted groundwater gradients indicate the groundwater and any contaminated water will flow parallel to the creek and does not run directly toward the creek. Ongoing periodic sampling of the surface water (Goose Prairie Creek) will be continued in order to evaluate if contamination is migrating to surface water.

Question/comment: The downstream surface water monitoring location (GPW-1) appears to be too far upstream to be affected by contaminated groundwater. An additional surface water monitor location, in the vicinity of well 50WW05, should be established to determine whether contaminated groundwater is affecting surface water quality.

Response: The expected surface water sampling location is downstream of the contaminated soil at LHAAP-47 and LHAAP-50 where surface runoff may occur. The sampling location may be moved farther downstream if that is deemed appropriate. The surface water monitoring is being conducted primarily to evaluate possible contamination of the creek from perchlorate contaminated soil at LHAAP-47 and LHAAP-50. At both of these sites, perchlorate contaminated soil will be removed as part of the remedial action.

3.2 Technical and Legal Issues

This section is used to expand on technical and legal issues. However, there are no issues of that nature beyond the technical issues already discussed in **Section 3.1**.

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Glossary of Terms

Administrative Record – The body of reports, official correspondence, and other documents that establish the official record of the analysis, clean up, and final closure of a site.

Background Levels – Naturally-occurring concentrations of inorganic elements (metals) that are present in the environment and have not been altered by human activity.

Characterization – The compilation of all available data about the waste unit to determine the rate and extent of contaminant migration resulting from the waste site, and the concentration of any contaminants that may be present.

Chemicals of Concern (COC) – Those chemicals that significantly contribute to a pathway in an exposure model of a hypothetical receptor (e.g., a child that resides on a site). They exceed either the calculated numerical limit for cumulative site cancer risk (1 in 10,000 exposed individuals) or the calculated numerical limit of 1 for non-carcinogenic effects, a value proposed by the USEPA.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – CERCLA was enacted by Congress in 1980 and was amended by the Superfund Amendments and Reauthorization Act in 1986. CERCLA provides federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites and established the Superfund Trust Fund.

Exposure – Contact of an organism with a chemical or physical agent. Exposure is quantified as the amount of the agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut) and available for absorption.

Federal Facility Agreement – A legal binding agreement among USEPA, TCEQ, and U.S. Army that sets the standards and schedules for the comprehensive remediation of Longhorn Army Ammunition Plant.

Groundwater – Underground water that fills pores in soil or openings in rocks to the point of saturation.

Human Health Risk Assessment – A study conducted as part of a remedial investigation to determine the risk posed to human health by site-related chemicals.

National Priorities List (NPL) – The USEPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under

Superfund. USEPA is required to update the NPL at least once a year. A site must be on the NPL to receive money from the Trust Fund for remedial action.

Record of Decision – A legal document presenting the remedial action selected for a site or operable unit. It is based on information and technical analyses generated during the remedial investigation/feasibility study and consideration of public comments on the statement of basis/proposed plan and community concerns.

Remedial Investigation – A study designed to gather data needed to determine the nature and extent of contamination at a Superfund site.

Resource Conservation and Recovery Act (RCRA) – Gives USEPA the authority to control the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA focuses only on active and future facilities and does not address abandoned or historical sites.

Responsiveness Summary – A summary of oral and/or written comments received during the proposed plan comment period and includes responses to these comments. The responsiveness summary is a key part of a ROD highlighting community concerns.

Screening-Level Ecological Risk Assessment – The initial phase of a baseline ecological risk assessment in which conservative concentrations of site chemicals are quantitatively compared to chemical- and media-specific generic effect levels. Those chemicals selected as chemicals of potential ecological concern are further refined through quantitative comparison to chemical- and species-specific effect doses, as well as qualitative examination. Those chemicals identified as chemicals of concern may be investigated further, remediated, or left in place per the decision of the risk managers.

Proposed Plan – A plan for a site cleanup that proposes a recommended or preferred remedial alternative. The Proposed Plan is available to the public for review and comment and the preferred alternative may change based on public and other stakeholder input.

