LONGHORN ARMY AMMUNITION PLANT KARNACK, TEXAS

ADMINISTRATIVE RECORD

Volume 16 of 16

2011

Bate Stamp Numbers

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Prepared for

Department of the Army
Longhorn Army Ammunition Plant

1976 – 2011

VOLUME 16 of 16

2011

A. Title: Dispute Resolution under Federal Facilities Agreement (FFA) and Response to Comments on Records of Decision (RODs) Sites LHAAP-16 and LHAAP-17, and for MMRP Sites LHAAP-001-R and LHAAP-003-R, Longhorn Army Ammunition Plant, Karnack, Texas

Author(s): U.S. Army, U.S. Environmental Protection Agency, Texas Commission on Environmental Quality

Recipient(s): U.S. Army, U.S. Environmental Protection Agency, Texas Commission on Environmental Quality

Date: 2011

Bate Stamp: 00112729 – 00113422

00112729

From:	Williams, Aaron K SWT
To:	Tzhone.Stephen@epamail.epa.gov; Fay Duke
Cc:	Rose Ms CIV USA OSA Zeiler; Lambert, John R SWT
Subject:	MMRP ROD (UNCLASSIFIED)
Date:	Tuesday, September 27, 2011 4:16:00 PM
Attachments:	09 2011 DRAFT FINAL ROD LHAAP-001-R_003-R-HIGHLIGHT.docx

Classification: UNCLASSIFIED
Caveats: NONE

Steve and Fay,

Please see attached revised MMRP ROD to address EPA and TCEQ comments. Changes from the previous MMRP ROD are highlighted in yellow for your review. We are proceeding with finalizing the MMRP ROD for signature.

Thanks,

Aaron K. Williams
Environmental Engineer, ARMY/FUDS Section
HTRW Design Center
Tulsa District
U.S. Army Corps of Engineers
918-669-4915

Classification: UNCLASSIFIED
Caveats: NONE

From: Williams, Aaron K SWT
To: Williams, Aaron K SWT; "Tzhone.Stephen@epamail.epa.gov"; "Fay Duke"
Cc: "Rose Ms CIV USA OSA Zeiler"; Lambert, John R SWT
Subject: RE: MMRP ROD (UNCLASSIFIED)
Date: Tuesday, September 27, 2011 4:21:00 PM
Attachments: MMRP ROD Figures 26 SEP 11 (2).pdf
Appendix B Figures Data.pdf

Classification: UNCLASSIFIED
Caveats: NONE

Additionally- attached figures.

Thanks,

Aaron K. Williams
Environmental Engineer, ARMY/FUDS Section
HTRW Design Center
Tulsa District
U.S. Army Corps of Engineers
918-669-4915

-----Original Message-----
From: Williams, Aaron K SWT
Sent: Tuesday, September 27, 2011 4:17 PM
To: Tzhone.Stephen@epamail.epa.gov; 'Fay Duke'
Cc: Rose Ms CIV USA OSA Zeiler; Lambert, John R SWT
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918-669-4915

Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

00112732

From:	Zeiler, Rose Ms CIV USA OSA
To:	Fay Duke; Tzhone.Stephen@epa.gov
Cc:	Lambert, John R SWT; Williams, Aaron K SWT
Subject:	Draft Final RODs for LHAAP-16 and LHAAP-17
Date:	Thursday, September 29, 2011 5:06:18 PM
Attachments:	DRAFT FINAL LHAAP-16 ROD.pdf 09 2011 DRAFT FINAL LHAAP-17 ROD.pdf

Steve and Fay,

Please see the attached draft final RODs for LHAAP-16 and LHAAP-17. Please note that I am sending them in response to your request and not as a change to the consultation process.

Rose
Rose M. Zeiler, Ph.D.,
Site Manager
Longhorn Army Ammunition Plant
479-635-0110 (0112 – fax)

FINAL
RECORD OF DECISION
LHAAP-16 LANDFILL
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

ON THE LINE

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

MARC No. W912QR-04-D-0027, Task Order No. DS02
Shaw Project No. 117591

September 2011

Table of Contents

Table of Contents (continued)

List of Tables

List of Figures

List of Appendices

Glossary of Terms

Located at the end of this ROD

Acronyms and Abbreviations

µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
BERA	baseline ecological risk assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
cfm	cubic feet per minute
cm/sec	centimeters per second
COC	chemical of concern
COPEC	chemical of potential ecological concern
COPC	chemical of potential concern
CSM	conceptual site model
DCA	dichloroethane
DCE	dichloroethene
DNT	dinitrotoluene
DPT	direct-push technology
ECOP	environmental condition of property
EPC	exposure point concentration
ESD	explanation of significant differences
ESTCP	Environmental Security Technology Certification Program
FFA	Federal Facility Agreement
FS	feasibility study
gpm	gallons per minute
GW-Res	TCEQ groundwater MSC for residential use
HEAST	health effects assessment summary tables
HI	hazard index
HQ	hazard quotient
IRA	interim remedial action
IRIS	Integrated Risk Information System
Jacobs	Jacobs Engineering Group, Inc.
LDR	land disposal restriction
LHAAP	Longhorn Army Ammunition Plant

Acronyms and Abbreviations (continued)

LTM	long-term monitoring
LUC	land use control
MCL	maximum contaminant level
mg/kg	milligrams per kilogram (parts per million [ppm] – soil analyses)
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
O&M	operation and maintenance
PCB	polychlorinated biphenyl
Plexus	Plexus Scientific Corporation
pvc	polyvinyl chloride
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RFA	RCRA Facility Assessment
RfD	reference dose
RI	remedial investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SF	slope factor
Shaw	Shaw Environmental, Inc.
STEP	Solutions to Environmental Problems, Inc.
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TAC	Texas Administrative Code
TCDD	tetrachlorodibenzo-p-dioxin
TCE	trichloroethene
TCLP	toxicity characterisitc leaching procedure
TCEQ	Texas Commission on Environmental Quality
TNT	trinitrotoluene
UCL	upper confidence limit

Acronyms and Abbreviations (continued)

U.S. Army	U.S. Department of the Army
USACE	U.S. Army Corps of Engineers
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USC	U.S. Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VC	vinyl chloride
VOC	volatile organic compound

1.0 The Declaration

1.1 Site Name and Location

Longhorn Army Ammunition Plant-16 (LHAAP-16), Landfill

Longhorn Army Ammunition Plant
Karnack, Texas

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

1.2 Statement of Basis and Purpose

This decision document presents the selected remedy for LHAAP-16 Landfill, 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 the site, including the remedial investigation (RI) (Jacobs Engineering Group, Inc. [Jacobs], 2000), baseline human health risk assessment (BHHRA) report (Jacobs, 2001a), addendum to the BHHRA (Jacobs, 2001b), installation-wide baseline ecological risk assessment (BERA) report (Shaw Environmental, Inc. [Shaw], 2007a), feasibility study (FS) (Jacobs, 2002), addendum to the FS report (Shaw, 2010), Proposed Plan (U.S. Department of the Army [U.S. Army], 2010) and other related documents contained in the Administrative Record for LHAAP-16.

This document is issued by the U.S. Army, the lead agency for this installation. The 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 LHAAP cleanup program. The USEPA and the U.S Army jointly select the remedy and TCEQ concurs with the selected remedy in this Record of Decision (ROD).

1.3 Assessment of the Site

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

1.4 Description of the Selected Remedy

The final selected remedy for LHAAP-16 includes maintenance of the existing cap, enhanced land use controls (LUCs), in situ enhanced bioremediation in a target area, biobarriers, and monitored natural attenuation (MNA). The final remedy also incorporates those LUCs already in place as a result of an early interim remedial action (IRA), a containment presumptive remedy.

The IRA was implemented from 1996 to 1998 at LHAAP-16 to address the landfill waste materials (source area). The containment remedy, a multilayer landfill cap, was necessary to mitigate potential risks posed by buried source material at the site. Placement of a multilayer cap addressed the risks associated with landfill source materials by eliminating the direct exposure pathway to source area waste material, preventing contaminant transport to surface water via surface runoff, and reducing leaching of contaminants to the groundwater. The IRA ROD (U.S. Army and USEPA, 1995) called for warning signage, use restrictions, regular inspections, maintenance and repair of the cover system and five-year reviews. The IRA ROD also noted that a final ROD would be issued when the groundwater investigations and subsequent risk assessment were completed.

The final selected remedy for LHAAP-16 protects human health and the environment by preventing human exposure to the landfill waste and contaminated groundwater, and preventing groundwater contaminated with chemicals of concern (COCs) from migrating into nearby surface water. The human health scenarios evaluated were based on the hypothetical future maintenance worker. In the groundwater, the COCs are trichloroethene [TCE], cis-1,2-dichloroethene [DCE], vinyl chloride [VC]), perchlorate, and five metals (arsenic, chromium, manganese, nickel and thallium). The components of the selected remedy are summarized below.

- Maintenance and repair of the existing landfill cap. Groundwater monitoring activities at select wells also will be conducted to evaluate the effectiveness of the existing landfill cap. The need to continue groundwater monitoring for this purpose will be evaluated at five-year reviews.

- In situ enhanced bioremediation in the most contaminated portion of the shallow and intermediate groundwater zones to reduce contaminant mass and lower the contaminant concentrations. Bioremediation will be implemented in conjunction with phased shut down of the existing groundwater extraction system.

- Installation of a biobarrier in the downgradient portion of the contaminant plume to prevent contaminated groundwater from seeping into Harrison Bayou at concentrations that would cause surface water to exceed Texas Surface Water Quality Standards, the Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs), and Texas medium-specific concentration (MSC) levels. A second biobarrier will be installed at the edge of the landfill to control potential migration of volatile organic compounds (VOCs) from the landfill. The purpose of the biobarriers in conjunction with natural attenuation will be to reduce groundwater contaminant and by-product contaminant concentrations to levels that will prevent surface water from exceeding surface water standards, to reduce groundwater contaminant and by-product contaminant concentrations to levels that attain groundwater cleanup standards, to reduce the potential migration of contaminants and by-product contaminant from the landfill, and to reduce groundwater contaminant and by-product contaminant mass.

- MNA will be implemented for areas outside the influence of the active remedies to assure protection of human health and the environment by documenting that further reductive dechlorination is occurring within the plume and that contaminant concentrations are being reduced to cleanup levels. MNA monitoring will be initiated immediately following issuance of the remedial design. Groundwater samples will be collected from wells that are determined to be outside any significant influence from the in situ enhanced bioremediation and the biobarriers. If MNA is not successful, a contingency remedy will be implemented. That contingency remedy will comprise injection of bioremediation amendments in locations that are selected based on evaluation of site data available at that time.

- MNA will also be implemented in the areas of active remediation following successful implementation of in situ bioremediation and the biobarriers. The active remedies will significantly reduce contaminant concentrations, and MNA will ultimately restore the groundwater to cleanup levels. MNA monitoring will be initiated at wells within the treatment areas when performance monitoring of the active remedies demonstrates that further amendment injections are not necessary. If MNA is not successful, the active remedies will be re-implemented, in part or in whole, based on evaluation of site data available at that time.

- Groundwater monitoring will be conducted to evaluate inorganic COCs. The need to continue groundwater monitoring for this purpose will be evaluated at five year reviews.

- Surface water monitoring will also be conducted to confirm that surface water standards for the contaminants and by-product contaminants are not exceeded in Harrison Bayou, which flows into Caddo Lake. The surface water sampling events will be conducted when groundwater sampling events are conducted for performance monitoring, MNA monitoring, and inorganics monitoring.

- LUCs to prevent human exposure to the landfill waste. The LUCs will remain in place as long as the landfill waste materials remain at the site. In addition, a LUC restricting the use of groundwater to environmental monitoring and testing only will remain in place until the contaminated groundwater attains groundwater cleanup levels in order to prevent human exposure to the contaminated groundwater. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

- CERCLA five-year reviews and inspections of physical mechanisms at LHAAP-16.

Based on a preliminary natural attenuation evaluation, groundwater cleanup levels in areas without in situ bioremediation are expected to be met through natural attenuation in approximately 280 years (Shaw, 2010). The time-frame will be reevaluated after additional sampling is conducted following shut down of the extraction system and implementation of in situ bioremediation and the biobarriers. MNA will be implemented for the entire site including areas of active remediation and areas outside the influence of active remedies where proper conditions of natural attenuation are established. Natural attenuation will be evaluated in the areas of active remedies 2 years following implementation of the remedies. In the areas outside of the active remedies, natural attenuation will be evaluated for 2 years immediately following issuance of the remedial design. If proper conditions of natural attenuation are established, monitoring for the entire site will continue at a reduced frequency. Otherwise, re-application of bio-amendments (i.e., additional in situ bioremediation) will be implemented.

The remedial design (RD) will include the specific LUCs and implementation details. The long-term groundwater and surface water monitoring and MNA performance monitoring plan will also be presented in the RD. Within 90 days of signing 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 the TCEQ) entered into the FFA for remedial activities at LHAAP on December 30, 1991. The U.S. Army will be responsible for implementation, maintenance, periodic inspection, reporting on and enforcement of the LUCs 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 ultimately responsible for: (1) CERCLA §121(c) five-year reviews; (2) notification of the appropriate regulators of any known LUCs deficiencies or violations; (3) access to the property to conduct any necessary response; (4) reservation of the authority to change, modify, or terminate the LUCs and any related transfer or lease provisions; and (5) ensuring the protectiveness of the selected remedy. U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of a LUCs objective at these sites after they have been transferred. The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or significant modification of a LUC, or in the highly unlikely event of a land use change inconsistent with the industrial/recreational use assumptions of the remedy. (There is no reasonably anticipated use of the property for other than wildlife refuge purposes). In the event that TCEQ and/or EPA and the Army agree with respect to any significant modification of the selected remedy, including the LUCs component of the selected remedy, the remedy will be changed consistent with the FFA and 40 C.F.R. §300.435(c)(2).

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-16 is independent of any other remedial action at LHAAP to address human health issues. To address ecological risk, LHAAP-16 was grouped with several other sites as part of the Waste Sub-Area. The final chemicals of potential ecological concern (COPECs) in soil that require remedial action in the Waste Sub-Area are barium, 2,4-dinitrotoluene (DNT), 2,6-DNT, 2,4,6-trinitrotoluene (TNT), and dioxins (Shaw, 2010). Based on the evaluation of soil samples collected during the RI from outside the landfill, the BERA concluded that no action is needed at LHAAP-16 for the protection of ecological receptors. The proposed remedy at LHAAP-17 will be sufficient to address ecological risks for the entire Waste Sub-Area. The proposed remedy at LHAAP-17 is identified in the Proposed Plan (Shaw 2010b) that has been reviewed and approved by the regulatory agencies. The Proposed Plan is in the Administrative Record file for LHAAP.

1.5 Statutory Determinations

The final selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, and is cost-effective. In addition, the remedy offers long-term effectiveness through the long-term inspection and maintenance of the landfill cap (that controls infiltration, contaminant runoff, and contaminant exposure) and implementation of LUCs which will minimize the potential risk to the hypothetical future maintenance worker posed by the landfill waste material and contaminated groundwater. Furthermore, evaluation of natural attenuation (including determination of contaminant reduction rates and routine monitoring of the attenuation until cleanup levels are met) will document the effectiveness of the final selected remedy. The final selected remedy is easily and immediately implementable.

The in situ bioremediation and biobarriers components of the selected remedy satisfy the statutory preference for treatment as a principal treatment element of the remedy. The MNA component does not address the statutory preference for treatment to the maximum extent practicable; MNA is a passive remedial action using natural processes. Although none of the landfill waste will be actively treated, the potential mobility and toxicity of the landfill waste contaminants would be minimized through proper landfill cap maintenance, and the biobarrier near the landfill fence line.

Because hazardous substances, pollutants, or contaminants may remain at the site above levels that allow for unlimited use and unrestricted exposure, reviews will be conducted every 5 years as required under CERCLA §121(c), U.S. Code (USC) Title 42 §9621(c). In accordance with 30 Texas Administrative Code (TAC) §335.566, a notification will be recorded in Harrison County records stating that the site has restrictions against intrusive activities (e.g., digging), is suitable for nonresidential use, and that a prohibition of groundwater use (except for environmental monitoring and testing) 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. Additional information can be found in the Administrative Record for this site.

- 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 sites as a result of the selected remedy (**Section 2.6**).
- COCs and their concentrations (**Section 2.7**).
- Baseline risk represented by the COCs (**Section 2.7**).
- Cleanup levels established for COCs and the basis for these levels (**Sections 2.7.4** and **2.8**).
- How source materials constituting principal threats are addressed at this site (**Section 2.11**).
- Key factor(s) 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**).

1.7 Authorizing Signatures

As the lead agency, the U.S. Army issues this ROD for LHAAP-16 which documents the final selected remedy. The undersigned is the appropriate approval authority for this decision.

Thomas E. Lederle 29 Sep 2011
(*Name*) (*Date*)
Thomas E. Lederle
Industrial Branch Chief
Base Realignment and Closure Division
U.S. Army

The U.S. Environmental Protection Agency approves the final selected remedy as provided in the ROD for LHAAP-16.

________________________ __________
(*Name*) (*Date*)

Samuel Coleman, P.E.
Director
Superfund Division
U.S. Environmental Protection Agency
Region 6

2.0 Decision Summary

2.1 Site Name, Location, and Description

LHAAP-16 Landfill

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: Landfill

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 USEPA 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.

LHAAP-16, a capped landfill, is located in the south-central portion of LHAAP and covers an area of approximately 20 acres (**Figure 2-2**). Harrison Bayou runs along the northeastern edge of LHAAP-16. The landfill was established in the 1940s and was used for the disposal of solid and industrial wastes until the 1980s when disposal activities were terminated.

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 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. LHAAP facility was reactivated with the opening of Plant 2, where pyrotechnic ammunition, such as photoflash bombs, simulators, hand signals, and tracers for 40 millimeter ammunition, were produced until 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 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 Force 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-16 Landfill was established in the 1940s and was used for disposal of solid and industrial wastes until the 1980s when disposal activities were terminated. The U.S. Army and the USEPA signed a ROD in 1995 approving an interim remedial action for LHAAP-16 to mitigate potential risks posed by buried source material at the site. The interim remedial action included the construction of a landfill cap, considered a component of the final remedy for the site. Construction of the 13-acre multilayer cap was completed in 1998. The ROD also specified that the U.S. Army would be required to “perform long-term maintenance of the cap.” The landfill cap would be inspected at regular intervals to check for erosion, settlement, and deep-rooted vegetation. Repairs would be implemented as needed. LUCs, such as future use restrictions, would also be required.

In addition, at the request of the regulatory authorities, but not pursuant to a decision document (e.g., a record of decision or consent order), a groundwater extraction system was voluntarily installed by the U.S. Army in 1996 and 1997 as a treatability study to prevent the groundwater plume from migrating to Harrison Bayou. The extraction system has now been operating for over 10 years (Shaw, 2010).

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 Materials 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. Groundwater monitoring wells were installed and water samples were collected from the wells at the LHAAP-16 site (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. Soil, groundwater, surface water and sediment samples were collected from the LHAAP-16 site (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.

Several investigations to determine the nature and extent of contamination in the soil, groundwater, surface water, and sediments at LHAAP-16 were conducted and are listed below. Samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), metals, explosive compounds, perchlorate, pesticides, polychlorinated biphenyls (PCBs), and/or dioxins/furans, depending on the focus of the investigation. For some of the earlier investigations, LHAAP sites were organized into groups, and LHAAP-16 was included in Group 2. LHAAP-16 was pulled out of Group 2 to allow for expedited decision making, and early actions to control the release of site-related contaminants. The following summarizes the investigations at LHAAP-16.

- **Multi-phase investigation of LHAAP-16**: Between 1993 and 1999 numerous investigations were conducted in a phased approach by Sverdrup, U.S. Army Corps of Engineers (USACE), and Jacobs. Activities included installation of monitoring wells and analysis of groundwater, surface water, soil, and sediment samples. Various landfill investigative tools were also used, including collecting soil gas samples. The results are documented in the RI report (Jacobs, 2000).

- **Plant-wide perchlorate investigation**: The soil and groundwater investigation was conducted by Solutions to Environmental Problems, Inc. (STEP) in 2000 through 2003 (STEP, 2005).

- **Baseline Human Health Risk Assessment**: The BHHRA (Jacobs, 2001a) used data from the investigations conducted through 1999. Dioxin and furan results had been omitted from the BHHRA, therefore an addendum to the BHHRA addressing potential human health risks associated with exposure to dioxins and furan was issued (Jacobs, 2001b). **Environmental Site Assessment: Media** evaluated in 2003 included soil and groundwater (Plexus, 2005), although no sampling was conducted at LHAAP-16 for this assessment.

- **Groundwater Monitoring**: Additional groundwater monitoring was conducted between 2003 and 2004 after the BHHRA was finalized to provide additional information regarding LHAAP-16 groundwater contamination identified during previous sampling events. Groundwater monitoring results from sampling conducted during Spring 2003, Spring 2004, and Winter 2004 were presented in the Groundwater Monitoring Report (USACE and ALL Consulting, 2007).

- **Surface Water Monitoring**: Since 1999 to present, surface water monitoring has been conducted on a quarterly basis at LHAAP-16. Surface water samples are collected from three locations in Harrison Bayou; upgradient, downgradient and immediately adjacent to LHAAP-16. Surface water analytical results indicated that in the past there has been some discharge by seepage into Harrison Bayou (Jacobs, 2002 and Shaw, 2007c).

- **Baseline Ecological Risk Assessment**: The BERA (Shaw, 2007a) iden**tified COPECs for the Waste S**ub-Area, which includes LHAAP-16. COPECs for the sub-area are addressed in the remedial actions for LHAAP-17, another site within the sub-area. The evaluation was based on environmental investigations from 1993 to 2006.

- **Feasibility Study**: The FS (Jacobs, 2002) was based on available results from investigation conducted up to 1999. The FS presented an interim analysis of remedial alternatives for LHAAP-16. Final Ecological risks and extent of groundwater remediation were not addressed in that document. Shaw issued the FS Addendum (Shaw, 2010) providing a basis for the final evaluation of alternatives and selection of a final remedy for LHAAP-16 consistent with the intended future use of LHAAP-16 as part of the national wildlife refuge. A new alternative, Alternative 7 was added to the existing FS. The FS Addendum also included natural attenuation and geochemical evaluation conducted in 2007, installation and sampling of wells near Harrison Bayou conducted in 2007, installation and sampling of wells to address data gaps conducted in 2008, and groundwater sampling for metals, perchlorate, and volatile organic compounds performed in 2009. The findings of the BERA were also included in the FS Addendum.

Figures 2-3 and **2-4** show the sampling locations for soil and groundwater, and surface water and sediment, respectively.

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.

In 1995 as part of the public participation requirements under CERCLA, the U.S. Army issued a Proposed Plan for LHAAP-16 (U.S. Army, 1995) followed by a ROD (U.S. Army and USEPA, 1995) for the site addressing an early IRA. The early IRA was necessary to mitigate potential risks posed by buried source materials. Specifically, the objectives of the IRA were to minimize long-term vertical infiltration of water through the landfill and minimize contaminant transport.

From 1996 to 1998 a landfill cover system (also referred to as a cap) was placed over the site (**Figure 2-5**) and was completed as part of an early IRA in accordance with the USEPA presumptive remedy guidance under CERCLA for municipal landfills (USEPA, 1993) and for military landfills (USEPA, 1996).

The FS (Jacobs, 2002), presenting an interim analysis of remedial alternatives for LHAAP-16, was issued in March 2002. In order to evaluate a final remedy for LHAAP-16, a FS Addendum (Shaw, 2010) was issued in March 2010, and the Proposed Plan (U.S. Army, 2010) was issued in September 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-16 and other environmental sites at LHAAP. The outreach program has included fact sheets, media interviews, site visits, invitations to attend quarterly RAB 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-16 was released to the Administrative Record and made available to the public for review and comment on September 23, 2010. A media release was sent to radio stations KETK, KMSS, KSLA, and KTBS on September 23, 2010. The 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 September 26, 2010. The newspaper and media notices for the meeting are provided in **Appendix A**. The public comment period for the Proposed Plan began on October 10, 2010, and ended November 9, 2010. A public meeting was held on October 19, 2010, in a formal format and with a court reporter. The transcript for the meeting is part of the Administrative Record. The significant comments (oral or written) are addressed in the Responsiveness Summary, which is included in this ROD as **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 scope and role of the action discussed in this ROD includes all remedial actions planned for this site. The final selected remedy at LHAAP-16 will prevent potential risks associated with exposure of the hypothetical future maintenance worker to landfill waste material and exposure to contaminated groundwater. The remedial action will include maintenance of the existing cap, groundwater use restrictions, installation of a biobarrier in the shallow groundwater zone adjacent to the landfill, in situ enhanced bioremediation in the shallow and intermediate groundwater zones, installation of a biobarrier in the shallow groundwater zone between LHAAP-16 and Harrison Bayou, and MNA of the shallow and intermediate groundwater zones.

The selected action at LHAAP-16 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 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) [background total dissolved solids (TDS) content less than or equal to 10,000 mg/L and that occurs within a geologic zone that is sufficiently permeable to transmit water to a pumping well in usable quantities]. The U.S. Army intends to return the contaminated groundwater at LHAAP-16 to its potential beneficial uses, which for the purposes of this ROD is considered to be attainment of the Safe Drinking Water Act (SDWA) 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 in place of the MCL, in accordance with 30 TAC 335.559(d)(2). 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 selected remedial action will treat the contaminated groundwater plume to prevent the migration of groundwater COCs and COC by-products into Harrison Bayou that would result in an exceedance of surface water criteria In addition, the selected remedial action will include groundwater monitoring to demonstrate that the contaminants and by-product contaminants are not migrating into Harrison Bayou at or above the SDWA MCLs, or if MCLs are not available, the Texas MSCs for GW-Res as authorized under 30 TAC 335.559(b) and surface water monitoring to confirm that surface water standards for the contaminants and by-product contaminants are not exceeded. For purposes of this ROD, surface water standards include the Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available, the Texas MSCs for GW-Res as authorized under 30 TAC 335.559(b).

The final selected remedy will protect human health and the environment. The human receptor evaluated was the hypothetical future maintenance worker. The maintenance and repair will preserve the integrity of the existing landfill cover system. In situ bioremediation will treat/remediate and reduce contaminant mass and lower contaminant concentrations in groundwater. Installation of biobarriers will treat/remediate and thereby control potential migration of contaminants and by-product contaminants from the landfill and will reduce groundwater contaminant mass thus providing additional protection of Harrison Bayou. Natural attenuation will further reduce groundwater contaminants and by-product contaminants respective concentrations. The LUCs to be implemented include groundwater use restrictions and land use restrictions to protect and maintain the integrity of the existing landfill cover system. The LUCs to protect and maintain the integrity of the landfill cap will remain in place as long as the landfill waste remains at the site. The LUCs restricting the use of groundwater to environmental monitoring and testing only will remain in place until the contaminated groundwater attains groundwater cleanup levels in order to prevent human exposure to the contaminated groundwater. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure. Without the selected remedial action, the potential for the contaminated groundwater to seep into Harrison Bayou, at levels that equal or exceed surface water standards constitutes an unacceptable risk to human health and the environment.

2.5 Site Characteristics

This section of the ROD presents a brief comprehensive overview of LHAAP-16 site characteristics with respect to the conceptual site model (CSM), 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. Detailed information about the site characteristics can be found in the RI (Jacobs, 2000).

2.5.1 Conceptual Site Model

Figure 2-6 illustrates the conceptual model for the source area at LHAAP-16. The model presents the role of the landfill cap constructed in the IRA of 1998 (**Section 1.4**) and specifies the potential exposure pathways that were cut off by the landfill cap. The construction of the cap as part of the IRA is consistent with USEPA (1993) guidance. **Figure 2-7** illustrates the conceptual model for the non-source area, which lies outside the landfill cap, and which may contain residues of waste materials that may have been transported from the landfill prior to the IRA of 1998. The model presents pathways associated with the non-source area media that are complete and are being considered for remediation, and pathways that are likely incomplete or have negligible impact and are not being considered for remediation.

The landfill contents are not thoroughly known, but disposal history indicates that TNT wastewater ash was deposited in the early 1940s. During the 1950s, a large bermed depression in the central section of the currently capped area was reportedly used for disposal of a variety of materials such as substandard TNT, barrels of chemicals, oil, paint, , scrap iron, containers, scrap metal, wood, and other items. Burn pits and waste storage were reported to be common at the site, although there is little documentation of these activities (Jacobs, 2002). Consistent with the USEPA guidance on presumptive remedies for landfills (1993), it was anticipated that the landfill would pose an unacceptable human health risk, and the landfill was capped as part of the 1998 IRA.

Before the landfill was capped, soil outside the landfill, the non-source area, could have become contaminated from spills, leaks, and runoff of contaminants from the landfill. The baseline human health risk assessment indicated that the cancer risk for the hypothetical maintenance worker was at the lower end of or below the target risk range for surface soil, surface/subsurface soil and sediment. The BERA concluded that no action is needed for LHAAP-16 for the protection of ecological receptors (Shaw, 2007a).

The groundwater is affected by contaminants from the landfill. This was probably caused by the migration of contaminants, via rainwater infiltration, from the landfill waste to groundwater prior to capping the landfill. Analytical results from groundwater samples indicate that the groundwater contamination poses a risk well above the target risk range. The primary COCs in groundwater include TCE, cis-1,2- DCE, vinyl chloride, and perchlorate. Since the groundwater at LHAAP-16 may pose a risk for the hypothetical future maintenance worker, the pathways considered for remediation include future industrial groundwater use.

The contaminants in the shallow groundwater migrate toward and discharge by seepage into Harrison Bayou. The seepage of contaminated groundwater into Harrison Bayou represents a groundwater to surface water pathway of exposure that is identified and addressed by the selected remedial action.

2.5.2 Overview of the Site

LHAAP-16 encompasses an area of approximately 20 acres, of which 13 acres are covered by a landfill cap, in the south-central portion of LHAAP. Harrison Bayou runs along the northeastern edge of LHAAP-16. Most of LHAAP-16 is relatively flat. The outer edges of the site are forested, and the land becomes steeper near Harrison Bayou. The capped landfill is vegetated. Surface drainage from LHAAP-16 flows mostly through small gullies and ditches to Harrison Bayou. Harrison Bayou flows into Caddo Lake, to the northeast of the site. The lake is a source of drinking water for several neighboring communities in Louisiana including Vivian, Oil City, Mooringsport, South Shore, Blanchard, Shreveport, and Bossier City.

The eastern and southeastern edges of LHAAP-16 are located within the 100-year floodplain of Harrison Bayou. LHAAP-16 has no known areas of archeological or historical importance.

2.5.3 Geology and Hydrogeology

The surface soil at LHAAP-16 consists of fine sandy loam. The subsurface is composed of medium plastic sandy silt, fine sands, and clay. The clay layers tend to separate the groundwater into shallow, intermediate, upper deep and deep zones.

The shallow groundwater zone varies in thickness from 9 to 18 feet and extends 33 feet below ground surface (bgs). Groundwater elevations were measured by Shaw in June 2007. The shallow zone groundwater elevation contours based on these data are shown on **Figure 2-8**. Depth to groundwater in the shallow zone is approximately 4 to 25 feet bgs. An intermediate groundwater zone containing fewer fines than the shallow zone extends from 35 to 62 feet bgs. **Figure 2-9** shows measured groundwater elevations and groundwater contours for the data collected in June 2007. The upper deep groundwater zone extends from approximately 80 to 151 feet bgs. The deep groundwater zone extends below 220 feet bgs. While flow is primarily horizontal in these zones, vertical interaction between the shallow and intermediate zones is evidenced by pumping test results as well as the presence of contamination in both zones. Such interconnection is consistent with soil layers formed in fluvial depositional environments. The groundwater flow direction is northeast toward Harrison Bayou in the shallow, intermediate and deep zones, while flow direction is southeast toward Harrison Bayou in the upper deep groundwater zone. Overall, the groundwater flow is toward Caddo Lake. The mean hydraulic conductivity value varies from 1.5×10^{-3} centimeters per second (cm/sec) in the shallow zone to 4.2×10^{-4} cm/sec in the deep zone (Jacobs, 2002).

Groundwater flow between the landfill and Harrison Bayou is also influenced by the presence of an extraction well system consisting of four wells in the shallow groundwater zone and four wells in the intermediate groundwater zone. The wells were installed in 1996 and 1997 as part of a treatability study.

2.5.4 Sampling Strategy

Several sampling events were conducted at LHAAP-16 from 1980 to 2009, as outlined in **Section 2.2.2** on site investigations. In the early investigations, groundwater monitoring wells were installed and 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, surface water and sediment sampling and installing additional monitoring wells to delineate the contamination. Samples were analyzed for various analytes including VOCs, SVOCs, metals, explosives, perchlorate, pesticides/PCBs, 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 dissolved oxygen, conductance, pH, oxidation-reduction potential, sulfide, methane, and chloride.

2.5.5 Nature and Extent of Contamination

The contaminated media at LHAAP-16 include buried source material (landfill waste under the cap) and the shallow and intermediate groundwater beneath and down-gradient of the landfill. A presumptive remedy (IRA) was implemented in 1996 through 1998 by placement of a multilayer cap at LHAAP-16 mitigating potential risks posed by buried landfill waste. The cap prevents rainfall from infiltrating and leaching contaminants from principal threat wastes within the landfill. However, contaminated groundwater still appears to be migrating from beneath the landfill presenting an unacceptable risk. A groundwater extraction system was installed as a treatability study to prevent the groundwater plume from migrating to Harrison Bayou.

The major groundwater COCs for LHAAP-16 identified in the FS (Shaw, 2010) are VOCs, including TCE, cis-1,2-DCE, and vinyl chloride and perchlorate in the shallow and intermediate groundwater. The approximate extent of VOC and perchlorate contamination in the shallow and intermediate zones is shown on **Figure 2-3**. The highest concentration of TCE detected was 173,000 micrograms per liter (µg/L) on October 1, 2003 at the extraction well 16EW02. The TCE plume's edge is defined by the MCL of 5 µg/L. The daughter products cis-1,2-DCE had a maximum detection of 520,000 µg/L on March 21, 1995 at 16PB08 and vinyl chloride had a maximum detection of 11,000 µg/L on June 15, 1998 at 16WW16. The maximum concentration for perchlorate was detected at 5990 µg/L at 16WW12 in October 2007. Five metals (arsenic, chromium, manganese, nickel and thallium) had sporadic elevated detections and were also retained as COCs. The detected metals do not appear to be associated with widespread contamination from the landfill.

Data collected from the upper deep groundwater zone indicate that no groundwater contamination has been detected since 1997. Data also confirmed that contaminants have not migrated down to the deep zone.

2.6 Current and Potential Future Land 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 National Wildlife Refuge boundary. Approved access for hunters is very limited.

The reasonably anticipated future use of LHAAP-16 is as part of 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 and will be used to facilitate a future transfer of LHAAP-16. 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 (16 USC 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

Harrison Bayou, which is located on and adjacent to LHAAP, currently supports wildlife and aquatic life. Humans may have limited access to parts of Harrison Bayou during animal hunts, but there is no routine use of Harrison Bayou located at LHAAP. Harrison Bayou does not carry adequate numbers and size of fish to support either sport or subsistence fishing. During the summer months, Harrison Bayou ceases flowing and/or dries up. The eastern portion of the LHAAP-16 is located within Harrison Bayou's 100-year flood-plain. When flowing, Harrison Bayou discharges into Caddo Lake, a large recreational lake covering 51 square miles with a mean depth of 6 feet. The watershed of the lake encompasses approximately 2,700 square miles. Caddo Lake is used extensively for fishing and boating. The anticipated future uses of surface water are the same as the current uses.

2.6.3 Current and Future Groundwater Uses

Groundwater in the drinking water aquifer (250-430 feet bgs) under and near LHAAP is currently used as a drinking water source. The drinking water aquifer should not be confused with the deep zone groundwater, which extends only to a depth of approximately 151 feet bgs. The deep zone groundwater and the drinking water aquifers are distinct from each other and there is no connectivity between the contaminated zone and the drinking water aquifer. There are five active water supply wells near LHAAP that are completed in the drinking water aquifer. One well is located in and owned by Caddo Lake State Park. The well is completed to a depth of 315 feet bgs 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 completed to approximately 430 feet bgs 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 all are 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 bgs.

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 Caddo lake National Wildlife Refuge, near the main entrance to LHAAP. The distances from these water supply wells to the middle of LHAAP-16 are approximately 2.2 miles, 1.75 miles, and 1.77 miles, respectively. The three water supply wells were completed at a depth much greater than the zone of contamination described at LHAAP-16. 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 national wildlife refuge does not include the use of the groundwater at LHAAP-16 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

Quantitative risk assessment for the non-source areas anticipated to have received contaminants migrating from the source area are consistent with USEPA (1993) guidance for presumptive remedies as conducted in the 1998 IRA. This section summarizes the results of the baseline human health and ecological risk assessments conducted for LHAAP-16 (Jacobs, 2001a; 2001b; Shaw 2007a). The risk assessment consists of a BHHRA (Jacobs, 2001a), an Addendum to the BHHRA (Jacobs, 2001b) and an installation-wide BERA performed by Shaw (Shaw, 2007a) and summarized in the Addendum to the Final FS (Shaw, 2010). The 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 Risk Assessment: Human Health Evaluation, Site 16* (Jacobs, 2001a), in the *Addendum to Final Baseline Risk Assessment: Human Health Evaluation, Site 16* (Jacobs, 2001b), in the *Final Feasibility Study LHAAP-16* (Jacobs, 2002), and in the *Final Addendum to Final Feasibility Study, LHAAP-16* (Shaw, 2010). The risk assessment used data from the investigations conducted through 1999. Results from the later investigations through 2009 did not change the overall outcome of the risk assessment. During the risk assessment, soil and groundwater, and Harrison Bayou surface water and sediment 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 human health risk did not include contaminant concentrations in the waste material within the landfill because the exposure to the waste material has been eliminated. The CSM that is associated with the risk assessment was introduced in **Section 2.5.1**, and is presented as **Figure 2-7**.

2.7.1.1 Identification of Chemicals of Potential Concern

The BHHRA identified chemicals of potential concern (COPCs) for LHAAP-16 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, number of samples with detectable concentrations, and exposure point concentrations (EPCs).

2.7.1.2 Exposure Assessment

The Jacobs risk assessment (Jacobs, 2001a; 2001b) presented the human health risks and hazards to an on-site trespasser under current site conditions for surface soil, surface water, sediment, and fish ingestion and a hypothetical future maintenance worker under an industrial scenario for soil and/or groundwater.

For the trespasser, reasonable exposure pathways evaluated 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 0.5 feet bgs). The trespasser scenario was also evaluated for potential contact with Harrison Bayou media including ingestion of sediment, dermal contact with sediment and surface water, and ingestion of fish.

The BHRRA found that for the current trespasser, none of the exposure pathways contributed to carcinogenic risk or non-carcinogenic hazard, thus the current trespasser data was not included in **Table 2-1**.

For the hypothetical future maintenance worker, reasonable soil exposure routes evaluated are: incidental ingestion of the surface soil (0 to 5 feet bgs), dermal contact with the surface soil, inhalation of particulates, and inhalation of VOCs from the soil (0 to 5 feet bgs).

For groundwater, reasonable exposure pathways for the hypothetical future maintenance worker 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 (IRIS) and Health Effects Assessment Summary Tables (HEAST).

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 $(\text{mg/kg-day})^{-1}$

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 sunlight. 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 a hazard quotient (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 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, based on the sum of all HQ's from different contaminants and exposure routes, 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 risk for soil and groundwater are 8.1×10^{-6} and 1.4×10^{-1}, respectively, based on the initial human health risk evaluation (Jacobs, 2001a). The dioxins and furans results had been omitted from the initial risk assessment evaluation. When the assessment was revised to address the potential human health risks associated with exposure to dioxins and furans congeners detected in surface and subsurface soil and groundwater (Jacobs, 2001b), the risks for soil and groundwater became 1.0×10^{-5} and 1.4×10^{-1}, respectively. Risks from potential exposure to dioxin and furan congeners detected in surface soil and groundwater are within USEPA target risk range. The HI for soil and groundwater are 0.13 and 1,230, respectively. The carcinogenic risk and non-carcinogenic hazard for soil are within the acceptable range. The carcinogenic risk and non-carcinogenic hazard for groundwater are unacceptable; therefore, the remedial action focuses on the groundwater. The major contributors to the non-carcinogenic hazard in groundwater were cis-1,2-DCE, TCE and 1,2-DCE accounting for approximately 97% of the total non-carcinogenic hazard. The carcinogenic risk in groundwater was driven by maximum detection of TCE, and vinyl chloride.

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 seven factors that would lead to overestimations, three that would lead to underestimations, and five that could lead to either over or underestimations.

2.7.2 Post Risk Assessment Data Evaluation

The risk assessment (Jacobs, 2001a; 2001b) was completed using data from the samples reported in the Final Remedial Investigation Report (Jacobs, 2000). Since that time, additional samples have been collected at LHAAP-16. A plant-wide perchlorate investigation was conducted in 2002, and the results were presented in the Plant-wide Perchlorate Investigation Report (STEP, 2005). Three groundwater monitoring events were conducted at the site during winter 2003, spring 2004, and winter 2004, and the results were reported in the Groundwater Monitoring Report (USACE and ALL CONSULTING, 2007). In 2007, 2008, and 2009, Shaw collected groundwater samples and analyzed them for various analytes, including analysis of MNA parameters in 2007. In 2007 and 2008, Shaw installed additional wells to better define the groundwater contamination.

2.7.2.1 Soil

No significant concentrations of perchlorate were detected in the soil samples collected at LHAAP-16. The results obtained from these post-risk assessment soil samples do not alter the conclusions of the risk assessment for soil. The cancer risks and non-cancer hazards posed by soil are 8.1×10^{-6} and 0.13, respectively. These fall within the acceptable ranges.

2.7.2.2 Groundwater

TCE was found in well 16EW02 at an estimated concentration of 173,000 µg/L in October 2003. This is higher than the groundwater exposure point concentration of 160,000 µg/L. However, both the risk and hazard were already noted as above 1×10^{-6} and 0.1, respectively, so TCE is already addressed as a potential COC and this does not change the outcome of the risk assessment. Methylene chloride was found in well 16WW16 at an estimated concentration of 9,500 µg/L in October 2000. This is higher than the groundwater exposure point concentration of 3,500 µg/L. However, both the risk and hazard were already noted as above 1×10^{-6} and 0.1, respectively, so methylene chloride is already addressed as a potential COC and this does not change the outcome of the risk assessment.

1,2-dichloroethane (DCA) was found in well 16EW01 at a concentration of 161 µg/L in April 2004. This is comparable to the groundwater exposure point concentration of 160 µg/L.

However, the risk was already noted as above 1×10^{-6}, so 1,2-DCA is already addressed as a potential COC and this does not change the outcome of the risk assessment.

1,1,2-trichloroethane was found in well 16EW02 at a concentration of 23.6 µg/L in April 2005. This is higher than the groundwater exposure point concentration of 12 µg/L. However, the risk was already noted as above 1×10^{-6}, so 1,1,2-trichloroethane is already addressed as a potential COC and this does not change the outcome of the risk assessment.

Acetone was detected in 16WW16 at an estimated concentration of 14,000 µg/L in October 2000. This is higher than the groundwater exposure point concentration of 3,920 µg/L. Both the previous maximum concentration of acetone in groundwater from 16EW01 in 1996 (3,920 µg/L), used as the EPC, and the most recent acetone result at 16WW16 from October 2000, did not exceed the Texas groundwater MSC for industrial use (GW-Ind comparison value of 92,000 µg/L. Acetone is not considered a COC for the hypothetical future maintenance worker at LHAAP-16.

Arsenic was found in well 16WW35 at an estimated concentration of 123 µg/L in March 2009. This is higher than the groundwater exposure point concentration of 34 µg/L. However, both the risk and hazard were already noted as above 1×10^{-6} and 0.1, respectively, so arsenic is already addressed as a potential COC and this does not change the outcome of the risk assessment.

Chromium was found in well 16WW34 at a concentration of 32,400 µg/L in February 2004. This is higher than the groundwater exposure point concentration of 5,220 µg/L. However, the hazard was already noted as above 0.1, so chromium is already addressed as a potential COC and this does not change the outcome of the risk assessment.

Nickel was found in well 16WW34 at a concentration of 1,780 µg/L in March 2009. This is higher than the groundwater exposure point concentration of 1,630 µg/L. However, the hazard was already noted as above 0.1, so nickel is already addressed as a potential COC and this does not change the outcome of the risk assessment.

Strontium was detected in 16WW25 at a concentration of 12,300 µg/L in December 2004. This is higher than the groundwater exposure point concentration of 10,400 µg/L. Both the previous maximum concentration of strontium in groundwater (10,400 µg/L), used as the EPC, that was from 16WW13 in October 1997 and the most recent strontium result at 16WW25 from December 2004 did not exceed the GW-Ind comparison value of 61,000 µg/L. Strontium is not considered a COC for the hypothetical future maintenance worker at LHAAP-16.

The maximum concentration of perchlorate (5,990 µg/L) in the groundwater was from 16WW12 in October 2007. Perchlorate was not analyzed in the samples collected prior to the risk assessment and therefore perchlorate was not included in the risk assessment evaluation. The maximum concentration of perchlorate at 5,990 µg/L was higher than the GW-Ind comparison value of 72 µg/L, therefore, perchlorate is added as a potential COC at LHAAP-16.

The other chemical concentrations found in groundwater samples collected after the risk assessment was completed, were all less than the values used for the exposure point concentrations.

The results obtained from these post-risk assessment groundwater samples do not alter the conclusions of the risk assessment for groundwater. The cancer risks and non-cancer hazards posed by groundwater are 1.4 x 10-1 and 1,230, respectively. These fall outside the acceptable ranges, and action is needed to manage and reduce those risks and hazards.

While these additional investigations did not change the overall outcome of the earlier BHHRA, they determined what COCs needed to be targeted by the remedial action. **Table 2-6** lists chemicals in the groundwater that have a carcinogenic risk greater than $1{\times}10^{-5}$ and those with an HQ greater than 0.1 for the hypothetical maintenance worker. The table also summarizes the justifications for which of the COPCs should be classified as COCs. COPCs in groundwater were identified as COCs when they posed a carcinogenic risk above the acceptable range (risk greater than $1{\times}10^{-4}$), when their HQ was greater than 1.0, or when the EPC was above the MCL or the GW-Ind. Perchlorate and chlorinated solvents were retained as COCs. Five inorganics (arsenic, chromium, manganese, thallium and nickel) had sporadic elevated detections and were also retained as COCs. While the occurrence of these metals does not appear to be associated with widespread contamination from the landfill, further monitoring is warranted. Recent data obtained after the BHRRA investigation was used when possible. **Table 2-7** presents the final list of COCs, along with cleanup levels.

2.7.3 Summary of Ecological Risk Assessment

The ecological risk for LHAAP-16 was addressed in the installation-wide BERA (Shaw, 2007a). The only medium of potential concern for ecological risk at LHAAP-16 is soil. LHAAP-16 is part of the Harrison Bayou watershed, and no COPECs were identified in Harrison Bayou surface water or sediment (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-16 lies within the Waste Sub-Area.

The BERA concluded that the final COPECs in soil that require remedial action in the waste sub-area are barium, 2,4-DNT, 2,6-DNT, 2,4,6-TNT, and dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin [TCDD] toxic equivalent) because of their potential to cause adverse impacts to one or more ecological receptors. These COPECs pose a potential risk to ecological receptors due to the direct contact with soil and indirect (i.e., dietary) exposure routes. The BERA evaluated eleven soil samples collected during the RI from outside the landfill. Results indicated that the ecological preliminary remediation goal was exceeded by barium in only one sample in surface soil but not in total soil. Removal or treatment of barium-impacted soil at LHAAP-16 would not appreciably lower the 95 percentile upper confidence limit (UCL) for the barium exposure point concentration in the Waste Sub-Area (Shaw, 2010). Therefore, it was concluded that barium within the Waste Sub-Area will be addressed at LHAAP-17, another site within the Waste Sub-Area. TNT and DNT were below detection limits; therefore, these explosive compounds do not contribute to ecological risk at LHAAP-16. Based on detected congeners, dioxins and furans in the soil at LHAAP-16 do not exceed ecological criteria (Shaw, 2007b). In summary, no action is needed at LHAAP-16 for the protection of ecological receptors.

2.7.4 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. Actions for the groundwater are necessary to address the potential for human health risks in the unlikely event there is an attempt to use groundwater as a potable water source. **Table 2-7** presents the COCs and their cleanup levels for groundwater and surface water. There are no COCs for soil.

As it concerns the contaminated groundwater at LHAAP-16, a SDWA MCL has been identified for each of the COCs with the exception of perchlorate, manganese and nickel. For those COCs and by-product (i.e., daughter) contaminants that have an MCL, the MCL constitutes the groundwater cleanup level to be attained. If no MCL exists for a COC and by-product contaminants found in the contaminated groundwater, the MSC for GW-Ind as authorized under 30 TAC 335.559(d), constitutes the groundwater cleanup standard to be attained. With respect to the surface waters that could be impacted by contaminated groundwater discharging into Harrison Bayou, which flows into Caddo Lake (a drinking water source), the Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available the Texas MSCs for GW-Res, as authorized under 30 TAC 335.559(b), constitute the surface water standards to be met at the site for the COCs and by-product (i.e., daughter) contaminants to confirm that the RAO for groundwater to surface water migration is achieved.

2.8 Remedial Action Objectives

The RAOs for LHAAP-16, which address contamination associated with the media at the site and take into account the future uses of LHAAP surface waters, land, and groundwater, are:

- Protection of human health and the environment by preventing exposure to landfill contents;
- Protection of human health and the environment by reducing leaching and migration of landfill hazardous substances into the groundwater;
- Protection of human health by preventing human exposure to the contaminated groundwater;
- Protection of human health and the environment by preventing COCs and COC by-products from migrating into Harrison Bayou at levels that cause surface water in Harrison Bayou to exceed surface water criteria; 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

Seven alternatives (including No Further Action) have been evaluated. 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 Further Action

As required by the NCP, the no action alternative provides a comparative baseline against which the action alternatives can be evaluated. At LHAAP-16, an interim remedy (landfill cap) has already been implemented and maintenance of that remedy is a legal requirement per the 1995 ROD. Therefore, the comparative baseline is considered to be "No Further Action." Under this alternative the existing landfill cap would be left in place and the landfill waste material, surface water, and groundwater would be left "as is," without implementing additional containment, removal, treatment, or other mitigating actions. The existing landfill cap would be maintained to isolate wastes from direct contact and to minimize the driving force of infiltration through the landfill thereby reducing the leaching of contaminants to groundwater. Land use controls would be implemented to protect the existing remedy (landfill cap). Closure and post-closure ARARs were identified for LHAAP-16 in the IRA ROD and these included 30 TAC 335.112, 335.118, 335.119 and 335.174 and 40 CFR Sections 264.228 and 264.310 addressing landfills and surface impoundments storing hazardous waste. Although closure requirements were met during implementation of the (landfill cap) presumptive remedy of the IRA, post-closure requirements remain appropriate and relevant. The existing groundwater extraction process and media monitoring would be discontinued. No other actions, including monitoring, would be implemented to reduce existing or potential future exposure to human and ecological receptors, although natural attenuation would be ongoing.

Estimated Capital Present Worth Cost: $0
Estimated O&M Present Worth Cost: $630,000
Cost Estimate Duration: 30 years
Estimated Present Worth Cost: $630,000

Alternative 2 – Maintenance of Existing Landfill Cap, Enhanced Groundwater Extraction and Land Use Controls

The major components of this alternative include the following.

- Maintenance of the landfill cap to preserve landfill cap integrity. The cap isolates wastes from direct contact and minimizes the driving force of infiltration through the landfill thereby reducing the leaching of contaminants to groundwater

- Enhanced groundwater extraction to increase reliability of the extraction wells and related equipment to treat contaminated groundwater from the shallow and intermediate groundwater plumes. Shallow groundwater will be treated before it seeps into Harrison Bayou

  – Monitoring wells and Harrison Bayou surface water sampling; quarterly for the first year followed by annual sampling

- LUCs to protect the existing remedy (landfill cap) and prevent human exposure to landfill waste

- A LUC prohibiting access to contaminated groundwater (except for monitoring and testing) until cleanup levels are reached

Estimated Capital Present Worth Cost: $760,000
Estimated O&M Present Worth Cost: $9,050,000
Cost Estimate Duration: 30 years
Estimated Present Worth Cost: $9,820,000

Alternative 3a – Maintenance of Existing Landfill Cap, Monitored Natural Attenuation and Land Use Controls

Alternative 3b – Maintenance of Existing Landfill Cap, Hot spot Extraction, Monitored Natural Attenuation and Land Use Controls

The major components of this Alternative 3a include the following:

- Maintenance of the landfill cap to preserve landfill cap integrity. The cap isolates wastes from direct contact and minimizes the driving force of infiltration through the landfill thereby reducing the leaching of contaminants to groundwater
- Discontinued use of the existing groundwater extraction system
- MNA documenting that the contaminated shallow and intermediate groundwater zones remain localized with minimal migration and that contaminant concentrations are being reduced to groundwater cleanup levels before seeping into Harrison Bayou
  - Reactivation of the existing groundwater extraction system and installation of additional extraction wells if MNA is found to be ineffective
  - Monitoring wells and Harrison Bayou surface water sampling; quarterly for the first year followed by annual sampling

- LUCs to protect the existing remedy (landfill cap) and prevent human exposure to landfill waste

- A LUC prohibiting access to contaminated groundwater except for monitoring and testing until cleanup levels are reached

- LUC restricting land use to industrial use for as long as the residual contamination remains

Alternative 3b is identical to Alternative 3a except an extraction well network would be operated in the groundwater hot spot for approximately 5 years to reduce contaminant mass followed by MNA throughout the rest of the O & M period.

Estimated Capital Present Worth Cost:	*(a) $620,000*
	(b) $1,290,000
Estimated O&M Present Worth Cost:	*(a) $2, 100,000*
	(b) $2,140,000
Cost Estimate Duration: 30 years	
Estimated Present Worth Cost:	*(a) $2,710,000*
	(b) 3,430,000

Alternative 4 – Maintenance of Existing Landfill Cap, In Situ Permeable Reactive Barrier (Passive Groundwater Treatment) and Land Use Controls

The major components of this alternative include the following:

- Maintenance of the landfill cap to preserve landfill cap integrity. The cap isolates wastes from direct contact and minimizes the driving force of infiltration through the landfill thereby reducing the leaching of contaminants to groundwater
- Discontinued use of the existing groundwater extraction system
- Installation of an in situ permeable reactive barrier across the heart of the shallow groundwater plume that is seeping into Harrison Bayou. The contaminants to be treated by this reactive media are TCE and perchlorate. The treatment process would be anaerobic biological degradation that uses a combination of gravel and various organic media.
  - Long-term monitoring (LTM) – Monitoring wells and Harrison Bayou surface water sampling; quarterly for the first year followed by annual sampling.
  - Semiannual sampling of the trench monitoring wells and the discharge of the reactive media treatment vessel.
- LUCs to protect the existing remedy (landfill cap) and prevent human exposure to landfill waste
- A LUC prohibiting access to contaminated groundwater except for monitoring and testing until cleanup levels are reached

Estimated Capital Present Worth Cost: $2,540,000

Estimated O&M Present Worth Cost: $2,020,000

Estimated Duration: 30 years

Estimated Total Present Worth Cost: $4,560,000

Alternative 5a – Landfill Hot Spot Removal, In Situ Permeable Reactive Barrier (Passive Groundwater Treatment), Off-Site Disposal and Land Use Controls

Alternative 5b – Complete Landfill Removal, In Situ Permeable Reactive Barrier (Passive Groundwater Treatment), Off-Site Disposal and Land Use Controls

The major components of Alternative 5a include the following:

- Removal of landfill hotspot areas based on the results of previous soil gas survey. The excavated waste would be field screened: the results would be used to define the location and nature of hot spot material to focus the excavation efforts and detail the waste handling and treatment process
- Repair of the landfill cap
- Discontinued use of the existing groundwater extraction system
- Installation of an in situ permeable reactive barrier across the portion of the shallow groundwater plume with the highest contaminant concentrations, reducing the contaminant mass seeping into Harrison Bayou
    - LTM - Monitoring wells and Harrison Bayou surface water sampling; quarterly for the first year followed by annual sampling.
    - Semiannual sampling of the trench monitoring wells and the discharge of the reactive media treatment vessel.
- Maintenance of the landfill cap to preserve landfill cap integrity. The cap isolates wastes from direct contact and minimizes the driving force of infiltration through the landfill thereby reducing the leaching of contaminants to groundwater
- LUCs to protect the existing remedy (landfill cap) and prevent human exposure to landfill waste
- A LUC prohibiting access to contaminated groundwater except for monitoring and testing until cleanup levels are reached
- **Alternative 5b** is identical to alternative 5a in all respects except that all of the landfill wastes would be removed. Because this alternative does not leave any waste in place, there are no long-term cap maintenance and landfill LUCs requirements. However, groundwater LUCs would remain in effect until groundwater cleanup levels are met.

Estimated Capital Present Worth Cost:	*(a)$3,080,000*
	(b) $106,110,000
Estimated O&M Present Worth Cost:	*(a)$9,990,000*
	(b) $9,490,000

Estimated Duration: 30 years
Estimated Total Present Worth Cost: (a)$13,070,000
(b) $115,610,000

Alternative 6 – Landfill Source In Situ Treatment, Monitored Natural Attenuation and Land Use Controls

The major components of this alternative include the following:

- In situ treatment of the landfill hot spots by soil vapor extraction (SVE) to reduce contaminant concentrations in targeted areas that have the highest concentrations
  - Maintenance and monitoring of the SVE system for 5 years.
- Maintenance of the landfill cap to preserve landfill cap integrity. The cap isolates wastes from direct contact and minimizes the driving force of infiltration through the landfill thereby reducing the leaching of contaminants to groundwater
- Repair of the landfill cap following completion of vapor extraction operations
- Discontinued use of the existing groundwater extraction system
- MNA documenting that the contaminated shallow and intermediate groundwater zones remain localized with minimal migration and that contaminant concentrations are being reduced to groundwater cleanup levels before seeping into Harrison Bayou
  - Reactivation of the existing groundwater extraction system and installation of additional extraction wells if MNA is found to be ineffective
  - LTM - Monitoring wells and Harrison Bayou surface water sampling; quarterly for the first year followed by annual sampling
- LUCs to protect the existing remedy (landfill cap) and prevent human exposure to landfill waste
- A LUC prohibiting access to contaminated groundwater except for monitoring and testing until cleanup levels are reached

Estimated Capital Present Worth Cost: $2,750,000

Estimated O&M Present Worth Cost: $3,650,000

Estimated Duration: 30 years

Estimated Total Present Worth Cost: $6,400,000

Alternative 7 – Cap, Land Use Controls, In Situ Enhanced Bioremediation, Biobarriers, and Monitored Natural Attenuation

The major components of this alternative include the following:

- Maintenance of the landfill cap to preserve landfill cap integrity. The cap isolates wastes from direct contact and minimizes the driving force of infiltration through the landfill thereby reducing the leaching of contaminants to groundwater

- Discontinue use of current extraction system

- Installation of a biobarrier in the shallow groundwater zone adjacent to the landfill near the fence line to degrade contaminants in groundwater

- In situ enhanced bioremediation in the most contaminated portion of the shallow and intermediate groundwater zones in conjunction with phased shut down of the existing groundwater extraction system.

- Installation of a second biobarrier in the shallow groundwater zone near Harrison Bayou to further degrade contaminants

- MNA of the shallow and intermediate groundwater zones to further reduce the concentrations of contaminants and by-product contaminants in the groundwater so that the contaminated groundwater attains groundwater cleanup levels/standards, and that surface water in Harrison Bayou is not adversely impacted by groundwater such that it fails to meet surface water standards for the COCs and by-product (daughter) contaminants.

  – Performance objectives to evaluate the MNA remedy performance after 2 years

  – A reapplication of bio-amendments if MNA is found to be ineffective

  – LTM semiannually for 3 years, annually until the next five-year review, then once every 5 years to remedy performance. Monitoring will continue until five-year review demonstrate that there is no further threat of release of contaminated groundwater into the surface water and the groundwater can be used without restriction. LTM will be initiated only after MNA performance monitoring and MNA is determined to be effective.

- LUCs to protect the existing remedy (landfill cap) and prevent human exposure to landfill waste.

- A LUC prohibiting access to contaminated groundwater except for monitoring and testing until cleanup levels are reached.

- A LUC restricting land use to nonresidential until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

Estimated Capital Present Cost: $390,000

Estimated O&M Present Worth Cost: $1,590,000

Estimated Duration: 30 years

Estimated Total Present Worth Cost: $1,980,000

2.9.2 Common Elements and Distinguishing Features of Each Alternative

Common Elements of Alternatives 1 through 7

LUCs are common to all alternatives, MNA is common to Alternatives 3, 6, and 7, and inspection/LTM is common to Alternatives 2 through 7. These elements are described below.

LUCs **–** The LUCs 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 LUCs. The U.S. Army will provide details of the LUCs long-term implementation and long-term maintenance actions in the RD for the site. The LUCs would prevent human exposure to landfill contents and residual groundwater contamination that may present an unacceptable risk to human health, and would preclude the withdrawal or use of groundwater beneath the site for anything other than environmental monitoring and testing. The groundwater use prohibition LUCs (except for monitoring and testing) would be maintained until the groundwater can be used without restrictions. The nonresidential land use LUC restriction would remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

In addition, within 90 days of signature of this ROD, the U.S. Army shall request the Texas Department of Licensing and Regulation to notify well drillers of groundwater use prohibitions based on a preliminary LUC boundary. Within one year of signature of this ROD, the U.S. Army shall: 1) request the Texas Department of Licensing and Regulation to notify well drillers of the final boundary of groundwater use prohibitions; and 2) notify the Harrison County Courthouse of the LUCs to include a map showing the area of groundwater restriction at the site, in accordance with 30 TAC 335.565.

To transfer LHAAP-16, an Environmental Condition of Property (ECP) document would be prepared and the Environmental Protection Provision from the ECP would be attached to the letter of transfer. The ECP will include land use and groundwater use restrictions as part of the Environmental Protection Provisions. The property would be transferred subject to the LUCs identified in the ECP. These restrictions would prohibit or restrict property uses that may result in damage to the existing remedy (landfill cap) or exposure to the contaminated groundwater (e.g., drilling restrictions). The U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of a LUCs objective at the site after it has been transferred. The U.S Army shall consult with TCEQ and obtain USEPA concurrence prior to the termination or significant modification of LUCs or in the highly unlikely event of a land use change inconsistent with the industrial/recreational use assumptions of the remedy. In the event that TCEQ and/or USEPA and the U.S. Army agree with respect to any significant modification of the selected remedy, including the LUCs component of the selected remedy, the remedy will be changed consistent with the FFA and 40 CFR §300.435(c)(2).

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. A preliminary natural attenuation evaluation indicates that MNA is a feasible remedy for certain portions of LHAAP-16, but not as a sole remedy for the entire site due to migration concerns for the shallow groundwater zone (Shaw, 2010). Monitoring activities associated with MNA would confirm the protection of human health and the environment by documenting the return of 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. In Alternative 3, contaminant reduction would occur by MNA alone in both the shallow and intermediate zones. In Alternative 6, SVE would reduce contaminant concentrations in targeted landfill source areas after which the treatment in both the shallow and intermediate zones would be MNA. In Alternative 7, contaminant reduction would occur by a biobarrier in the shallow zone adjacent to the landfill, in situ enhanced bioremediation in the most contaminated portion of the shallow and intermediate zones, and a second biobarriers in the shallow groundwater zone near Harrison Bayou. Contaminant reduction would occur by MNA alone in the areas outside the influence of the active remedies in both the shallow and intermediate zones.

MNA performance monitoring will be conducted quarterly for the first 2 years in the areas outside the influence of the active remedies. For the active remedies areas, MNA performance monitoring will be conducted quarterly for 2 years following implementation of the remedies. After eight quarterly sampling events, MNA effectiveness 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).

Inspection/Long-Term Groundwater Monitoring **–** Alternatives 2 through 7 include inspection and long-term groundwater and surface water monitoring activities. The long-term reliability of the LHAAP-16 landfill cap to control infiltration, contaminant runoff, and contaminant exposure depends on adequate long-term inspection and maintenance. Further groundwater and surface water monitoring would be used to evaluate contaminant and by-product contaminant migration, confirm that the COCs and by-product contaminants in the groundwater plumes degrade in a manner to achieve attainment of groundwater cleanup standards/levels, and to verify that COCs and by-product COC contaminant levels in Harrison Bayou are less than the surface water standards. The eventual groundwater concentration goal is to reduce COC concentrations to groundwater cleanup levels. The LUCs, cap maintenance, and long-term monitoring would be continued as required to demonstrate effectiveness of the remedy, compliance with applicable or relevant and appropriate requirements (ARARs), and RAOs, and to support five-year reviews.

Distinguishing Features of the Alternatives

Alternative 2, Alternative 3a and Alternative 3b

The distinguishing feature of **Alternative 2** is the inclusion of enhanced groundwater extraction. **Alternative 3a** when compared to Alternative 2 is distinguished by the discontinued use of the extraction system relying on MNA to reduce the groundwater contamination and impacts to Harrison Bayou over long-term. **Alternative 3b** is identical to 3a except that an extraction well network will be operated in the groundwater hot spot for approximately 5 years to reduce contaminant mass, followed by MNA. These actions are described below.

Enhanced Groundwater Extraction **–** The current groundwater extraction system would be upgraded to increase reliability of the extraction wells and related equipment and increase its hydraulic influence on the shallow and intermediate groundwater plume. There are eight existing groundwater extraction wells that were installed at the site in 1996 as part of a groundwater treatability study and design. The extraction wells were installed as four pairs (nests) each consisting of a shallow well (wells 16EW01 through 16EW04) installed in the shallow saturated zone, and an intermediate well (wells 16EW05 through 16EW08) installed to a depth of approximately 55 feet screened in the intermediate saturated zone. Historically, the extraction wells have produced below the optimum combined flow of 8 gallons per minute (gpm). Several upgrades to the existing system would be implemented to improve performance and minimize system downtime. The existing pumps have been a maintenance problem, often clogging with soil fines. Polyvinyl chloride (pvc) check valves and filter socks would be installed to remove soil fines. A remote level control system offered by the pump manufacturer would be installed at each well to allow water level adjustments to keep the pumps submerged, reducing the iron fouling problems. To reduce the amount of time the compressor runs, the 2-hp air compressor unit would be replaced by a 7-hp compressor.

Additional Extraction Wells **–** Based on an evaluation of the shallow and intermediate plume locations, the hydrogeologic conditions, and the location and estimated hydraulic influence of the existing extraction well network, there is considerable uncertainty as to the effectiveness of the current system's ability to adequately capture the northernmost portions of the plume. To capture that part of the plume, a pair of nested, 4-inch ID extraction wells, one each in the shallow and intermediate zones, would be installed approximately 75 to 100 feet north of extraction wells 16EW01and 16EW05. These new extraction wells would capture the northern components of the shallow and intermediate groundwater plumes. They would be tied into the groundwater extraction system piping. It is estimated that these new wells would produce approximately 2 gpm. The extracted groundwater would be treated at the LHAAP-18/24 treatment plant.

Water Treatment **–** The extracted groundwater would be treated at the groundwater treatment plant at LHAAP-18/24. The plant was originally built to treat contaminated water from other LHAAP sites. Since 1996 the plant has also treated groundwater from LHAAP-16 extraction wells, which contribute less than 10 percent of the total amount of water treated at the plant. The treatment plant uses air stripping, metals precipitation, carbon adsorption, and catalytic oxidation and would not require modification for this alternative. A fluidized bed reactor was added for perchlorate treatment and has been operating since April 2001. The plant is capable of treating chlorinated solvents, perchlorate, and metals. Plant influent from all sources is blended in a 300,000-gallon equalization tank before treatment. Treated effluent is discharged into Harrison Bayou or injected at LHAAP-18/24.

Performance Monitoring **–** Groundwater and surface water monitoring would be required throughout the O&M period, estimated to be beyond the 30-year present worth period. O&M would include continuous pumping of the extraction wells, monitoring of environmental media, extraction well and monitoring well maintenance, and water treatment. Harrison Bayou would be sampled at three locations quarterly for one year followed by annual sampling and the samples submitted for VOC and perchlorate analyses. It is also assumed that 2 new monitoring wells would be installed on the other side of Harrison Bayou and a total of 10 wells also monitored for VOCs and perchlorate. The wells would be sampled quarterly for the first year followed by annual sampling.

Upgrading the existing extraction system and installation of the new extraction wells is estimated to take approximately 3 months. The groundwater extraction system would need to operate until contaminated groundwater at LHAAP-16 has attained the SDWA MCLs and Texas MSCs for GW-Ind. For those COCs and by-product (i.e., daughter) contaminants that have an MCL, the MCL constitutes the groundwater cleanup level to be attained. If no MCL exists for any COC found in the contaminated groundwater, the Texas MSCs for GW-Ind, as authorized under 30 TAC 335.559(d) constitutes the groundwater cleanup standard/level to be attained. With respect to the surface waters that could be impacted by contaminated groundwater seeping into Harrison Bayou, the Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available the Texas MSCs for GW-Res, as authorized under 30 TAC 335.559(b), constitute the surface water standards for the COCs and by-product (i.e., daughter) contaminants to confirm that the RAO for groundwater to surface water migration is achieved.

Groundwater Hot Spot Extraction **–** The groundwater contaminant mass would be significantly reduced through an aggressive pump and treat operation in the heart of the shallow and intermediate contaminant plumes. The system would use four new shallow zone extraction wells, 2 existing shallow zone extraction wells, and two existing intermediate zone extraction wells. Existing shallow zone wells 16EW01 and 16EW02 would complete the shallow zone extraction network in the heart of the shallow plume. The four new shallow zone extraction wells would be installed to 30 feet. Existing intermediate zone wells 16EW05 and 16EW06 are located in the heart of the intermediate zone plume. All new wells would be constructed the same as existing extraction wells (4-inch-diameter pvc with pneumatic pumps), and both new and existing wells would employ the upgrades identified in Alternative 2. With the exception of 16EW01, 16EW02, 16EW05, and 16EW06, the existing extraction wells would not be operated under this alternative.

The extraction wells would be tied into the existing extraction well network, and the extracted groundwater would be treated at the groundwater treatment plant at LHAAP-18/24. The well network would be operated for an estimated 5 years. It is roughly estimated that the contaminant mass in this section of the shallow and intermediate zone plumes would be reduced by up to 50 percent. Extraction well maintenance would be required for the whole duration of groundwater extraction.

Performance monitoring would be conducted as described for Alternative 2. One of the Harrison Bayou sampling locations would be adjacent to the seep.

Alternative 4, Alternative 5a and Alternative 5b

The distinguishing feature of **Alternatives 4, 5a**, and **5b** is the inclusion of groundwater treatment. Compared to Alternative 4, the distinguishing features of **Alternatives 5a** and **5b**, are the inclusion of landfill hot spot excavation and complete landfill excavation, respectively. These actions are described below.

***In Situ Permeable Reactive Barrier (Passive Groundwater Treatment)* –** To protect Harrison Bayou from shallow contaminated groundwater infiltration from the seep at the northeastern end of the site, an in situ treatment system would be installed across the heart of the shallow groundwater contaminant plume. This barrier would consist of a gravel filled groundwater collection trench with a reactive media bed located at the downslope discharge point of the collection trench. The highly permeable gravel in the trench would channel the shallow groundwater to the reactive media contained in a buried treatment vessel. The collection trench is sized to intercept only that part of the shallow groundwater plume with highest contaminant concentrations, likely having the greatest impact on VOC levels in Harrison Bayou. Installation of the trench would create a preferential flow path. The actual size and location of the trench would need to be determined during the design.

The reactive media vessel would be located approximately 250 feet downslope from the end of the collection trench to provide adequate head to move the collected groundwater through the treatment vessel. A perforated pipe would be buried at the bottom of the collection trench to convey the collected groundwater through a non-perforated pipe connected to the reactive media treatment vessel. The treatment vessel would be filled with the reactive media and sized to provide the requisite residence time for the contaminants to be treated. The treatment vessel discharges to a buried drain field, allowing the treated groundwater to drain into the soil downslope of the treatment vessel. The placement of the reactive media in a treatment vessel instead of the entire collection trench would reduce the overall media cost and facilitate the replacement of the media when expended.

The contaminants to be treated by this reactive media are TCE and perchlorate. The treatment process would be an anaerobic biological degradation process that would use a combination of gravel and various organic media. The treatment vessel would be buried to enhance anaerobic conditions. The organic media would function as carbon sources for the anaerobic microbes. Possible sources of media are, among others, compost, vegetables, molasses, cotton seed, and citrate which can be used in combination to achieve the necessary treatment levels. The organic media mix and the size of the treatment vessel must be determined through treatability testing and design. It is assumed that the media would require replacement every 5 years. Three shallow monitoring wells (one every 100 feet) would be installed immediately downgradient of the collection trench to monitor the performance of the trench.

The excavated soil material removed from the trenching operations would be placed in a prepared staging area. The excavated soil would be sampled and analyzed for perchlorate, VOCs, SVOCs, toxicity characteristic leaching procedure (TCLP), metals, dioxins/furans, and PCBs and could likely be used as clean fill at the site. Dewatering of the trench may be required during excavation. Any groundwater removed would be assumed to be contaminated and would be treated at the groundwater treatment plant at LHAAP-18/24.

It would take at least 6 months to conduct the reactive barrier treatability study. It would take approximately 6 months to clear and grub the area, install the soil staging area, and install the permeable reactive barrier. The permeable reactive barrier would have to be operated until the upgradient groundwater contamination degraded to the point that no future impacts to Harrison Bayou are likely. Groundwater and surface water monitoring would be required throughout the O&M period, estimated to be required beyond the 30-year present worth period.

Landfill Hot Spot Excavation – The landfill hot spots would be removed with conventional excavation equipment. To verify the hot spot locations, 10 test trenches would be excavated at various locations across the landfill, biased by the results of the previous soil gas survey. These test trenches, dug to the bottom of the landfill, would provide insight into the physical makeup of the waste likely to be excavated, in addition to analytical data from samples taken from these trenches. The excavated waste would be segregated, roughly catalogued, and placed in 55-gallon drums for disposal. Debris would be taken from each of the trenches and screened in the field for VOCs and analyzed for perchlorate, VOCs, SVOCs, TCLP, metals, dioxins/furans, and PCBs. The results of this sampling effort would be used to define the location and nature of hot spot material to focus the excavation efforts and detail the waste handling and treatment processes.

Once the location of the hot spot material was confirmed, an excavation path would be cut into the landfill through the center of the assumed hot spot areas. This approach would expose the greatest volume of hot spot material while minimizing disturbances to the areas of the landfill that would not be excavated. The cap covering the hot spots would be carefully removed before excavation, facilitating the replacement of the liner and other cap material after excavation is complete.

The excavated material would be placed in piles on a staging area adjacent to the landfill. Every 200 cubic yards of waste placed in the waste staging area would be sampled and analyzed for VOCs, SVOCs, TCLP, metals, dioxins/furans, and PCBs to determine whether it meets the waste acceptance criteria of the off-site disposal facility. Approximately 60 samples would be collected and shipped to an offsite laboratory. The waste would remain in the staging area until the analytical results are received from the laboratory. The probable condition is that all of the waste is not RCRA-hazardous and could be disposed of in an industrial landfill. Once the waste was sampled and determined to meet the waste acceptance criteria of the disposal facility, it would be loaded into dump trucks and transported for disposal.

Landfill Cap Repair – The cap would be repaired following landfill hot spot excavation under Alternative 5a. The open excavations would be backfilled with clean fill, and a geocomposite clay liner and a 20-mil geomembrane would be installed and joined with their counterparts in the existing cap. Approximately 425 cubic yards of soil would then be graded into the existing soil cover.

Complete Landfill Excavation – There is a degree of uncertainty as to the total volume and locations of the hot spot material. Although the results of the soil gas survey indicate the possible location of hot spot material based on elevated soil gas readings, it is possible that the volume and locations of the hot spot material are much greater and more widespread. The results of the test trenching would add significantly to the confidence level for hot spot locations, volume, and constituents, but uncertainty remains because of the inherent variability in landfill wastes and the scarcity of disposal information. Alternative 5b addresses the distinct possibility that once full-scale excavation begins, hot spots may be found throughout the landfill. To place an upper bound on the volume of waste to be excavated under this alternative, this option assumes all of the landfill wastes would need to be excavated (approximately 327,000 cubic yards of material).

The excavation, sampling, and waste transportation methods for Alternative 5b would be identical to that described for Alternative 5a. Approximately 327,000 cubic yards of backfill would be required, and waste samples collected and analyzed for every 200 cubic yards of waste removed. The entire landfill would be excavated in sections. The cap from each section would be removed as that section is excavated. Excavation operations would take approximately 30 months. Groundwater and surface water monitoring would be required throughout the O&M period.

In Situ Permeable Reactive Barrier (Permeable Reactive Barrier) **–** To meet surface water standards in Harrison Bayou, an in situ treatment system would be installed across the majority of the shallow groundwater contaminant plume to intercept and treat all contaminated shallow groundwater that may seep into Harrison Bayou. This permeable reactive barrier would be installed in both Alternatives 5a and 5b and operate identically to the permeable reactive barrier used in Alternative 4. This barrier would be approximately 700 feet long in order to intercept the entire shallow groundwater plume.

The possibility of the intermediate groundwater plume impacting Harrison Bayou is remote, but because of the aggressive approach to meeting surface water standards under this alternative, the intermediate zone groundwater would also be intercepted. The proposed design of the collection trench and treatment vessel relies on hydraulic head to move the collected groundwater through the trench into the treatment vessel. The intermediate zone groundwater level is below the level of the treatment vessel and even if the collection trench were constructed to intercept the intermediate zone there would be no hydraulic head to induce the collected groundwater to flow up to the treatment vessel. Because some type of active extraction would be necessary for the intermediate zone, the existing wells were selected over a deeper trench and pumping due to ease of implementation and lower cost. This alternative would use the existing intermediate zone extraction wells (16EW05, 16EW06, 16EW07, and 16EW08) to capture the intermediate zone plume. The existing shallow zone extraction wells would not be used. An additional intermediate zone extraction well would be installed north of 16EW05. It would be placed in the same location and constructed identically to the additional intermediate zone well described in Alternative 2. The extracted water would be piped through the existing transport system to the existing groundwater treatment plant. Seven shallow zone monitoring wells (one every 100 feet) would be installed immediately downgradient of the collection trench to monitor trench performance.

The soil excavated from the trench would be staged in the staging area used for the landfill waste. The soil would be sampled and analyzed for perchlorate, VOCs, SVOCs, TCLP, metals, dioxins/furans, and PCBs. It is assumed that this soil could be used as clean fill. Dewatering may be required during the excavation of the trench. Note however, these soils would be subject to the waste analysis and land disposal restriction requirements found in 40 C.F.R. §§ 262.11 and 268.7. The groundwater removed would likely be contaminated and transported to the treatment plant at LHAAP-18/24.

It would take at least 6 months to conduct a reactive barrier treatability study. The clearing and grubbing of the waste staging area and its construction would take approximately 1 month. The partial removal of the cap and the excavation of the 10,000 cubic yards of hot spot material would take approximately 6 months. The off-site transportation and disposal of the excavated waste material would lag behind the waste removal by 1 month. The backfilling of the excavation area, the repair of the cap, and the closure of the landfill would take 1 month. The reactive barrier would be installed concurrently with the hot spot excavation. It would take approximately 6 months to clear and grub the reactive barrier area and install the barrier. The overall duration of this alternative is approximately 12 months. Groundwater and surface water monitoring would be required throughout the O&M period, estimated to be required beyond the 30-year present worth period.

Samples for both Alternatives 5a and 5b would be collected semi-annually from the trench monitoring wells and the discharge of the media treatment vessel. These samples would be analyzed for VOCs, perchlorate, and general chemistry parameters. It is assumed that the media in the permeable reactive barrier would be replaced and disposed of every 5 years.

The contingent action for Alternatives 5a and 5b addresses the possibility that a percentage of the excavated landfill waste is RCRA-characteristic hazardous waste; it is assumed that 5 percent would be RCRA characteristic hazardous waste and require treatment to meet land disposal restrictions (LDRs) before disposal.

Alternative 6

The distinguishing feature of **Alternative 6** is the inclusion of a SVE system that would be installed in the hot spots to remove the bulk of the volatile organics (e.g., TCE, cis-l,2-dichloroethene, vinyl chloride, etc.) that likely permeate the hot spot waste. The vapor extraction operations would consist of a temporary extraction system for a short-term pilot test and a more permanent, skid- or trailer-mounted system for long-term operations. These actions are described below.

***Pilot Test* –** The pilot test would be conducted to collect the necessary information to design and install the long-term skid- or trailer-mounted system. The pilot test would consist of a soil gas survey in 10 locations to verify the location and relative concentrations of VOCs in the landfill waste. Based on this information a pilot-scale vapor extraction system would be installed and operated as a proof of principle. Four soil-vapor extraction wells would be installed to 15 feet bgs and would feed an estimated 250 cubic feet per minute (cfm) of vapor and water to a vacuum extraction truck and an internal combustion engine. The collected VOCs would be destroyed in the internal combustion engine. Water collected from the extraction effort would be discharged to the contaminated groundwater collection tank currently used for the LHAAP-16 groundwater extraction system. This extracted water would ultimately be treated at the LHAAP treatment plant. The components of the pilot test would include the following:

- Engineering phase – develop work plans; procure subcontractors
- Field phase – install extraction wells; conduct extraction for 2 months
- Reporting – evaluate data and report results.

Soil Vapor Extraction – Based on the results of the pilot test, a full-scale extraction system would be designed and installed. Approximately eight additional wells would be installed in the areas with elevated soil gas readings found during the pilot test soil gas survey. Each extraction well is assumed to have a radius of influence of 50-75 feet. A header would be run above ground to each well, and each well would be equipped with a valve to allow adjustment of air flow. The vapor extraction system would consist of a blower, knockout tank, and a catalytic oxidation unit. The catalytic oxidation unit would be propane-fueled and have a throughput of approximately 500 cfm (assumes 300 cfm/acre × 1.5 acres). VOC concentrations in the extracted air would be automatically monitored. The components of the long-term vapor extraction would include:

- Reporting – prepare an annual report on system performance
- Engineering phase – design and procure system and subcontractors
- Installation – install additional extraction wells and install piping, treatment unit, and utilities
- Operation – start up, operate, and maintain unit
- Reporting – prepare an annual report on system performance

Water discharged from the extraction system would be sent to the existing groundwater storage tank at LHAAP 16 before being pumped to the groundwater treatment plant at LHAAP-18/24. It is assumed that the vapor extraction system would operate for 5 years.

The installation, operation, documentation, and reporting of the pilot-scale vapor extraction test results would take approximately 4 months. The installation of the full-scale extraction system would take 6 months, and the unit would operate for approximately 5 years. It is estimated that all of the VOCs that can be practicably removed by this system would have been removed in this time period. Following completion of vapor extraction operations, the extraction wells would be plugged and abandoned and the cap repaired in those areas.

The vapor extraction system would require maintenance and monitoring over the 5 years that it would be in operation. It is likely that all of the equipment would operate for the full 5 years without the need for replacement if maintenance is routinely performed. Water and water vapor would be collected, transported, and treated at the treatment plant at LHAAP-18/24 for the entire 5 years.

Alternative 7

The distinguishing features of **Alternative 7** are the inclusion of an in situ enhanced bioremediation and biobarriers. These actions of Alternative 7 are described below.

In Situ Bioremediation – To treat the highest levels of chlorinated ethenes, located in the vicinity of the shallow extraction wells and upgradient of those wells, in situ bioremediation would be performed. This technology uses a carbon source and a bioaugmentation culture to create conditions favorable for reductive dechlorination. Preliminary MNA evaluation results indicates that reductive dechlorination is taking place in the shallow groundwater zone at LHAAP-16, but carbon levels appear to decrease with distance from the landfill itself. Therefore, the addition of a carbon source would further encourage the growth of microorganisms in the subsurface. As the microorganisms multiply, they would consume available respiratory substrates including iron and sulfate. As those respiratory substrates are consumed, conditions would be created which are favorable to destruction of chlorinated ethenes via reductive pathways. A bioaugmentation culture (e.g., SDC-9) would also be added to provide a microbial species specifically able to completely degrade TCE to harmless ethene.

It is proposed to inject the carbon source and bioaugmentation culture into the shallow zone using direct push technology (DPT), and into the intermediate zone by injection through existing wells. It has been assumed that approximately 40 injection points would be required within the treatment area. The details of implementation would be established during remedial design. The number of DPT injection points and the injection volumes would be finalized at that time. The design effort would consider optional injection patterns. Once the carbon source and the bioaugmentation culture were injected into the subsurface, reducing conditions would be created, followed by a significant reduction in chlorinated ethene concentrations.

Biobarriers – A biobarrier would be installed in the downgradient portion of the groundwater plume to prevent contaminated groundwater from seeping into Harrison Bayou at concentrations that cause the surface water in Harrison Bayou to exceed the surface water standards for the COCs and by-product COCs. A second biobarrier would be installed at the edge of the landfill between 16WW38 and 16WW13 to control potential migration of VOCs from the landfill. Specifically, a row of injection points perpendicular to groundwater flow direction would be installed down-gradient of the shallow monitoring well close to Harrison Bayou (16WW12). The biobarrier would consist of emulsified oil that will enable ambient microorganisms to create favorable conditions and a bioaugmentation culture (e.g., SDC-9) to provide a microbial species that is able to completely degrade TCE to ethene. The emulsified oil is a slow-release carbon source with an enhanced subsurface longevity; it would be injected to provide a long-lasting source of fermentable carbon to stimulate the biological reduction of perchlorate and TCE and its daughter products.