Superfund Amendments and Reauthorization Act (SARA) – Amended CERCLA in 1986. SARA resulted in more emphasis on permanent remedies for cleaning up hazardous waste sites, increased the focus on human health problems posed by hazardous waste sites, and encouraged greater citizen participation in making decisions on how sites should be cleaned up.

Superfund – The common name used for CERCLA; also referred to as the Trust Fund. The Superfund Program was established to help fund cleanup of hazardous waste sites. It also allows legal action to force those responsible for sites to clean them up.

Appendix A

Public Meeting Newspaper and Media Notices

PUBLIC NOTICE
THE UNITED STATES ARMY INVITES PUBLIC COMMENT ON THE PROPOSED PLANS FOR ENVIRONMENTAL SITES LHAAP-46, -49, -50, -35A(58), AND THE PISTOL RANGE, LONGHORN ARMY AMMUNITION PLANT, TEXAS

The U.S. Army is the lead agency for environmental response actions at Longhorn Army Ammunition Plant (LHAAP). In partnership with Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency Region 6, the U.S. Army has developed Proposed Plans for the following NPL sites: LHAAP-46, LHAAP-49, LHAAP-50, LHAAP-35A(58), and the Pistol Range. Although the Proposed Plans identify preferred remedies for each of the sites, the U.S. Army welcomes the public's review and comments. The public comment period begins January 25, 2010, and concludes February 23, 2010. **On Tuesday, January 26, 2010, from 6:00 to 8:00 p.m., the U.S. Army is inviting all interested parties to attend an open house forum to view the Proposed Plans and ask questions. The open house forum will be held at the Karnack Community Center, Highway 134 and Spur 449, Karnack, Texas.** Copies of the Proposed Plans and supporting documentation are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670. Summaries of each of the sites, including discussion of various alternatives that were evaluated, are provided below.

LHAAP-46, the former Plant 2 production area, is located in the north-central portion of LHAAP and covers an area of approximately 190 acres. Plant 2 was used to produce pyrotechnic devices from February 1952 to 1956 and was reactivated to produce pyrotechnic and illumination devices from 1964 until approximately 1997. Three alternatives were evaluated for addressing the contaminated groundwater at the site: 1) no action; 2) monitored natural attenuation (MNA) and land use controls (LUCs); and 3) in situ bioremediation, short-term LUCs, and long-term monitoring (LTM). Based on available information, the preferred remedy is MNA and LUCs. The preferred remedy would utilize groundwater use restriction LUCs to protect human health by preventing human exposure to contaminated groundwater and MNA to return the contaminated water to its potential beneficial use as drinking water, wherever practicable.

LHAAP-49, a former Acid Storage Area, is located in the west-central portion of LHAAP and covers an area of approximately 30 acres. The site was used from 1942 to 1945 for formulation and storage of acids and acid mixtures in support of trinitrotoluene production. Based on available information, the preferred remedy at this time is no action. The recommendation is based on the existing data and determination of no unacceptable risk to human health or to ecological receptors at LHAAP-49.

LHAAP-50, a former sump water tank, is located in the north-central portion of LHAAP and covers an area of approximately 1 acre. Historically, LHAAP-50 contained a 47,000-gallon capacity aboveground storage tank which received wastewater from various industrial waste sumps from 1955 to 1988. Three alternatives were evaluated for addressing the contaminated groundwater and soil at the site: 1) no action; 2) soil - excavation, groundwater - MNA and LUCs; and 3) soil - excavation, groundwater - in situ bioremediation, MNA, and LUCs. Based on available information, the preferred remedy at this time is the second alternative: excavation and off-site disposal of perchlorate-contaminated soils, and MNA and LUCs for groundwater. The preferred remedy would ensure protection of human health by eliminating the soil-to-groundwater and soil-to-surface water pathways, implementing groundwater use restriction LUCs to prevent exposure to contaminated groundwater, and implementing MNA until groundwater cleanup levels are achieved.