Once reducing conditions were achieved in the biobarrier, bioaugmentation culture (e.g., SDC-9) would be added to provide microorganisms to completely degrade chlorinated ethenes. The emulsified oil would be injected across the path of shallow groundwater to form two biobarriers – one close to Harrison Bayou and another at the eastern edge of the landfill. Sufficient emulsified oil would be added to each injection point to provide a sustained carbon source for an estimated 3 to 5 years. Follow-up injections would be conducted if deemed necessary from the performance groundwater monitoring results. Concentrations of COCs downgradient of the biobarriers will be monitored to evaluate the continuing effectiveness of the biobarriers.

2.9.3 Expected Outcomes of Each Alternative

Alternative 1 would allow the site to remain a hazard to human receptors due to the potential ingestion of contaminated groundwater; and to the environment, because no remedial activities would be conducted and there would be no LUCs except for cap maintenance. Note however, the landfill cap maintenance would comply with RCRA landfill closure and post-closure care regulations. Alternatives 2 through 7 all provide engineering controls, treatment, containment, or removal and disposal of the waste material to levels protective of human receptors and the environment, including the groundwater at the site, and Harrison Bayou. The six action alternatives have very similar outcomes of preventing exposure to landfill wastes and contaminated groundwater utilizing the landfill cap and LUCs. Alternatives 2, 3, 4, 6, and 7 would maintain the surface water standards of Harrison Bayou through a variety of treatment processes. Alternative 2 takes advantage of the existing groundwater treatment plant. Alternative 3b, 4, 5a, 6 and 7 would achieve groundwater cleanup standards/levels in less time through utilization of active treatment. The similar outcomes include restoration of the contaminated groundwater by attainment of the SDWA MCLs for those COCs and by-product (i.e., daughter) contaminants that have an MCL, to the extent practicable, and consistent with 40 CFR §300.430(e)(2)(i)(B&C). Because no SDWA MCL exist for some COCs including perchlorate, manganese, and nickel, the MSCs (GW-Ind) as authorized under 30 TAC 335.559(d) constitutes the groundwater cleanup standard to be attained. Similar outcomes also include the protection of surface water standards in surface waters that may be impacted by the contaminated groundwater discharges at LHAAP. As such, the Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available the Texas MSCs (GW-Res) as authorized under 30 TAC 335.559(b), constitute the surface water standards that will be monitored to confirm protection of Harrison

Bayou surface waters. In addition, the groundwater and surface water monitoring activities associated with Alternatives 2 through 7 would confirm the protection of human health and the environment by documenting the return of 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. The groundwater LUCs will remain in place until the contaminated groundwater attains groundwater cleanup levels, LUCs to prevent human exposure to landfill waste will remain in place as long as the landfill waste remains at the site and the LUC restricting land use to nonresidential will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

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 2-8** 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.

Alternative 1, the no further action alternative, does not protect human health or the environment because no remedial activities would be conducted and no LUCs (except for cap maintenance) would be maintained. Therefore, LHAAP-16 contamination would present unacceptable risks to human health and the environment through ingestion of groundwater. The other six alternatives, collectively referred to as the action alternatives, would provide engineering controls, treatment, containment, or removal and disposal of the waste material to levels protective of human health and the environment.

The six action alternatives would provide access and use restrictions, capping of buried wastes (except for the entire landfill excavation option of Alternative 5), and long-term media monitoring. The landfill cap and LUCs would prevent exposure to landfill wastes and contaminated groundwater.

Alternatives 2, 3, 4, 6, and 7 would maintain Harrison Bayou water quality through a variety of means. Alternative 2 maintains the current actions of capping and groundwater extraction to contain the contaminated groundwater plume and prevent it from further impacting Harrison

Bayou. Alternatives 3, 4, and 7 are similar to Alternative 2 in that they all maintain the cap, but they all discontinue the groundwater extraction system (Alternative 3b after an estimated 5 years). Alternative 4 uses an in situ permeable reactive barrier installed parallel to Harrison Bayou, and Alternatives 3, 6, and 7 use MNA to assure protection of Harrison Bayou. Alternative 6 couples vapor extraction of the landfill hot spots with groundwater natural attenuation. Alternative 7 utilizes in situ bioremediation of target areas and biobarriers in conjunction with groundwater natural attenuation.

Alternative 5a is the second most aggressive of all the alternatives in that it removes the landfill hot spots (conventional excavation, off-site disposal) and installs a permeable reactive barrier to treat groundwater before it seeps into Harrison Bayou. Alternative 5b, the most aggressive alternative, removes all of the landfill waste and uses the same reactive barrier as in Alternative 5a. All alternatives are protective, though Alternative 5b is most reliable in the long term because it has less reliance on long-term LUCs.

All action alternatives satisfy the RAOs for LHAAP-16. Action alternatives provide confirmation that human health and the environment will be protected because the monitoring will be conducted to confirm that active remedies and/or MNA is returning the contaminated shallow and intermediate groundwater zones at LHAAP-16 to their 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 LUCs would protect human health by preventing exposure to landfill waste, protecting the landfill cover system and 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.

2.10.2 Compliance with ARARs

Section 121(d) of CERCLA and 40 CFR §300.430(f)(1)(ii)(B) require 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 seeped into Harrison Bayou, chemical-specific ARARs for surface water consumption are applicable, relevant and appropriate. Specifically, Texas surface water quality standards are set forth in 30 TAC 307.6(d)(1) for TCE (5 µg/L), 1,2-DCA (5 µg/L), 1,1-DCE (7 µg/L), 1,1,2-TCA (5 µg/L), vinyl chloride (2 µg/L), arsenic (10 µg/L), and thallium (2 µg/L) will be met for surface water at LHAAP-16. The SDWA MCL constitute the cleanup standards/levels to be met per 30 TAC 335.559(b). The MCL for cis-1,2-DCE (70 µg/L), methylene chloride (5 µg/L), chromium (100 µg/L), will be met at the site. The MSC

(GW-Res) for nickel (730 µg/L), and perchlorate (26 µg/L), and the 95%UTL for manganese (7,820 µg/L) will be met at the site.

Alternative 1 does not comply with chemical-specific ARARs because no additional remedial action would be implemented. All of the action alternatives comply with chemical-specific ARARs for groundwater because they will return the contaminated shallow and intermediate groundwater zones at LHAAP-16 to their potential beneficial use as a 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 335.559(d)(2). 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. All of the action alternatives comply with surface water chemical specific ARARs because active remedial processes will reduce the contaminant concentrations in groundwater to the cleanup levels prior to seeping into surface water.

Location-specific and action-specific MCLs would not apply to Alternative 1 since no remedial activities would be conducted. All of the action alternatives 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 clean-up levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

The no further action alternative would not be effective in the long term, because the baseline risk assessment indicates that the current groundwater conditions are not protective of human health and the environment, and no remedial activities would be conducted to address groundwater under this alternative.

All alternatives except Alternative 5b rely on LUCs and source isolation (i.e., capping) to isolate the residual waste from potential receptors. With the exception of the complete landfill excavation option for Alternative 5b, all action alternatives would leave waste on site. Because Alternative 5b removes the entire landfill source term, it is the most reliable in long-term protection of future human receptors. Alternatives 5a and 6 are the next most reliable in the long term because of their removal and in situ treatment, respectively, of the hot spot wastes. The long-term cap maintenance and LUCs offered by Alternatives 2, 3, 4, 5a, 6, and 7 restricting access to the contaminated media would adequately maintain residual risks below acceptable levels. If cap maintenance and monitoring programs are maintained and the owner of LHAAP-

16 maintains the LUCs, the cap and LUCs programs can reliably maintain residual risks at acceptable levels.

The permeable reactive barriers used in Alternatives 5a and 5b to avoid the potential risk that the contaminated groundwater seeping into surface water could cause Harrison Bayou to exceed surface water standards, may be effective and relatively reliable with long-term maintenance and monitoring. To control seepage into Harrison Bayou, Alternatives 2 and 3b extract and treat contaminants in groundwater. Alternative 2 requires long-term groundwater extraction, which has proven to be moderately effective. The extraction system has had reliability problems as with any mechanical system that must operate over the long term. Alternative 3b extracts groundwater for a shorter amount of time.

The other action alternatives rely on treatment options (i.e., in situ permeable reactive barrier, in situ bioremediation, biobarriers) along with MNA to protect Harrison Bayou. The in situ permeable reactive barriers used in Alternatives 4, 5a, and 5b and in situ bioremediation and biobarriers used in Alternative 7, would require regular monitoring and replacement of the reactive media to maintain long-term effectiveness. Long-term maintenance of these barriers could prove to be problematic because of potential fouling of the treatment media and changing geochemistry that could reduce their effectiveness. Collection trenches at LHAAP-16 would be difficult to design to effectively intercept the contaminated groundwater and drain by use of gravity. Permeable barriers and biobarriers were selected to be the representative process option because of their flexibility in being used to address VOC and perchlorate removal.

If operating effectively, the in situ groundwater treatment process of Alternatives 4 and 5 and in situ enhanced bioremediation and biobarriers of Alternative 7, more reliably meet the surface water objective of preventing seepage of contaminants into Harrison Bayou than the natural attenuation option in Alternatives 3 and 6. Results of the MNA evaluation for LHAAP-16 indicated that natural attenuation is a feasible remedy for certain portions of the site but not as a sole remedy due to migration concerns for the shallow groundwater zone. Alternatives 3 and 6 have a planned contingent action of using the enhanced extraction and treatment system of Alternative 2 if natural attenuation is not occurring at a sufficient level to control future seepage into Harrison Bayou.

Alternative 7 utilizes in situ bioremediation and biobarriers to further degrade the contaminants in groundwater in conjunction with MNA. Based on the results of the ESTCP semi-passive biobarrier technology demonstration (ESTCP, 2005; ESTCP, 2007) and the preliminary MNA evaluation, the groundwater contaminants at LHAAP-16 have been shown to be amenable to degradation by biological processes prior to seepage into Harrison Bayou. In summary, all of the action alternatives, including their contingent actions, would effectively meet the RAOs. The reliability of the permeable treatment barrier of Alternatives 4 and 5 is less certain than that of the extraction system of Alternative 2 and 3b, but it may be more effective than the natural attenuation component of Alternatives 3a, 6, and 7. The biological processes utilized in Alternative 7 have been shown to be effective and reliable at LHAAP-16. The current source action, a cap, is limiting releases from the landfill material to the groundwater. However, the removal of the hot spots in Alternative 5a (to the extent these can be found without completely removing the composite synthetic/ bentonite clay liner), or treatment of those same hot spots as in Alternative 6, could enhance the reliability of the cap. LUCs to prevent access to the landfill material are considered effective. There is no information to suggest that the hot spots identified as the probable source of migration of contaminants to groundwater would also have the greatest risk if accessed, so these alternatives are not considered more reliable. However, full removal of the waste, Alternative 5b, would be the most reliable.

Monitoring activities associated with all action alternatives would confirm 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.

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.

The no further action alternative does not include treatment and would not result in a reduction of toxicity, mobility, or volume of contaminants.

Alternatives 2, 3, 4, and 7 would not address the landfill source other than providing containment through capping. Alternative 3a, through its complete reliance on groundwater natural attenuation, provides the least reduction in contaminant volume and toxicity. The natural biological and chemical processes, over time, would gradually reduce the toxicity of VOCs in groundwater and the overall volume of contaminated groundwater. Alternative 4, with its permeable reactive barrier, would reduce the toxicity and volume of the shallow groundwater that passes through it. Although the groundwater upgradient of the reactive barrier is unaffected by the reactive media (until it passes through it), the reactive barrier provides a greater reduction in toxicity and volume than Alternative 3a. Alternatives 2 and 3b actively remove contaminated groundwater from the heart of the plume and treat it ex situ in the LHAAP treatment plant. The processes in the treatment plant would reduce the toxicity and volume of the extracted groundwater. Much of the contamination in the groundwater plume would be reduced over time, offering greater reductions in toxicity and volume than that in Alternative 3a.

Alternative 7 includes in situ bioremediation in the vicinity of shallow wells and upgradient of the wells with the highest levels of chlorinated ethenes. The process would reduce the toxicity and volume. The biobarriers provide further reduction of toxicity, mobility, and volume of the groundwater that passes through them. MNA in conjunction with in situ bioremediation would enhance reduction of toxicity and volume. Alternative 7 includes treatment of groundwater within the plume itself. Alternatives 3a, 3b, 6, and 7 include a natural attenuation component together with dilution, dispersion, and other natural processes that have the capability of ultimately reducing the contaminants to satisfy the chemical-specific ARARs.

Alternative 6 includes the in situ treatment of the landfill. The extracted VOCs, the majority of the source at LHAAP-16, would be destroyed in a thermal oxidation unit. Although the contaminants in groundwater would be treated only through natural degradation processes, the overall reduction in toxicity and volume is greater than other alternatives.

Alternative 5 removes source material from the site, but the base action does not include treatment of that material. The permeable barrier does provide some reduction of toxicity of contaminants through treatment. If the excavated material is RCRA-characteristic, treatment of such materials to meet LDRs would satisfy the CERCLA Section 121(b) statutory preference for treatment.

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.

The no further action alternative would not involve any action; therefore, there would be no increase in short-term risks and no short-term environmental effects.

Through LUCs and engineered controls (e.g., physical barriers, administrative controls, and dust suppression), the six action alternatives would be protective of the community during implementation. Alternative 3a would be the most protective in the short term because there is no construction or off-site transportation. Alternative 5b and, to a lesser extent, Alternative 5a would pose the greatest potential exposure and transportation risks to the public due to the extensive waste excavation and transportation activities. Local and site traffic would be similar for all other alternatives.

The cap maintenance activities at the landfill would require the same health and safety measures for all alternatives except for Alternative 5b. Alternative 5b and to a lesser extent Alternative 5a require extensive handling of the landfill waste and thus pose the greatest risk to remediation workers. Alternative 5a would also be inherently dangerous for workers and machinery because a landfill is an unstable area for trench excavation. Alternative 6 presents lower risks to remediation workers than Alternative 5a because of the less intrusive waste operations of the vapor extraction operations. Appropriate mitigative measures would be applied during construction and transportation to attain appropriate worker and public health exposure requirements in all action alternatives. By planning the construction, excavation, and transportation activities in accordance with industry and OSHA codes and requirements, risks from contaminant exposure and construction operations would be controlled to acceptable levels. All of the remaining alternatives pose similar risks to the remediation worker with Alternative 3a being the safest alternative to implement.

The short-term disturbance of on-property vegetation and wildlife habitat would be greatest under Alternatives 5a and 5b, primarily because of the waste excavation activities and the installation of the long groundwater collection trench. There would be short-term impacts on the vegetation and wildlife habitats in the vicinity of the permeable reactive barrier under alternative 4 and in situ bioremediation injection points and biobarriers under alternative 7, though less than that for the longer barriers in Alternatives 5a and 5b. The vapor extraction operations in Alternative 6 would lightly impact vegetation on the landfill. The remaining alternatives would have little to no short-term impacts above those related to minor maintenance activities. For earthwork and construction activities, sediment deposition into Harrison Bayou would be controlled. Erosion control measures would include surface grading; placement of rip rap and silt fences; covering surfaces with straw, mulch, riprap, or geotextile fabrics; and/or using riprap in areas with high water velocity. Following completion of all construction and excavation, disturbed areas would be regraded with clean backfill and revegetated with native grasses.

The approximate construction time for the action alternatives ranges from 6 months in Alternative 2 to 36 months in Alternative 7. Because the source term is effectively controlled in all of the alternatives (with appropriate cap maintenance), the length of time required before groundwater containment systems are no longer needed are comparable, outside the 30-year present worth period. Additional source actions (Alternatives 5 and 6) are likely to lessen the time required to control the groundwater.

The MNA evaluation for LHAAP-16 demonstrated that natural attenuation is occurring in some areas at the site. The attenuation of contaminants was observed at the source and side-downgradient of the plume. However, the shallow groundwater zone plume is still migrating along the groundwater flow direction toward Harrison Bayou. The intermediate groundwater zone plume is more stable with less migration along the flow direction toward Harrison Bayou. Thus, natural attenuation is a feasible remedy for certain portions of the site but not as a sole remedy due to migration concerns for the shallow zone. MNA is proposed for Alternative 7 in conjunction with in situ bioremediation to enhance reductive dechlorination within the plume and a biobarrier to prevent the seepage of contaminants into surface water. Natural attenuation would be evaluated after 2 years of quarterly monitoring and a re-application of bio-amendments (i.e., additional in situ bioremediation) would be implemented if deemed necessary.

Detailed evaluation of natural attenuation processes would be required to determine whether the Harrison Bayou remediation levels can be met in the near future or whether a contingent action is needed under Alternatives 3 and 6.

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 further action alternative, no new remedial action would be taken. Therefore, there would be no difficulties or uncertainties with implementation.

Overall, all of the action alternatives are technically feasible to implement. Although Alternatives 5a, 5b, and 6 would require more time, equipment, and activity than the other alternatives, the components of most alternatives use technologies that have been straightforward to implement at other sites with contaminants and conditions similar to those found at LHAAP-16. These technologies would be implemented using conventional equipment and construction methods. The excavation of the landfill wastes under Alternatives 5a and 5b would be moderately difficult because of the inherent difficulties associated with excavating debris from a landfill with an uncertain disposal history. Given the uncertain nature of the wastes in the landfill, the potential for delays in excavation exist should anomalous items or debris be encountered. Likewise, coordination issues between excavation, waste characterization sampling, and disposal could slow the process. Alternative 5a has additional implementation difficulties due to the need to penetrate and rebuild the capping system and the impracticability of verifying that all potential sources of groundwater contamination are removed. Although the media in the reactive barrier in Alternatives 4, 5a, and 5b is expected to treat VOCs and perchlorate, the specific conditions at LHAAP-16 (low gradient, high VOCs, low perchlorate levels) have not been tested. There are negative interactions with other site contaminants that could reduce the media's performance. Based on the ESTCP semi-passive biobarriers technology demonstrations, groundwater contaminants at LHAAP-16 are amenable to degradation by biological processes under Alternative 7. All components of Alternative 7 are readily implementable. Alternative 5b, and to a lesser extent Alternative 5a, would be the most technically difficult to implement.

Alternative 6 would be more technically implementable than Alternatives 5a and 5b, though there may be some challenges associated with the installation of the vapor extraction system in the landfill wastes. Also, the uncertainties associated with the flow of soil gas through the variable and heterogeneous buried waste would also contribute to difficulties in implementability and performance. However, the process is robust and would remove adequate volumes of soil vapor. Alternative 6 also has uncertainty associated with the implementation and operation of a permeable barrier.

There are few technical challenges to the implementation of Alternative 4 other than those associated with the installation of the permeable reactive barrier. Although Alternative 3a does not require the installation of any engineered components, the uncertainty in the long-term effectiveness of natural attenuation with the source term still in place may cause future delays should a contingent action need to be implemented. The groundwater extraction system and water treatment plant used in Alternatives 2 and 3b are currently operating and proven in their operation and effectiveness and make these alternatives the most technically implementable.

Administratively, all alternatives are implementable. Virtually all services and materials required for the implementation of the action alternatives would be standard for the construction industry and would be readily available. However, considerable testing and development may be needed to produce an effective design for in situ treatment of VOCs and perchlorate in groundwater. Alternative 5 is the least administratively implementable because of the off-site waste transportation and disposal activities. Various Department of Transportation regulations (e.g., 49 CFR 172, 173, and 177) apply to the transportation of wastes such as those expected from the landfill, and the waste acceptance criteria of the off-site disposal facility must be complied with. In the event that a portion of the wastes must be treated before disposal (Alternative 5 contingent action), the waste acceptance criteria of the treatment facility must also be met. Alternatives 4 and 5 would also require personnel with specialized experience in reactive barrier treatability testing, installation, and operation. The vapor extraction activities in Alternative 6 would require personnel with specialized experience in vapor extraction installation and operation. Alternative 7 would require expertise in engineering design and implementation of the in situ bioremediation and the biobarrier component of the alternative. Alternative 2 and Alternative 3 are the most administratively implementable.

2.10.7 Cost

Cost estimates are used in the CERCLA 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 developed 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 cost estimates include capital costs (including fixed-price remedial construction) and long-term O&M costs (post-remediation). Present worth costs were developed for each alternative assuming a discount rate of 2.7 percent. The estimates for all alternatives utilize a 30-year project life for costing purposes, although the timeframe to achieve RAOs is expected to be longer. The costs of Alternatives 1 through 6 have been updated from the costs presented in the Final FS (Jacobs, 2002) to January 2008 using the Engineering News Record construction cost index, and the costs of five-year reviews have been added to all alternatives. Also, the cost of Alternative 1 has been updated to reflect the ongoing cap maintenance/inspection activities and the implementation of LUCs under the Interim ROD for LHAAP-16.

The progression of present worth costs from the least expensive alternative to the most expensive alternative is as follows: Alternative 1, Alternative 7, Alternative 3a, Alternative 3b, Alternative 4, Alternative 6, Alternative 2, Alternative 5a, and Alternative 5b. Lowest costs are associated with Alternative 1 because no further remedial activities would be conducted. Alternative 7 has the lowest present worth and capital costs of the action alternatives. Alternatives 3a, 3b, and 4 are next in costs (all $5,000,000 or below). While Alternatives 3a and 3b rely heavily on a passive remedial action component (MNA), Alternative 7 utilizes active technologies (in situ bioremediation and biobarriers) prior to MNA; those active technologies lead to much lower monitoring costs in the future, thus giving Alternative 7 a lower total present value cost. The large O&M cost for groundwater treatment (Alternative 2) and the higher capital and O&M cost of in situ vapor extraction (Alternative 6) make these alternatives roughly twice as expensive as Alternatives 3a, 3b, and 4. However, if other sites require use of the LHAAP groundwater treatment plant, the cost of Alternative 2 will be comparable to Alternative 3.

Alternatives 5a (present worth of $13 million) and 5b (present worth of $116 million) are considerably more expensive because of the combination of high capital costs and high O&M costs. The contingent action costs do not change the order of costs.

2.10.8 State/Support Agency Acceptance

The USEPA and TCEQ have reviewed the Proposed Plan, which presented Alternative 7 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. Three sets of written public comments were received during the 30-day public comment period; there were no verbal comments from the October 19, 2010 public meeting. The topics of the comments included: time the landfill will continue to be a source of contamination, time required to achieve cleanup levels, effectiveness of MNA, defining the extent of groundwater contamination, adequacy of the monitoring wells and Harrison Bayou sampling locations, perchlorate cleanup levels, and additional contaminants (antimony, thallium, dioxins and furans) to be added to the list of COCs. Comment responses were provided and incorporated into the ROD, including reiteration of the evaluation criteria for the selected remedy, explanation that the landfill cover system implemented in 1998 as part of the IRA was intended to be consistent with the final remedy and is considered a component of the final selected remedy, explanation that the existing monitoring wells and surface water sampling locations are adequate to monitor contamination at the site and within Harrison Bayou. In addition, explanation as to why thallium will be added to the COC list while antimony and dioxins/furans were not selected as COCs is given. The written comments received and their responses are presented in the Responsiveness Summary (**Section 3.0**).

2.11 Principal Threat Wastes

LHAAP-16 was used primarily as a solid and industrial waste landfill. Placement of the landfill cap prevents rainfall from further infiltrating and leaching contaminants from principal threat wastes in the landfill. However, contaminated groundwater beneath the landfill area continues to migrate. A groundwater extraction and treatment system was voluntarily installed in 1996 to prevent the groundwater plume from migrating to Harrison Bayou.

Capping the landfill as opposed to waste treatment or removal is a presumptive remedy at landfills as it has been shown to be more effective in comparison to other remedies. Landfill removal and landfill source treatment alternatives were included in the comparative analysis of alternatives performed during the feasibility study (Jacobs, 2002) for LHAAP-16. These remedial alternatives did not demonstrate increases in effectiveness that was balanced by their increased costs and short-term impacts.

2.12 The Selected Remedy

2.12.1 Summary of Rationale for the Selected Remedy

Alternative 7, capping, LUCs, in situ enhanced bioremediation in a target area, biobarriers, and MNA, is the selected alternative for LHAAP-16 and is consistent with the intended future use of the site as a national wildlife refuge. This alternative would satisfy the RAOs for the site through the following:

- Maintenance and repair of the existing landfill cap will preserve the integrity of the cap, thus preventing exposure to landfill contents and protecting human health and the environment by reducing leaching and migration of landfill hazardous substances into groundwater. Closure and post-closure ARARs were identified for LHAAP-16 in the IRA ROD and these included 30 TAC 335.112, 335.118, 335.119 and 335.174 and 40 CFR Sections 264.228 and 264.310 addressing landfills and surface impoundments storing hazardous waste. Although closure requirements were met during implementation of the (cap) presumptive remedy of the IRA, post-closure requirements remain appropriate and relevant.

- Treatment of groundwater by in situ enhanced bioremediation in the more contaminated areas and installation of biobarriers will reduce contaminant mass and control contaminated groundwater from migrating into Harrison Bayou. The above selected remedial actions employing treatment along with MNA, will ultimately restore the groundwater to attain groundwater cleanup standards/levels.

- MNA for areas outside the influence of the active remedies will assure protection of human health and the environment by documenting that further reductive dechlorination is occurring within the groundwater plume and that contaminant concentrations are being reduced to attain surface water and groundwater standards/levels.
- Landfill LUCs will remain in place as long as the landfill waste remains at the site. In addition, the LUC restricting the use of groundwater to environmental monitoring and testing only, will remain in place until the contaminated groundwater attains groundwater cleanup standards/levels in order to prevent human exposure to the contaminated groundwater. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that surface soil and subsurface soil meet unrestricted use criteria.

Groundwater monitoring will be conducted to confirm that COC and by-product contaminant concentrations in the groundwater plume are declining through treatment and natural processes and that Harrison Bayou is protected from groundwater seeps that fail to attain groundwater cleanup standards/levels. In situ bioremediation and biobarriers constitute treatment measures designed to reduce the COCs and by-products contaminant mass, and protect Harrison Bayou from contaminant and by-product contaminant seeps that would cause Harrison Bayou surface water to exceed Texas Surface Water Quality Standards. Monitoring will continue until it is demonstrated that groundwater has achieved the cleanup standards.

The selected remedies employing treatment will significantly reduce contaminant concentrations. The remedies employing treatment along with MNA will ultimately restore the groundwater to attain groundwater cleanup standards/levels. The performance of natural attenuation will be evaluated by 2 years of monitoring using data acquired from quarterly results. If MNA is not successful, the active remedies will be re-implemented, in part or in whole, based on evaluation of site data available at that time.

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

Alternative 7 is readily implementable and no significant short-term risks to worker health and safety or to the community would be expected. The present worth cost of Alternative 7 is lower than the other remedial alternatives except for Alternative 1, the no further action alternative.

Based on the information currently available, the U.S. Army believes that the selected alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the CERCLA §121(b) criteria used to evaluate remedial alternatives. The selected alternative will 1) be protective of human health and the environment; 2) comply with ARARs; 3) be cost-effective; 4) utilize permanent solution; and 5) utilizes treatment as a principal element.

The U.S Army will present details of the in situ bioremediation and biobarrier implementation, groundwater and surface water monitoring plan, LUCs implementation plan, and the MNA remedy implementation in a remedial design for LHAAP-16.

2.12.2 Description of the Selected Remedy

The selected remedy, Alternative 7, was outlined in **Section 2.9**; that description is expanded in the following discussion. The remedy may undergo modifications as a result of the RD and construction processes. Modifications of 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 remedy and the contingency remedies include:

- *Cap Maintenance*. The existing cap was designed as a standard RCRA-style multilayer cap. The current cap meets USEPA performance standards established for hazardous waste landfill closure and post-closure care. Therefore, the current cap will not be modified as part of this alternative. Further, consistent with the requirements described in the 1995 ROD for LHAAP-16 establishing an interim remedial action for the site to mitigate potential risks posed by buried landfill waste, the existing cap will continue to be monitored, maintained, and repaired, as necessary, to preserve its long-term effectiveness. This includes inspections of the landfill to check for erosion, settlement, and deep-rooted vegetation and implementation of necessary repairs. Routine maintenance and repair of the cap will include actions needed to preserve the integrity of the cap (e.g., mowing, seeding, and settlement/erosion repair). Post-closure requirements identified as ARARs in the IRA ROD are considered appropriate and relevant and include 40 CFR 264.228 (b)(1), (3), and (4), 264.310 (b)(1), (3), (4) and (5) and 30 TAC 335.174.

- *Land Use Control*. The LUCs will prohibit access to the contaminated groundwater except for environmental monitoring and testing only, will preserve the integrity of the landfill cap and restrict intrusive activities (e.g., digging) that would degrade or alter the cap, and restrict land use to nonresidential. The landfill LUCs will remain in place as long as the landfill waste remains at the site. The LUCs restricting the use of groundwater to environmental monitoring and testing only will remain in place until the contaminated groundwater attains groundwater cleanup levels in order to prevent human exposure to the contaminated groundwater. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that the contaminated surface soil and subsurface soil meet unrestricted use criteria. LUCs 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 LUCs. The boundary of the LUCs would enclose the site boundaries and the plume boundaries shown on **Figure 2-3**.

The U.S. Army would be responsible for implementation, maintenance, inspection, reporting on, and enforcement of the LUCs. 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 LUCs 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 the protectiveness of the selected remedy. In the event that TCEQ and/or EPA and the Army agree with respect to any significant modification of the selected remedy, including the LUCs component of the selected remedy, the remedy will be changed consistent with the FFA and 40 C.F.R. §300.435(c)(2) . The U.S. Army shall retain the ultimate responsibility for remedy integrity as provided in the 1991 FFA.

LUCs implementation and maintenance actions would be described in the RD for LHAAP-16. The LUCs would be included in the property transfer documents and a recordation of them would be filed in the Harrison County Courthouse. The LUCs will prevent human exposure to groundwater contaminated with chlorinated solvents, metals, and perchlorate through the prohibition of groundwater use (except for environmental monitoring and testing) and require cap protection and maintenance. The groundwater LUCs shall be maintained until there is no further threat of releases of contaminated groundwater into the surface water and the concentrations of contaminants and by-product (daughter) contaminants have been reduced to below their respective MCLs under the SDWA to allow unrestricted use and unlimited exposure at LHAAP-16. In addition, within 90 days of signature of this ROD, the U.S. Army shall request the Texas Department of Licensing and Regulation to notify well drillers of groundwater use prohibitions based on a preliminary LUC boundary. Within one year of signature of this ROD, the Army shall: 1) request the Texas Department of Licensing and Regulation to notify well drillers of the final boundary of groundwater use prohibitions; and 2) notify the Harrison County Courthouse of the LUCs to include a map showing the area of groundwater use prohibition at the site, in accordance with 30 TAC 335.565. The landfill LUCs will remain in place as long as the landfill waste remains at the site. The LUCs restricting the use of groundwater to environmental monitoring and testing only will remain in place until the contaminated groundwater attains groundwater cleanup levels in order to prevent human exposure to the contaminated groundwater. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that the contaminated surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

Monitoring activities associated with the LUCs would be undertaken to confirm that groundwater is not being used and the cap is protected and maintained.

Long-term operational requirements under this alternative would include maintenance of the LUCs. Groundwater monitoring will demonstrate no migration of the plume and the eventual reduction of contaminates to levels below cleanup levels.

The need for continued groundwater and surface water monitoring will be evaluated every 5 years during the reviews. Monitoring for metals will be evaluated at the first five year review to determine if any further monitoring for metals is warranted. Sampling frequency and analytical requirements will be presented as an appendix to the RD for LHAAP-16.

- *In Situ Bioremediation*. The desired outcome will be to reduce contaminant mass and lower the contaminant concentrations that reach the biobarrier in the future. Elevated levels of chlorinated ethenes (TCE 1,2-DCE, and VC) have been observed in the shallow groundwater zone downgradient of the landfill cap at LHAAP-16, and will be treated by an addition of a carbon source. Evidence indicates that reductive dechlorination is taking place in the shallow groundwater zone at LHAAP-16, but carbon levels appear to decrease with distance from the landfill itself. Therefore, the addition of a carbon source will further encourage the growth of microorganisms in the subsurface. As the microorganisms multiply, they will consume available respiratory substrates including iron and sulfate. As those respiratory substrates are consumed, conditions are created which are favorable to destruction of chlorinated ethenes via reductive pathways. A bioaugmentation culture (e.g., SDC-9) will also be added to provide a microbial species specifically able to completely degrade TCE to harmless ethene. Injection of the carbon source and bioaugmentation culture into the shallow zone will be accomplished utilizing DPT, and into the intermediate zone by injection through the existing wells. The number of DPT injection points and the injection volumes will be finalized at that time. The design effort will consider optional injection patterns. Once the carbon source and the bioaugmentation culture have been injected into the subsurface, reducing conditions will be created, followed by a significant reduction in chlorinated ethene concentrations.

  The natural attenuation rates measured for TCE showed half-lives ranging from less than 2 years to more than 25 years. Half-lives measured for TCE daughter by-products (cis-1,2-DCE and VC) and perchlorate were much faster, so the attenuation rate of TCE determines the time to reach cleanup goals. The application of in situ bioremediation is expected to reduce the half-life for TCE to between 2 and 5 years, thus accelerating remediation in the treatment area.

- *Biobarriers.* The purpose of the biobarriers (in conjunction with natural attenuation) is to reduce groundwater concentrations to levels that will not cause surface water to exceed surface water standards, to control potential migration of contaminants from the landfill, and to reduce groundwater contaminant mass. A biobarrier will be installed in the downgradient portion of the contaminant plume to prevent contaminated groundwater from seeping into Harrison Bayou at concentrations that would cause surface water to exceed Texas Surface Water Quality Standards, SDWA MCL standards and Texas MSC for GW-Res standards. A second biobarrier will be installed at the edge of the landfill between 16WW38 and 16WW13 to control potential migration of VOCs from the landfill. Specifically, a row of injection points perpendicular to groundwater flow direction will be installed down-gradient of the shallow monitoring well close to Harrison Bayou (16WW12). The biobarrier will consist of emulsified oil that will enable ambient microorganisms to create favorable conditions and a bioaugmentation culture (e.g., SDC-9) to provide microbial species able to completely degrade TCE to ethene. The emulsified oil is a slow-release carbon source with an enhanced subsurface longevity; it will be injected to provide a long-lasting source of fermentable carbon to stimulate the biological reduction of perchlorate and TCE and its daughter products. Sufficient emulsified oil will be added to each injection point to provide a sustained carbon source for an estimated 3 to 5 years. Follow-up injections will be conducted if deemed necessary from the performance groundwater monitoring results. COC and by-product concentrations will be reduced as contaminated groundwater flows through the biobarrier. Concentrations of COCs and by-product downgradient of the biobarriers will be monitored to evaluate the continuing effectiveness of the biobarriers.

- *MNA to return groundwater to its potential beneficial use, wherever practicable.* A preliminary MNA evaluation demonstrated that natural attenuation is occurring in some areas at LHAAP-16. The attenuation of perchlorate, TCE, 1,2-DCE, VC, and 1,1-DCE have been observed at the source and side-downgradient of the plume. However, the shallow groundwater zone plume is still migrating along the groundwater flow direction toward Harrison Bayou. The intermediate groundwater zone plume is more stable with less migration along the flow direction. Thus, natural attenuation is a feasible remedy for certain portions of the site but not as a sole remedy for the entire plume due to migration concerns for the shallow zone. Therefore, MNA is proposed for LHAAP-16 in conjunction with in situ bioremediation to enhance reductive dechlorination within the groundwater plume. Biobarriers will prevent the seepage of contaminants and by-product contaminants into surface water (i.e. Harrison Bayou). 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 2 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, the 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 consideration of plume stability, the USEPA lines of evidence (USEPA, 1999) and the anaerobic screening (USEPA, 1998) as follows:

    - 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 potential based on evaluation biodegradation screening scores using USEPA guidance

    - 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 involving in situ bioremediation to reach the RAOs if MNA is found to be ineffective.* The contingency remedy will use reapplication of bio-amendments (i.e. additional in situ bioremediation) 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 the 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. LTM will be implemented at a frequency of semiannual for 3 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 to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen.* The results from monitoring will be reviewed during the five-year review. Unless otherwise indicated by the data, the wells will then be sampled at each five-year review. .

- *Groundwater and Surface Water Monitoring.* Groundwater monitoring will continue at LHAAP-16 to evaluate the effectiveness of the cap, confirm the decrease in COC concentrations within the groundwater plume, and to protect surface water in Harrison Bayou from the seepage of contaminated groundwater that would prevent Harrison Bayou from attaining the surface water standards for those contaminants. Following completion of the MNA evaluation, groundwater and surface water monitoring will continue at a number of locations. The monitoring program will be established during remedial design. Following the MNA evaluation, sampling will be conducted semi-annually for 3 years. Surface water and wells will then be sampled annually until the next five-year review and every 5 years thereafter unless otherwise indicated by the data.

- *Long-Term Operations.* Long-term operations will include maintenance of the landfill cap, maintenance of LUCs, and groundwater and surface water monitoring. Additional injections (approximately every 5 years) of vegetable oil may be required at the biobarriers to provide continued treatment effectiveness. LUCs include activities to protect the integrity of the landfill cap and to restrict groundwater use at the site. Groundwater use restrictions will remain in place until groundwater COC and by-product contaminant concentrations drop to levels below the SWDA MCLs and Texas MSCs for GW-Ind, and support unrestricted use of the groundwater. Groundwater and surface water monitoring will be implemented at least every 5 years. Monitoring will continue until the sampling data demonstrate that there are no releases or threat of releases of contaminated groundwater into Harrison Bayou at levels that would cause surface water to exceed the Texas Surface Water Quality Standards, the SDWA MCLs, and Texas MSCs for GW-Res for the COCs and by-product COCs that are present..

2.12.3 Cost Estimate for the Selected Remedy

Table 2-9 presents the present worth analysis of the cost for the selected remedy, Alternative 7. 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. Modifications 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 $1,980,000, using a discount rate of 2.7%. The capital cost is estimated at $390,000. The total O&M present value cost is estimated at approximately $1,590,000. The O&M cost includes evaluation of MNA, maintenance of the cap, maintenance of LUCs, two additional emulsified vegetable oil injections subsequent to the initial implementation of the barrier, and LTM through Year 30. The LTM will support the required CERCLA five-year reviews.

2.12.4 Expected Outcomes of Selected Remedy

The purpose of this response action is to attain the RAOs stated in Section 2.8 of this ROD. The groundwater will be restored to attain groundwater cleanup standards/levels, to the extent practicable. With respect to the COCs and by-product contaminants found in the groundwater at the site, the groundwater cleanup standards/levels include attainment of the SDWA MCL for those COCs and by-product (i.e., daughter) contaminants that have a MCL, to the extent practicable, consistent with 40 C.F.R. § 300.430(e)(2)(i)(B & C). Because no SDWA MCL exists for some COCs and by-product contaminants including perchlorate, manganese and nickel, the MSCs (GW-Ind) as authorized under 30 TAC 335.559(d) constitutes the groundwater cleanup standard to be attained (Table 2-7). Surface water standards in surface waters impacted by the contaminated groundwater seeps at LHAAP will be protected as well. The Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available the Texas MSCs (GW-Res) as authorized under 30 TAC 335.559(b), constitute the surface water standards in Harrison Bayou.

The expected outcome of the selected remedy is that the contaminants and by-product contaminants in the groundwater will be reduced to attain the SDWA MCLs and Texas MSCs for GW-Ind, and that any groundwater seeping into Harrison Bayou will be at concentrations that do not result in exceedances of the Texas Surface Water Quality Standards for the COCs and by-product COCs. Achievement of the groundwater cleanup standards/levels is anticipated to be completed in approximately 280 years. This approximate timeframe to achieve cleanup levels is considered reasonable for the anticipated future land use as a national wildlife refuge. The actual time frame depends on the success of the active remediation, but, for cost estimating purposes, it is assumed that five-year reviews will continue until Year 30. When the groundwater cleanup levels have been attained, the groundwater LUC restriction will be removed. However, the LUCs to protect the landfill remedy will remain in place as long as the landfill waste remains at the site. The nonresidential use LUC will remain in place until the contaminated surface soil and subsurface soil attain cleanup standards/levels that support unlimited use and unrestricted exposure. In the short-term (prior to the groundwater achieving MCLs), 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 MCLs).

In addition, the monitoring activities associated with MNA will confirm 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. The groundwater LUCs will remain in place until groundwater COC and by-product contaminant concentrations drop to levels below the SDWA MCLs and Texas MSCs. The groundwater LUC will prohibit the use of the site's groundwater except for environmental monitoring and testing.

As part of the evaluation of MNA, attenuation rates are computed and evaluated in accordance with the USEPA guidance material (USEPA, 1998). Time-dependent attenuation rate constants and estimated in-well cleanup times are determined based on COC concentration data over time from individual wells assuming first order degradation kinetics. Attenuation rates are calculated for the monitoring wells with the highest concentrations for which the available data allow such a calculation. Attenuation rates are based on the following formula from the USEPA guidance (USEPA, 1998):

$$C = C_o e^{-kt}$$

where: C = concentration at time t
C_o = initial concentration
k = attenuation rate constant (first order reaction).

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 reduces 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 7 will achieve the RAOs for LHAAP-16 by protecting human health from exposure to landfill waste and contaminated groundwater, reducing the COC and by-product contaminant concentrations within the groundwater plume to attain groundwater cleanup standards/levels, and reducing surface water quality impacts to Harrison Bayou such that surface water standards/levels for COCs and by-products are not exceeded. LUCs and continued maintenance of the existing cap would ascertain that receptors are not exposed to landfill contents or contaminated groundwater. Notification of LUCs would be recorded with Harrison County. Upon transfer of the land to another federal agency (e.g., the USFWS), the LUCs would be incorporated into the transferee's land management program. If LHAAP-16 is transferred out of federal control, restrictions would be required to address prohibitions and/or restrictions concerning property uses (e.g., drinking water well installation) in order to prevent exposure to landfill material or contaminated groundwater. The LUCs associated with the contaminated groundwater would be required while the COC and by-product contaminants attained the SDWA MCLs and Texas MSCs for GW-Ind.

The cap is considered an effective means of source control to reduce contamination entering the groundwater via prevention of surface water infiltration. In situ bioremediation would reduce the mass of contamination in the heart of the shallow groundwater plume and in specific target areas within the intermediate groundwater zone. The biobarriers would prevent the eastward migration of COCs in the shallow groundwater. Natural attenuation would also reduce the COC concentrations in both the shallow and intermediate groundwater plumes over time, thereby reducing the potential risk of human exposure. A MNA program would be implemented to verify the effectiveness of monitored natural attenuation following shutdown of the extraction wells and completion of the in situ bioremediation. Further monitoring would be used to evaluate contaminant and by-product contaminant migration, confirm that the COCs and by-product (daughter) contaminants in the groundwater plumes continue to degrade , and verify that contaminant and by-product contaminant concentration levels in Harrison Bayou do not exceed the in-stream standards/levels of the Texas Surface Water Quality Standards, SDWA MCLs and Texas MSCs for GW-Res standards. The eventual groundwater concentration remedial action objective is the return of groundwater to its potential beneficial uses as drinking water, wherever practicable. Achievement of this RAO will be measured by attainment of the SDWA MCLs and Texas MSCs for GW-Ind for all COCs.