LHAAP-35A(58), known as the Shops Area, is located in the north-central portion of LHAAP and covers approximately 11 acres. The Shops Area was established in 1942 as part of the installation's initial construction. Plant-operated laundry, automotive, woodworking, metalworking, painting, refrigeration, and electrical shops served the needs of the overall facility and became inactive in 1996 and 1997. Four alternatives were evaluated for addressing the contaminated groundwater at the site: 1) no action; 2) MNA with LUCs; 3) in situ bioremediation with short-term LUCs and LTM; and 4) in situ bioremediation followed by MNA and LUCs for the eastern plume, and MNA and LUCs for the western plume. Based on available information, the preferred remedy at this time is the fourth alternative: in situ bioremediation followed by MNA and LUCs for the eastern plume, and MNA and LUCs for the western plume. The preferred remedy would ensure protection of human health by 1) implementing groundwater use restriction LUCs which prevent human exposure to contaminated groundwater and 2) returning the contaminated water to its potential beneficial use as a drinking water, wherever practicable, through MNA and in situ bioremediation.

The former **Pistol Range** is located in the southeastern portion of LHAAP and covers an area of approximately 0.4 acres. The area was used by base security personnel as early as the 1950s and intermittently through 2004 as a small arms firing range. The target area was a natural, wooded slope at the eastern side of the site. Soil with contamination above industrial cleanup levels was excavated and disposed off site during a 2009 removal action. Based on available information, the preferred remedy at this time is no action. The recommendation is based on existing data and determination of no unacceptable risk to human health or to ecological receptors.

For further information or to submit written comments, contact: Dr. Rose M. Zeiler, Longhorn Army Ammunition Plant, P.O. Box 220, Ratcliff, Arkansas, 72951; phone number 479-635-0110 or e-mail rose.zeiler@us.army.mil.

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PUBLIC NOTICE
THE UNITED STATES ARMY INVITES PUBLIC COMMENT ON THE PROPOSED PLANS FOR ENVIRONMENTAL SITES LHAAP-46, -49, -50, -35A(58), AND THE PISTOL RANGE, LONGHORN ARMY AMMUNITION PLANT, TEXAS
PUBLIC MEETING AT KARNACK COMMUNITY CENTER MARCH 9, 2010

The U.S. Army is the lead agency for environmental response actions at Longhorn Army Ammunition Plant (LHAAP). In partnership with Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency Region 6, the U.S. Army has developed Proposed Plans for the following NPL sites: LHAAP-46, LHAAP-49, LHAAP-50, LHAAP-35A(58), and the Pistol Range. Although the Proposed Plans identify preferred remedies for each of the sites, the U.S. Army welcomes the public's review and comments. The public comment period began January 25, 2010, and has been extended to March 25, 2010. **On Tuesday, March 9, 2010, from 7:00 to 9:00 p.m., the U.S. Army is inviting all interested parties to attend a public presentation of the proposed remedies for these sites and to ask questions and provide comments on the Proposed Plans. Questions, comments, and responses on the Proposed Plans will be recorded by a court reporter. This public meeting will be held at the Karnack Community Center, Highway 134 and Spur 449, Karnack, Texas.** Copies of the Proposed Plans and supporting documentation are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670. Summaries of each of the sites, including discussion of various alternatives that were evaluated, are provided below.

LHAAP-46, the former Plant 2 production area, is located in the north-central portion of LHAAP and covers an area of approximately 190 acres. Plant 2 was used to produce pyrotechnic devices from February 1952 to 1956 and was reactivated to produce pyrotechnic and illumination devices from 1964 until approximately 1997. Three alternatives were evaluated for addressing the contaminated groundwater at the site: 1) no action; 2) monitored natural attenuation (MNA) and land use controls (LUCs); and 3) in situ bioremediation, short-term LUCs, and long-term monitoring (LTM). Based on available information, the preferred remedy is MNA and LUCs. The preferred remedy would utilize groundwater use restriction LUCs to protect human health by preventing human exposure to contaminated groundwater and MNA to return the contaminated water to its potential beneficial use as drinking water, wherever practicable.