A site-wide ecological baseline risk assessment has been performed for LHAAP. As noted in **Section 2.7.3**, no action is required to address soil concentrations outside the landfill to protect ecological receptors at LHAAP-16. Therefore, ecological risks can be controlled by preventing contact with contents of the landfill. Maintenance of the existing cap and enforcement of LUCs will achieve that objective.

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 2-10**.

Chemical-Specific ARARs

The chemical-specific ARAR is the attainment of the SDWA MCL for all groundwater COCs and by-product contaminants. For those COCs and by-product contaminants that do not have an MCL, the Texas MSCs for GW-Ind as authorized under 30 TAC 335.559(d) constitutes the groundwater chemical-specific ARAR to be attained. The selected remedial action employs treatment including in situ bioremediation and biobarriers, and passive remedial action (i.e., MNA) to return the contaminated shallow and intermediate groundwater zone at LHAAP-16 to its potential beneficial use as drinking water, wherever practicable. For the purposes of this ROD attainment of the SDWA MCLs or the Texas MSC for GW-Ind if no MCL is available, constitutes a return of the contaminated groundwater to it potential beneficial use as a drinking water. If a return to potential beneficial uses is not practicable based upon 40 C.F.R.§ 300.430(f)(1)(ii)(C), this alternative would still meet the NCP remedy selection requirements by reducing or controlling exposure to the contaminated groundwater consistent with 40 C.F.R.§ 300.430(e)(9). With respect to the surface waters impacted by the contaminated groundwater seeping into Harrison Bayou, the Texas Surface Water Quality Standards (in-stream) found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available the Texas MSCs for GW-Res as authorized under 30 TAC 335.559(b), constitute the surface water standards confirming protectiveness of the remedy.

Location-Specific ARARs

The activities that will be conducted under this alternative will comply with location-specific ARARs.

Action-Specific ARARs

The selected remedy has potential action-specific ARARs related to the following activities: site preparation, construction, and excavation activities; waste management activities, well construction and post closure care.

- **Site preparation, construction, and excavation activities**: Certain on-site preparation, construction, and/or excavation activities will be necessary under all remediation actions to prepare the site for remediation, including the soil-moving or site-grading activities. Storm water discharges from construction activities that disturb equal to or greater than one acre of land must comply with the substantive requirements of a USEPA National Pollutant Discharge Elimination System (NPDES) general permit (40 CFR 122.26; 30 TAC 205, Subchapter A; and 30 TAC 308.121), depending on the amount of acreage disturbed. Substantive requirements include implementation of good construction management techniques; phasing of large construction projects; minimal clearing; and sediment, erosion, structural, and vegetative controls to mitigate runoff and satisfy discharge requirements.

- **Waste Management**: 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 wastes must be managed in accordance with the ARARs for waste management listed in **Table 2-10** 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 or extraction 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-16 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.

- **Post-closure Care**: Closure and post- closure ARARs were identified for LHAAP-16 in the IRA ROD and included 30 TAC 335.112, 335.118, 335.119 and 335.174 and 40 CFR Sections 264.228 and264.310 addressing landfills and surface impoundments storing hazardous waste. Closure requirements were met during implementation of the (cap) presumptive remedy of the IRA. Post-closure requirements are appropriate and relevant and include 40 CFR 264.228 (b)(1), (3), and (4), 264.310 (b)(1), (3), (4) and (5) and 30 TAC 335.174.

2.13.3 Cost-Effectiveness

Alternative 7 has the lowest present worth and capital costs of the action alternatives that were evaluated in the FS (Jacobs, 2002) and FS Addendum (Shaw, 2010). Alternative 7 utilizes active technologies (in situ bioremediation and biobarriers) prior to MNA; those active technologies lead to much lower monitoring costs in the future, thus giving Alternative 7 a relatively low total present value cost. **Table 2-9** is the cost estimate summary table for the selected remedy.

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

The U.S. Army has determined that the selected final remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site. In situ bioremediation will lower groundwater COC concentrations in the most contaminated portion of the groundwater plume. Biobarriers between the landfill and Harrison Bayou will provide additional reduction of COC concentrations in the groundwater through degradation by biological processes prior to seeping into Harrison Bayou. The active biodegradation that occurs as part of the natural attenuation, together with dilution, dispersion, and other natural processes has the capability to ultimately reduce the groundwater contaminants to cleanup levels. Although none of the landfill waste will be actively treated, the long-term reliability of the landfill cap to control infiltration, contaminant runoff, and contaminant exposure depends on adequate long-term inspection and maintenance. If a portion of the cap is breached and contaminants subsequently leach into the groundwater, the biobarrier would capture the additional contamination. However, the breach would need to be corrected in a reasonable time frame, and the increased groundwater contaminant loading would increase the frequency of bioremediation amendment injections at the biobarrier.

Alternative 7 would provide almost immediate protection because the LUCs would be implemented relatively quickly. Maintenance of this control would be required until natural attenuation processes reduce COC and by-product (daughter) contaminant concentrations to below cleanup levels.

2.13.5 Preference for Treatment as a Principal Element

The selected remedy satisfies the statutory preference for treatment as a principal element of the remedy. The selected final remedy will reduce the toxicity, mobility, or volume of COCs in groundwater through the implementation of in situ bioremediation and biobarriers. The in situ bioremediation will lower COC concentrations in the most contaminated portion of the shallow groundwater plume to levels that can be effectively treated by the biobarrier near Harrison bayou. The biological activity in the biobarriers and the bioremediation treatment area will significantly reduce the overall mass of COCs in the groundwater. In conjunction with natural attenuation, these treatments will convert the COCs to innocuous byproducts, thereby reducing the toxicity of the contaminants. In addition, natural attenuation will provide a reduction in the volume of contaminated groundwater. Although none of the landfill waste will be actively treated, the potential mobility and toxicity of the landfill waste contaminants will be minimized through proper landfill cap maintenance, and the biobarrier near the landfill fence line.

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 this remedy will result in contaminants that remain onsite above levels that allow unlimited use and unrestricted exposure, a review will be conducted at least every 5 years to ascertain 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-16 was released for public comments on October 10, 2010. The Proposed Plan identified Alternative 7 as the Preferred Alternative for groundwater remediation. The U.S. Army reviewed all written comments during the public comment period (there were no verbal comments). 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 Potential Concern
and Medium-Specific Exposure Point Concentrations

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil (0 to 5.0 feet below ground surface)

Exposure Point	Chemical	Concentration Detected[1] (mg/kg)		Number of Samples with Detectable Conc.	Exposure Point Concentration (mg/kg)	Statistical Measure
		Minimum	Maximum			
Incidental ingestion, inhalation of particulates, inhalation of volatiles, dermal contact	Metals					
	Aluminum	4.52E+03	2.15E+04	20	2.15E+04	maximum
	Antimony	4.8E-01	4.8E-01	1	1.64E+00	95% UCL
	Arsenic	1.43E+00	1.44E+01	36	7.44E+00	95% UCL
	Barium	4.67E+01	3.84E+02	34	1.72E+02	95% UCL
	Beryllium	3.80E-01	1.4E+00	9	1.4E+00	maximum
	Cadmium	5.10E-01	8.60E-01	4	5.70E-01	95% UCL
	Chromium	7.80E+00	4.09E+01	40	2.27E+01	95% UCL
	Cobalt	2.80E+00	1.98E+01	19	1.98E+01	maximum
	Copper	3.40E+00	1.05E+01	14	9.17E+00	95% UCL
	Lead	3.02E+00	4.93E+01	41	1.81+01	95% UCL
	Manganese	2.92E+01	1.27E+03	20	1.27E+03	maximum
	Mercury	2.00E-02	6.20E-02	7	7.00E-02	95% UCL
	Nickel	4.10E+00	1.73E+01	29	1.18E+01	95% UCL
	Selenium	6.10E-01	1.40E+00	6	7.40E-01	95% UCL
	Silver	5.50E-01	5.50E-01	1	6.9E-01	95% UCL
	Strontium	2.4E+00	6.27E+01	14	6.27E+01	maximum
	Thallium	1.80E-01	5.96E+00	8	1.18+00	95% UCL
	Vanadium	1.43E+01	4.33E+01	9	4.33E+01	maximum
	Zinc	1.19E+01	1.68E+02	20	7.92E+01	95% UCL
	Semivolatile Organics					
	Butyl Benzyl Phthalate	9.60E-01	9.60E-01	1	3.32E-01	95% UCL
	Di-N-Butyl Phthalate	1.60E+00	1.90E+00	8	6.75E-01	95% UCL
	Volatile Organics					
	Acetone	2.20E-02	1.03E-01	4	1.60E-02	95% UCL
	Methylene Chloride	5.00E-03	1.00E-02	3	6.40E-03	95% UCL
	Styrene	2.00E-03	9.30E-02	2	8.10E-03	95% UCL
	Trichloroethene	6.50E-02	2.20E-01	4	1.10E-02	95% UCL

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

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical	Concentration Detected[1] (µg/L)		Number of Samples with Detectable Conc.	Exposure Point Concentration (µg/L)	Statistical Measure
		Minimum	Maximum			
Incidental ingestion, inhalation of volatiles, dermal contact	*Explosive*					
	1,3-Dinitrobenzene	3.29E-01	1.56E+00	18	1.56E+00	maximum
	2,4,6-Trinitrotoluene	9.00E-01	1.56E+00	3	2.40E+02	maximum[a]
	4-Amino-2,6-Dinitrotoluene	5.90E-02	1.00E+00	18	1.00E+00	maximum
	2,6-Dinitrotoluene	4.50E-02	2.63E-01	10	2.63E-01	maximum
	HMX	1.20E-01	2.90E+00	2	2.90E+00	maximum
	Nitrobenzene	6.20E-02	1.50E+00	8	2.00E+01	maximum[a]
	3-Nitrotoluene	2.00E-01	1.00E+00	3	1.10E+01	maximum[a]
	Tetryl	3.49E-01	4.40E+00	3	3.60E+01	maximum[a]
	RDX	2.70E-01	4.75E+00	15	2.00E+02	maximum[a]
	1,3,5-Trinitrobenzene	3.02E-01	7.40E-01	3	2.20E+00	maximum[a]
	Metals					
	Aluminum	1.10E+02	6.70E+04	34	6.70E+04	maximum
	Arsenic	7.00E+00	3.40E+01	24	3.40E+01	maximum
	Barium	1.70E+01	9.90E+03	78	9.90E+03	maximum
	Beryllium	6.00E-01	7.40E+00	6	7.40E+00	maximum
	Cadmium	1.10E+00	5.45E+00	7	8.00E+00	maximum[a]
	Chromium	1.00E+01	5.22E+03	52	5.22E+03	maximum
	Cobalt	5.30E+01	1.10E+03	4	1.10E+03	maximum
	Copper	2.10E+01	4.84E+02	19	4.84E+02	maximum
	Lead	3.00E+00	5.70E+01	14	2.00E+02	maximum[a]
	Manganese	1.50E+01	2.98E+04	50	2.98E+04	maximum
	Mercury	2.00E-01	8.60E-01	12	1.60E+00	maximum[a]
	Nickel	1.50E+01	1.63E+03	45	1.63E+03	maximum
	Selenium	7.00E+00	1.56E+01	8	1.56E+01	maximum
	Silver	1.40E+01	1.14E+02	4	1.14E+02	maximum
	Strontium	5.80E+01	1.04E+04	51	1.04E+04	maximum
	Thallium	1.20E+01	1.20E+01	1	1.20E+01	maximum
	Vanadium	9.70E+01	1.46E+02	3	1.46E+02	maximum
	Zinc	2.10E+01	3.70E+04	26	3.70E+04	maximum
	Pesticides					
	Aldrin	4.00E-02	4.00E-02	1	4.00E-02	maximum
	Semivolatile Organics					
	Bis(2-ethylhexyl)phthalate	1.10E+01	2.60E+01	5	2.60E+01	maximum
	Butyl Benzyl Phthalate	5.00E+00	7.00E+00	3	7.00E+00	maximum

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

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical	Concentration Detected[1] (µg/L) Minimum	Concentration Detected[1] (µg/L) Maximum	Number of Samples with Detectable Conc.	Exposure Point Concentration (µg/L)	Statistical Measure
Incidental ingestion, inhalation of volatiles, dermal contact	*Volatile Organics*					
	Acetone	1.00E+01	3.92E+03	4	3.92E+03	maximum
	Benzene	8.30E-01	5.00E+00	4	5.00E+00	maximum
	Bromodichloromethane	1.10E+00	8.40E+00	3	8.40E+00	maximum
	2-Butanone	6.50E+00	6.50E+00	1	3.40E+01	maximum[a]
	Chloroform	5.20E-01	3.60E+01	21	1.20E+02	maximum
	1,1-Dichloroethane	6.00E-01	3.60E+01	4	3.60E+01	maximum
	1,1-Dichloroethene	9.90E-01	7.40E+02	16	7.40E+02	maximum
	1,2-Dichloroethane	2.20E+01	1.60E+02*	6	1.60E+02	maximum
	1,2-Dichloroethene	1.60E+01	2.75E+05	11	2.75E+05	maximum
	cis-1,2-Dichloroethene	5.20E-01	2.70E+05	53	5.20E+05	maximum[a]
	1,1,2-Trichloroethane	1.20E+01	1.20E+01	1	1.20E+01	maximum
	Ethylbenzene	5.00E+00	5.00E+00	1	5.00E+00	maximum
	Methylene chloride	5.6E-01*	3.50E+03	16	3.50E+03	maximum
	Toluene	2.90E+01	2.90E+01	1	2.90E+01	maximum
	Trichloroethene	8.40E-01	5.8E+04*	104	1.60E+05	maximum[a]
	Trichlorofluoromethane	8.00E-01	8.92E+02	2	8.92E+02	maximum
	1,2,4-Trimethylbenzene	6.80E-01	2.40E+01	2	2.40E+01	maximum
	1,3,5-Trimethylbenzene	1.60E+01	1.60E+01	1	1.60E+01	maximum
	Vinyl Chloride	4.80E+00	1.10E+04	17	1.10E+04	maximum
	Xylene	8.00E-01	1.20E+01	2	1.20E+01	maximum

Notes
[1] Minimum/maximum detected concentration above the reporting limit
* Maximum concentration was from a duplicate sample collected during the sampling event
[a] Maximum detected concentration from a grab sample
---: No information available
µg/L micrograms per liter
HMX high melting explosives
mg/kg milligrams per kilogram
RDX 1,3,5-Trinitroperhydro-1,3,5-triazine
UCL upper confidence limit

References

Jacobs Engineering Group, Inc. (Jacobs), 2001, *Final Baseline Risk Assessment Human Health Evaluation, Site 16 Landfill remedial Investigation/Feasibility Study, Longhorn Army Ammunition Plant, Karnack, Texas*, Final, 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, 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, 2001a).

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
Explosive				
1,3-Dinitrobenzene	---	---	---	---
2,4,6-Trinitrotoluene	3.00E-02	3.00E-02	--	USEPA-IRIS, 1999
4-Amino-2,6-Dinitrotoluene	1.00E-02	1.00E-02	---	TNRCC, 2000
2,6-Dinitrotoluene	6.80E-01	6.80E-01	---	USEPA-IRIS, 1999
HMX	---	---	---	---
Nitrobenzene	---	---	---	---
3-Nitrotoluene	---	---	---	---
Tetryl	---	---	---	---
RDX	1.10E-01	1.10E-01	---	USEPA-IRIS, 1999
1,3,5-Trinitrobenzene	---	---	---	---
Metals				
Aluminum	---	---	---	---
Antimony	---	---	---	---
Arsenic	1.50E+00	5.00E+00	---	USEPA-IRIS, 1999
Barium	---	---	---	---
Beryllium	---	---	---	---
Cadmium	---	---	---	---
Chromium	---	---	---	---
Cobalt	---	---	---	---
Copper	---	---	---	---
Lead	---	---	---	---
Manganese	---	---	---	---
Mercury	---	---	---	---
Nickel	---	---	---	---
Selenium	---	---	---	---
Silver	---	---	---	---
Strontium	---	---	---	---
Thallium	---	---	---	---
Vanadium	---	---	---	---
Zinc	---	---	---	---
Pesticides				
Aldrin	1.70E+01	1.70E+01	--	USEPA-IRIS, 1999
Semivolatile Organics				
Bis(2-ethylhexyl)phthalate	1.40E-02	1.40E-02	--	USEPA-IRIS, 1999
Butyl Benzyl Phthalate	---	---	---	---
Di-N-Butyl Phthalate	---	---	---	---
Volatile Organics				
Acetone	---	---	---	---
Benzene	2.90E-02	2.90E-02	--	USEPA-IRIS, 1999
Bromodichloromethane	6.20E-02	6.20E-02		USEPA-IRIS, 1999
2-Butanone (MEK)	---	---	---	---
Chloroform	6.10E-03	6.10E-03	--	USEPA-IRIS, 1999

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

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
1,1-Dichloroethane	---	---	---	---
1,1-Dichloroethene	6.00E-01	6.00E-01	--	USEPA-IRIS, 1999
1,2-Dichloroethane	9.10E-02	9.10E-02	--	USEPA-IRIS, 1999
1,2-Dichloroethene	---	---	---	---
cis-1,2-Dichloroethene	---	---	---	---
1,1,2-Trichloroethane	5.70E-02	5.70E-02	--	USEPA-IRIS, 1999
Ethylbenzene	---	---	---	---
Methylene chloride	7.50E-03	7.50E-03	--	USEPA-IRIS, 1999
Styrene	---	---	---	---
Toluene	---	---	---	---
Trichloroethene	1.10E-02	1.10E-02	--	USEPA-NCEA, 1999
Trichlorofluoromethane	---	---	---	---
1,2,4-Trimethylbenzene	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---
Vinyl Chloride	1.90E+00	1.90E+00	--	USEPA-HEAST, 1997
Xylene	---	---	---	---

Pathway: Inhalation

Chemical of Concern	Unit Risk Factor (µg/m3)	Inhalation Cancer Slope Factor (mg/kg-day)	Weight of Evidence/ Carcinogen Guideline Description	Source/Date
Explosive				
1,3-Dinitrobenzene	---	---	---	---
2,4,6-Trinitrotoluene	---	---	---	---
4-Amino-2,6-Dinitrotoluene	---	---	---	---
2,6-Dinitrotoluene	---	---	---	---
HMX	---	---	---	---
Nitrobenzene	---	---	---	---
3-Nitrotoluene	---	---	---	---
Tetryl	---	---	---	---
RDX	---	---	---	---
1,3,5-Trinitrobenzene	---	---	---	---
Metals				
Aluminum	---	---	---	---
Antimony	---	---	---	---
Arsenic	4.30E-03	1.50E+01	---	USEPA-IRIS, 1999
Barium	---	---	---	---
Beryllium	2.40E-03	8.40E+00	--	USEPA-IRIS, 1999
Cadmium	1.80E-03	6.30E+00	--	USEPA-IRIS, 1999
Chromium	1.20-E02	4.20+01	---	USEPA-IRIS, 1999
Cobalt	---	---	---	---
Copper	---	---	---	---
Lead	---	---	---	---

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

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
Manganese	---	---	---	---
Mercury	---	---	---	---
Nickel	---	---	---	---
Selenium	---	---	---	---
Silver	---	---	---	---
Strontium	---	---	---	---
Thallium	---	---	---	---
Vanadium	---	---	---	---
Zinc	---	---	---	---
Pesticides				
Aldrin	4.90E-03	1.72E+01	--	USEPA-IRIS, 1999
Semivolatile Organics				
Bis(2-ethylhexyl)phthalate	---	---	---	---
Butyl Benzyl Phthalate	---	---	---	---
Di-N-Butyl Phthalate	---	---	---	---
Volatile Organics				
Acetone	---	---	---	---
Benzene	7.80E-06	2.70E-02	--	USEPA-IRIS, 1999
Bromodichloromethane	---	---	---	---
2-Butanone (MEK)	---	---	---	---
Chloroform	2.30E-05	8.10E-02	--	USEPA-IRIS, 1999
1,1-Dichloroethane	---	---	---	---
1,1-Dichloroethene	5.00E-05	1.80E-01	--	USEPA-IRIS, 1999
1,2-Dichloroethane	2.60E-05	9.10E-02	--	USEPA-IRIS, 1999
1,2-Dichloroethene	---	---	---	---
cis-1,2-Dichloroethene	---	---	---	---
1,1,2-Trichloroethane	1.60E-05	5.60E-02	--	USEPA-IRIS, 1999
Ethylbenzene	---	---	---	---
Methylene chloride	4.70E-07	1.65E-03	--	USEPA-IRIS, 1999
Styrene	---	---	---	---
Toluene	---	---	---	---
Trichloroethene	1.70E-06	5.95E-03	--	---
Trichlorofluoromethane	---	---	---	---
1,2,4-Trimethylbenzene	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---
Vinyl Chloride	---	3.00E-01	--	USEPA-HEAST, 1997
Xylene	---	---	---	---

Notes
--- : No information available
µg/m³: micrograms per cubic meter
HMX: High melting explosives
mg/kg-day: milligrams per kilogram per day
RDX: 1,3,5-Trinitroperhydro-1,3,5-triazine

Weight of Evidence/Carcinogen Guideline Description Information:
Not provided in the Final Baseline Risk Assessment Human Health Evaluation(Jacobs, 2001a)

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

References

Jacobs Engineering Group, Inc. (Jacobs), 2001a, *Final Baseline Risk Assessment Human Health Evaluation for the Site 16 Landfill Remedial Investigation/Feasibility Study, Longhorn Army Ammunition Plant, Karnack, Texas*, Final, June.

Texas Natural Resources Conservation Commission (TNRCC), 2000. Toxicity Factors Table, October 2000.

USEPA-HEAST, 1997, *Health Effects Assessment Summary Tables (HEAST), FY-1997, Update*. Office of Emergency and Remedial Response, USEPA, Washington, D.C. EPA/540/R-97-036, July.

USEPA-IRIS, 1999. Integrated Risk Information System (IRIS). United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 1999.

USEPA-NCEA, USEPA Region 3 Risk-Based Concentration Tables 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 in soil and groundwater. 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, 2001a).

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
Explosive						
1,3-Dinitrobenzene	Chronic	1.00E-04	1.00E-04	Splenic weight	---	USEPA-IRIS, 1999
2,4,6-Trinitrotoluene	Chronic	5.00E-04	5.00E-04	Liver effects	---	USEPA-IRIS, 1999
4-Amino-2,6-Dinitrotoluene	Chronic	1.67E-04	1.67E-04	---	---	TNRCC, 2000
2,6-Dinitrotoluene	Chronic	1.00E-03	1.00E-03	Whole body	---	USEPA-HEAST, 1997
HMX	Chronic	5.00E-02	5.00E-02	Hepatic lesions	---	USEPA-IRIS, 1999
Nitrobenzene	Chronic	5.00E-04	5.00E-04	Hematological effects, adrenal, renal, hepatitis lesions	---	USEPA-IRIS, 1999
3-Nitrotoluene	Chronic	1.00E-02	1.00E-02	Spleen lesions	---	USEPA-HEAST, 1997
Tetryl	Chronic	---	---		---	---
RDX	Chronic	3.00E-03	3.00E-03	Prostate	---	USEPA-IRIS, 1999
1,3,5-Trinitrobenzene	Chronic	3.00E-02	3.00E-02	Increased splenic weight	---	USEPA-IRIS, 1999
Metals						
Aluminum	Chronic	---	---	---	---	---
Antimony	Chronic	4.00E-04	1.20E-04	Whole body	---	USEPA-IRIS, 1999
Arsenic	Chronic	3.00E-04	9.00E-05	Skin, blood vessels	---	USEPA-IRIS, 1999
Barium	Chronic	7.00E-02	2.10E-02	Increased blood pressure	---	USEPA-IRIS, 1999
Beryllium	Chronic	2.00E-03	6.00E-04	Small intestine	---	USEPA-IRIS, 1999
Copper	Chronic	---	---	---	---	---
Cadmium	Chronic	5.00E-04	1.50E-04	Proteinuria	---	USEPA-IRIS, 1999
Chromium	Chronic	1.50E+00	4.50E-01	---	---	USEPA-IRIS, 1999
Manganese	Chronic	1.40E-01	4.20E-02	CNS effects	---	USEPA-IRIS, 1999
Mercury	Chronic	---	---	---	---	---
Nickel	Chronic	2.00E-02	6.00E-03	Body weight	---	USEPA-IRIS, 1999
Selenium	Chronic	---	---	---	---	---
Silver	Chronic	5.00E-03	1.50E-03	Argyria	---	USEPA-IRIS, 1999
Strontium	Chronic	6.00E-01	1.80E-01	Rachitic bone	---	USEPA-IRIS, 1999
Thallium	Chronic	---	---	---	---	---
Vanadium	Chronic	7.00E-03	2.10E-03	---	---	USEPA-HEAST, 1997
Zinc	Chronic	3.00E-01	9.00E-02	---	---	USEPA-IRIS, 1999
Pesticides						
Aldrin	Chronic	3.00E-05	3.00E-05	Liver toxicity	---	USEPA-IRIS, 1999
Semivolatile Organics						
Bis(2-ethylhexyl)phthalate	Chronic	2.00E-02	2.00E-02	Liver	---	USEPA-IRIS, 1999
Butyl Benzyl Phthalate	Chronic	2.00E-01	2.00E-01	Liver	---	USEPA-IRIS, 1999
Di-N-Butyl Phthalate	Chronic	1.00E-01	1.00E-01	Increased mortality		USEPA-IRIS, 1999

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

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
Volatile Organics						
Acetone	Chronic	1.00E-01	1.00E-01	Liver, kidney		USEPA-IRIS, 1999
Benzene	Chronic	---	---	---	---	---
Bromodichloromethane	Chronic	2.00E-02	2.00E-02	Renal cytomegaly	---	USEPA-IRIS, 1999
2-Butanone (MEK)	Chronic	6.00E-01	6.00E-01	Fetal birth weight	---	USEPA-IRIS, 1999
Chloroform	Chronic	1.00E-02	1.00E-02	Liver	---	USEPA-IRIS, 1999
1,1-Dichloroethane	Chronic	1.00E-01	1.00E-01	---	---	USEPA-HEAST, 1997
1,1-Dichloroethene	Chronic	9.00-E03	9.00E-03	Hepatic lesions	---	USEPA-IRIS, 1999
1,2-Dichloroethane	Chronic	---	---	---	---	---
1,2-Dichloroethene	Chronic	2.00E-02	2.00E-02	Blood	---	USEPA-IRIS, 1999
cis-1,2-Dichloroethene	Chronic	1.00E-02	1.00E-02	Blood	---	USEPA-HEAST, 1997
1,1,2-Trichloroethane	Chronic	4.00E-03	4.00E-03	Clinical serum chemistry	---	USEPA-IRIS, 1999
Ethylbenzene	Chronic	1.00E-01	1.00E-01	Liver, kidney	---	USEPA-IRIS, 1999
Methylene chloride	Chronic	6.00E-02	6.00E-02	Liver	---	USEPA-IRIS, 1999
Styrene	Chronic	2.00E-01	2.00E-01	Red blood cells, Liver effects	---	USEPA-IRIS, 1999
Toluene	Chronic	2.00E-01	2.00E-01	Liver, kidney	---	USEPA-IRIS, 1999
Trichloroethene	Chronic	6.00E-03	6.00E-03	NA	---	USEPA-NCEA, 1999
Trichlorofluoromethane	Chronic	3.00E-01	3.00E-01	Whole body (increased mortality)	---	USEPA-IRIS, 1999
1,2,4-Trimethylbenzene	Chronic	5.00E-02	5.00E-02	---	---	TNRCC, 2000
1,3,5-Trimethylbenzene	Chronic	5.00E-02	5.00E-02	---	---	TNRCC, 2000
Vinyl Chloride	Chronic	---	---	---	---	---
Xylene	Chronic	2.00E+00	2.00E+00	Hyperactivity, body weight	---	USEPA-IRIS, 1999

Pathway: Inhalation

Chemical of Concern	Chronic/ Subchronic	Inhalation RfC (mg/m^3)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source/Date
Explosive					
1,3-Dinitrobenzene	Chronic	---	---	---	---
2,4,6-Trinitrotoluene	Chronic	---	---	---	---
4-Amino-2,6-Dinitrotoluene	Chronic	0.0001	---	---	TNRCC, 2000
2,6-Dinitrotoluene	Chronic	---	---	---	---
HMX	Chronic	---	---	---	---
Nitrobenzene	Chronic	0.002	Blood effects	----	USEPA-HEAST, 1997
3-Nitrotoluene	Chronic	---	---	---	---
Tetryl	Chronic	---	---	---	---
RDX	Chronic	---	---	---	---
1,3,5-Trinitrobenzene	Chronic	---	---	---	---
Metals					
Aluminum	Chronic	---	---	---	---

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

Chemical of Concern	Chronic/ Subchronic	Inhalation RfC (mg/m^3)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source/Date
Antimony	Chronic	---	---	---	---
Arsenic	Chronic	---	---	---	---
Barium	Chronic	0.0005	Fetal toxicity	---	USEPA-HEAST, 1997
Beryllium	Chronic	0.00002	Lungs	---	USEPA-IRIS, 1999
Cadmium	Chronic	---	---	---	---
Chromium	Chronic	0.0001	---	---	USEPA-IRIS, 1999
Cobalt	Chronic	---	---	---	---
Copper	Chronic	---	---	---	---
Lead	Chronic	---	---	---	---
Manganese	Chronic	0.00005	Impairment of neurobehavioral function	---	USEPA-IRIS, 1999
Mercury	Chronic	0.0003	Nervous system/neurotoxicity	---	USEPA-IRIS, 1999
Nickel	Chronic	---	---	---	---
Selenium	Chronic	---	---	---	---
Silver	Chronic	---	---	---	---
Strontium	Chronic	---	---	---	---
Thallium	Chronic	---	---	---	---
Vanadium	Chronic	---	---	---	---
Zinc	Chronic	---	---	---	---
Pesticides					
Aldrin	Chronic	---	---	---	---
Semivolatile Organics					
Bis(2-ethylhexyl)phthalate	Chronic	---	---	---	---
Butyl Benzyl Phthalate	Chronic	---	---	---	---
Di-N-Butyl Phthalate	Chronic	---	---	---	---
Volatile Organics					
Acetone	Chronic	---	---	---	---
Benzene	Chronic	---	---	---	---
Bromodichloromethane	Chronic	---	---	---	---
2-Butanone (MEK)	Chronic	1	Decreased fetal birth weight	---	USEPA-IRIS, 1999
Chloroform	Chronic	---	---	---	---
1,1-Dichloroethane	Chronic	0.5	Kidney		USEPA-HEAST, 1997
1,1-Dichloroethene	Chronic	---	---	---	---
1,2-Dichloroethane	Chronic	---	---	---	---
1,2-Dichloroethene	Chronic	0.79	---	---	TNRCC, 2000
cis-1,2-Dichloroethene	Chronic	---	---	---	---
1,1,2-Trichloroethane	Chronic	---	---	---	---
Ethylbenzene	Chronic	1	Developmental toxicity	---	USEPA-IRIS, 1999
Methylene chloride	Chronic	3	Liver	---	USEPA-HEAST, 1997
Styrene	Chronic	1	CNS effects	---	USEPA-IRIS, 1999
Toluene	Chronic	0.4	Neurological effects	---	USEPA-IRIS, 1999
Trichloroethene	Chronic	---	---	---	---
Trichlorofluoromethane	Chronic	0.7	Kidney	---	USEPA-HEAST, 1997
1,2,4-Trimethylbenzene	Chronic	0.125	---	---	TNRCC, 2000

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

Chemical of Concern	Chronic/ Subchronic	Inhalation RfC (mg/m^3)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source/Date
1,3,5-Trimethylbenzene	Chronic	0.125	---	---	TNRCC, 2000
Vinyl Chloride	Chronic	---	---	---	---
Xylene	Chronic	---	---	---	---

Notes

---: No information for a compound with no toxicity value (NTV)

CNS	central nervous system
HMX	high melting explosives
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
RDX	1,3,5-Trinitroperhydro-1,3,5-triazine
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), 2001a, *Final Baseline Risk Assessment Human Health Evaluation for the Site 16 Landfill Remedial Investigation and Feasibility Study, Longhorn Army Ammunition Plant, Karnack, Texas*, Final, June.

Texas Natural Resources Conservation Commission (TNRCC), 2000. Toxicity Factors Table, October 2000.

USEPA-HEAST, 1997, *Health Effects Assessment Summary Tables (HEAST), FY-1997, Update*. Office of Emergency and Remedial Response, USEPA, Washington, D.C. EPA/540/R-97-036, July.

USEPA-IRIS, 1999. Integrated Risk Information System. United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 1999.

Summary of Toxicity Assessment

This table provides non-carcinogenic risk information relevant to the contaminants of concern in both soil and groundwater. The list of chemicals of potential 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, 2001a). The uncertainty factor and modifying factor used in the development of a references dose were not available in the risk assessment evaluation report (Jacobs, 2001a).

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 (particulates)	Inhalation (volatiles)	Dermal	Exposure Routes Total
Soil (0 to 5.0 ft)	Soil and particulates	Incidental ingestion, dermal contact, inhalation of particulates, inhalation of volatiles	*Metals*					
			Arsenic	3.9E-06	5.9E-09		4.2E-06	8.1E-06
			Beryllium		6.2E-10			6.2E-10
			Cadmium		1.9E-10			1.9E-10
			Chromium		5.0E-08			5.0E-08
			Volatile Organics					
			Methylene Chloride	1.7E-11	5.6E-16	3.3E-10	5.4E-11	4.0E-10
			Trichloroethene	4.2E-11	3.5E-15	4.7E-09	1.3E-10	4.87E-09
							Soil risk total	8.1E-06

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
Groundwater	Groundwater	Incidental ingestion, inhalation of volatiles, dermal contact	*Explosives*				
			2,4,6-Trinitrotoluene	2.5E-05	NE		2.5E-05
			4-Amino-2,6-Dinitrotoluene	3.5E-08	NE		3.5E-08
			2,6-Dinitrotoluene	6.3E-07	NE		6.3E-07
			RDX	7.7E-05	NE	NE(Kp<=0.01)	7.7E-05
			Metals				
			Arsenic	1.8E-04	NE	NE(Kp<=0.01)	1.8E-04
			Pesticides				
			Aldrin	2.4E-06	NE	NE(Kp<=0.01)	2.4E-06
			Semivolatile Organics				
			Bis(2-ethylhexyl)phthalate	1.3E-06	NE		1.3E-06
			Volatile Organics				
			Benzene	4.9E-07	1.8E-06	2.3E-07	2.52E-06
			Bromodichloromethane	1.8E-06			1.8E-06

Table 2-4 *(continued)*
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
			Chloroform	2.6E-06	1.3E-04	1.2E-06	1.3E-04
			1,1-Dichloroethene	1.6E-03	1.7E-03	1.1E-04	3.41E-03
			1,2-Dichloroethane	5.1E-05	1.9E-04		2.41E-04
			1,1,2-Trichloroethane	2.4E-06	9.0E-06		1.14E-05
			Methylene Chloride	9.0E-05	7.4E-05	NE(Kp<=0.01)	1.64E-04
			Trichloroethene	6.2E-03	1.2E-02	5.6E-03	2.38E-02
			Vinyl Chloride	7.0E-02	4.1E-02	NE(Kp<=0.01)	1.11E-01
						Groundwater risk total =	1.4E-01
						Total risk =	1.4E-01

Notes

Kp	Dermal permeability coefficient
NE	Not evaluated through this exposure pathway. Chemical is not identified as volatile.
NE(Kp<=0.01)	Based on USEPA Region 6 guidance, COPCs with a Kp<=0.01 were not evaluated for dermal contact while showering (USEPA, 1995)
RDX	1,3,5-Trinitroperhydro-1,3,5-triazine

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-16. 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 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 1.4E-01. 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 COCs contributing the most to the groundwater risk are TCE, VC, cis-1,2-DCE and perchlorate. This risk level indicates that if no clean-up action is taken, an individual would have an increased probability of 1 in 10 of developing cancer as a result of site-related exposure to the COCs.

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
Ground-water	Ground-water	Ingestion or exposure through showering	*Explosives*					
			1,3-Dinitrobenzene	--	1.5E-01			1.5E-01
			2,4,6-Trinitrotoluene	--	4.6E+00			4.6E+00
			4-Amino-2,6-Dinitrotoluene	--	5.9E-02	1.28E+00		1.3E+00
			2,6-Dinitrotoluene	--	2.6E-03			2.6E-03
			HMX	--	5.6E-04			5.6E-04
			Nitrobenzene	--	4.0E-01	1.28E+00		1.68E+00
			3-Nitrotoluene	--	1.1E-02		7.4E-04	1.17E-02
			RDX	--	6.7E-01			6.7E-01
			1,3,5-Trinitrobenzene	--	7.3E-04			7.3E-04
			Metals					
			Arsenic	--	1.1E+00	NE	NE (Kp<=0.01)	1.1E+00
			Barium	--	1.39E+00	NE	NE (Kp<=0.01)	1.39E+00
			Beryllium	--	3.6E-02	NE	NE (Kp<=0.01)	3.6E-02
			Cadmium	--	1.6E-01	NE	NE (Kp<=0.01)	1.6E-01
			Chromium	--	1.7E+01	NE	NE (Kp<=0.01)	1.7E+01
			Manganese	--	2.07E+00	NE	NE (Kp<=0.01)	2.07E+00
			Nickel	--	8.0E-01	NE	NE (Kp<=0.01)	8.0E-01
			Selenium	--	3.0E-02			3.0E-02
			Silver	--	2.2E-01	NE	NE (Kp<=0.01)	2.2E-01
			Strontium	--	1.7E-01	NE	NE (Kp<=0.01)	1.7E-01
			Vanadium	--	2.0E-01	NE	NE (Kp<=0.01)	2.0E-01
			Zinc	--	1.2E+00	NE	NE (Kp<=0.01)	1.2E+00
			Pesticides					
			Aldrin	--	1.3E-02	NE	NE (Kp<=0.01)	1.3E-02
			Semivolatile Organics					
			Bis(2-ethylhexyl)phthalate		1.3E-02	NE	NE (Kp<=0.01)	1.3E-02
			Butyl Benzyl Phthalate	--	3.4E-04	NE	2.90E-05	3.69E-04
			Acetone	--	3.8E-01			3.8E-01
			Bromodichloromethane	--	4.1E-03			4.1E-03
			2-Butanone (MEK)	--	5.5E-04	4.2E-03		4.75E-03
			Chloroform	--	1.2E-01		5.4E-02	1.74E-01
			1,1-Dichloroethane	--	3.5E-03	9.1E-03		1.26E-02
			1,1-Dichloroethene	--	8.0E-01		5.9E-02	8.59E-01
			1,2-Dichloroethene	--	1.4E+02	4.54E+01		1.85E+02
			cis-1,2-Dichloroethene	--	5.1E+02			5.1E+02
			1,1,2-Trichloroethane	--	3.0E-02			3.0E-02
			Ethylbenzene	--	4.9E-04	6.0E-04	2.3E-03	3.39E-03

Table 2-5 *(continued)*
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
			Methylene chloride	--	5.7E-01	1.5E-01	NE (Kp<=0.01)	7.2E-01

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
			Toluene	--	1.4E-03	9.6E-03	6.5E-03	1.75E-02
			Tetrachloroethene	--	1.4E-03		2.5E-03	3.9E-03
			Trichloroethene	--	2.7E+02		2.3E+02	5.0E+02
			Trichlorofluoromethane	--	2.9E-02	1.65E-01	2.3E-03	1.96E-01
			1,2,4-Trimethylbenzene	--	4.6E-03	2.51E-02	3.0E-03	3.27E-02
			1,3,5-Trimethylbenzene	--	3.2E-03	1.69E-02	1.3E-03	2.14E-02
			Xylene		6.0E-05		2.2E-05	8.2E-05
Groundwater Hazard Index Total =								1.23E+03
Receptor Hazard Total (soil and groundwater) =								1.23E+03

Notes

---	No information available
CNS	Central nervous system
Kp	Dermal permeability coefficient
HMX	High melting explosives
NE	Not evaluated through this exposure pathway
NE (Kp<=0.01)	Based on USEPA Region 6 guidance, chemicals of potential concern with a Kp<=0.01 were not evaluated for dermal contact while showering (USEPA, 1995)
RDX	1,3,5-Trinitroperhydro-1,3,5-triazine

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 for LHAAP-46. 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 31 for groundwater indicates that the potential for adverse non-carcinogenic effects could occur from exposure to contaminants in that medium; the components having HQs greater than 1 are thallium, antimony, and manganese. The non-carcinogenic risk from exposure to trichloroethene in groundwater could not be evaluated due to the lack of non-carcinogenic toxicity criteria for trichloroethene. The estimated HI of 0.12 for soil is acceptable.

Table 2-6
Chemicals of Potential Concern in Groundwater

Chemical	Baseline Risk Assessment Results			Comparison Value		Maximum Result (µg/L)	Maximum Result from Post Risk Assessment Data	Retained as Chemical of Concern?
	EPC (µg/L)	Risk	HI	Value (µg/L)	Basis			
Perchlorate	none	-	-	72	GW-Ind	5,990	Yes	YES, 3
1,3-Dinitrobenzene	1.56	-	0.15	10	GW-Ind	1.56	No	NO, 6
2,4,6-Trinitrotoluene	240	2.50E-05	4.6	51	GW-Ind	240	No	NO, 5
4-Amino-2,6-dinitrotoluene	1	3.50E-08	1.34	17	GW-Ind	1	No	NO, 6
Nitrobenzene	20	-	1.68	51	GW-Ind	20	No	NO, 5
RDX	200	7.70E-05	0.67	26	GW-Ind	200	No	NO, 5
Arsenic	34	1.80E-04	1.1	10	MCL	123	Yes	YES, 1
Barium	9,900	-	1.39	2,000	MCL	9,900	No	NO, 2
Cadmium	8	-	0.16	5	MCL	29	No	NO, 2
Chromium	5,220	-	17	100	MCL	32,400	Yes	YES, 3
Manganese	29,800	-	2.07	7,820	95% UTL Background	29,800	No	YES, 1
Nickel	1,630	-	0.8	2,040	GW-Ind	1,803.5	No	YES, 1
Silver	114	-	0.22	511	GW-Ind	114	No	NO, 6
Strontium	10,400	-	0.17	61,300	GW-Ind	12,300	Yes	NO, 6
Thallium	12	-	-	2	MCL	90.5	Yes	YES, 1
Zinc	37,000	-	1.2	31,000	GW-Ind	37,000	No	NO, 5
Trichloroethene	160,000	2.38E-02	500	5	MCL	173,000	Yes	YES, 3
1,1-Dichloroethene	740	3.41E-04	0.859	7	MCL	740	No	YES, 3
1,2-Dichloroethane	160	2.41E-04	-	5	MCL	161	Yes	YES, 3
1,2-Dichloroethene	275,000	-	185.4	70	MCL for cis-1,2-DCE	275,000	No	NO, 4
cis-1,2-Dichloroethene	520,000	-	510	70	MCL	520,000	No	YES, 3
Vinyl chloride	11,000	1.11E-01	-	2	MCL	11,000	No	YES, 3
1,1,2-Trichloroethane	12	1.14E-05	0.03	5	MCL	23.6	Yes	YES, 1
Acetone	3,920	-	0.38	92,000	GW-Ind	14,000	Yes	NO, 6
Chloroform	120	1.34E-04	0.17	80	MCL for trihalomethanes	36	No	NO, 6
Methylene chloride	3,500	1.64E-04	0.72	5	MCL	9,500	Yes	YES, 3
Trichlorofluoromethane	892	-	0.196	80	MCL for trihalomethanes	892	No	NO, 5

Table 2-6 *(continued)*
Chemicals of Potential Concern in Groundwater

Notes:

List of Chemicals is from Table 4-9 of the Final Baseline Human Health Risk Assessment for Site 16 Landfill (plus perchlorate).
Constituents/Parameters with Hazard Index (HI) > 0.1 or Cancer Risk (Risk) > 1.00E-5 are selected.

(1) Retained as a COC to be monitored for 5 years, then evaluated again.
(2) Excluded as a COC because earlier exceedances of MCL were not confirmed by subsequent sampling.
(3) Retained as a COC because a significant number of results exceed the MCL or GW-Ind.
(4) Excluded as a COC because the parameter will be superseded by cis-1,2-DCE.
(5) Excluded as a COC because only one or 2 anomalous sample results in early sampling were above the Comparison Value.
(6) Excluded as a COC because no detected result ever exceeded the comparison value.

μg/L	micrograms per liter
GW-Res	Texas Groundwater Medium-Specific Concentration for Residential Use
HI	Hazard Index
MCL	maximum contaminant level
95% UTL	Value from Final Evaluation of Perimeter Well Data for Use as Groundwater Background (Shaw, 2007).

Table 2-7
Groundwater and Surface Water Cleanup Levels

Chemical of Concern	Cleanup Level	
	Onsite Groundwater (µg/L)	Compliance Zone (Harrison Bayou) (µg/L)
	MCL	MCL
Trichloroethene	5	5
cis-1,2-Dichloroethene	70	70
1,1-Dichloroethene	7	7
1,2-Dichloroethane	5	5
Vinyl Chloride	2	2
1,1,2-Trichloroethane	5	5
Methylene Chloride	5	5
Chromium	100	100
Arsenic	10	10
Thallium	2	2
	GW-Ind	GW-Res
Nickel	2,040	730
Perchlorate	72	26
	GW-Ind	95% UTL Background
Manganese	14,300	7,820

Notes and Abbreviations:

All values are in micrograms per liter (µg/L).

Source: TCEQ, 2006.

GW-Res Texas Groundwater Medium-Specific Concentration for Residential Use
MCL maximum contaminant level
NE not established
95% UTL value from Final Evaluation of Perimeter Well Data for Use as Groundwater Background (Shaw, 2007)

Table 2-8
Comparative Analysis of Alternatives

Criteria	Alternative 1 No Further Action (Maintenance of Existing Landfill Cap, Land Use Controls [Cap Only])	Alternative 2 Cap, Enhanced Groundwater Extraction, Land Use Controls	Alternative 3a/3b Cap, Monitored Natural Attenuation, Land Use Controls[1]	Alternative 4 Cap, In Situ Permeable Reactive Barrier, Land Use Controls	Alternative 5a/5b Landfill Removal, In Situ Permeable Reactive Barrier, Land Use Controls[2]	Alternative 6 Landfill Source Treatment, Monitored Natural Attenuation, Land Use Controls	Alternative 7 Cap, Monitored Natural Attenuation, Land Use Controls, In Situ Enhanced Bioremediation, Biobarriers
Overall protection of human health and the environment	Protection of human health provided by cap and associated LUCs. No additional protection from exposure to groundwater. Does not demonstrate protection of Harrison Bayou from potential groundwater impacts.	Protection of human health provided by cap and land use controls. Protection of Harrison Bayou provided by groundwater extraction.	Protection of human health provided by cap and land use controls. Protection of Harrison Bayou provided by natural attenuation.	Protection of human health provided by cap and land use controls. Protection of Harrison Bayou provided by permeable reactive barrier.	Protection of human health provided by cap (5a), source removal (5b) and land use controls. Protection of Harrison Bayou provide by groundwater treatment.	Protection of human health provided by removal and treatment of some source material and by cap and land use controls. Protection of Harrison Bayou provided by natural attenuation.	Protection of human health provided by cap and land use controls. Protection of Harrison Bayou provided by biobarriers, in situ bioremediation, and natural attenuation.
Compliance with ARARs	No compliance with chemical-specific ARARs in groundwater. Complies with location- and action-specific ARARs.	Does not comply with ARARs that apply drinking water requirements to groundwater. Complies with location-and action-specific ARARs.	Meets all ARARs.	Does not comply with ARARs that apply drinking water requirements to groundwater. Complies with location-and action-specific ARARs.	Does not comply with ARARs that apply drinking water requirements to groundwater. Complies with location-and action-specific ARARs.	Meets all ARARs.	Meets all ARARs.
Long-term effectiveness and permanence	Landfill cap and associated LUCs would be effective and reliable so long as they are maintained indefinitely. Not effective for groundwater.	Effective reliability depends on long-term maintenance and controls and ability to locate extraction wells in complex geology.	Alternative 3b enhances effectiveness of MNA by reducing the mass of contamination. If MNA is not proven effective in the long term, a contingent action of groundwater extraction would be implemented (see Alternative 2)	Effectiveness of permeable reactive barrier is uncertain and relies on adequate long-term maintenance.	Similar to Alternative 4, but reliability enhanced with source removal. More aggressive remedial approach.	Similar to Alternative 3a but reliability is enhanced by source treatment.	Should be effective and permanent as indicated by the results of the technology demonstration and the preliminary MNA evaluation. In situ bioremediation will permanently reduce contaminant mass in its treatment area.

Table 2-8 *(continued)*
Comparative Analysis of Alternatives

Criteria	Alternative 1 No Further Action (Maintenance of Existing Landfill Cap, Land Use Controls [Cap Only])	Alternative 2 Cap, Enhanced Groundwater Extraction, Land Use Controls	Alternative 3a/3b Cap, Monitored Natural Attenuation, Land Use Controls[1]	Alternative 4 Cap, In Situ Permeable Reactive Barrier, Land Use Controls	Alternative 5a/5b Landfill Removal, In Situ Permeable Reactive Barrier, Land Use Controls[2]	Alternative 6 Landfill Source Treatment, Monitored Natural Attenuation, Land Use Controls	Alternative 7 Cap, Monitored Natural Attenuation, Land Use Controls, In Situ Enhanced Bioremediation, Biobarriers
Reduction of toxicity, mobility, or volume through treatment	No active reduction.	Some reduction in groundwater toxicity and volume through active treatment. No source treatment.	Alternative 3a includes no active reduction in toxicity, mobility, or volume. Alternative 3b includes a small reduction in toxicity and volume. No source treatment.	Moderate reduction in groundwater toxicity. No source treatment.	Longer trench results in larger reduction in groundwater toxicity than Alternative 4. Source treatment only if RCRA waste is identified.	Significant source reduction in toxicity and volume. Groundwater COC reduction is identical to Alternative 3.	No source treatment. Provides permanent and irreversible reduction in groundwater toxicity and volume via in situ bioremediation, biobarriers, and MNA.
Short-term effectiveness	Minimal impact to the community, workers, or the environment from short-term activities.	Minimal impact to the community, workers, or the environment from short-term activities. Provides almost immediate protection.	Minimal impact to the community, workers, or the environment from short-term activities. Provides almost immediate protection.	Minor disruption due to installation of the permeable reactive barrier.	Significant short-term impacts to the community from transportation and for worker risk from excavation activities. Risks can be controlled.	Potential for worker risk during source treatment. Risks can be controlled.	Minimal disruption due to implementation of in situ bioremediation and biobarrier. Provides almost immediate protection with the implementation of land use controls.
Implementability	Readily implemented.	Readily implemented. Most of the components of this alternative are already in place.	If natural attenuation does not occur, Alternative 2 would be implemented.	Need to design an effective system considering hydraulics and biological process in situ.	Most difficult to implement. Coordination of excavation, waste sampling, transportation, and disposal would be difficult. Also, need to minimize releases of contaminated material during excavation activities.	Source action not typically applied to landfills. Therefore, initial testing will be required.	Readily implemented because equipment and personnel required for implementation of this alternative (including the design of the biobarrier) are readily available.

Table 2-8 *(continued)*
Comparative Analysis of Alternatives

Criteria	Alternative 1 No Further Action (Maintenance of Existing Landfill Cap, Land Use Controls [Cap Only])	Alternative 2 Cap, Enhanced Groundwater Extraction, Land Use Controls	Alternative 3a/3b Cap, Monitored Natural Attenuation, Land Use Controls[1]	Alternative 4 Cap, In Situ Permeable Reactive Barrier, Land Use Controls	Alternative 5a/5b Landfill Removal, In Situ Permeable Reactive Barrier, Land Use Controls[2]	Alternative 6 Landfill Source Treatment, Monitored Natural Attenuation, Land Use Controls	Alternative 7 Cap, Monitored Natural Attenuation, Land Use Controls, In Situ Enhanced Bioremediation, Biobarriers
Cost[3]							
• Capital Expenditures	$0	$777,000	$620,000 (a) $1,307,000 (b)	$2,596,000	$3,138,000 (a) $111,826,000 (b)	$2,781,000	$393,000
• O&M Expenditures	$914,000	$13,898,000	$2,943,000 (a) $3,011,000 (b)	$2,889,000	$15,289,000 (a) $14,585,000 (b)	$4,676,000	$2,004,000
• Total Present Worth	$632,000	$9,816,000	$2,713,000 (a) $3,426,000 (b)	$4,563,000	$13,070,000 (a) $115,606,000 (b)	$6,399,000	$1,980,000

Notes and Abbreviations:

[1] Alternative 3b is identical to Alternative 3a except an extraction well network will be operated in the groundwater hot spot for approximately 5 years to reduce contaminant mass, followed by MNA throughout the rest of the O&M period.

[2] Alternative 5b is identical to Alternative 5a except all of the landfill waste will be removed (compared with hot spot removal under Alternative 5a).

[3] Costs have been rounded to the nearest $1,000. The capital and O&M expenditures are the sums of each year's costs without regard to discount rates or escalation rates. Each year's expenditures were converted to present worth using a 2.7% discount rate and were summed to yield the total present worth. The costs of Alternatives 1 through 6 have been updated to January 2008 using the Engineering News Record construction cost index, and the costs of five-year reviews have been added to all alternatives. Per the Army's request, the costs for all alternatives have been modified by removing the standard escalation rate (average 3 percent per year) from the present worth calculation. Also, the cost of Alternative 1 has been updated to reflect the ongoing cap maintenance/inspection activities and the implementation of LUCs under the ROD for LHAAP-16.

ARAR applicable or relevant and appropriate requirement
COC chemical of concern
LUCs land use controls
MNA monitored natural attenuation
O&M operation and maintenance
RCRA Resource Conservation and Recovery Act

Table 2-9
Remediation Cost Table, Selected Remedy (Alternative 7)
Present Worth Analysis

PROJECT LOCATION: Karnack, Texas									DATE: January 2010		
			O & M Costs						Present Value (NPV)		
FY	Capital Costs	Capital Costs							Discount Rate	Capital	O & M
	ISEB	Other	Cap Maintenance	Biobarrier	Performance Monitoring	MNA	LTM	Total	2.7%		
									NPV	392,596	1,587,057
2010	201,713	190,882	30,568	82,364	169,844		0	282,776			
2011	0	0	22,689		136,228		0	158,916			
2012	0	0	22,689			140,863	0	163,551			
2013	0	0	22,689			149,397	0	172,086			
2014	0	0	22,689				72,058	94,746			
2015	0	0	30,568	82,364			0	112,932			
2016	0	0	22,689				0	22,689			
2017	0	0	22,689				0	22,689			
2018	0	0	22,689				0	22,689			
2019	0	0	22,689				72,058	94,746			
2020	0	0	30,568	82,364			0	112,932			
2021	0	0	22,689				0	22,689			
2022	0	0	22,689				0	22,689			
2023	0	0	22,689				0	22,689			
2024	0	0	22,689				72,058	94,746			
2025	0	0	30,568				0	30,568			
2026	0	0	22,689				0	22,689			
2027	0	0	22,689				0	22,689			
2028	0	0	22,689				0	22,689			
2029	0	0	22,689				72,058	94,746			
2030	0	0	30,568				0	30,568			
2031	0	0	22,689				0	22,689			

Table 2-9 *(continued)*
Remediation Cost Table, Selected Remedy (Alternative 7)
Present Worth Analysis

PROJECT LOCATION: Karnack, Texas									DATE: January 2010		
			O & M Costs						Present Value (NPV)		
FY	Capital Costs	Capital Costs							Discount Rate	Capital	O & M
	ISEB	Other	Cap Maintenance	Biobarrier	Performance Monitoring	MNA	LTM	Total	2.7%		
									NPV	392,596	1,587,057
2032	0	0	22,689				0	22,689			
2033	0	0	22,689				0	22,689			
2034	0	0	22,689				72,058	94,746			
2035	0	0	30,568				0	30,568			
2036	0	0	22,689				0	22,689			
2037	0	0	22,689				0	22,689			
2038	0	0	22,689				0	22,689			
2039	0	0	22,689				72,058	94,746			
Total Expenditures	201,713	190,882	727,934	247,091	306,072	290,260	432,346	2,003,703			$1,979,653

<u>Notes and Abbreviations</u>:

Major assumptions are as described below. Quantities and assumptions are for cost estimating purposes only. For further details, refer to the Final Addendum to Final Feasibility Study, LHAAP-16 (Shaw, 2010).

Capital costs include: in situ bioremediation, the first injection for the biobarriers, and establishment of LUCs.

O&M costs for the MNA evaluation, maintenance of the cap, maintenance of the LUCs, long-term monitoring, and two additional emulsified vegetable oil injections subsequent to the initial implementation of the biobarriers. LTM would support the required CERCLA five-year reviews.

Monitoring costs are based on the assumption that sampling is conducted at 7 shallow zone wells and 5 intermediate zone wells, with one quality control sample in each zone and one surface water location in Harrison Bayou. The sampling frequency is quarterly for 2 years (Years 1 and 2), then semiannual for 3 years (Years 3 through 5), then annual for Years 6 through 10, and finally every5 years (Years 15, 20, 25, and 30). Analysis of the initial groundwater sampling event is for VOCs and perchlorate and MNA parameters. Samples collected in subsequent monitoring events will be analyzed for VOCs, metals, perchlorate and MNA parameters. Five year reviews are conducted in Years 5, 10, 15, 20, 25, and 30.

The discount rate of 2.7% is based on the 30-year Real Interest Rate from Office of Management and Budget Circular A-94, Appendix B, Revised December 2009.

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
ISEB in situ enhanced bioaugmentation
LTM long-term monitoring
LUC land use control
MNA monitored natural attenuation
NPV net present value
O&M operation & maintenance
VOC volatile organic compounds

Table 2-10
Description of ARARs for Final Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Groundwater		
Federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs) 40 CFR 141	Applicable to drinking water for a public water system—**relevant and appropriate** for water that could potentially be used for human consumption	Must not exceed MCLs/non-zero MCLGs for water designated as a current or potential source of drinking water. See Table 2-7 for specific numeric criteria
TCEQ Texas Risk Reduction Rules 30 TAC 335	Applicable to industrial groundwater—**relevant and appropriate** for hypothetical future maintenance worker exposure to groundwater .	If no maximum contaminant level has been promulgated, groundwater must not exceed the industrial medium-specific concentration. See Table 2-7 for specific numeric criteria.
Surface Water		
State of Texas Surface Water Quality Standards: General Criteria and Toxic Materials Criteria 30 TAC 307.4 30 TAC 307.6	Applicable to surface waters of the state - **applicable** if water is discharged to a surface water body or surface waters are remediated as part of the remedial action.	Discharges to waters of the state must not cause in-stream exceedance of numeric and narrative water quality standards. Remediation of contaminated surface waters must ensure that numeric and narrative water quality standards are achieved, as determined by 307.8 (Application of the Standards) and Section 307.9 (Determination of Standards Attainment). See Table 2-7 for specific numeric criteria.
State of Texas Surface Water Quality Standards: Antidegradation 30TAC 307.5	Applicable to surface waters of the state – **applicable** if water is discharged directly to a surface water body or surface waters are remediated as part of the remedial action.	No activity subject to regulatory action that would cause degradation of waters that exceed fishable/swimmable quality will be allowed. Degradation is defined as a lowering of water quality by more than a de minimis extent but not to the extent than an existing use is impaired. Water quality sufficient to protect existing uses will be maintained. The highest water quality sustained since November 28, 1975, defines baseline conditions for determination of degradation.
General Site Preparation, Construction, and Excavation Activities		
Air Contaminants – General Nuisance Rules 30 TAC 101.4	Emissions of air contaminants—**applicable**.	No person shall discharge from any source whatsoever one or more air contaminants or combinations thereof, to exceed an opacity of 30 percent for any 6-minute period as are or may tend to be injurious to or to adversely affect human health or welfare, animal life, vegetation, or property, or as to interfere with the normal use and enjoyment of animal life, vegetation, or property.
Storm Water Runoff Controls 40 CFR 122.26; 30 TAC 205, Subchapter A; 30 TAC 308.121	Storm water discharges associated with construction activities—**applicable** to disturbances of equal to or greater than 1 acre of land.	Good construction management techniques, phasing of construction projects, minimal clearing, and sediment, erosion, structural, and vegetative controls shall be implemented to mitigate storm water run-on/runoff in areas of active remediation.
Waste Management		

Table 2-10 *(continued)*
Description of ARARs for Final Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
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 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., personal protective equipment [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.
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.	Remedial activities derived waste (from monitoring, intercepting and treating contaminated groundwater) is expected for this facility. 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.
		Well Construction
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.	Injection wells shall be completed in accordance with the technical requirements of Section 76.1000, as appropriate. Substantive requirements applicable to the injection wells will be adhered to.
Class V Injection Wells 30 TAC 331, Subchapters A,C and H	Installation, operation, and closure of injection wells 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. Substantive requirements applicable to the injection wells will be adhered to.
		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.

Table 2-10 *(continued)*
Description of ARARs for Final Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
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.
Post Closure Care		
Post Closure Care Requirements for Hazardous Waste Landfills 40 CFR 264.310(b) 40 CFR 264.228(b)(1)(3)(4) 30 TAC 335.174(b)	Closure of a RCRA landfill – **relevant and appropriate** to closure or post closure under CERCLA of landfills containing RCRA hazardous waste	Owner or operator must • Maintain the effectiveness and integrity of the final cover including making repairs to the cap as necessary to correct effects of settling, erosion, etc.; • Prevent run-on and runoff from eroding or otherwise damaging final cover; and • Maintain and monitor a groundwater monitoring system.

Abbreviations:

CFR Code of Federal Regulations
FR Federal Register
PPE personal protective equipment
RCRA Resource Conservation and Recovery Act of 1976
TAC Texas Administrative Code

00112835

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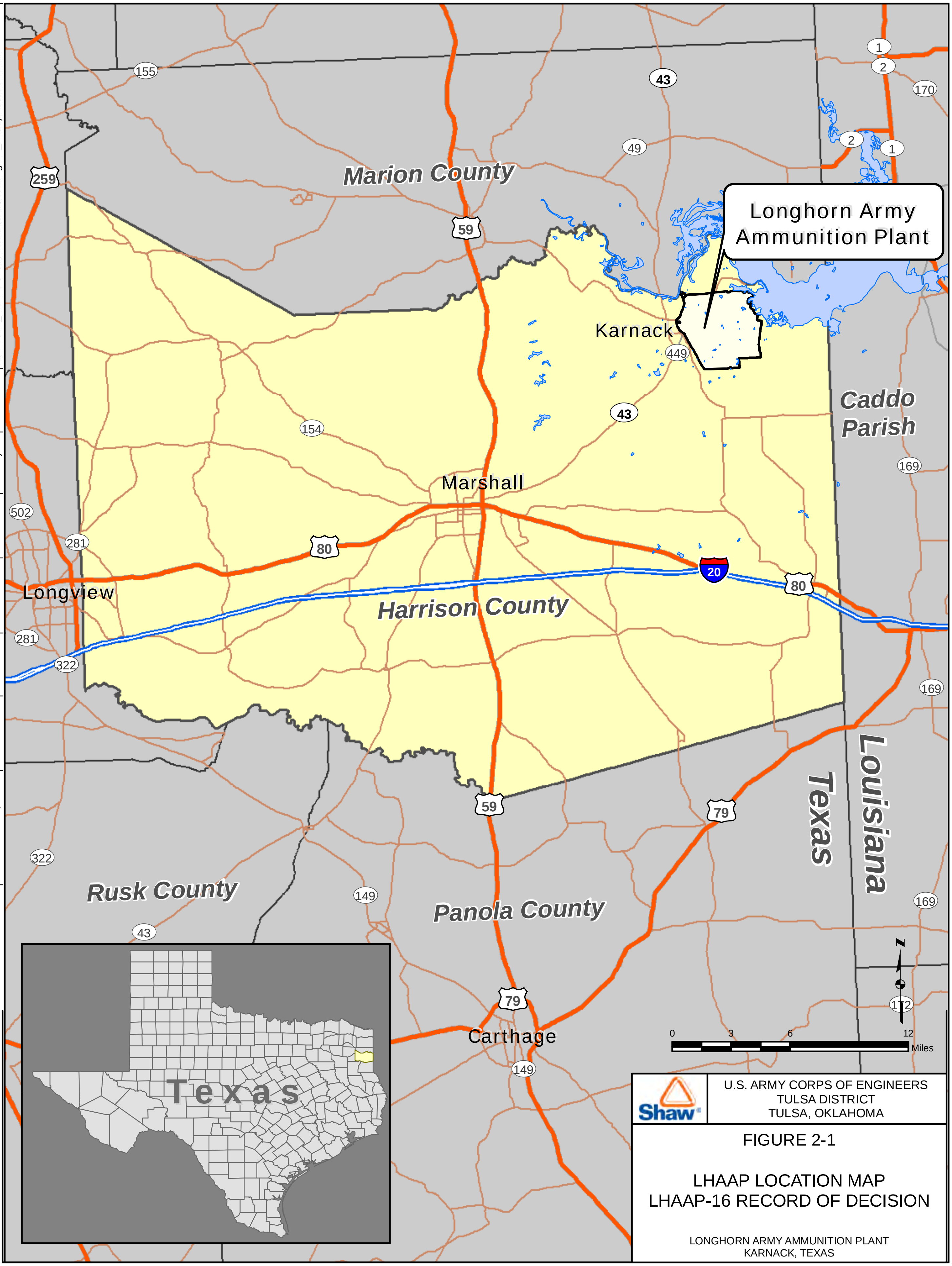
CHECKED BY R. Duffield 10/28/09
APPROVED BY A. Maylia 10/15/2010
FILE NAME T:\117591_LHAAP\Doc\Mxd\Site16\Rod\Fig2-1_LhaapLocation.mxd



U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

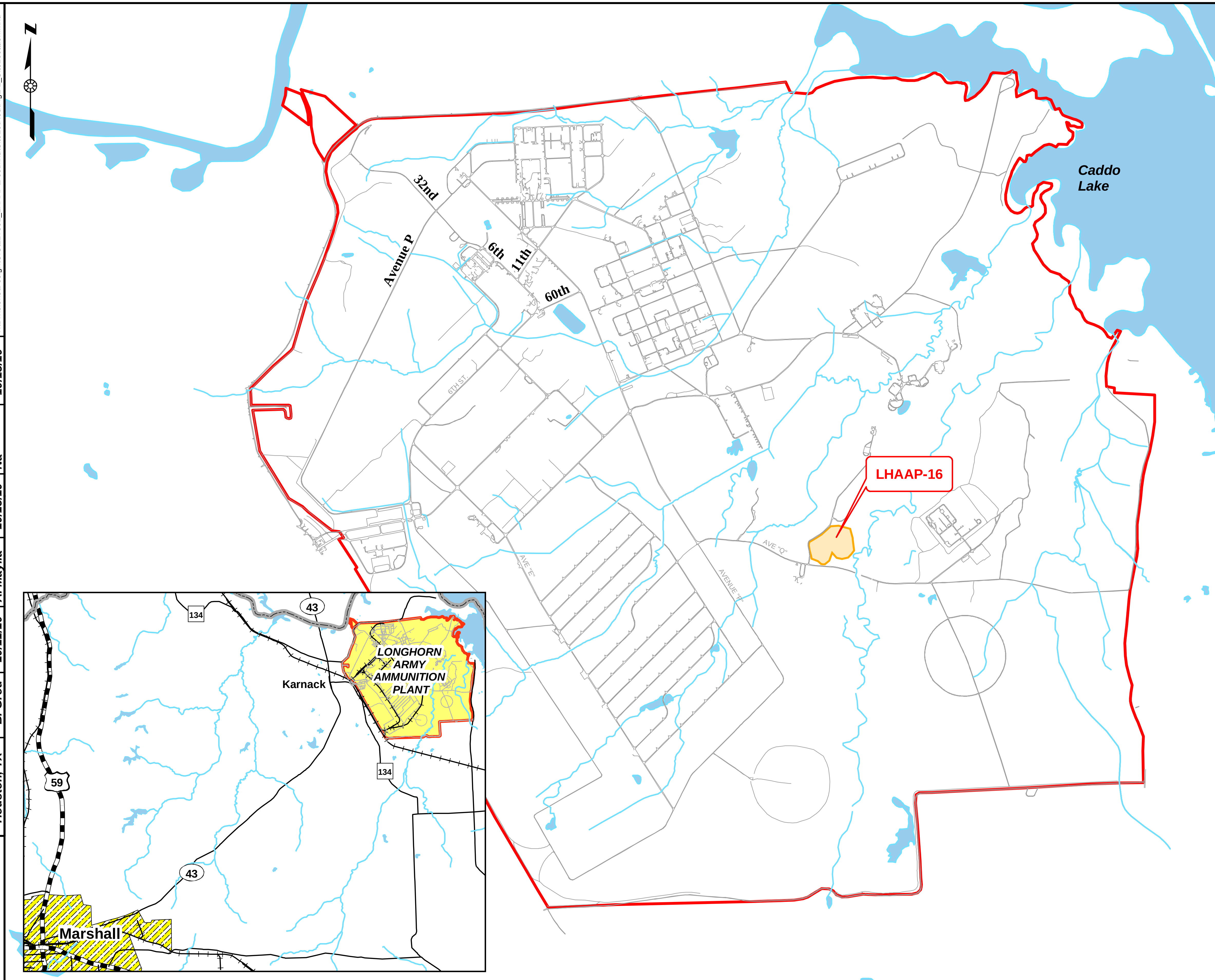
FIGURE 2-1

LHAAP LOCATION MAP
LHAAP-16 RECORD OF DECISION

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00112836

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		FILE PATH
Houston, TX	B. Grod	10/11/10	A. Mayila	10/15/10	Na	10/15/10	T:\Divisions\Design\GIS\117591_LHAAP\Doc\Mxd\Site16\Rod\Fig2-2_SiteLocation.mxd



LEGEND

- Stream
- Road
- LHAAP Boundary
- Site
- Lake

N

0 1,250 2,500 5,000 Feet

Shaw

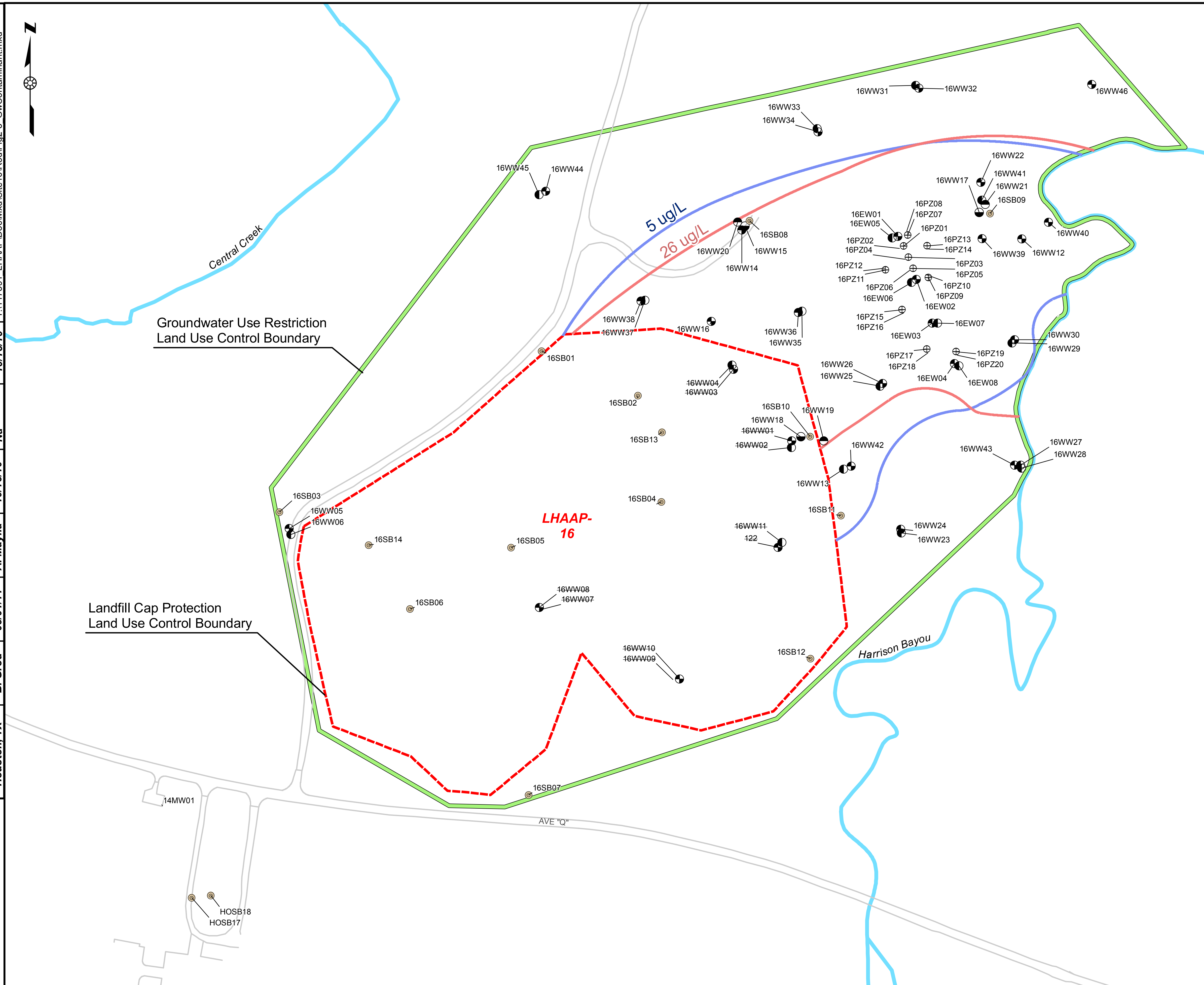
U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-2

SITE LOCATION MAP
LHAAP-16 RECORD OF DECISION

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00112837



LEGEND

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Upper Deep Monitoring Well
- Deep Monitoring Well
- Piezometer
- Soil Boring
- Extent of Perchlorate Contamination > 26 ug/L in Intermediate and Shallow Zones
- Extent of TCE Contamination > 5 ug/L in Intermediate and Shallow Zones
- Road
- Stream
- Groundwater Use Restriction Land Use Control Boundary
- LHAAP-16 Landfill Fence

Notes:
1. Abandoned or Plugged Wells (Ex. ~~Well ID~~)

0 50 100 200 300 400 Feet

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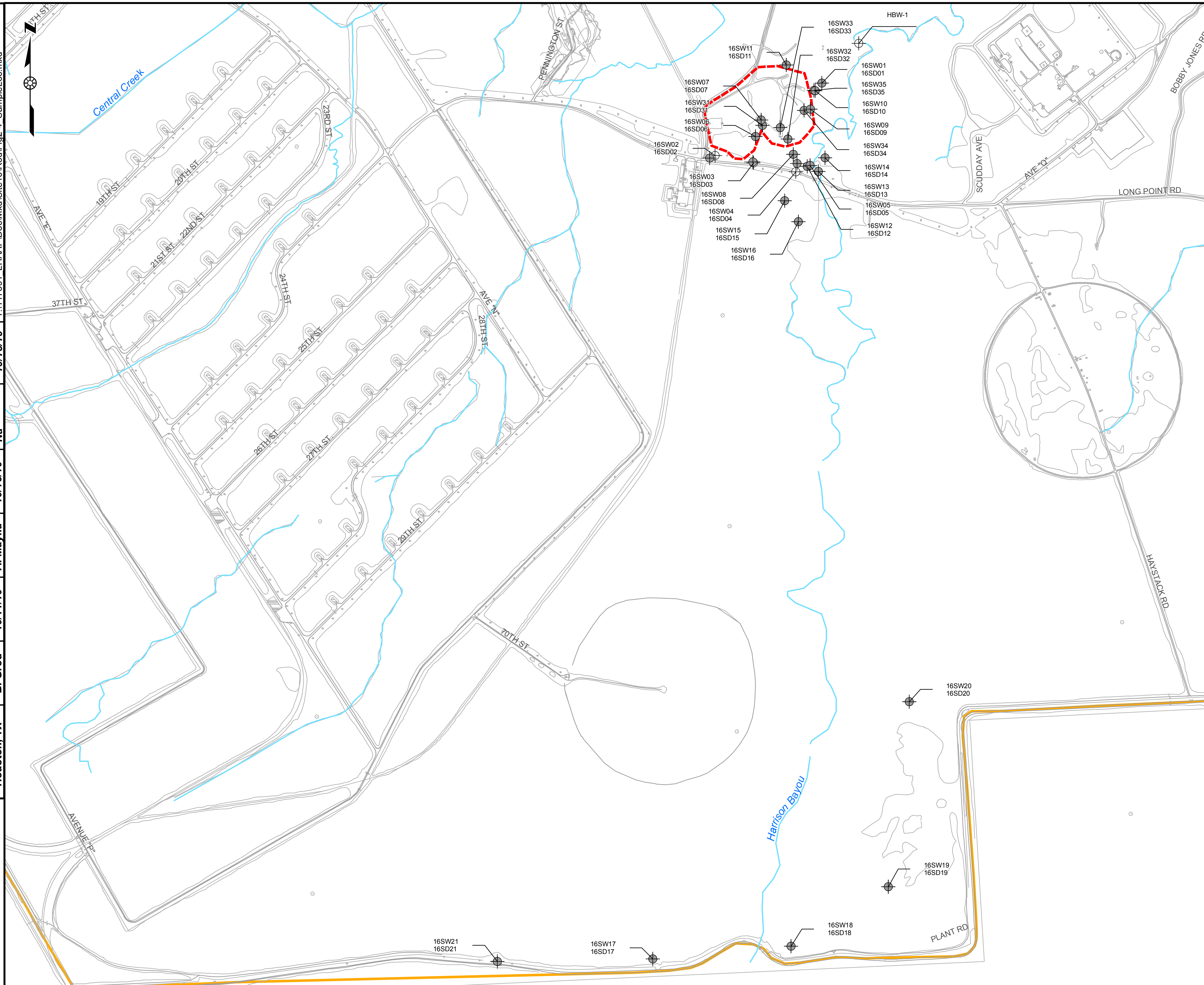
FIGURE 2-3
SOIL AND GROUNDWATER SAMPLE LOCATIONS, EXTENT OF GROUNDWATER CONTAMINATION, AND LAND USE CONTROL BOUNDARIES
LHAAP-16 RECORD OF DECISION
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

FILE PATH	T:\117591_LHAAP\DocMxd\Site16\RodFig2-3_GwContaminant.mxd
APPROVED BY	Na 10/15/10
CHECKED BY	A. Mayila 10/15/10
DRAWN BY	B. Grod 03/01/11
OFFICE	Houston, TX

00112838



LEGEND

- Sediment Sample
- Surface Water Sample
- LHAAP-16 Landfill Fence
- Stream
- Road
- LHAAP Boundary

0 500 1,000 2,000
Feet

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FIGURE 2-4
SURFACE WATER/SEDIMENT
SAMPLE LOCATIONS MAP
LHAAP-16 RECORD OF DECISION
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Grod 10/11/10	A. Mayila 10/15/10	Na 10/15/10	T:\117591 LHAAP\Doc\Mxd\Site16\Rod\Fig2-4_SampleLoc.mxd

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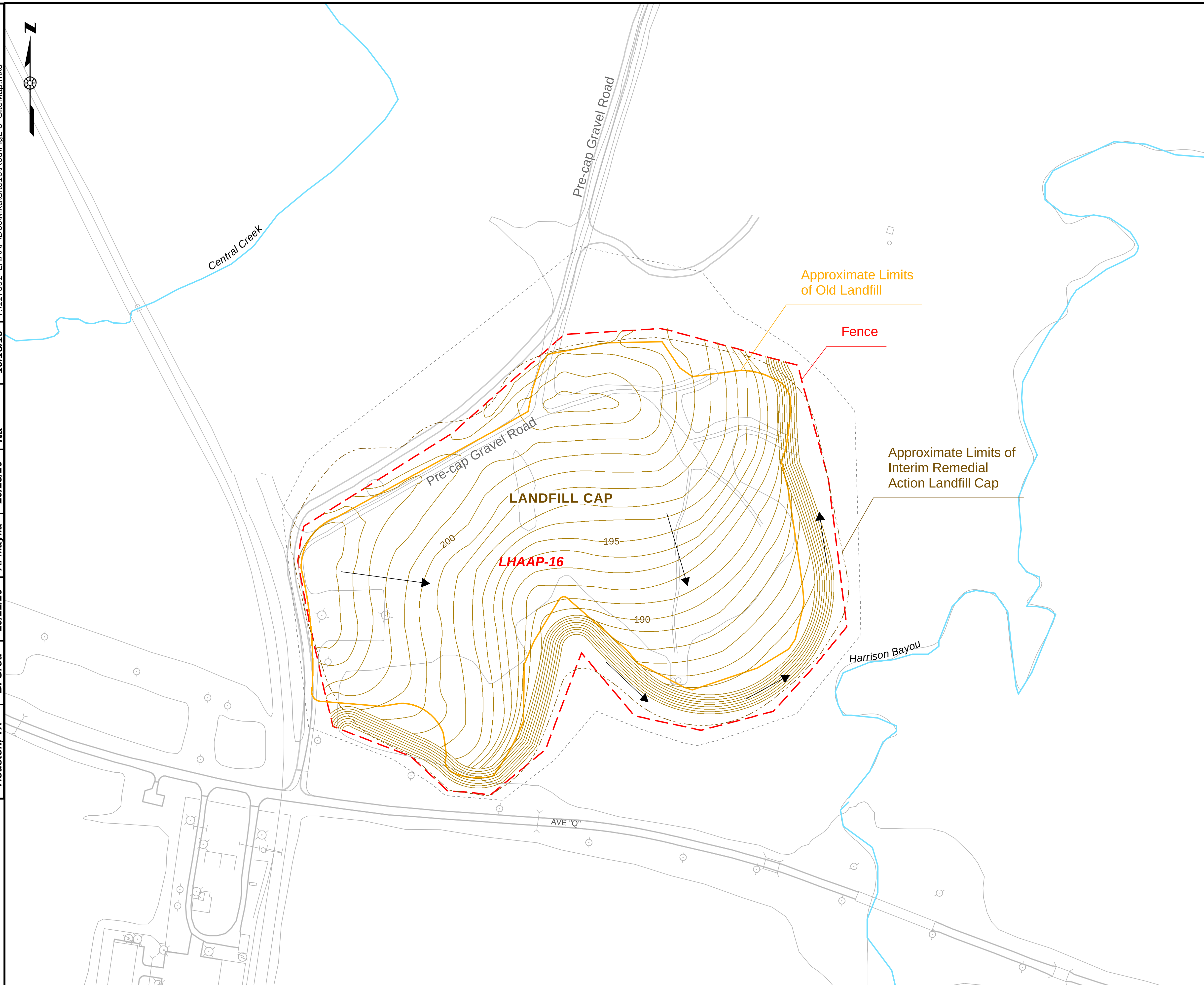


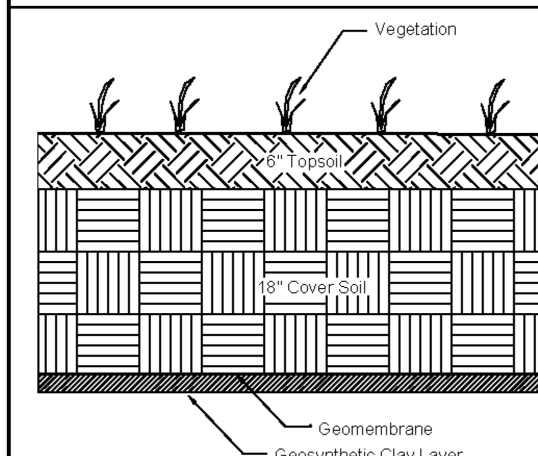
LEGEND

LHAAP-16 Landfill Fence

Landfill Cap Contours

Stream

Road



Cap Cross Section

0 115 230 460 Feet

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FIGURE 2-5

SITE MAP
LHAAP-16 RECORD OF DECISION

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Grod 10/11/10	A. Mayila 10/15/10	Na 10/15/10	T:\117591_LHAAP\Doc\Mxd\Site16\Rod\Fig2-5_SiteMap.mxd

00112840

OFFICE	DRAWN BY		APPROVED BY		FILE PATH
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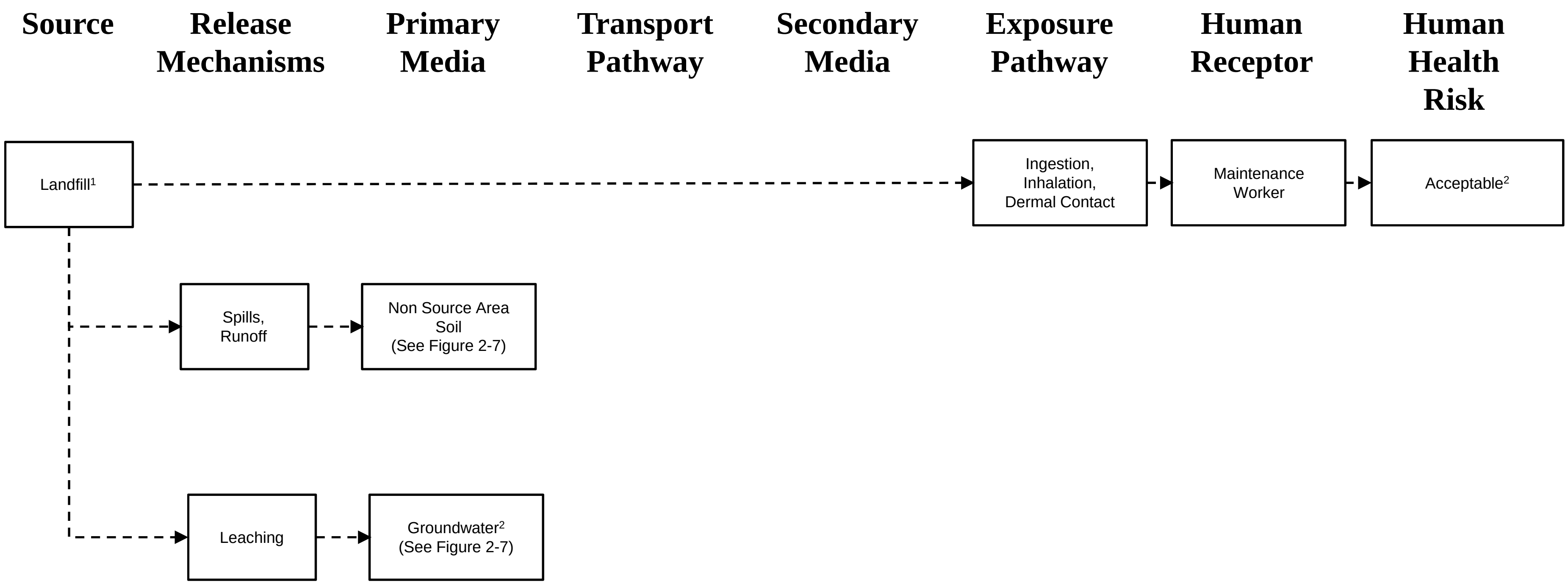

Pathway cut off by cap

Notes:
1. The LHAAP-16 Landfill cap was completed as part of an Interim Remedial Measure 1998.
2. Landfill cap cuts off direct exposure pathways and hydraulically isolates source area from groundwater.