LHAAP-49, a former Acid Storage Area, is located in the west-central portion of LHAAP and covers an area of approximately 30 acres. The site was used from 1942 to 1945 for formulation and storage of acids and acid mixtures in support of trinitrotoluene production. Based on available information, the preferred remedy at this time is no action. The recommendation is based on the existing data and determination of no unacceptable risk to human health or to ecological receptors at LHAAP-49.

LHAAP-50, a former sump water tank, is located in the north-central portion of LHAAP and covers an area of approximately 1 acre. Historically, LHAAP-50 contained a 47,000-gallon capacity aboveground storage tank which received wastewater from various industrial waste sumps from 1955 to 1988. Three alternatives were evaluated for addressing the contaminated groundwater and soil at the site: 1) no action; 2) soil - excavation, groundwater - MNA and LUCs; and 3) soil - excavation, groundwater - in situ bioremediation, MNA, and LUCs. Based on available information, the preferred remedy at this time is the second alternative: excavation and off-site disposal of perchlorate-contaminated soils, and MNA and LUCs for groundwater. The preferred remedy would ensure protection of human health by eliminating the soil-to-groundwater and soil-to-surface water pathways, implementing groundwater use restriction LUCs to prevent exposure to contaminated groundwater, and implementing MNA until groundwater cleanup levels are achieved.

LHAAP-35A(58), known as the Shops Area, is located in the north-central portion of LHAAP and covers approximately 11 acres. The Shops Area was established in 1942 as part of the installation's initial construction. Plant-operated laundry, automotive, woodworking, metalworking, painting, refrigeration, and electrical shops served the needs of the overall facility and became inactive in 1996 and 1997. Four alternatives were evaluated for addressing the contaminated groundwater at the site: 1) no action; 2) MNA with LUCs; 3) in situ bioremediation with short-term LUCs and LTM; and 4) in situ bioremediation followed by MNA and LUCs for the eastern plume, and MNA and LUCs for the western plume. Based on available information, the preferred remedy at this time is the fourth alternative: in situ bioremediation followed by MNA and LUCs for the eastern plume, and MNA and LUCs for the western plume. The preferred remedy would ensure protection of human health by 1) implementing groundwater use restriction LUCs which prevent human exposure to contaminated groundwater and 2) returning the contaminated water to its potential beneficial use as a drinking water, wherever practicable, through MNA and in situ bioremediation.

The former **Pistol Range** is located in the southeastern portion of LHAAP and covers an area of approximately 0.4 acres. The area was used by base security personnel as early as the 1950s and intermittently through 2004 as a small arms firing range. The target area was a natural, wooded slope at the eastern side of the site. Soil with contamination above industrial cleanup levels was excavated and disposed off site during a 2009 removal action. Based on available information, the preferred remedy at this time is no action. The recommendation is based on existing data and determination of no unacceptable risk to human health or to ecological receptors.

For further information or to submit written comments, contact: Dr. Rose M. Zeiler, Longhorn Army Ammunition Plant, P.O. Box 220, Ratcliff, Arkansas, 72951; phone number 479-635-0110 or e-mail rose.zeiler@us.army.mil.

MEDIA RELEASE

The United States Army has prepared Proposed Plans for five environmental sites at the Longhorn Army Ammunition Plant: LHAAP-46, -49, -50, -35A(58) and the former Pistol Range. The Proposed Plans are documents that describe the sites and their proposed remedies. The Proposed Plans were developed to facilitate public involvement in the remedy selection process.

Copies of the Proposed Plans and supporting documentation are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas 75670, beginning January 25, 2010. The public comment period has been extended to March 25, 2010.

An informal open forum was held on January 26, 2010. A second public meeting, with a formal question and answer session, will be held on March 9, 2010, from 7:00 to 9:00 p.m. at the Karnack Community Center, Highway 134 and Spur 449, Karnack, Texas 75661.

All written public comments on the Proposed Plans must be postmarked on or before March 25, 2010. Written comments may be provided to Dr. Rose M. Zeiler, Longhorn Army Ammunition Plant, P.O. Box 220, Ratcliff, Arkansas 72951, or e-mailed to rose.zeiler@us.army.mil. E-mailed comments must be submitted by close of business on March 25, 2010.