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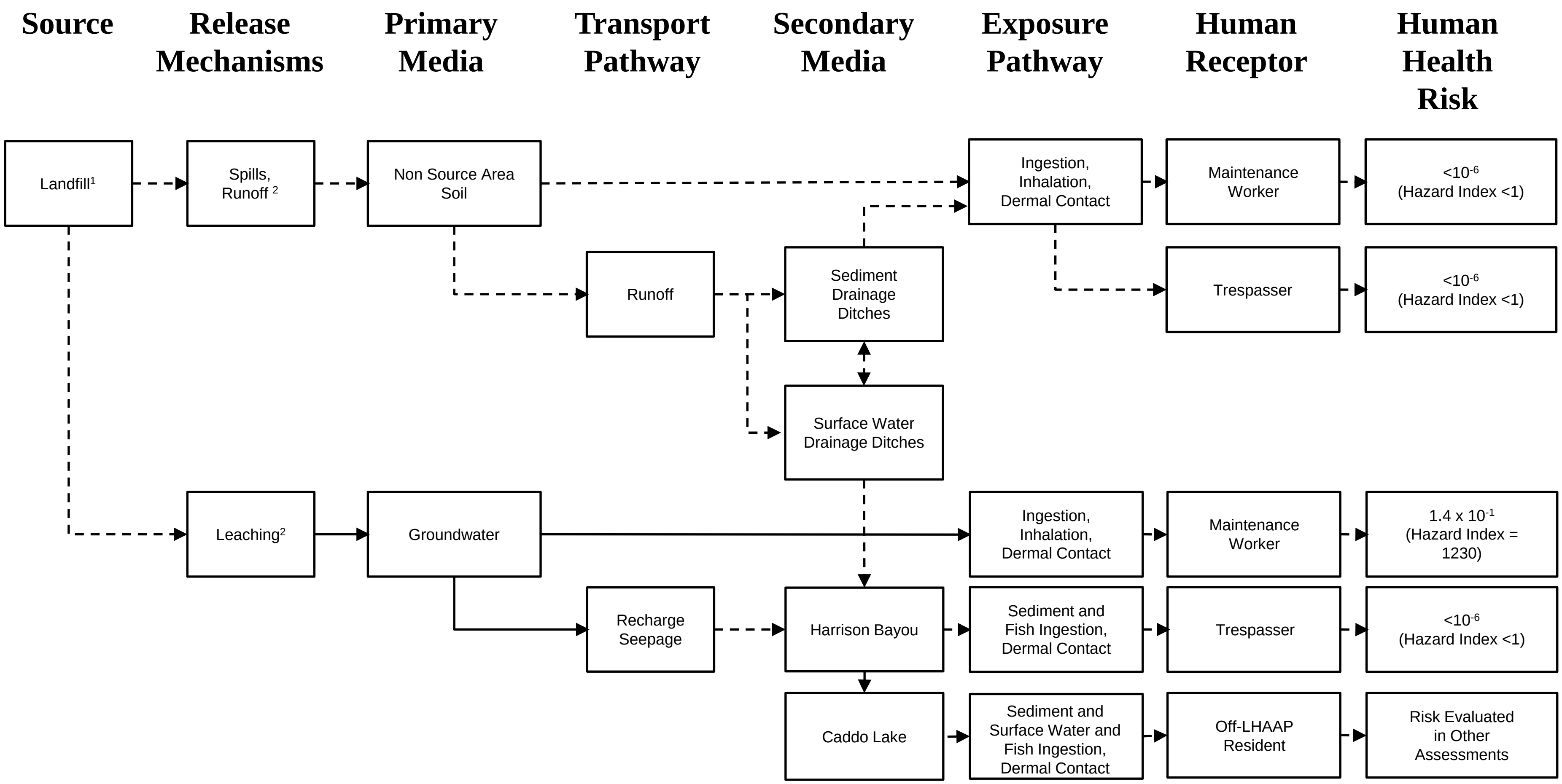
FIGURE 2-6
CONCEPTUAL SITE MODEL
LHAAP-16
SOURCE AREA

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00112841

OFFICE	DRAWN BY		APPROVED BY		FILE PATH
HOU	B. Grod	10/12/10	A. Mayila	10/17/10	T:\Divisions\Design\GIS\117591_LHAAP\Doc\Mxd\ConceptualSiteModel.pptx



Pathway considered for remediation

Pathway not considered for remediation[3]

Notes:
1. The LHAAP-16 Landfill cap was completed as part of an Interim Remedial Measure 1998.
2. Prior to Interim Remedial Measure in 1998.
3. Risks are within acceptable range or are evaluated in separate assessments of Harrison Bayou or Caddo Lake.

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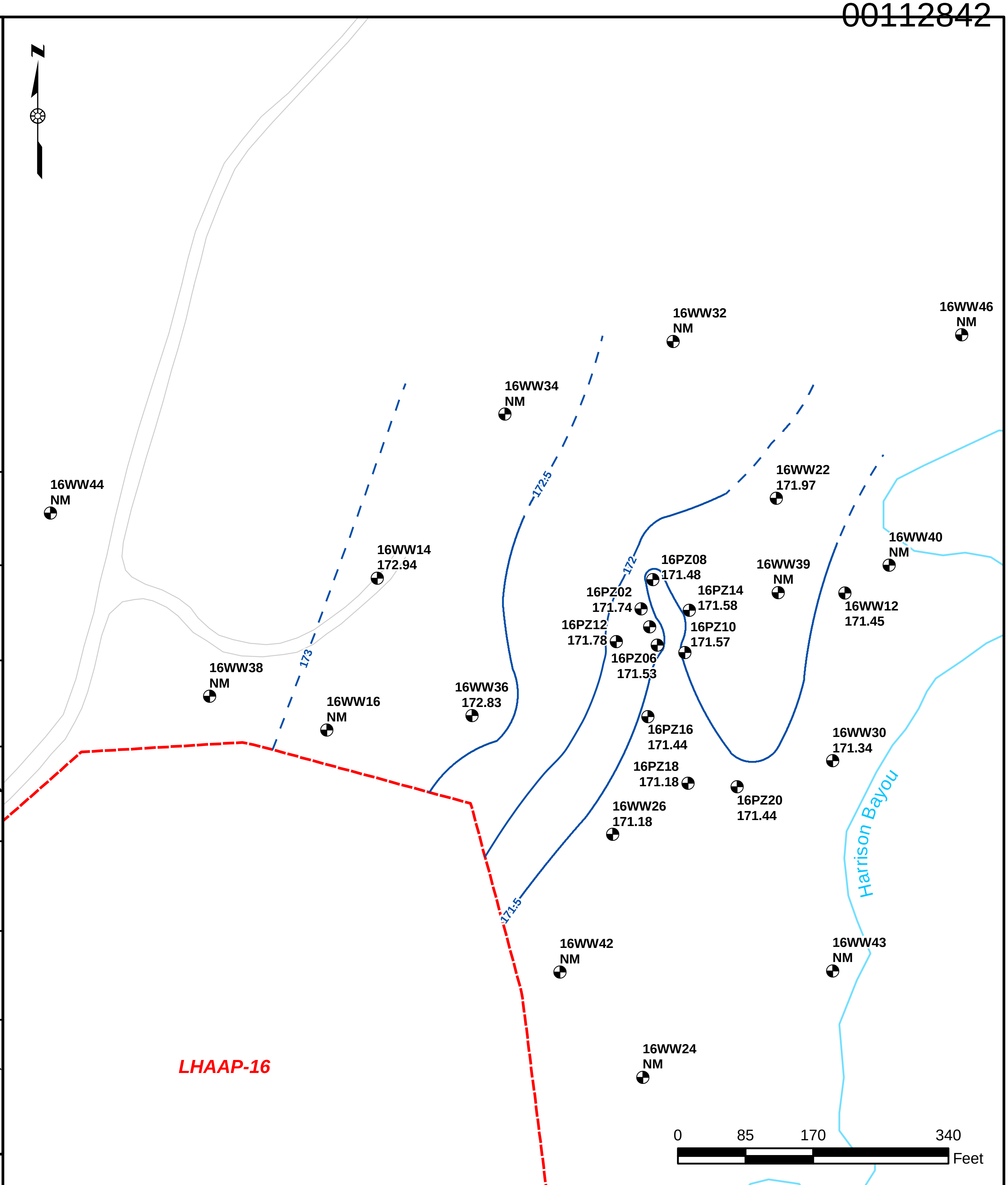
FIGURE 2-7
CONCEPTUAL SITE MODEL
LHAAP-16
NON-SOURCE AREA

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00112842

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		FILE PATH
Houston, TX	B. Grod	10/11/2010	A. Mayila	10/15/2010	Na	10/15/2010	T:\Divisions\Design\GIS\117591_LHAAP\DocMxd\Site16\Rod\Fig2-8_GwShallow.mxd



Legend

- Shallow Monitoring Well
- Groundwater Elevation Countour
- Inferred Groundwater Elevation Countour
- Road
- Harrison Bayou
- LHAAP-16 Landfill Fence

NM - Not Measured

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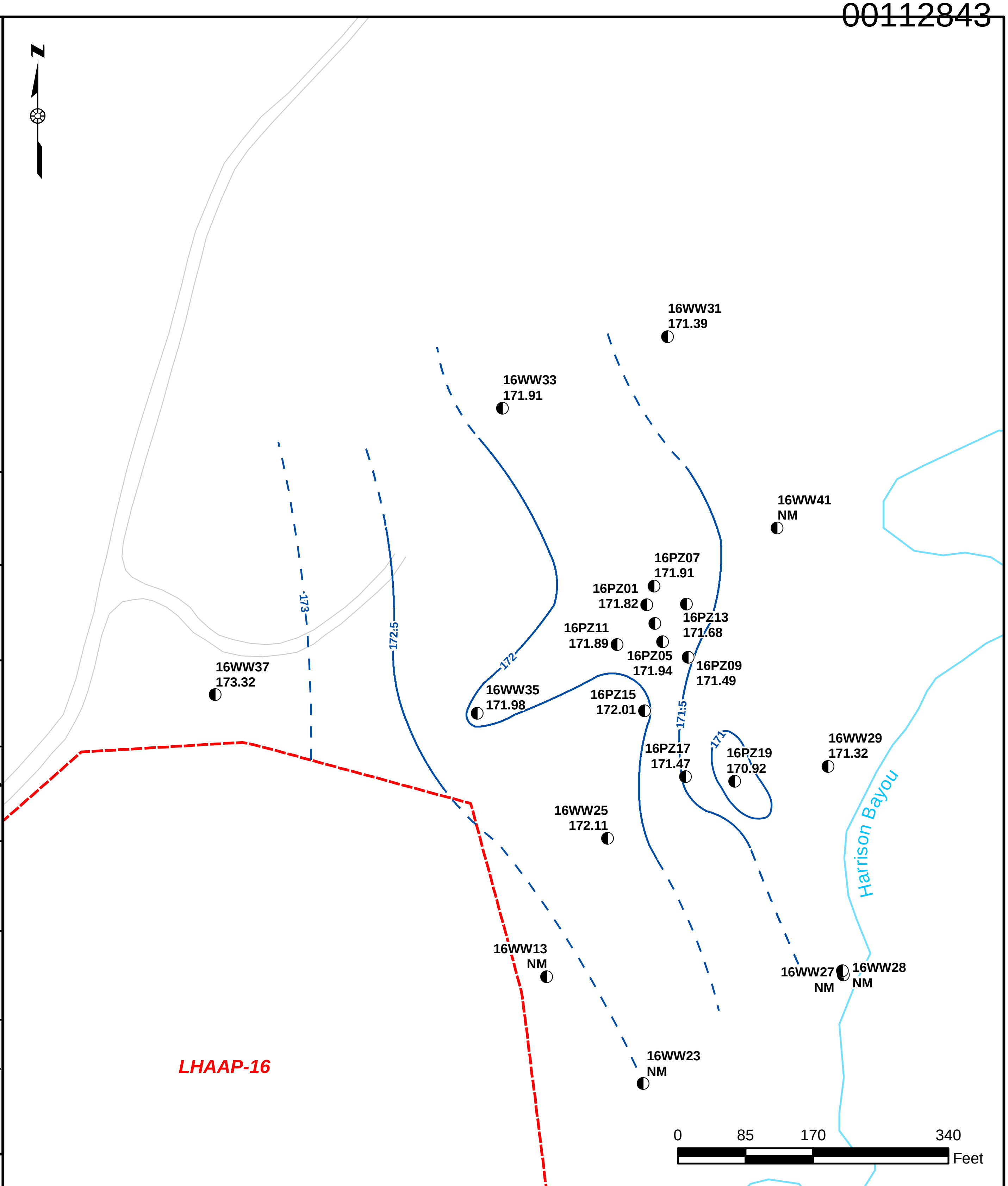
FIGURE 2-8

SHALLOW ZONE
GROUNDWATER ELEVATION MAP
JUNE 2007 DATA
LHAAP-16 RECORD OF DECISION

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00112843



Legend

- ◐ Intermediate Monitoring Well
- Groundwater Elevation Countour
- Inferred Groundwater Elevation Countour
- Road
- Harrison Bayou
- LHAAP-16 Landfill Fence

NM - Not Measured

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FIGURE 2-9

INTERMEDIATE ZONE
GROUNDWATER ELEVATION MAP
JUNE 2007 DATA
LHAAP-16 RECORD OF DECISION

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		FILE PATH
Houston, TX	B. Grod	10/11/2010	A. Mayila	10/15/2010	Na	10/15/2010	T:\Divisions\Design\GIS\117591_LHAAP\DocMxd\Site16\Rod\Fig2-9_GwIntermediate.mxd

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-16 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-16 through public meetings, the Administrative Record for the facility, and announcements published in the Shreveport Times and Marshall News Messenger newspapers. **Section 2.3** discusses community participation on LHAAP-16, including the dates for the public comment period, the date, location, and time of the public meetings, and the location of the Administrative Record. The following documents related to community involvement were added to the Administrative Record:

- Transcript of the public meeting on October 19, 2010
- Presentation slides from the October 19, 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 March 14, 2011.

3.1 Stakeholder Issues and Lead Agency Responses

This section responds to significant issues raised by stakeholders including the public and community groups that were received in written or verbal form.

Question/comment: The Army states that it could take 280 years to reduce groundwater contaminant concentrations to acceptable levels. It is not reasonable to propose plans that could require water quality monitoring, maintenance of the landfill cap, maintenance of the biobarriers, and maintenance of LUCs for such a length of time.

The Army should take steps to reduce the length of time that will be required to achieve acceptable contaminant concentrations. These steps could include: installation of an effective pump and treat system, modification of the proposed in-situ bioremediation system to cover a greater portion of the site and to operate until acceptable concentrations are achieved, thermal treatment (e.g., steam stripping), and elimination or reduction of the contaminant source by removing the landfill or reducing the mass of contaminants that it contains.

Response: Given the nature of the residual contaminants that are present at LHAAP-16, the length of time that will be required to achieve cleanup levels would be long for any of the remedial alternatives, whether treatment, migration control, or source control by removal.

It is believed that TCE was present within the landfill as DNAPL has dissolved into the groundwater at very high concentrations and migrated to the east (down-gradient of the landfill). This high concentration region acts as a secondary source of groundwater contamination. Although TCE may remain in the landfill, the landfill cover system has significantly reduced the driving force of recharge and added a degree of isolation to the remaining waste. Removal of the landfill would not affect the secondary source of groundwater contamination outside the landfill and would be a very large cost without corresponding benefit.

The LUCs restricting the use of groundwater will be highly effective as will be long term maintenance of the LUCs, given that the reasonably anticipated future use of the site is as a national wildlife refuge (i.e., Caddo Lake National Wildlife Refuge) and the owner a federal agency. 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. A national wildlife refuge by its very nature includes physical access and use restrictions, and is subject to control and continual inspection by Refuge personnel. The LUCs will restrict access to the groundwater for purposes other than environmental testing until cleanup levels are met. 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.

Since LHAAP-16 is enclosed within a national wildlife refuge with no current or planned use of groundwater for human consumption, plume stability and protection of Harrison Bayou are key measures for evaluation of a remedial strategy. A detailed analysis of alternatives, including those with aggressive treatments, was conducted according to the evaluation criteria identified in the NCP (40CFR 300.430). Advantages, disadvantages, and trade-offs were considered as part of the evaluation process during the feasibility study (Jacobs, 2002). The suggested alternatives were considered in the FS and were not seen as sufficiently advantageous over the preferred alternative (Shaw, 2010).

Question/Comment: Groundwater contamination at LHAAP-16 is caused by contaminants being leached from wastes in the landfill. The landfill could continue to generate large amounts of contaminants for decades or centuries. The Army's preferred alternative does not attempt to reduce the length of time that the landfill will generate contaminants.

The Army should attempt to reduce the length of time the landfill will generate large amounts of contaminants. This could be done by 1) removing the landfill or 2) treating the landfill to reduce the mass of contaminants it contains (e.g., hot-spot removal, flushing with surfactants or solvents, bioremediation, vapor extraction).

Response: It is believed that TCE was present within the landfill as DNAPL has dissolved into the groundwater at very high concentrations and migrated to the east (down-gradient of the landfill). This high concentration region acts as a secondary source of groundwater contamination. Although TCE may remain in the landfill, the landfill cover system has significantly reduced the driving force of recharge and added a degree of isolation to the remaining waste. The biobarrier will be installed at the edge of the landfill to treat/remediate and thereby control potential migration of contaminants from the landfill. Removal of the landfill would not affect the secondary source of groundwater contamination outside the landfill and would be a very large cost without corresponding benefit. Since LHAAP-16 is enclosed within a national wildlife refuge with no current or planned use of groundwater for human consumption, plume stability and protection of Harrison Bayou are more important measures for evaluation of remedial alternatives than the time factor.

In 1998 a landfill system was placed over the site and was completed as part of an early Interim Remedial Action (IRA) in accordance with the USEPA presumptive remedy guidance under CERCLA for municipal landfills (EPA 540-F-93-035) and for military landfills (EPA 540-F-96-020). Capping as opposed to waste treatment or removal, is a presumptive remedy at landfills as it has been shown to be more appropriate in comparison to other remedies. The IRA was intended to be consistent with the final remedy and is considered a component of the final remedy being proposed for LHAAP-16.

Landfill removal and landfill source treatment alternatives were included in the comparative analysis of alternatives performed during the feasibility study (Jacobs, 2002) and during the generation of the proposed plan (Shaw 2010) for LHAAP-16. These remedial alternatives did not demonstrate increases in effectiveness that were balanced by their increased costs and short-term impacts.

Question/Comment: The Army's 280 year estimate of cleanup time due to natural attenuation is not based on solid evidence. It appears that the Army chose this number because it was the cleanup time calculated for natural attenuation of TCE at well 16WW16. However, a longer TCE cleanup time (492 years) was calculated for well 16WW12. In addition, contaminant concentrations in some wells are stable or increasing rather than decreasing (e.g., perchlorate in well 16WW12, and TCE in well 16WW36). The calculated cleanup time due to natural attenuation for these wells would be infinity.

The Army does not address the question of whether the remedial actions it has conducted at the site have affected the cleanup time calculations. That is, are the contaminant reductions seen at the site due to natural attenuation, the remedial actions, or both?

Response: The duration of 280 years was considered as a reasonable estimate based on the prior history of TCE concentrations at 16WW16. The wells with stable or increasing concentrations are in areas where treatment will be applied, or where biobarriers will cut off renewal of contaminants from upgradient areas. Implementing the remedy is expected to expedite attenuation rates, making them faster, so the worst case scenario at 16WW12 was not chosen as a representative case. Instead the second slowest measurable attenuation was used as an initial estimate for duration.

Contaminant reductions thus far are due to a combination of past actions and natural attenuation. Past actions have removed contaminant mass in some areas of the site and can thus be assumed to have reduced cleanup time in those specific areas, though there is insufficient historical data to quantify the extent of that reduction. The areas most affected in this way would be the capture zone of the extraction wells and a small area immediately down-gradient of the semi-passive biobarrier. The cleanup times at locations that are outside the immediate down-gradient vicinity of the semi-passive biobarrier and far from the extraction wells can be assumed to be outside any significant influence from either of those past actions. Most of the wells at the site (e.g., 16WW16, 16WW12, 16WW43, etc.) are outside those influences.

Question/Comment: The Army intends to evaluate the effectiveness of natural attenuation in a 28 month period following the installation of the biobarriers and the in-situ bioremediation system, and after groundwater extraction has been discontinued. This does not appear to make sense. The effects of the remedial actions will persist for some unknown period of time. How will the Army distinguish between the effects of the remedial actions, and the effects of natural attenuation?

Response: The application of biobarriers and bioremediation will be in discrete areas. The effectiveness of remedial actions will be evaluated for wells in those areas. MNA will be evaluated for wells that are outside the remedial action areas.

Question/Comment: The Army should clearly explain how it will determine whether natural attenuation is reducing contaminants concentrations at an acceptable rate.

Response: The Army intends to present details of the MNA remedy implementation in a remedial design for LHAAP-16. The regulatory guidance established by USEPA (1998) for MNA will be followed to demonstrate that natural attenuation is occurring.

Question/Comment: The passive biobarriers will intercept groundwater only in the shallow zone. However, the intermediate zone also contains high concentrations of contaminants. The Army should explain why it chose not to extend the passive barriers into the intermediate zone.

Response: Biobarriers were not extended into the intermediate zone because the intermediate zone does not intersect surface water in Harrison Bayou. The intermediate zone is deeper than the flowline elevation of the bayou. The highest recent COC concentrations in the intermediate zone are more than 10 times lower than recent COC concentrations in the shallow zone. Nonetheless, the intermediate zone will be addressed via bioremediation injections in the most contaminated locations that have been detected within that zone. MNA will be implemented for areas outside the influence of the active remedies. Monitoring will verify protection of human health and the environment by documenting that further reductive dechlorination is occurring within the plume, that the plume is not migrating, and that contaminant concentrations are being reduced to cleanup levels.

Question/Comment: The pumping of the extraction wells may be limiting the lateral expansion of the contaminant plume. After the extraction wells are shut down, the plume may expand such that it will flow around the ends of the down gradient biobarrier. The Army should consider this possibility in its final remedial design.

Response: There are no plans to remove the extraction system, just to turn it off. The extraction wells will be shut down after application of in situ bioremediation. In situ bioremediation is expected to greatly reduce contaminant concentrations in the application area, minimizing the migration of contaminants toward the biobarrier that will be installed near the bayou. The biobarrier at the landfill is expected to treat contaminated groundwater thereby controlling renewal of the plume at the landfill boundary. The biobarrier is a treatment remedy for contaminated groundwater and not a physical barrier to preventing flow of groundwater. The remnants of the plume are expected to attenuate over time, and groundwater monitoring will continue to check for future potential migration.

Question/Comment: Groundwater up-gradient of Harrison Bayou is highly contaminated, and the contaminant plume emanating from the landfill is discharging to Harrison Bayou. However, there is no reason to believe that Harrison Bayou acts as a complete barrier to groundwater flow. A portion of the contaminant plume may extend beyond the bayou. The Army should install monitor wells to the east of Harrison Bayou to determine the full extent of groundwater contamination.

Response: Since 1999, the Army has collected quarterly surface water samples from three locations in Harrison Bayou. During August 2003 and August 2007, perchlorate was detected in the surface water samples collected from one sampling location in Harrison Bayou (HBW-1) indicating there is some discharge by seepage into Harrison Bayou. Except for the 2 quarters, perchlorate was not detected in any other samples during any other sampling events.

Many wells exist on the east side of Harrison Bayou. The pair of wells closest to the east is 18WW10 (shallow) and 18WW11 (intermediate), which show no COC contamination.

Question/Comment: The proposed monitor well network will not detect contaminants that flow to the southeast of the down gradient barrier. The Army should install at least one shallow and one intermediate monitor well between the southeast end of the barrier and Harrison Bayou.

The proposed monitor well network does not include an intermediate monitor well between the down gradient barrier and Harrison Bayou. The Army should install an intermediate monitor well next to well 16WW40.

The proposed monitor well network will not detect contaminants that flow thorough the northern portion of the down gradient barrier. The Army should install at least one shallow and one intermediate monitor well between the northern portion of the barrier and Harrison Bayou.

The extent of the contaminant plume in the shallow aquifer north of well 16WW22, and in the intermediate aquifer north of well 16WW41, is unknown. The Army should install at least one shallow well and one intermediate monitor well to the north of these wells.

Response: The need for installation of additional monitoring wells will be evaluated during the remedial design.

Question/Comment: The Army Corps of Engineers determined that the eastern portion of the site is within the floodplain of Harrison Bayou. It is not clear, however, whether any portion of the landfill itself is in the floodplain. The Army should determine whether any portion of the landfill is within the floodplain. If it is, steps should be taken to protect the landfill from the effects of flooding.

Response: The southeastern edge of the landfill is within the floodplain (U.S. Department of Housing and Urban Development, Flood Hazard Boundary Map, Harrison County, Texas, Unincorporated Area, Community Panel Number 480847 0004 A, Effective date: September 6, 1977, Converted by Letter Effective 11/1/89). This was known at the time the record of decision was signed for design and construction of the landfill. The southeastern portion of the landfill was designed with a compacted soil berm to protect the cap from flood waters. Additionally, the landfill cap is inspected periodically and maintenance is performed as necessary. The design and the follow-up inspection/maintenance activities are expected to be sufficient to protect the landfill from the effects of flooding.

Question/Comment: The Army is proposing only one sampling point on Harrison Bayou near site 16. Thus, if contaminants are detected, the Army will not be able to determine whether they are coming from site 16 or from an upstream source. In addition, this single sampling point will not detect any site 16 contaminants that enter Harrison Bayou downstream of the point. That is, it will not detect contaminants that may flow around the northern end of the biobarrier, or through the barrier if it fails to function as intended.

Response: Based on groundwater flow and the proximity of Harrison Bayou, sampling location HBW-1 is considered the location most likely to reveal contamination resulting from LHAAP-16. Continued sampling of HBW-1 or a nearby location will be required by the ROD for LHAAP-16. In accordance with a 1999 agreement between Army, TCEQ, and EPA, the Army currently collects quarterly surface water samples from HBW-1 plus two other locations in Harrison Bayou - HBW-10, which is upstream, and HBW-7, which is downstream. While the Army, TCEQ, and EPA might agree to alter the locations of HBW-7 and HBW-10 at some later date, perchlorate results over the last 10 years have indicated that HBW-1 is the location of greatest concern.

In addition, the selected remedy also includes a network of monitoring wells down gradient of the biobarrier in addition to the surface water sampling. Therefore, concentrations of groundwater that has the potential to enter into Harrison Bayou would be known.

Question/Comment: Although Harrison Bayou was not flowing on October 19, 2010, there was a pool of standing water in the streambed. This pool was about 30 feet upstream of well 16WW40, and in the same area as the seep that was sampled in 1995. The pool was approximately 20 feet long, three feet wide, and a few inches deep. This pooled water may be groundwater that has discharged to the streambed. During periods when Harrison Bayou was not flowing, the Army should monitor the streambed for pools of water. If they are present, they should be sampled. The Army should also monitor the banks of Harrison Bayou for seeps and should attempt to sample any that are discovered.

Response: Previous sampling of the standing water in Harrison Bayou indicated that in the past contaminated groundwater discharged by seepage into Harrison Bayou. Because the basis for sampling is protection of human health by protecting the surface water that flows through Harrison Bayou to Caddo Lake, continued sampling of standing water in pools will serve no purpose. Periodic sampling of surface water is already conducted on a quarterly basis at three locations in Harrison Bayou. The banks of Harrison Bayou will be inspected for locations of possible seeps.

Question/Comment: The Army performed a 'streamlined' Human Health Risk Assessment for Harrison Bayou at site 16. This risk assessment found that the excess lifetime cancer risk for dermal contact with Harrison Bayou surface water was 1.62 x 10^{-5}. This is higher than the lower bound (1.0 x 10^{-6}) of the EPA target risk range. The streamlined assessment did not estimate the human health risk from drinking the water, nor did it estimate the effects that the water could have on Caddo Lake. The Army stated that a full risk assessment of Harrison Bayou would be conducted as part of the Group 2 risk assessment. However, site 16 does not appear to have been included in the Group 2 risk assessment. The Army should perform a full Human Health Risk Assessment for Harrison Bayou at site 16.

Response: The calculated risk from surface water (1.62×10^{-5}) was within the range of acceptable risk levels for excess lifetime cancer risk (1×10^{-4} to 1×10^{-6}). The Group 2 Risk Assessment included a risk assessment for Harrison Bayou and sampling location HBW-1, which is associated with LHAAP-16 was included as part of that assessment. Additionally the risk assessment report states "because the depth of this surface water body ranges from a few inches to a few feet, it is unlikely that it would be used to any significant extent for swimming; therefore, the incidental ingestion of surface water is not evaluated".

Question/Comment: Concentrations of antimony and thallium that exceed the EPA MCL are commonly detected in groundwater at site 16. However, the Army has not included antimony or thallium as contaminants of concern (COC). The Army should either include antimony and thallium as a COCs for groundwater at site 16, or explain why they are omitted.

Response: Antimony and thallium are commonly found in groundwater and were detected in groundwater at LHAAP-16. However, they were not found to be significant contributors to cancer risk or non-cancer hazard in groundwater at LHAAP-16 during the human health risk assessment conducted for the site (Jacobs, 2001). The detections of antimony and thallium were erratic and did not appear to represent a plume of contamination. Additionally, they were not detected above background levels in soil at the landfill. These factors indicated that their occurrence was unlikely to be associated with contamination from the landfill. The detections of antimony in groundwater were also within the range of groundwater background values at Longhorn AAP (Shaw, 2007) indicating antimony is naturally occurring at the site. Therefore, antimony has not been included in the list of contaminants of concern at the site. Since thallium does not have a background value and has had historically high detection limits (2003 and 2004 analytical results), additional groundwater sampling for thallium will be integrated into the RD phase for LHAAP-16.

Question/Comment: The Army is using reporting limits for thallium in groundwater that are higher than the EPA MCL. Thus, concentrations of thallium that exceed the MCL may be undetected or unreported. The Army should use a thallium reporting limit that is less than the MCL.

Response: Given the results from 1997 (which had appropriate detection limits) and the lack of significant soil results, the U.S. Army considered thallium in the LHAAP-16 groundwater samples to be naturally occurring sporadic detections that were unrelated to site contamination. However, the Army concurs that analytical results in 2003 and 2004 samples had high detection limits and drive the need for further evaluation of thallium. Thus, thallium will be added to the COC list and will be the subject of additional groundwater monitoring. Monitoring results will be evaluated at the first five-year review to determine if any further monitoring for thallium is warranted.

Question/Comment: High concentrations of dioxins and/or furans have been detected in surface water and groundwater at site 16. However, neither dioxins nor furans are included as COCs for surface water or groundwater. The Army should either include dioxins and furans as COCs, or explain why they are omitted.

Response: The concentrations of dioxins/furans were evaluated as a composited value for total dioxins/furans based on relative toxicities of the individual chemicals. That composited value is the toxicity equivalent (TEQ), and it can be directly compared with the MCL for dioxin. The highest TEQ dioxin concentration was lower than the MCL, so dioxins/furans were not selected as a COC.

Question/Comment: The Army's cleanup level for perchlorate is 26 µg/L. This is TCEQ's groundwater medium specific concentration for residential use (GW-Res). However, the EPA's Health Advisory (HA) level for perchlorate is 15 µg/L. Although the HA is not an enforceable MCL, it is reasonable to assume that when it is finally established, the perchlorate MCL will be similar to the HA. The Army should explain why it did not use the HA level as the cleanup level.

Response: The cleanup level for perchlorate is 26 µg/L, from the TCEQ GW-Res value, which is enforceable in the State of Texas. The Army does not propose unenforceable limits as cleanup levels. If enforceable limits change in the future, or are newly introduced, the difference between the cleanup level and any such new limits will be a subject for discussion during the five-year reviews.

Question/Comment: The final details of the remedial action will be presented in a Remedial Design (RD). The Army should make the RD available for public review and comment as soon as it is developed. The Army's Proposed Plan does not mention the development of a contingency plan to be invoked if the remedial actions are not performing satisfactorily. A contingency plan should be included in the RD.

Response: The public will be provided with updates on remedial design and remedial action status through the RAB meeting and any concerns can be addressed through this forum. The RD will include performance objectives, schedule and other design criteria and will follow established regulatory guidance for MNA.

The concept of a contingency plan for what to do if the remedy is unsuccessful as implemented is inherent in the process of remediation. The remedy must be determined to be operating properly and successfully. Other opportunities for implementing contingency plans will occur with each five-year review.

Question/Comment: The Army reported an average groundwater speed in the shallow zone of 36.7 ft/yr. However, groundwater speeds in the shallow zone range from 0.44 ft/yr - 990 ft/yr.

The higher values may be associated with paleochannels, while the lower values may be associated with ancient overbank deposits that border the paleochannels. When evaluating the transport of contaminants in groundwater, we are usually more concerned with the contaminants that flow most rapidly, rather than those that flow at average or lower speeds.

Response: Noted. The groundwater velocity is not directly measured, but is estimated from groundwater gradients and the average of hydraulic conductivities measured in individual wells. There can be considerable variability of hydraulic conductivity from well to well, so using the average hydraulic conductivity is reasonable for calculating the overall groundwater velocity for the entire site.

Question/Comment: Alternative 7 seems to be the path of least resistance rather than a proactive approach. It appears the Army is trying to do as little as possible for a very contaminated site and not fix the problems for LHAAP-16. The relative low cost was based on the Army's 30 year payout and the possible length of time to remediate the landfill is projected to be 280 years. More investigation should be conducted before finalizing the plans for Site 16 Landfill.

Response: More investigation is not considered necessary to understand the contamination and hydrogeology at LHAAP-16. Additional investigations are unlikely to alter the conclusions that have led to the development of remedial alternatives for the site. Delaying implementation of a remedy to perform more investigations would be less protective of human health than proceeding with the preferred remedy. Besides actively treating the more contaminated portions of the groundwater, the preferred remedy will require monitoring, control of groundwater use, and periodic review of the conditions of the site. The components of the remedy that apply to the more contaminated portions of the groundwater would be implemented within a few years – well within the 30 year period of the cost estimate. Due to the future land use, it is reasonable to utilize monitored natural attenuation to address the remaining contamination over a much longer time period. The preferred remedy has been deemed to be protective of the human health and the environment.

Question/Comment: The Army's proposal for dealing with this highly contaminated landfill consist mostly of future monitoring, periodic groundwater water treatment, and implementing some small barrier walls to hopefully slow down the migration of contaminated groundwater into nearby Caddo Lake. Unfortunately, this is already happening, although the Army claims to not know to what extent. Site 16 landfill remedy has a projected cost of a little less than 2 million dollars for its proposed 30 year clean-up plan. The Army says it will possibly take 280 years to complete the site 16 landfill clean-up; this must indicate that the site is highly contaminated.

Response: A landfill cap and cover system was placed over the site and was completed as part of an early IRA. Landfill cap is a presumptive remedy for municipal landfills (USEPA, 1993) and for military landfills (USEPA, 1996). A landfill cap and cover system eliminated the direct exposure pathway to source area waste material, preventing contaminant transport to surface water via surface runoff, and reducing leaching of contaminants to the groundwater The IRA was intended to be consistent with the final remedy and is considered a component of the final remedy being proposed for LHAAP-16.

Rather than slowing the migration of the contamination, the proposed biobarriers and bioremediation injections are intended to destroy much of the identified contamination. The active remedies that apply to the more contaminated portions of the groundwater would be implemented first and followed by monitored natural attenuation. Due to the future land use, it is reasonable for the preferred alternative to utilize monitored natural attenuation to address the areas outside of the active remedies over a much longer time period.

Question/Comment: Does the Army have a plan for what it intends to do after the first 30 year segment of the clean-up project has been completed? Could it possibly be the same remedy continued, or a new plan at a much greater cost? Or, could it be that nothing will be done because the sands of time have by then washed away all the records and memory of site 16, leaving it for future generations to unknowingly suffer from and possibly have to deal with?

Response: The expectation at this time is that the remedy would continue. At the five-year reviews, the remedy is evaluated and adjusted or changed if necessary.

Question/Comment: The remediation cost is $183.00 per day for LHAAP-16 for 'no' removal of many "known" and "unknown" toxic chemicals buried at the site. Site 16 landfill has been determined by the EPA to be so contaminated it is listed as a Federally Funded Military Superfund Clean-up site. There are most likely metal containers of toxic chemicals buried at the site that will eventually rust through and cause additional soil and groundwater contamination beyond what is currently known or detected.

Response: A detailed analysis of several alternatives including landfill removal was conducted in accordance with the evaluation criteria identified in the NCP (40CFR 300.430). Advantages, disadvantages, and trade-offs were considered as part of the evaluation process during the feasibility study (Jacobs, 2002). The selected remedy for LHAAP-16 was preferred over other alternatives because it provides the best combination of major trade-offs, is protective of human health and the environment and is compliant with regulatory requirements.

Question/Comment: Nearby Caddo Lake may eventually be home to this toxic waste since it is migrating through the soil and groundwater in that direction.

Response: The history of LHAAP-16 indicates the contamination migrates via groundwater flow, not through transport of soil. Contaminated groundwater does exist at LHAAP-16, but is not flowing into Caddo Lake. While sample results for Harrison Bayou surface water indicate that it is within the allowable water quality limits for the contaminants of concern, the groundwater near the bayou has elevated concentrations of those contaminants. The concern for preventing seepage of contaminants to the bayou was a significant factor in proposing a remedial action that includes a biobarrier to intercept that contamination.

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

Glossary of Terms

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

ARARs – Applicable or relevant and appropriate requirements. Refers to the federal and state requirements that a selected remedy will attain.

Attenuation – The process by which a compound is reduced in concentration over time, through absorption, adsorption, degradation, dilution, and/or transformation.

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

Baseline Ecological Risk Assessment (BERA) – A study conducted as part of a remedial investigation to determine the risk posed to environmental receptors by site-related chemicals.

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

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

Chemicals of Concern (COCs) – 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 carcinogenic risk (1 in 10,000 exposed individuals) or the calculated numerical limit of 1 for non-carcinogenic effects, a value proposed by the USEPA.

Chemical of Potential Concern (COPCs) – Those chemicals that are identified as a potential threat to human health or the environment and are evaluated further in the baseline risk assessment. COCs are a subset of the COPCs that are identified in the Remedial Investigation/Feasibility Study as needing to be addressed by the response action proposed in the Record of Decision.

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

Glossary of Terms (continued)

environment. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites and established the Superfund Trust Fund.

Contaminant Plume – A column of contamination with measurable horizontal and vertical dimensions that is suspended and moves with groundwater.

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 binding legal 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.

Maximum Contaminant Level (MCL) – The maximum contaminant level is the maximum permissible level of a contaminant in a public water system. MCLs are defined in the Code of Federal Regulation (40 CFR 141, National Primary Drinking Water Regulations, which implement portions of the Safe Drinking Water Act). The TCEQ has adopted MCLs as the regulatory cleanup levels for both industrial and residential uses. Any detected compound in the groundwater samples with a MCL was evaluated by comparing it to its associated MCL.

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.

Organic Compounds – Carbon compounds such as solvents, oils, and pesticides. Most are not readily dissolved in water.

Perchlorate – Ammonium perchlorate is a strong oxidizing compound that was used in various industries (solid rocket and jet propellant, medical field, and other processes).

Glossary of Terms (continued)

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 process and consideration of public comments on the 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, transport, 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, including responses to these comments. The responsiveness summary is a key part of a ROD highlighting community concerns.

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. 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.

Surface Media – The soil (surface or subsurface), surface water, and sediment present at a site as applicable.

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.

Trichloroethene (TCE) – TCE is a colorless or blue liquid with an odor similar to ether. It is man-made and does not occur naturally in the environment. TCE was once commonly used to remove oils and grease from metal parts and is used in the dry cleaning industry.

Appendix A

Public Meeting Newspaper and Media Notices

PUBLIC NOTICE
THE UNITED STATES ARMY INVITES PUBLIC COMMENT ON THE PROPOSED PLAN FOR ENVIRONMENTAL SITE LHAAP-16
LONGHORN ARMY AMMUNITION PLANT, TEXAS
PUBLIC MEETING ON OCTOBER 19, 2010,
AT THE CADDO LAKE STATE PARK RECREATIONAL FACILITY

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 (USEPA), the U.S. Army has developed the Proposed Plan for NPL site LHAAP-16. Although the Proposed Plan for LHAAP-16 identifies the preferred remedy for the site, the U.S. Army welcomes the public's review and comments. Beginning on October 10, 2010 copies of the Proposed Plan and supporting documentation will be available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670. The public comment period is October 10, 2010, through November 9, 2010. **The public meeting will be held on Tuesday, October 19, 2010 at the Caddo Lake State Park Group Recreation Hall from 7:00 PM to 9:00 PM.** Caddo Lake State Park is located at 245 Park Road 2 near Karnack, Texas off of FM 2198 between SH 43 and Old Farm to Market Road 134, approximately 1 mile north from the Karnack Pos Office (and front gate of the former Longhorn Army Ammunition Plant). The park entrance fee will be waived for the attendees of this meeting. Questions, comments, and responses on the Proposed Plan will be recorded by a court reporter during the public meeting. Written comments will be accepted throughout the public comment period.

Longhorn Army Ammunition Plant (LHAAP) is an inactive, government-owned, formerly contractor-operated and -maintained industrial facility located in central-east Texas in the northeastern corner of Harrison County. The installation occupies nearly 8,416 acres between State Highway 43 at Karnack, Texas, and the western shore of Caddo Lake. LHAAP was established in December 1941 near the beginning of World War II for the manufacture of trinitrotoluene. Other past industrial operations at the installation included the use of secondary explosives, rocket motor propellants, and various pyrotechnics, such as illuminating and signal flares and ammunition. LHAAP was found to have actual and potential releases of hazardous substances or pollutants or contaminants associated with past operations, and it was added to the National Priorities List (NPL) in 1990.

LHAAP-16 encompasses an area of approximately 20 acres in the south-central portion of LHAAP. Harrison Bayou runs along the northeastern edge of LHAAP-16. The landfill was established in the 1940s and was used for disposal of solid and industrial wastes until the 1980s when disposal activities were terminated. The Army and USEPA signed a Record of Decision in 1995 approving an interim remedial action for LHAAP-16 to mitigate potential risks posed by buried source material at the landfill. The interim remedial action included the construction of a multilayer landfill cap, which was completed in 1998.

The current Proposed Plan for LHAAP-16 addresses groundwater contamination as well as material buried in the landfill at the site. Continued maintenance of the existing landfill cap has been retained as a component of most of the remedial alternatives considered for the site. In addition, most alternatives include specific measures for groundwater remediation, and all alternatives utilize some degree of land use controls (LUCs). The full list of alternatives is: I) No action; 2) Cap, enhanced groundwater extraction; 3a) Cap, monitored natural attenuation; 3b) Cap, hot spot extraction, monitored natural attenuation; 4) Cap, passive groundwater treatment; 5a) Landfill hotspot removal, passive groundwater treatment; 5b) Complete landfill removal, passive groundwater treatment; 6) Landfill Source Treatment (in situ), monitored natural attenuation; and 7) Cap, monitored natural attenuation, in situ enhanced bioremediation, passive bio barriers. Based on available information, the preferred remedy is Alternative 7, which addresses the groundwater contamination at LHAAP-16 in a manner that is cost-effective and consistent with the Army's intent to transfer the site to the USFWS for use as a wildlife refuge. Alternative 7 would be protective of human health due to the implementation of LUCs prohibiting unauthorized use of the cap and groundwater, thereby eliminating the potential contaminant exposure pathways for human receptors. The bioremediation and bio barriers would reduce contaminant concentrations in groundwater and prevent discharge of contamination to Harrison Bayou.

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 a Proposed Plan for the environmental site LHAAP-16 Landfill, at the Longhorn Army Ammunition Plant. The Proposed Plan is the document that describes LHAAP-16 and its proposed remedies. The Proposed Plan was developed to facilitate public involvement in the remedy selection process.

Copies of the Proposed Plan and other supporting documentation for LHAAP-16 are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670. The public comment period is October 10, 2010 through November 9, 2010.

A public meeting will be held on October 19, 2010, from 7:00 to 9:00 p.m. at the Caddo Lake State Park Group Recreation Hall located at 245 Park Road 2 off FM 2198, between SH 43 and Old Farm to Market Road 134 near Karnack, Karnack, Texas approximately 1 mile north from the front gate of the former Longhorn Army Ammunition Plant. The park entrance fee will be waived for attendees of this meeting.

All written public comments on the Proposed Plan must be postmarked on or before November 9, 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 November 9, 2010.

FINAL

RECORD OF DECISION
LHAAP-001-R (SOUTH TEST AREA/BOMB TEST AREA) AND LHAAP-003-R (GROUND SIGNAL TEST AREA)
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

ON THE LINE

Prepared for

U.S. Army Corps of Engineers
Tulsa District
1645 South 101st East Avenue
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Prepared by

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
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MARC No. W912BV-07-D-2004, Task Order No. 0007
Shaw Project No. 133363

September 2011

Table of Contents

Table of Contents (continued)

List of Tables

List of Figures

List of Appendices

Glossary of Terms

Located at the end of this Decision Document

Acronyms and Abbreviations

μg/kg	microgram per kilogram
μg/L	microgram per liter
AM	action memorandum
BERA	baseline ecological risk assessment
bgs	below ground surface
BIP	blow-in-place
CD	cultural debris
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CTT	closed, transferring, and transferred
DNT	Dinitrotoluene
DoD	Department of Defense
EE/CA	Engineering Evaluation/Cost Analysis
EPS	Environmental Protection Systems, Inc.
FFA	Federal Facility Agreement
ft	foot/feet
GW-Ind	groundwater MSC for industrial use
GWP-Ind	soil MSC for industrial use based on groundwater protection
HMX	high-molecular-weight RDX or high melt explosive
HRR	historical records review
IRP	Installation Restoration Program
LHAAP	Longhorn Army Ammunition Plant
LUC	land use control
MC	munitions constituents
MCL	maximum contaminant level
MD	munitions debris
MEC	munitions and explosives of concern
mm	Millimeter
MMRP	Military Munitions Response Program
MOA	memorandum of agreement
MPPEH	material potentially presenting an explosive hazard
MRS	munitions response site
MSC	medium-specific concentration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	no further action
NPL	national priorities list
OB/OD	open burn/open detonation
RAB	Restoration Advisory Board
RDX	research department explosive (hexahydro-1,3,5-trinitro-1,3,5-triazine)

Acronyms and Abbreviations *(continued)*

ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
Shaw	Shaw Environmental, Inc.
SI	site inspection
STEP	Solutions to Environmental Problems
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TNT	Trinitrotoluene
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
WP	white phosphorus

1.0 Declaration

1.1 Site Name and Location

Military Munitions Response Program (MMRP) Sites LHAAP-001-R, South Test Area/Bomb Test Area, and LHAAP-003-R, Ground Signal Test Area.

Longhorn Army Ammunition Plant (LHAAP)
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 remedy for LHAAP-001-R and LHAAP-003-R, located at the Longhorn Army Ammunition Plant in Karnack, Texas. The remedy was selected 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), 40 Code of Federal Regulations (CFR) Part 300.

The remedy selection was based on the Administrative Record file for these sites, including the Site Inspection (SI) Report (e^2M, 2005), the Engineering Evaluation/Cost Analysis (EE/CA) (Cape, 2007) and Action Memorandum (AM) (U.S. Army, 2007), the Munitions Constituents (MC) Data Summary Report (Shaw Environmental, Inc. [Shaw], 2011), the Munitions and Explosives of Concern (MEC) Removal Action Report (EODT Technology, Inc. [EODT], 2009), the Installation-wide Baseline Ecological Risk Assessment (BERA) Report (Shaw, 2007), the Proposed Plan (U.S. Army, 2011), and other related documents contained in the Administrative Record for the Munitions Response Sites (MRS) LHAAP-001-R and LHAAP-003-R.

This document is issued by the U.S. Army, the lead agency for this installation. The 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 at the former LHAAP. The USEPA and the Army jointly select the remedy and TCEQ concurs with LUCs and limited groundwater monitoring in this Record of Decision (ROD).

1.3 Assessment of the Site

The response action selected in this ROD is necessary to protect the public health and safety from explosive hazards that may have remained at the sites after the 2008 removal action and to confirm that the levels of perchlorate in groundwater are protective of human health.

1.4 Description of the Selected Remedy

The selected remedy for LHAAP-001-R and LHAAP-003-R is implementation of LUCs and limited groundwater monitoring for perchlorate, in addition to the completed removal action. The lead agency has determined that the LUCs identified in the 2008 removal action and a LUC restricting use to nonresidential are necessary to protect public health and safety related to MC or MEC at LHAAP-001-R, South Test Area/Bomb Test Area, and LHAAP-003-R, Ground Signal Test Area, and that limited groundwater monitoring for perchlorate will be conducted to confirm that the levels in groundwater are below 72 µg/L, the State of Texas groundwater medium-specific concentration (MSC) for industrial use (GW-Ind).

Throughout the ROD document for these two MRS, the term MC refers to the data gap constituent of white phosphorous (WP) and the emerging contaminant perchlorate. U.S. Army, regulators, and project stakeholders met in 2005 for technical planning meetings and agreed that metals and explosives, typically included as MCs, were addressed with the Installation Restoration Program (IRP) RODs signed in 1998 for Sites LHAAP-27 and LHAAP-54. These sites are co-located with MRS LHAAP-001-R and LHAAP-003-R, respectively.

MEC items were found at both sites during the EE/CA investigations. Subsequently, MEC items were located and removed during surface removals over the entire areas of LHAAP-001-R and LHAAP-003-R, and a subsurface removal to depth in the open burn/open detonation (OB/OD) area within LHAAP-001-R. Although these removal actions provide an effective solution for reducing risk of exposure by reducing the potential for any direct contact with MEC or material potentially presenting explosive hazard (MPPEH), there is the potential that some MEC remains. Therefore, the sites are not suitable for unrestricted use. LUCs for both LHAAP-001-R and LHAAP-003-R promote ongoing protection of human safety against potential explosive hazards that may have remained at the sites. The LUCs are: 1) restrictions against intrusive activities include digging, 2) restriction to nonresidential use only, 3) warning signage at the perimeter of the sites, and, 4) education programs for future refuge visitors, staff, and volunteers (EODT, 2009).

Environmental sampling results at LHAAP-001-R and LHAAP-003-R indicate that there is no risk to human health and safety from perchlorate or WP. Limited groundwater monitoring is intended to confirm perchlorate levels in groundwater are below the GW-Ind to verify protection of human health and the environment. If, after three rounds of groundwater sampling at LHAAP-001-R and one round of groundwater sampling at LHAAP-003-R, the results that are evaluated on or before the first five year review indicate detections at levels below the GW-Ind value of 72 micrograms per liter (µg/L) for perchlorate, groundwater monitoring will cease and the wells will be plugged and abandoned.

Monitoring in the form of Five-Year Reviews will be conducted to ensure that the LUCs are specified, implemented, monitored, reported on, and enforced in an efficient, cost effective manner that ensures long-term protectiveness. Texas Administrative Code (TAC) §335.566, requires that the LUCs be filed in Harrison County. With the exception of the nonresidential LUC, the specific LUCs and implementation details are provided in the Final Work Plan for the MEC Removal Action at the Former Longhorn Army Ammunition Plant, LHAAP-001-R (Site 27) and LHAAP-003-R (Site 54) (EODT, 2008). A LUC RD will be prepared within 90 days of the ROD. LUC boundaries and sign locations are depicted on **Figures 2-7** and **2-8**. The U.S. Army will remain responsible for implementation, maintenance, periodic inspection, reporting on and enforcement of the LUCs in accordance with the LUC plan in Appendix I of the removal action work plan (EODT, 2008). Although the U.S. Army may transfer these responsibilities to another party through property transfer agreements 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 the LUC and any related transfer or lease provisions; and (5) ensuring the protectiveness of the selected remedy.

The U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of a LUC objective at these sites after they have 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 industrial/recreational use assumptions of the remedy. In the event that TCEQ and/or USEPA and the U.S. Army agree with respect to any significant modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the Federal Facility Agreement (FFA) and 40 CFR. §300.435(c)(2).

1.5 Statutory Determinations

The statutory preference for treatment was addressed with the MEC removal action which removed source material from the site and destroyed MEC. The selected remedy, implementation of LUCs identified in the 2008 removal action and the nonresidential LUC are protective of human health and safety, complies with Federal and State requirements that are applicable or relevant and appropriate, and is cost effective. In addition, the remedy offers long-term effectiveness through the maintenance and implementation of LUCs that over the long term will reduce reduces risk associated with potential MEC hazards that may have remained at the sites. The limited groundwater monitoring for perchlorate will confirm perchlorate level in groundwater is below GW-Ind.

Because explosive hazards may remain at the sites that do not allow for unlimited use and unrestricted exposure, five-year reviews will be conducted for MRS LHAAP-001-R and LHAAP-003-R to ensure protection of human health and safety 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 restriction against intrusive activities, including digging, is in place. 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. Additional information can be found in the Administrative Record for this site.

- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater as identified in the streamlined risk assessment and ROD (**Section 2.6**).
- Potential land and groundwater use that will be available at the sites as a result of the selected remedy (**Section 2.6**).
- COCs and their concentrations (**2.7**).
- Baseline risk represented by the COCs (**2.7**).
- Cleanup levels established for COCs and the basis for these levels (**Not Applicable**).
- How source materials constituting principal threats are addressed at this site (**Section 2.11**).
- Key factor(s) 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**).

00112875

1.7 Authorizing Signatures

As the lead agency, the U.S. Army issues this ROD for LHAAP-001-R and LHAAP-003-R which documents the selected remedy. The undersigned is the appropriate approval authority for this decision.

Thomas E. Lederle 29 Sep 2011

Thomas E. Lederle *(Date)*
Industrial Branch Chief
BRAC Division, ACSIM
U.S. Army

The U.S. Environmental Protection Agency approves the selected remedy as provided in the ROD for LHAAP-001-R and LHAAP-003-R.

__________________________ ___________

Samuel Coleman, P.E. *(Date)*
Director
Superfund Division
U.S. Environmental Protection Agency
Region 6

2.0 Decision Summary

2.1 Site Name, Location, and Description

LHAAP-001-R, South Test Area/Bomb Test Area, and LHAAP-003-R, Ground Signal Test Area

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 (DoD)

Source of Cleanup Money: U.S. Army, DoD and MMRP

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

LHAAP was placed on the 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 Section 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 sites addressed in this ROD are LHAAP-001-R and LHAAP-003-R, which are shown on **Figure 2-2** and discussed below.

LHAAP-001-R, the South Test Area/Bomb Test Area, is located in the southern portion of LHAAP and covers an area of approximately 79 acres. LHAAP-001-R was constructed in 1954 and used for testing photoflash bombs produced at the facility until about 1956. During the late 1950s, illuminating signal devices were also demilitarized within pits excavated in the vicinity of the test pad. During the early 1960s, leaking production items may have been demilitarized by detonation. Leaking WP munitions were supposedly disposed of although no primary source documentation concerning this effort was located. A 1984 LHAAP Contamination Survey stated the area had been relatively inactive since the early 1960s and no disposal or testing activities were carried out in this area. LHAAP-001-R is co-located with IRP site LHAAP-27.

LHAAP-003-R, the Ground Signal Test Area, is located in the southeastern portion of LHAAP and covers an area of approximately 80 acres. LHAAP-003-R was used intermittently starting in April 1963 for aerial and on-ground testing and destruction of a variety of devices, including pyrotechnic signal devices, red phosphorus smoke wedges, infrared flares, illuminating mortar shells and cartridges, button bombs, and various types of explosive simulators. The site was also used intermittently over a 20-year period for testing and burn-out of rocket motors. From late 1988 through 1991, the site was also used for burn-out of Pershing missile rocket motors. Occasionally, leaking WP munitions were burned at the site as a demilitarization activity. LHAAP-003-R is co-located with IRP site LHAAP-54.

These sites are surrounded by an area (approximately 7,000 acres) that was 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 U.S. Army, the lead agency for environmental response actions at LHAAP, is acting in partnership with USEPA Region 6 and TCEQ in planning and implementing remedial actions at MRS LHAAP-001-R and LHAAP-003-R.

2.2 Site History and Enforcement Activities

2.2.1 Site History

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. In 1952, the facility was reactivated and production of pyrotechnic ammunition, such as photoflash bombs, simulators, hand signals, and tracers for 40 millimeter (mm) ammunition continued at Plant 2 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 as the primary operation at LHAAP until 1965 when Plant 2 was 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 DoD 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 (USSR).

LHAAP-001-R: The site was identified in the U.S. Army Closed, Transferring, and Transferred (CTT) Range/Site Inventory as 6.75 acres in size; however, a 1981 aerial photograph, historical records, a site visit, and a teleconference on 17 May and 18 May 2005 between U.S. Army Corps of Engineers (USACE) and U.S. Army Environmental Center indicated the site should be 79 acres including Demolition Sub Areas 1, 2 and 3.

The LHAAP-001-R site was constructed in 1954 and used by Universal Match Corporation for testing M120A1 photoflash bombs produced at the facility until about 1956. The bombs were tested by exploding them in the air over an elevated, semi-elliptical earthen test pad. Bombs awaiting testing were stored in three earth-covered concrete bunkers. The bombs tested were 150-pound M120/M120A photoflash bombs filled with photoflash powder and containing a black powder booster charge for bursting the bomb and a timed nose fuze.

During the late 1950s, illuminating signal devices were also demilitarized within pits excavated in the vicinity of the test pad at the site. During the early 1960s, leaking production items such as XM40E5 “button bombs” may have been demilitarized by detonation in the South Test Area/Bomb Test Area (LHAAP-001-R) or the Ground Signal Test Area (LHAAP-003-R). The XM40E5 is a small (approximately 1- by 1.25-inch) anti-intrusion mine also referred to as a "Gravel" Mine, which explodes on impact. It is believed that leaking WP munitions were disposed of in this area although no primary source documentation concerning this effort was located. Occasional leaking WP munitions were burned at the site as a demilitarization activity. Other sources indicate that possibly 3- to 4-pound canisters of WP were demilitarized in the vicinity of the test pad. The 1984 LHAAP Contamination Survey (Environmental Protection Systems, Inc. [EPS], 1984) stated the area has been relatively inactive since the early 1960s and no disposal or testing activities were carried out in this area.

LHAAP-003-R: The site was used intermittently starting in April 1963 for aerial and on-ground testing and destruction of a variety of devices, including pyrotechnic signal devices, red phosphorus smoke wedges, infrared flares, illuminating 60 and 81 mm mortar shells, illuminating 40 to 155 mm cartridges, button bombs, and various types of explosive simulators. The site was also used intermittently over a 20-year period for testing and burn-out of rocket motors from Nike-Hercules, Pershing, and Sergeant missiles systems. Around 1970, a Sergeant rocket motor reportedly exploded in an excavated pit near the center of the site. Debris was reportedly placed in the resulting crater and backfilled. However, later MEC clearance to depth in the area found no rocket motor. From late 1988 through 1991, the site was also used for burn-out of rocket motors in Pershing missiles destroyed in accordance with the Intermediate-Range Nuclear Forces Treaty between the United States and the former USSR. Occasionally, leaking WP munitions were burned at the site as a demilitarization activity.

2.2.2 Enforcement Activities

Due to the release of hazardous substances, pollutants, and contaminants from operation and maintenance activities at the facility, the USEPA placed LHAAP on the NPL on August 9, 1990.

Activities to remediate contamination associated with the listing of LHAAP as an NPL 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 Section 120 FFA for remedial activities at LHAAP. The FFA became effective December 30, 1991.

2.3 Community Participation

The U.S. Army, USEPA, TCEQ and the Restoration Advisory Board (RAB) have provided public outreach to the surrounding community concerning LHAAP-001-R and LHAAP-003-R, and other environmental sites at LHAAP. The outreach program has included fact sheets, media interviews, site visits, invitations to attend quarterly RAB 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 Proposed Plan (U.S. Army, 2011) for the LUCs and limited groundwater monitoring for perchlorate for both LHAAP-001-R and LHAAP-003-R was released to the Administrative Record file and made available to the public for review and comment on July 13, 2011. A notice of availability of the Proposed Plan and other related documents in the Administrative Record file was published in the *Marshall News Messenger* on June 29, 2011. A 30-day public comment period for the Proposed Plan began on July 13, 2011. The public meeting was held on July 21, 2011. Written comments were received from the general public.

The Administrative Record may be found at the information repositories maintained at the following locations:

Public Library

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.

Longhorn Army Ammunition Plant

Location:	U.S. Army Office Trailer Longhorn Army Ammunition Plant Karnack, Texas 75670

2.4 Scope and Role of Operable Unit or Response Action

The land on which these sites are located is excess to the U.S. Army's needs and is intended for transfer to the USFWS for incorporation into the Caddo Lake National Wildlife Refuge. Future anticipated use is consistent with an industrial/recreational level of exposure. These two sites can be addressed independent of response actions at other environmental sites at LHAAP.

2.5 Site Characteristics

This section of the ROD presents an overview of LHAAP-001-R and LHAAP-003-R 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 Physical Characteristics

2.5.1.1 LHAAP-001-R

LHAAP-001-R is located near the southern boundary of LHAAP (**Figure 2-2**). The surface features at LHAAP-001-R include a deteriorated asphalt and gravel road running from the entrance to the test pad. Concrete bunkers and the site of the demolished former observation building are located alongside the road about halfway between the entrance and the test pad. A circular, 50-foot (ft) wide fire lane with a 2,000-ft diameter is centered at the test pad. Since the observation building has been demolished, the site is currently overgrown with brush and small trees. Formerly cleared areas in the vicinity of the test pad and alongside the access road are also overgrown with vegetation.

Soil at the site consists of interbedded silty and clayey sands, sandy silts, and clays of the Wilcox Group. The topography slopes gently to the east and surface water runoff from the hillside flows generally to the southeast and into Harrison Bayou. Groundwater at the site was encountered between 7 and 9 ft below ground surface (bgs). Groundwater is topographically controlled with a general flow direction to the east toward the floodplain of Harrison Bayou.

2.5.1.2 LHAAP-003-R

LHAAP-003-R is located in the southeastern portion of LHAAP (**Figure 2-2**). Surface features at LHAAP-003-R include an asphalt road (Haystack Road) that intersects Long Point Road just east of its intersection with Avenue Q. The site is currently undeveloped and has become overgrown with woody vegetation.

The site is located within the watersheds of Saunders Branch and Harrison Bayou. Both Saunders Branch and Harrison Bayou flow into Caddo Lake. Surface water runoff from the site is towards drainage ditches located alongside the circular dirt road forming the outer margin of the site. The ditches converge to the northeast and the southwest directing surface water to Saunders Branch and Harrison Bayou, respectively.

Soil at the site consists of interbedded silty and clayey sands, sandy silts, and clays of the Wilcox Group. The depth to groundwater at the site averages about 15 feet bgs with some seasonal fluctuations. The regional groundwater flow direction is to the north-northeast toward Caddo Lake; however, during periods of high precipitation the groundwater flow direction in the southwestern portion of the site diverts to the northwest towards Harrison Bayou.

2.5.2 Nature and Extent of Contamination

MMRP sites LHAAP-001-R and LHAAP-003-R are co-located with the IRP sites LHAAP-27 and LHAAP-54, respectively. Between 1982 and 1996, several investigations were conducted in a phased approach to determine the nature and extent of contamination at LHAAP-27 and LHAAP-54. Media investigated included soil, groundwater, surface water, and sediment. Based on the results of the investigations and the risk assessment conducted for the sites, an IRP no further action (NFA) ROD under CERCLA for Hazardous, Toxic, and Radioactive Waste was signed with regulatory concurrence in January of 1998 for LHAAP-27 and LHAAP-54 (USACE, 1998).

From 2002 to 2007, investigations related to the MMRP were conducted at LHAAP. As a result of the records review for the U.S. Army CTT Range/Site Inventory in 2002, the South Test Area/Bomb Test Area and Ground Signal Area were designated LHAAP-001-R and LHAAP-003-R, respectively (e^2M, 2002). For these two MRS, investigations were conducted to determine the presence or absence of MEC, and to address the identified data gaps including WP and perchlorate.

2.5.2.1 LHAAP-001-R

Perchlorate was identified as an emerging contaminant and perchlorate data for environmental media was collected after the 1998 NFA ROD was signed. In May and October 2000, a total of 26 soil samples were collected from 13 soil borings (27SB01 through 27SB13) and analyzed for perchlorate (Solutions to Environmental Problems [STEP], 2005). Two samples were collected from each boring from two depth intervals; 0 to 0.5 ft and 1 to 2 ft bgs. Perchlorate was detected in only one (27SB01 at depth of 0 to 0.5 ft) of the 26 soil samples at a concentration of 28.9 micrograms per kilogram (µg/kg), a level lower than the MSC for industrial use based on groundwater protection (GWP-Ind) value of 7,200 µg/kg.

During three consecutive quarterly sampling events, groundwater samples were collected from six existing shallow monitoring wells to determine whether perchlorate was present in the underlying groundwater as a result of past historical activities. The six monitoring wells are located in areas with the highest potential for impact from site activities and in the direction of flow across the site from west to east toward Harrison Bayou. During the first quarter (April to May 2000), four groundwater samples were collected from four existing monitoring wells (MW-131, MW-132, 27WW01, 27WW04). Perchlorate was detected in two of the wells, 27WW01 and 27WW04, at concentrations of 52.6 and 16.4 µg/L, respectively. Both levels were below the groundwater MSC for industrial use (GW-Ind) value of 72 µg/L. No maximum contaminant level (MCL) exists for perchlorate. Perchlorate concentrations were below detection limits in all the six monitoring wells (MW-131, MW-132, 27WW01 through 27WW04) sampled during the second quarter (August through October 2000). During the third quarter, January through February 2001, perchlorate was not detected in the groundwater samples collected from three sampled wells, MW-131, 27WW01, and 27WW04. Two of the six wells at LHAAP-001-R were not sampled during two of the three sampling events.

In October 2009, USEPA collected additional groundwater samples from the existing six monitoring wells to confirm groundwater conditions at the site. Perchlorate was detected in three wells with only one of the three above the GW-Ind value of 72 μg/L at a concentration of 76 μg/L. The USEPA's perchlorate detection of 76 μg/L was an estimate from a diluted sample. The U.S. Army collected split samples at the same time that the USEPA collected samples from the six monitoring wells. Perchlorate was detected in two wells for the U.S. Army split samples, with a maximum concentration below the GW-Ind value of 72 μg/L (Shaw, 2011).

In March 2003, USFWS conducted an investigation at the former LHAAP facility to determine contaminant levels in soil and sediment (USFWS, 2003). Soil samples were collected from five locations (FWS-055, -056, -058, -063, and -201) within LHAAP-001-R. Soil analytical results indicated that metals and semivolatile organic compounds were detected at low concentrations, but not above screening levels, and the site was not included as one of the areas requiring further evaluation. Perchlorate was not detected above the reporting limit.

Between 2002 and 2004, a MMRP SI was conducted for LHAAP-001-R to determine the presence or absence of MEC and/or MC at the site which may have remained from activities conducted by the DoD during operations of the MRS, and may pose a threat to human health and/or the environment (e^2M, 2005).

Results of the historical records review (HRR) and a visual site inspection verified MEC presence at the site. Possible sources areas for MEC and MC identified during the SI included the following:

- Testing areas associated with the various suspected ordnance types.
- A Demolition Area located within the footprint of LHAAP-001-R. This area was reportedly designed for detonation of dangerous/unserviceable ammunition.
- Spent flares, a 155 mm WP projectile, shrapnel from photoflash bombs, and ordnance related scrap found on the site.

The SI identified a data gap in earlier soil sampling, in that, although demilitarization activities including open pit burning and explosive detonation were conducted at the site, no analysis for the munitions constituent WP was performed at the site. The SI recommended that further investigation be conducted to address the identified data gap.

In 2007, an EE/CA was conducted to facilitate completion of a non-time-critical removal action of MEC at the site (CAPE, 2007). Field activities conducted during the EE/CA characterized MEC and addressed the WP data gap at the site. Twenty-one (21) MEC and MPPEH items along with 700 pounds of munitions debris (MD) were recovered at the surface or within the top 6 inches of the soil. The items were clustered within an area suspected of the use of OB/OD activities, although never permitted as an OB/OD unit. The suspected OB/OD area is approximately 14 acres in size.

Based on the heaviest MPPEH concentrations or historical detonations, soil samples were collected within LHAAP-001-R to determine if evidence of WP existed in areas where MC was most likely to exist. One soil sample (BTA-27-LHAAP-001-RS-01A) was collected near the center of the suspected OB/OD area. A second soil sample (BTA-27-LHAAP-001-RS-01B) was collected in a scarred area identified as the photo flash cartridge disposal area in the historical review. Both areas are near locations where MPPEH items were recovered during the field investigations. In addition, pre- and post-detonation samples were collected in association with explosive demolition of MPPEH recovered during the field activities. Soil samples were collected from 0 to 6-inches bgs. Analytical results indicated that neither WP nor explosives (1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2,4,6-TNT, 2,4-dinitrotoluene (DNT), 2,6-DNT, 2-amino-4,6-DNT, 2-nitrotoluene, 3-nitrotoluene, 4-amino-2,6-DNT, 4-nitrotoluene, HMX, nitrobenzene, RDX, and tetryl) were identified at concentrations above detection limits in any soil samples at the site. In addition, there was no indication of the presence of explosives in any of the pre- or post-detonation samples. The removal action objective of protection of human health from WP and explosives at unacceptable concentrations had been achieved as demonstrated by the soil analytical results. All site sample locations are shown on **Figure 2-3**.

The EE/CA recommended surface and subsurface removal of MEC items with LUCs to reduce the risk within LHAAP-001-R. Between August and November 2008, a MEC non-time-critical removal action was conducted and LUCs were developed for the site (EODT, 2009). Surface clearance of the entire site and subsurface clearance to the depth of detection was performed at LHAAP-001-R. Magnetometer-assisted surface clearance was performed for the entire site of approximately 79 acres. Site preparations included brush removal. The clearance team worked in grids and established 5-ft sweep lanes within each grid, removing and disposing of all surface MEC and MPPEH, MD, cultural debris (CD), and range-related debris. A total of 90 MEC/MPPEH items were located and destroyed, and a total of 6,742 pounds of MD and 154 pounds of CD were removed during the course of surface clearance.

Subsurface MEC removal was conducted for the suspected OB/OD area of approximately 14 acres within LHAAP-001-R. Magnetometers were utilized to detect surface and subsurface anomalies. Each detected anomaly was excavated until the item was located, identified, and a magnetic signature was no longer detected at the location. All MEC/MPPEH encountered were explosively destroyed to verify that no residual explosive hazard existed. A total of 294 MEC/MPPEH items and 14 inert items were located, excavated, and removed and a total of 15,397 pounds of MD and 1,722 pounds of CD were removed during the course of subsurface clearance. All MEC items were destroyed using the “blow-in-place” (BIP) method following approved demolition procedures. All debris was consolidated and relocated to the site lay down area. The debris was stored in approved containers, inspected, verified and certified as free of explosives, and shipped off site for final disposition. Locations for the surface and subsurface clearance are shown on **Figure 2-4**.

LUCs were designed and constructed for the site consistent with recommendations of the EE/CA and AM that included:

- Restriction against intrusive activities. TAC § 335.569, Appendix III requires that the restriction be recorded in the Harrison County Clerk’s Office, with the survey, map, and LUC language.
- Signage at the perimeter of LHAAP-001-R. Signs were installed at the perimeter of the site, serving as the physical demarcation of the controlled areas. The signs have visibility from one sign to the next with a maximum spacing of 100 ft. The signs include warning of the potential presence of MEC and state the restriction against intrusive activities.
- Education program for future refuge visitors, staff, and volunteers. The program includes informational pamphlets and safety video warning of the potential presence of MEC and presenting examples of MEC that were or may be found at the site.

2.5.2.2 LHAAP-003-R

Perchlorate was identified as an emerging contaminant, and perchlorate data for environmental media was collected after the ROD was signed. Between May 2000 and February 2001, during three consecutive quarterly sampling events, groundwater samples were collected from three existing shallow monitoring wells to determine whether perchlorate contamination had occurred in the underlying groundwater as a result of past historical activities (STEP, 2005). The wells are located adjacent to the three surface water features that drain the entire LHAAP-003-R site. Because the shallow groundwater flow pattern is heavily influenced by surface flow in this area, the wells represent groundwater from the entire site. During the first quarter (April and May 2000), perchlorate was detected at concentrations of 26.8, 20.4, and 22.7 µg/L, in groundwater samples collected from monitoring wells MW-127, MW-128, and 18WW16, respectively. The detections were below the GW-Ind value of 72 µg/L. No MCL exists for perchlorate. Perchlorate concentrations were below detection limits in the three monitoring wells during the second quarter (August through October 2000). During the third quarter, January through February 2001, perchlorate was detected in only one groundwater sample collected from well 18WW16 at a concentration of 8 µg/L, well below the GW-Ind of 72 µg/L. No perchlorate was detected in the water samples from wells MW-127 and MW-128. Three of the seven wells at

LHAAP-003-R were not sampled during two of the three sampling events. Groundwater samples were also collected from Geoprobe points (GPSAS54-01, -02, and -03) installed in June 2001. Perchlorate was below detection limits in all three grab samples.

In October 2009, USEPA collected additional groundwater samples from the existing four monitoring wells to confirm groundwater conditions at the site. Perchlorate was detected in only one well at a concentration that was well below the GW-Ind value of 72 μg/L. The U.S. Army collected split samples at the same time that the USEPA collected samples from the four monitoring wells. Perchlorate was detected in one well for the U.S. Army split samples at a concentration well below the GW-Ind value of 72 μg/L.

In March 2003, USFWS conducted an investigation at the former LHAAP facility to determine contaminant levels in soil and sediment (USFWS, 2003). Soil samples were collected from two locations (FWS-095 and FWS-223) within LHAAP-003-R. These two locations are along the surface drainage that flows toward Saunders Branch on the east side of the site. Soil analytical results indicated that metals were detected at low concentrations confirming previous findings. Perchlorate was not detected.

Between 2002 and 2004, a MMRP SI was conducted for LHAAP-003-R to determine the presence or absence of MEC and/or MC at the site which may have remained from activities conducted by the DoD during operations of the MRS. The SI verified MEC presence at the site (e^2M, 2005).

Results of the HRR and a visual site inspection verified MEC presence at the site. Possible source areas for MEC and MC identified during the SI included: testing areas associated with the various suspected ordnance types; a confirmed mortar impact area on site with numerous unidentified ordnance item shapes on the surface and outside the mortar berm; a site reportedly used for the testing and burnout of Pershing and Sergeant rocket motors; and areas associated with past demilitarization activities. In addition, a Sergeant rocket motor reportedly exploded at the site around 1970 and debris was reportedly placed in the resulting crater and backfilled. It was also reported that occasionally WP munitions were burned at the site. It appears that most of the items tested at this location were statically fired and observed for adequate illumination and burn time and not launched by a weapons system.

The SI identified a data gap in earlier soil sampling, in that, although demilitarization activities were conducted at the site and occasionally demolition and burning of WP munitions were performed, no analysis for the munitions constituent WP was performed at the site. The SI recommended that further investigation be conducted to address the identified data gap.

In 2007, an EE/CA was conducted to facilitate completion of a non-time-critical removal action of MEC at the site (CAPE, 2007). Field activities conducted during the EE/CA characterized

MEC and addressed the WP data gap at the site. Fourteen (14) MEC and MPPEH items along with 513 pounds of MD were recovered at the surface or within the top 6 inches of the soil. The items were clustered within the former Mortar Test Area. Based on the heaviest MPPEH concentrations or historical detonations, soil samples were collected within LHAAP-003-R to determine if evidence of WP existed in areas where MC was most likely to exist. One soil sample (BTA-54-LHAAP-001-RS-01A) was collected within the area identified as the mortar firing range. A second soil sample (BTA-54-LHAAP-001-RS-01B) was collected in a scarred area identified as the Rocket Motor Area in the historical review. In addition, pre- and post-detonation samples were collected in association with explosive demolition of MPPEH recovered during the field activities. Soil samples were collected from 0 to 6-inches bgs. Analytical results indicated that no WP or explosives (1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2,4,6-TNT, 2,4-DNT, 2,6-DNT, 2-amino-4,6-DNT, 2-nitrotoluene, 3-nitrotoluene, 4-amino-2,6-DNT, 4-nitrotoluene, HMX, nitrobenzene, RDX, and tetryl) were identified at concentrations above detection limits in any soil samples at the site. In addition, there was no indication of the presence of explosives in any of the pre- or post-detonation samples. The removal action objective of protection of human health from WP or explosives at unacceptable concentrations had been achieved as demonstrated by the soil analytical results. All site sample locations are shown on **Figure 2-5**.

The EE/CA recommended surface clearance of MEC items with LUCs to reduce the risk within LHAAP-003-R. Between August and November 2008, a MEC removal action was conducted and LUCs were developed for the site (EODT, 2009). Magnetometer-assisted surface clearance was performed at LHAAP-003-R for the entire site of approximately 80 acres. Site preparations included brush removal. The clearance team worked in grids and established 5-ft sweep lanes within each grid, removing and disposing of all surface MEC and MPPEH, MD, CD, and range-related debris. Twelve MEC/MPPEH items and one inert item were located and destroyed and 6,880 pounds of MD and 5,981 pounds of CD were removed during the course of surface clearance. All MEC items were destroyed using the BIP method following approved demolition procedures. All debris was consolidated and relocated to the site lay down area. The debris was stored in approved containers, inspected, verified and certified as free of explosives, and shipped off site for final disposition. Locations for the surface clearance are shown on **Figure 2-6**.

LUCs were designed and constructed for the site consistent with recommendations of the EE/CA and AM that included:

- Restriction against intrusive activities. TAC § 335.569, Appendix III requires that the restriction be recorded in the Harrison County Clerk's Office, with the survey, map, and LUC language.
- Signage at the perimeter of LHAAP-003-R. Signs were installed at the perimeter of the site, serving as the physical demarcation of the controlled areas. The signs have

visibility from one sign to the next with a maximum spacing of 100 ft. The signs include warning of the potential presence of MEC and state the restriction against intrusive activities.

- Education program for future refuge visitors, staff, and volunteers. The program includes informational pamphlets and safety video warning of the potential presence of MEC and presenting examples of MEC that were or may be found at the site.

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.

The reasonably anticipated future use of LHAAP-001-R and LHAAP-003-R 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 and will be used to facilitate transfer of LHAAP-001-R and LHAAP-003-R. Presently the Caddo Lake National Wildlife Refuge occupies approximately 7,000 acres of the 8,416-acre former installation. A change in use from wildlife refuge requires 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 flow into Caddo Lake. Caddo Lake is a large recreational area that covers 51 square miles and has a mean depth of 6 ft. 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 ft bgs) near LHAAP is currently used as a drinking water source. The drinking water aquifer should not be confused with the deep zone groundwater, which extends only to a depth of approximately 151 feet bgs. The deep zone groundwater and the drinking water aquifer are distinct from each other and there is no connectivity between the deep zone groundwater and the drinking water aquifer. There are currently five active water supply wells near LHAAP that are completed in the drinking water aquifer. One well is located in and owned by Caddo Lake State Park. The well is completed to a depth of 315 ft bgs 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 completed to approximately 430 ft bgs 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. Because of 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 ft bgs.

Three water supply wells are located within the boundary of LHAAP itself. One well is located at the Fire Station/Security Office approximately 2.3 miles north-northwest of LHAAP-001-R and 2.39 miles northwest of LHAAP-003-R. The second well is located approximately 0.35 miles southwest of the Fire Station/Security Office and 2.19 miles north-northwest of LHAAP-001-R and 2.39 miles northwest of LHAAP-003-R. The third well is located north of the administration building, near the entrance to LHAAP approximately 2.16 miles west-northwest of LHAAP-001 and 2.73 miles west-northwest of LHAAP-003-R. Two additional wells previously supplied water to the installation, but these have been plugged and abandoned. Although all three provide water at the tap, none are used for drinking water. None of the water supply wells is associated with the two sites addressed by this ROD Document.

Based on the anticipated future use of the facility (i.e., a wildlife refuge), the groundwater at the two sites will not be used in the future as a drinking water source. However, to be conservative, it is assumed that future use is industrial. The future industrial scenario for LHAAP conservatively assumes limited use of groundwater as a drinking water source. No WP or explosives were identified at detectable concentrations in any soil samples collected from LHAAP-001-R and LHAAP-003-R. Perchlorate was detected in only one soil sample at a concentration that was well below the GWP-Ind value at LHAAP-001-R. The soils at the two sites are not potential sources of contribution of perchlorate, WP, or explosives into the underlying groundwater. All perchlorate detections in groundwater at LHAAP-001-R were below the GW-Ind value except for one detection by USEPA in 2009 at a concentration of 76 μg/L, slightly above the risk-based GW-Ind of 72 μg/L in one well. The result was an estimate from a diluted sample. The U.S. Army's split sample for the same well indicated that perchlorate was detected at a concentration of 50 μg/L, below the GW-Ind. The U.S. Army result is consistent with previous detected levels for the site. Therefore, no evaluation of groundwater against the criterion set forth for human ingestion in an industrial land use scenario was performed.

2.7 Summary of Site Risks

This section contains the results of the risk evaluation for LHAAP-001-R and LHAAP-003-R addressing WP and explosives and MEC risk to human health and safety.

2.7.1 Summary of Site Risk for LHAAP-001-R

2.7.1.1 MEC Risk to Human Safety

The risk evaluation for LHAAP-001-R addressed risks to human safety related to the potential presence of MEC.

The risk factors associated with MEC items were categorized in three classes: MEC factors, site characteristics factors, and human factors. MEC factors are related to the type of MEC, the sensitivity, the quantity (density), and the depth. Site characteristic factors include the accessibility and stability of areas where MEC items are located. Human factors are related to the population density and population activities.

During the EE/CA field activities, twenty one (21) MPPEH items along with 700 pounds of MD were recovered at LHAAP-001-R, with most of the items clustered in the suspected OB/OD area. The types of ordnance items found were pyrotechnic or illumination in nature; no high explosives or fuzed items were identified. All items were at the surface or within the top 6 inches of soil. Accordingly, the MEC density, ordnance-type hazard, and sensitivity factors were all assigned a value of 1. The site stability was rated stable, with the rating for contact level risk associated with future human activities as significant. Because the reasonably anticipated future land use is incorporation into the existing wildlife refuge and the significant refuge activities, the probable future population density at the site is low. Taking all risk factors into consideration, the risk assessment indicated moderate MEC risk to human safety for LHAAP-001-R.

Through the surface removal action MEC items were located and removed over the entire surface area, thereby reducing the risk to the future land user. The subsurface removal action located, excavated, and removed MEC or MPPEH items to a depth consistent with the expected future land use and the significant refuge activities, all of which are non-intrusive. The subsurface removal provided an effective solution for reducing risk of exposure by reducing the potential for any direct contact with MEC or MPPEH.

However, because there is a reasonable potential that some MEC remained after the removal action there is a potential risk to the public. Consistent with the recommendations of the EE/CA and the AM (U.S. Army, 2007), LUCs were identified to promote ongoing protection of human safety against potential explosive hazards that may have remained at the site.

2.7.1.2 MC Risk to Human Health

The MC risk to human health at LHAAP-001-R refers to the risk to human health from exposure to WP and explosives in soil and groundwater. The risk evaluation is based on the reasonably anticipated future use as a national wildlife refuge and does not address unrestricted use.

During the EE/CA investigation activities, no WP or explosives were identified at detectable concentrations in any soil samples collected and there was no indication of the presence of explosives in any pre- or post-detonation samples. There is not a complete pathway for WP or explosives. Therefore, there is no risk associated with WP or explosives.

Additional sampling conducted by the USEPA in 2009 resulted in a detection of perchlorate at a concentration of 76 μg/L, slightly above the risk-based GW-Ind of 72 μg/L in one well. The result was an estimate from a diluted sample. The U.S. Army's split sample for the same well indicated that perchlorate was detected at a concentration of 50 μg/L, below the GW-Ind. The U.S. Army result is consistent with previous detected levels for the site and, therefore, there was no need to evaluate risk associated with perchlorate because there was no exceedance of the GW-Ind.

2.7.1.3 Ecological Risk

The ecological risk for LHAAP-001-R was addressed in the installation-wide BERA (Shaw, 2007). 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. The individual sites at LHAAP were grouped into one of these sub-areas, which were delineated 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 were made in the context of the overall conclusions of the sub-area in which the site falls. Site LHAAP-001-R lies within the Low Impact Sub-Area, and the BERA concluded that no unacceptable risk was present in the Low Impact Sub-Area (Shaw, 2007).

Summary results from the BERA indicated that perchlorate was not selected as a final constituent of potential ecological concern because all estimated receptor ecological effects quotient were less than 1 and there was no evidence of a perchlorate source area. In addition, during the EE/CA, no WP or explosives were identified in any soil samples and there was no indication of the presence of explosives in any pre- or post-detonation samples confirming the determination of no risk to the environment for LHAAP-001-R.

2.7.2 Summary of Site Risk for LHAAP-003-R

2.7.2.1 MEC Risk to Human Safety

The risk factors associated with MEC items were categorized into three classes: MEC factors, site characteristics factors, and human factors. MEC factors are related to the type of MEC, the sensitivity, the quantity (density), and the depth. Site characteristic factors include the accessibility and stability of areas where MEC items are located. Human factors are related to the population density and population activities.

During the EE/CA field activities, fourteen (14) MPPEH items along with 513 pounds of MD were recovered at LHAAP-003-R with most items clustered in the former Mortar Test Area. The types of ordnance items found were pyrotechnic or illumination in nature except the miscellaneous fuzes. All fuzes were inspected and were determined to have functioned as designed. All items were at the surface or within the top 6 inches of soil. Accordingly, the MEC density, ordnance-type hazard, and sensitivity factors were all assigned a value of 1. The site stability was rated stable, with the rating for contact level risk associated with future human activities as significant. Because the reasonably anticipated future land use is incorporation into the existing wildlife refuge and the significant refuge activities (all of which are non-intrusive), the probable future population density at the site is low. Taking all risk factors into consideration, the risk assessment indicated low MEC risk to human safety for LHAAP-003-R.

Through the surface removal action MEC items were located and removed over the entire site thereby reducing the risk to the future land user.

However, because there is a reasonable potential that some MEC remained after the removal action there is a potential risk to the public. Consistent with the recommendations of the EE/CA and the AM (U.S. Army, 2007), LUCs were identified for the site to promote ongoing protection of human safety against potential explosive hazards that may have remained at the site.

2.7.2.2 MC Risk to Human Health

The MC risk to human health at LHAAP-003-R refers to the risk to human health from exposure to WP and explosives in soil and groundwater. The risk evaluation is based on the reasonably anticipated future use as a national wildlife refuge and does not address unrestricted use.

During the EE/CA investigation activities, no WP or explosives were identified at detectable concentrations in any soil samples collected and there was no indication of the presence of explosives in any pre- or post-detonation samples. There is not a complete pathway for WP or explosives. Therefore, there is no risk associated with WP or explosives.

The additional groundwater sampling conducted by the USEPA and U.S. Army in 2009 indicated that perchlorate was detected in one well at a concentration well below the GW-Ind, and therefore there was no need to evaluate risk associated with perchlorate.

2.7.2.3 Ecological Risk

The ecological risk for LHAAP-003-R was addressed in the installation-wide BERA (Shaw, 2007). 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. The individual sites at LHAAP were grouped into one of these sub-areas, which were delineated 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 were made in the context of the overall conclusions of the sub-area in which the site falls. Site LHAAP-003-R lies within the Low Impact Sub-Area, and the BERA concluded that no unacceptable risk was present in the Low Impact Sub-Area (Shaw, 2007).

In addition, during the EE/CA, no WP or explosives were identified in any soil samples and there was no indication of the presence of explosives in any pre- or post-detonation samples confirming the determination of no risk to the environment for LHAAP-003-R.

2.8 Remedial Action Objectives

The remedial action objective for LHAAP-001-R and LHAAP-003-R is protection of human health and safety from explosive hazards that may have remained at the sites after the MEC removal action and confirmation that perchlorate is present in groundwater at levels below the chemical specific criterion.

2.9 Description of Alternatives

Two alternatives (including No Action) have been evaluated. 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

The no action alternative provides a comparative baseline against which the other risk-reduction alternatives can be evaluated. No alternative technology is associated with this alternative and no risk-reduction measures resulting in the treatment, containment, removal of, or limited exposure to MEC would take place. No actions would be implemented to reduce existing or potential future exposure to human receptors. Limited sampling of groundwater would not be conducted.

The no action alternative is appropriate for sites where no MEC has been found; where there is no documented evidence of MEC firing, burial, or impact areas; or where the nature and extent of exposure (e.g., small arms ammunition) poses minimal threat to those who may encounter MEC.

LHAAP-001-R and LHAAP-003

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

Alternative 2 – Land Use Controls and Limited Groundwater Monitoring

LUCs are MEC response actions intended to mitigate or reduce potential residual risk remaining after completion of munitions response actions. Selected LUCs may also be used to supplement removal actions. As a stand-alone response action, LUCs do not result in the removal of additional MEC. To the extent the controls are effective and are maintained, the threat to human safety is reduced. The level of protection is greater than that provided by Alternative 1 (No Action) because informing the public of dangers related to ordnance reduces the likelihood of accidental exposure to MEC that may remain after the 2008 removal action.

This alternative includes restrictions against intrusive activities (dig restrictions), restrictions against land use other than nonresidential, warning signage at the perimeter of the sites, and education programs for future refuge visitors, staff, and volunteers.

The warning signs alert individuals to the former use and dangers at the site. Signs provide information regarding the nature of the hazard, how to avoid the hazard, give notice of dig restrictions, and provide a contact for additional information. The signs have been placed around the perimeter of the sites and are visible at all points. Educational and notification programs are designed as an integral part of the alternative. Explosive safety educational programs are intended to inform the public about the controls, how to identify hazards, and what to do if hazards are discovered. Informational pamphlets and a video have been developed to warn the public of the hazards of ordnance based on the historical context of former operations that occurred at the LHAAP.

To confirm that perchlorate in groundwater at LHAAP-001-R and LHAAP-003-R is present at levels that are below chemical-specific criterion applicable to the intended future use of the site, limited groundwater monitoring would be conducted. Three rounds of groundwater sampling at

LHAAP-001-R and one round of groundwater sampling at LHAAP-003-R will be conducted and the results compared to the TCEQ GW-Ind value of 72 micrograms per liter (µg/L) for perchlorate.

LHAAP-001-R
Estimated Capital Present Worth Cost: $16,600
Estimated O&M Present Worth Cost: $97,300
Cost Estimate Duration: 30 years
Estimated Present Worth Cost: $113,900

LHAAP-003-R
Estimated Capital Present Worth Cost: $11,100
Estimated O&M Present Worth Cost: $71,100
Cost Estimate Duration: 30 years
Estimated Present Worth Cost: $82,200

2.9.2 Common Elements and Distinguishing Features of Each Alternative

Only Alternative 2, LUCs and Limited Groundwater Monitoring meets the RAO. LUCs would serve to inform potential site receptors of any MEC hazards that remain in the area. LUCs restrict intrusive activities at the site and educate the public of the dangers that may remain after the MEC removal action. LUCs consist of dig restrictions, MEC warning signs spaced every 100 feet, information pamphlets, a MEC safety video to present MEC hazards and safety to the public and site workers and a restriction against any use other than nonresidential.

Only Alternative 2 includes a provision for limited groundwater monitoring for perchlorate to confirm the levels are protective of human health.

2.10 Summary of Comparative Analysis of Response 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 for each MRS. 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 2-1** summarizes the comparative analysis of the alternatives for LHAAP-001-R and LHAAP-003-R.

2.10.1 Overall Protection of Human Health and Safety

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.

Overall protection of human safety measures how well each alternative reduces public exposure and interaction with MEC, the reduction in terms of possible injury or death to humans, and protection of the environment. The following factors are evaluated for this criterion:

- Net reduction in MEC
- Estimated quantity of residual MEC
- Expected depth of residual MEC
- Potential exposure pathway between humans and MEC for projected future land use
- Potential for an individual to interact with MEC if an exposure occurs.

Although a MEC removal action was conducted at LHAAP-001-R and LHAAP-003-R, some MEC may have remained. The No action alternative does not reduce MEC risk to potential onsite receptors. The LUCs of Alternative 2 are protective of human safety because they cut off the exposure pathway.

The limited groundwater monitoring for perchlorate that is part of Alternative 2 provides overall protection of human health by confirming that perchlorate in groundwater does not exceed the TCEQ GW-Ind, which is protective of the future intended user. The No Action alternative has no provision for limited groundwater monitoring. Alternative 2 meets the RAOs.

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).

Compliance with the ARARs criterion measures how well an alternative meets chemical-, action-, and location-specific ARARs (federal, state, and local). Chemical-specific ARARs exist for MEC sites and are related to the presence of MC and the protection of human health. The screening of MC and WP sampling data at LHAAP-001-R indicated they were not constituents of concern. However, because the level of perchlorate in groundwater requires confirmation that it is protective of human health, the TCEQ GW-Ind for perchlorate is appropriate and relevant. Only Alternative 2 provides a means to confirm compliance with the chemical specific ARAR for perchlorate in groundwater.

An action specific ARAR, 30 TAC 335, is applicable to well abandonment. Only Alternative 2 would address this requirement.

No location-specific ARARs are identified for these two sites.

2.10.2 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.

No action is the lowest ranked alternative for long-term effectiveness because it does not reduce the potential for exposure to any remaining MEC over the long term nor does it confirm that perchlorate in groundwater is not present at levels that may present a risk to human health. The LUCs of Alternative 2 can provide risk reduction over the long term by cutting off the exposure pathway. LUCs reduce risk associated with MEC hazards as long as they are effectively maintained.

2.10.3 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.

Because the screening of MC and WP sampling data at LHAAP-001-R and LHAAP-003-R indicated they were not constituents of concern, treatment technology was not necessary. This includes perchlorate in groundwater, which only requires confirmation that it meets the TCEQ GW-Ind.

Alternatives 1 and 2 do not include treatment and would not result in reduction of toxicity, mobility, or volume reduction of MEC. The completed MEC removal action removed source material from the sites.

2.10.4 Short-Term Effectiveness

Short-term effectiveness criteria measures how well an alternative meets the exposure and interaction reduction objectives during its implementation and is characterized by:

- The ability of the alternative to reduce risk during implementation
- The potential for adverse effects on the environment during the implementation
- The time required to implement the alternative
- The potential for adverse effects on humans, including the community and personnel involved in implementation of the alternative.

Neither Alternative 1 nor Alternative 2 involve active remedial measures. No activities are associated with Alternative 1 and the activities associated with Alternative 2 are protective to the surrounding community from short-term risks.

Alternative 2 contains the LUCs as the remedy and would provide almost immediate protection through implementation of the LUC that prohibits intrusive activities. The LUCs and limited groundwater monitoring of Alternative 2 would provide short-term risk reduction by informing workers of hazards associated with MEC potentially at the site during groundwater monitoring activities and with the potential presence of perchlorate in groundwater at levels exceeding the TCEQ GW-Ind. There would be no exposure for workers repairing/maintaining signs which are located just outside the perimeters of LHAAP-001-R and LHAAP-003-R.

2.10.5 Implementability

Implementability is a measure of whether a MEC response action alternative can be physically and administratively implemented, maintained, and enforced. It is also a measure of the availability of the services and materials needed to implement the alternative. Another consideration for implementability is regulatory agency and community acceptance of a given alternative. For implementability, the response alternatives are ranked by technical and administrative feasibility, the availability of services and materials and the regulatory agency and community acceptance of the alternative.

The no action alternative is the easiest alternative to implement in terms of both technical and administrative feasibility. Under the no action alternative no services or materials are required.

The technology associated with implementing the LUCs alternative (i.e., sign maintenance) is reliable, readily accessible, and easily implemented. There should be no implementation safety concerns related to the MEC warning sign repair/maintenance at both sites, as this will occur outside the perimeter of the sites. Groundwater monitoring of the existing wells is easily implemented as no additional services or materials are required beyond sampling requirements and it is known to meet regulatory and community acceptance.

2.10.6 Cost

Cost estimates are used in the CERCLA 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 developed are preliminary estimates with an intended accuracy range of –30 to +50 percent.

The benefit of the investment in risk reduction is considered when ranking the alternatives. This involves evaluating the reduction in risk to the public versus the cost of implementing the alternative. There is no investment cost associated with no action, however, the no action alternative does not provide any MEC risk reduction at LHAAP-001-R and LHAAP-003-R or confirmation groundwater sampling. LUCs costs include maintenance costs for LUCs (e.g., replacing weathered signs), groundwater sampling and monitoring well abandonment, and five-year reviews. The LUCs provide the greatest reduction of risk.

2.10.7 State/Support Agency Acceptance

The USEPA and TCEQ have reviewed the Proposed Plan, which presented LUCs with limited groundwater monitoring 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.

2.10.8 Community Acceptance

Community acceptance is an important consideration in the final evaluation of the selected remedy. One set of written public comments was received during the 30-day public comment period; there were no verbal comments from the July 21, 2011 public meeting. The topics of the comments included: monitoring metals in groundwater, detection limits for metals in soil and sediment, groundwater flow, adequacy of monitoring well coverage, and perchlorate standard in groundwater. The written comments received and their responses are presented in the Responsiveness Summary (**Section 3.0**).

2.11 Principal Threat Wastes

Between August and November 2008, a MEC removal action was conducted for LHAAP-001-R and LHAAP-003-R to remove potential explosive hazards and a potential source of munitions constituents. For LHAAP-001-R, surface removal was conducted for the entire site and subsurface removal for the suspected OB/OD area. For LHAAP-003-R, surface clearance was conducted for the entire site. In addition, screening of MC and WP sampling data indicated they were not constituents of concern at LHAAP-001-R and LHAAP-003-R, although a requirement to confirm that perchlorate in groundwater does not exceed the chemical specific ARAR was identified. There are no known principal threat wastes at these two MRS sites.

2.12 The Selected Remedy

2.12.1 Summary of Rationale for the Selected Remedy

Implementation of LUCs and limited groundwater monitoring for perchlorate in addition to the completed removal action is the selected remedy for LHAAP-001-R and LHAAP-003-R and is consistent with the intended future use of the site as a national wildlife refuge. The presence of MEC items at LHAAP-001-R and LHAAP-003-R was confirmed during the EE/CA investigation, therefore, a MEC removal was implemented for the MRS sites. MEC items were located and removed during surface removals over the entire areas of LHAAP-001-R and LHAAP-003-R, and a subsurface removal to depth in the OB/OD area within LHAAP-001-R. Although the removal action provided an effective solution for reducing risk of exposure by reducing the potential for any direct contact with MEC, there is the potential that some MEC remains. Therefore, the sites are not suitable for unrestricted use. LUCs for both LHAAP-001-R and LHAAP-003-R promote ongoing protection of human safety against potential explosive hazards that may have remained at the sites and satisfy the RAO for the sites.

Environmental sampling results at LHAAP-001-R and LHAAP-003-R indicate that there is no risk to human health and safety from perchlorate or WP. Limited groundwater monitoring is intended to confirm perchlorate levels in groundwater are below the GW-Ind to verify protection of human health and the environment.

The selected alternative offers a high degree of long-term effectiveness, can be readily implemented, and is cost-effective.

The U.S. Army believes the selected alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the CERCLA §121(b) criteria used to evaluate remedial alternatives. The selected alternative will: 1) be protective of human health and safety; 2) comply with ARARs; 3) be cost-effective; and 4) utilize a permanent solution; by 5) reducing the volume of the potential source for MEC contaminants and pollutants.

The details and description of the LUCs, except for the nonresidential LUC, and roles/responsibilities can be found in the approved LUC design and plan included as Appendix I of the Final Work Plan for the MEC Removal Action at the Former Longhorn Army Ammunition Plant, LHAAP-001-R (Site 27) and LHAAP-003-R (Site 54) (EODT, 2008). The nonresidential LUC will be added to the Notice of Land Use Controls to be recorded in Harrison County and will be added to the 2007 Longhorn Army Ammunition Plant Comprehensive LUC Management Plan.

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

2.12.2 Description of the Selected Remedy

The selected remedy for LHAAP-001-R and LHAAP-003-R is implementation of LUCs and limited groundwater monitoring in addition to the completed removal action.

Between August and November 2008, a MEC non-time critical removal action was conducted for the LHAAP-001-R and LHAAP-003-R. Surface clearance was performed at LHAAP-001-R and LHAAP-003-R for the entire sites and subsurface clearance to depth of detection was performed at LHAAP-001-R in the OB/OD area. The MEC removal action located and removed MEC items thereby reducing the risk to the future land user. Although these removal actions provide an effective solution for reducing risk of exposure by reducing the potential for any direct contact with MEC or MPPEH, there is the potential that some MEC remains. Therefore, LUCs will be implemented for the sites.

The major components of the selected remedy include:

- ***Land Use Control.*** LUCs were designed and constructed to promote ongoing protection of human safety against potential explosive hazards that may have remained at the sites. The LUCs' performance objectives are to identify areas that could possibly contain MEC, ensure all personnel within the site boundaries are made aware of possible safety issues concerning MEC and restrict uses and activities that could result in explosive safety risks. The recordation notification for the sites which will be filed with Harrison County will include a description of the LUCs. The boundary of the LUCs encloses the site boundaries shown on **Figures 2-7** and **2-8**. The locations of the signs are also shown on **Figures 2-7** and **2-8**. LUCs for the MRS sites include:

  - Restriction against intrusive activities. TAC § 335.569, Appendix III requires that the restriction be recorded in the Harrison County Clerk's Office, with the survey, map, and LUC language.

  - Restriction against uses other than nonresidential.

  - Signage at the perimeter of LHAAP-001-R and LHAAP-003-R. Signs are in place at the perimeter of the sites, serving as the physical demarcation of the controlled areas. The signs have visibility from one sign to the next with a maximum spacing of 100 ft. The signs include warning of the potential presence of MEC, state the restriction against intrusive activities, and provide a contact number.

  - Education program for future refuge visitors, staff, and volunteers. The program includes informational pamphlets and safety video warning of the potential presence of MEC and presenting examples of MEC that were or may be found at the site.

- ***Limited Groundwater Monitoring*.** Environmental sampling results at LHAAP-001-R and LHAAP-003-R indicate that there is no risk to human health and safety from perchlorate or WP. However, limited groundwater monitoring is intended to confirm perchlorate levels in groundwater are below the GW-Ind to verify protection of human health and the environment. If, after three rounds of groundwater sampling at LHAAP-001-R and one round of groundwater sampling at LHAAP-003-R, the results that are evaluated on or before the first five year review indicate detections at levels below the GW-Ind value of 72 micrograms per liter (μg/L) for perchlorate, groundwater monitoring will cease and the wells will be plugged and abandoned.

The U.S. Army would be responsible for implementation, maintenance, inspection, reporting, and enforcement of the LUCs. 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 the protectiveness of the selected remedy. In the event that TCEQ and/or EPA and the Army agree with respect to any significant 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).

The details and description of the LUCs implementation and maintenance actions were presented in the LUC design and plan (EODT, 2008) associated with the 2008 removal action. Within 90 days of signing the ROD, the U.S. Army will prepare and submit the LUC RD to USEPA consistent with the schedule of Section XVI of the Federal Facility Agreement (FFA). The LUC RD will be the 2008 LUC design and plan revised to include the nonresidential LUC. The LUCs would be included in the property transfer documents and a recordation of the area of intrusive activity restriction would be filed in the Harrison County Courthouse.

Monitoring in the form of Five-Year Reviews will be conducted to ensure that the LUCs are specified, implemented, monitored, reported on, and enforced in an efficient, cost effective manner that ensures long-term protectiveness. Texas Administrative Code (TAC) §335.566, requires that the LUCs be filed in Harrison County.

2.12.3 Cost Estimate for the Selected Remedy

Tables 2-2 and **2-3** are the cost estimate summary tables for LHAAP-001-R and LHAAP-003-R, respectively. The information in the tables is based on the best available information regarding the anticipated scope of the selected remedy. The quantities used in the estimate are for estimating purposes only. Changes in the cost elements may occur as a result of new information and data collected during the O&M 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 the selected remedy is approximately $113,900 and $82,200 for LHAAP-001-R and LHAAP-003-R, respectively, using a discount rate of 2.3%. The capital cost is estimated at $16,600 and $11,100, for LHAAP-001-R and LHAAP-003-R, respectively. The total O&M present value cost is estimated at approximately $97,300 and $71,100 for LHAAP-001-R and LHAAP-003-R, respectively. The O&M costs includes three quarters of perchlorate sampling for LHAAP-001-R and one quarter of sampling for LHAAP-003-R, semiannual mowing and signage maintenance for both sites for 30 year. O&M would support the required CERCLA five-year reviews.

2.13 Expected Outcomes of Selected Remedy

The purpose of this remedial action is to attain the RAO of protecting human health and safety from explosive hazards that may have remained at the sites. The LUCs will promote ongoing protection of human safety against potential explosive hazards that may have remained at the site. The limited groundwater monitoring for perchlorate will confirm levels in groundwater are below the GW-Ind to verify protection for human health and the environment.

2.14 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.

2.14.1 Protection of Human Health and the Environment

The selected remedy, LUCs and limited groundwater monitoring will achieve the RAO. The LUCs provide an effective solution for reducing the risk of exposure by reducing the potential for any direct contact with MEC remaining at the sites after the 2008 removal action. Because of the reasonable potential that some MEC may remain, the sites are not suitable for unrestricted use. The LUCs at both LHAAP-001-R and LHAAP-003-R will promote ongoing protection of human safety against potential explosive hazards that may have remained at the sites. Notification of the LUCs will be recorded with Harrison County. The limited groundwater monitoring for perchlorate provides overall protection of human health by assuring that perchlorate in groundwater does not exceed the TCEQ GW-Ind, which is protective of human health.

A site-wide ecological baseline risk assessment has been performed for LHAAP. As noted in **Sections 2.7.1.3**, and **2.7.2.3** the BERA concluded that no unacceptable ecological risk was present at LHAAP-001-R and LHAAP-003-R.

2.14.2 Compliance with ARARs

The selected remedy complies with all ARARs. The ARARs are presented below and in **Table 2-4**.

<u>Chemical-specific ARARs</u>

Because the screening of MC and WP sampling data at LHAAP-001-R and LHAAP-003-R indicated they were not constituents of concern, the RAO was met and the addition of MC-related ARARs, with the exception of perchlorate in groundwater, is not necessary. The chemical-specific ARAR is relevant and appropriate for perchlorate. Specifically, 30 TAC 335 provides the TCEQ GW-Ind of 72 µg/L for perchlorate in groundwater.

Location-specific ARARs

There are no location-specific ARARs.

Action-specific ARARs

The selected remedy triggers an action-specific ARAR related to well abandonment. Available standards for well plugging/abandonment would provide ARARs for such actions. Texas has promulgated technical requirements in Chapter 76 of Title 16 of the TAC applicable to plugging/abandonment of water wells. In particular, 16 TAC 76.1004 (*Standards for Capping and Plugging of Wells and Plugging Wells that Penetrate Undesirable Water or Constituent Zones*) provides ARARs for the plugging/abandonment of groundwater monitoring wells.

2.14.3 Cost-Effectiveness

There are no costs associated with the no action alternative. **Tables 2-2** and **2-3** present cost estimates for the LUCs and groundwater monitoring for LHAAP-001-R and LHAAP-003-R, respectively. Completion of the MEC removal action and the design and construction of LUCs under the 2008 removal action lowered costs for the sites.

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

The U.S. Army has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site. The MEC removal action provided an effective solution for reducing risk of exposure by reducing the volume of the potential source of MEC contaminant and pollutants and for any direct contact with MEC or MPPEH. LUCs provide immediate protection. Maintenance of this control would be required as long as there is a potential of hazards from MEC that might have remained at the site.

2.14.5 Preference for Treatment as a Principal Element

The statutory preference for treatment was addressed with the MEC removal action which removed source material from the site and destroyed MEC. The LUCs do not include treatment of MEC but will promote ongoing protection of human safety against potential explosive hazards that may have remained at the sites.

2.14.6 Five-Year Review Requirements

Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(C) provide the statutory and legal basis for conducting five-year reviews. Although the MEC removal actions provide an effective solution for reducing risk of exposure by reducing the potential for any direct contact with MEC, there is the potential that some MEC remains. Therefore, the sites are not suitable to allow unlimited use and unrestricted exposure. A review will be conducted at least every five years to confirm that the remedy continues to provide adequate protection of human health and safety.

2.15 Documentation of Significant Changes

The Proposed Plan for LHAAP-001-R and LHAAP-003-R was released for public comment in July 2011. The Proposed Plan included the LUCs in Alternative 2 as well as limited groundwater monitoring for perchlorate. No significant changes have been made to the proposed plan for the sites. Written comments were received during the public comment period. It was determined that no significant changes to the decision, as originally identified in the Proposed Plan, were necessary or appropriate.

Table 2-1
Comparative Analysis of Alternatives

Comparative Analysis of Alternatives Criteria	Alternative 1 No Action	Alternative 2 Land Use Controls and Limited Groundwater Monitoring
Overall protection of human health and safety	No protection. Does not achieve RAOs.	Protection of human health and safety provided by maintenance of LUCs that cuts off the exposure pathway. Includes groundwater monitoring to confirm the levels of perchlorate in groundwater are protective of human health. Achieves the RAOs.
Compliance with ARARs	Does not comply with ARARs	Complies with ARARs.
Long-term effectiveness and permanence	Not effective due to the presence of residual MEC that may have remained at the site.	High in effectiveness by prohibiting use of the site and educating the public of the potential hazards.
Reduction of toxicity, mobility, or volume through treatment	No active reduction.	No active reduction.
Short-term effectiveness	No reduction in risk in the short term.	LUCs provide short-term risk reduction by informing workers conducting groundwater monitoring activities of the potential MEC hazards and of the use restrictions. .
Implementability	Readily implemented.	Readily implemented, technical needs are not complex.
Costs *		
LHAAP-001-R		
Capital Expenditure	$0	$16,600
O & M Expenditure	$0	$97,300
Total Present Worth	$0	$113,900
LHAAP-003-R		
Capital Expenditure	$0	$11,100
O & M Expenditure	$0	$71,127
Total Present Worth	$0	$82,200

Table 2-2
Remediation Cost Table, Selected Remedy (LHAAP-001-R)
Present Worth Analysis

PROJECT LOCATION:	Karnack, Texas								DATE:	September 2011	
			O & M Costs						Present Value (NPV)		
FY	Capital Costs	Capital Costs							Discount Rate	Capital	O & M
		Other	LTM					Total	2.3%		
									NPV	16,618	97,317
2011	16,618	0	36,263					36,263			
2012	0	0	1,344					1,344			
2013	0	0	8,815					8,815			
2014	0	0	1,344					1,344			
2015	0	0	1,344					1,344			
2016	0	0	1,344					1,344			
2017	0	0	1,344					1,344			
2018	0	0	8,815					8,815			
2019	0	0	1,344					1,344			
2020	0	0	1,344					1,344			
2021	0	0	1,344					1,344			
2022	0	0	1,344					1,344			
2023	0	0	8,815					8,815			
2024	0	0	1,344					1,344			
2025	0	0	1,344					1,344			
2026	0	0	1,344					1,344			
2027	0	0	1,344					1,344			
2028	0	0	8,815					8,815			
2029	0	0	1,344					1,344			
2030	0	0	1,344					1,344			
2031	0	0	1,344					1,344			

Table 2-2 *(continued)*
Remediation Cost Table, Selected Remedy (LHAAP-001-R)
Present Worth Analysis

PROJECT LOCATION:	Karnack, Texas									DATE:	September 2011	
			O & M Costs							Present Value (NPV)		
FY	Capital Costs	Capital Costs								Discount Rate	Capital	O & M
		Other	LTM						Total	2.3%		
										NPV	16,618	97,317
2032	0	0	1,344						1,344			
2033	0	0	8,815						8,815			
2034	0	0	1,344						1,344			
2035	0	0	1,344						1,344			
2036	0	0	1,344						1,344			
2037	0	0	1,344						1,344			
2038	0	0	8,815						8,815			
2039	0	0	1,344						1,344			
2040	0	0	1,344						1,344			
Total Expenditures	16,618	0	120,053						120,053			**$113,935**

Notes:

The discount rate of 2.3% is based on OMB Circular A-94 Appendix C, Revised December 2010.

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
LTM long-term monitoring
LUC land use control
NPV net present value
O&M operation & maintenance

Table 2-3
Remediation Cost Table, Selected Remedy (LHAAP-003-R)
Present Worth Analysis

PROJECT LOCATION:	Karnack, Texas								DATE:	September 2011	
			O & M Costs						Present Value (NPV)		
FY	Capital Costs	Capital Costs							Discount Rate	Capital	O & M
		Other	LTM					Total	2.3%		
									NPV	11,079	71,127
2011	11,079	0	10,073					10,073			
2012	0	0	1,344					1,344			
2013	0	0	8,815					8,815			
2014	0	0	1,344					1,344			
2015	0	0	1,344					1,344			
2016	0	0	1,344					1,344			
2017	0	0	1,344					1,344			
2018	0	0	8,815					8,815			
2019	0	0	1,344					1,344			
2020	0	0	1,344					1,344			
2021	0	0	1,344					1,344			
2022	0	0	1,344					1,344			
2023	0	0	8,815					8,815			
2024	0	0	1,344					1,344			
2025	0	0	1,344					1,344			
2026	0	0	1,344					1,344			
2027	0	0	1,344					1,344			
2028	0	0	8,815					8,815			
2029	0	0	1,344					1,344			
2030	0	0	1,344					1,344			
2031	0	0	1,344					1,344			
2032	0	0	1,344					1,344			
2033	0	0	8,815					8,815			

Table 2-3 *(continued)*
Remediation Cost Table, Selected Remedy (LHAAP-003-R)
Present Worth Analysis

PROJECT LOCATION:	**Karnack, Texas**								**DATE:**	**September 2011**	
			O & M Costs						**Present Value (NPV)**		
FY	**Capital Costs**	**Capital Costs**							**Discount Rate**	**Capital**	**O & M**
		Other	**LTM**					**Total**	2.3%		
									NPV	**11,079**	**71,127**
2034	0	0	1,344					1,344			
2035	0	0	1,344					1,344			
2036	0	0	1,344					1,344			
2037	0	0	1,344					1,344			
2038	0	0	8,815					8,815			
2039	0	0	1,344					1,344			
2040	0	0	1,344					1,344			
Total Expenditures	11,079	0	93,864					93,864			**$82,206**

Notes and Abbreviations:

The discount rate of 2.3% is based on OMB Circular A-94 Appendix C, Revised December 2010.

CERCLA *Comprehensive Environmental Response, Compensation, and Liability Act*
LTM *long-term monitoring*
LUC *land use control*
NPV *net present value*
O&M *operation & maintenance*

Table 2-4
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Groundwater		
TCEQ Texas Risk Reduction Rules 30 TAC 335	Applicable to industrial groundwater**—**relevant and appropriate for hypothetical future maintenance worker exposure to groundwater.	If no maximum contaminant level has been promulgated, groundwater must not exceed the industrial medium-specific concentration. For perchlorate, the GW-Ind is 72 μg/L.
Wells		
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 abandoned in accordance with the technical requirements of Section 76.1004, as appropriate.

00112912

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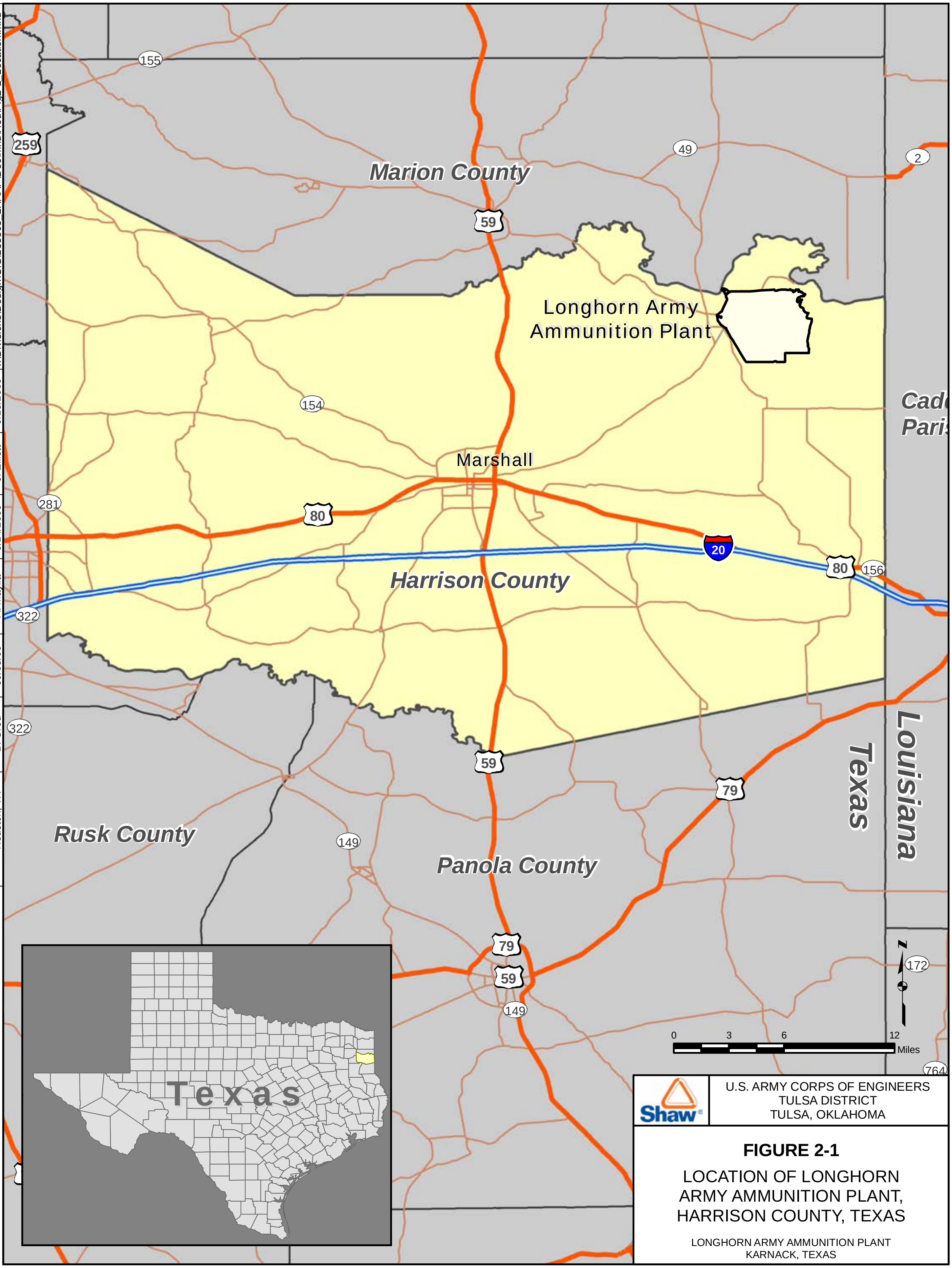

U.S. ARMY CORPS OF ENGINEERS
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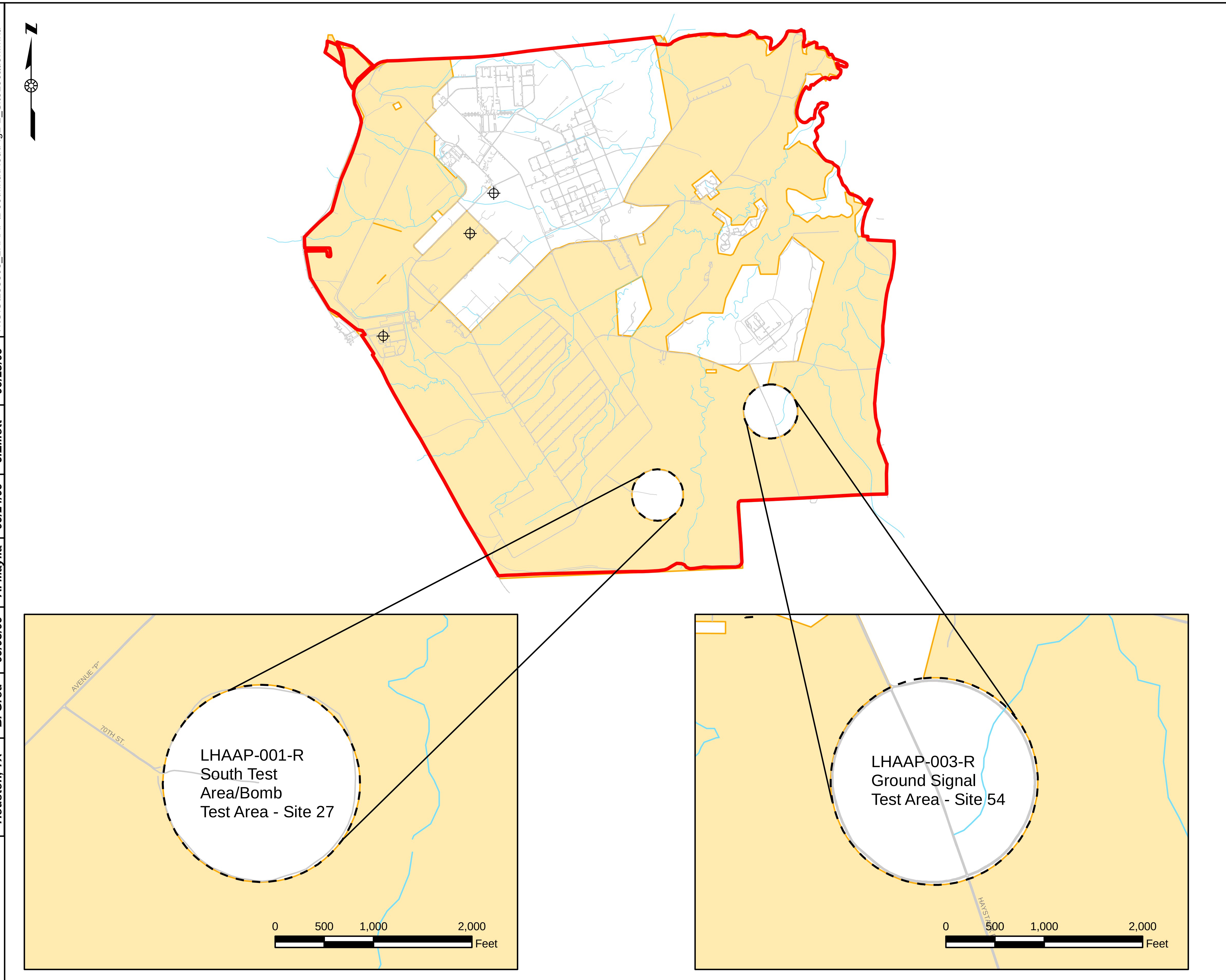
TULSA, OKLAHOMA

FIGURE 2-1

LOCATION OF LONGHORN ARMY AMMUNITION PLANT, HARRISON COUNTY, TEXAS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00112913



LEGEND

- LHAAP Water Supply Well
- Road
- Stream
- MUNITIONS RESPONSE SITES
- Longhorn Base Boundary
- Caddo Lake National Wildlife Refuge

OFFICE	Houston, TX
DRAWN BY	B. Grod 09/03/09
CHECKED BY	A. Mayila 09/14/09
APPROVED BY	J.Elliott 09/15/09
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Shaw

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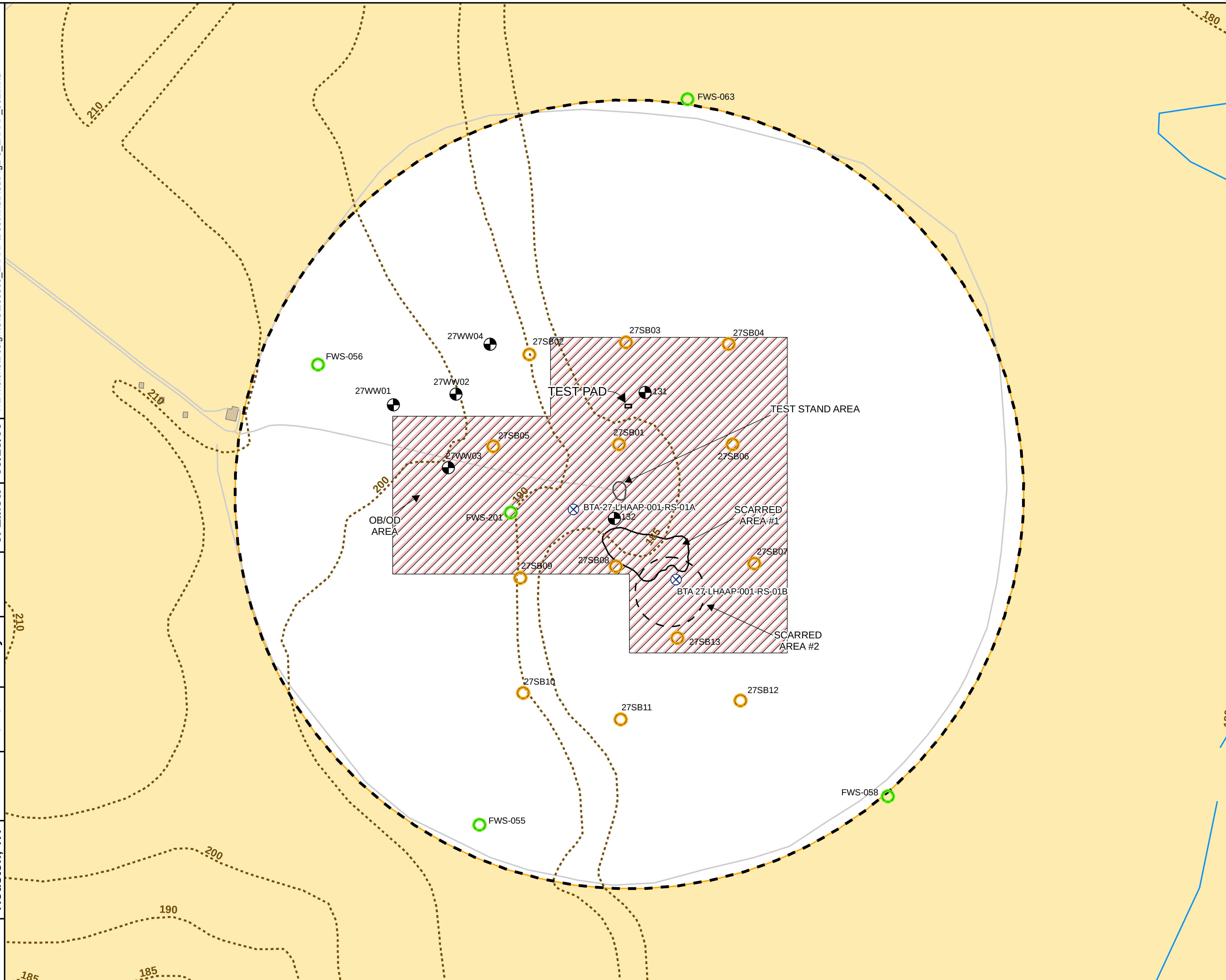
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-2

SITE LOCATION MAP
LHAAP-001-R and LHAAP-003-R

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00112914



LEGEND

MONITORING WELL
SOIL SAMPLE, (SVERDRUP, 2000) (STEP, 2005)
SOIL SAMPLE, (USFWS, 2003)
SOIL SAMPLE, (CAPE, 2006)
Contours
Road
Stream
South/Bomb Test Area
Test Pad
Test Stand Area
Scarred Area #1
Scarred Area #2
OB/OD Area
Building
Caddo Lake National Wildlife Refuge

1 inch = 250 feet

0 125 250 500 Feet

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TULSA, OKLAHOMA

FIGURE 2-3

SAMPLING LOCATIONS
SOUTH TEST AREA / BOMB TEST AREA
LHAAP-001-R

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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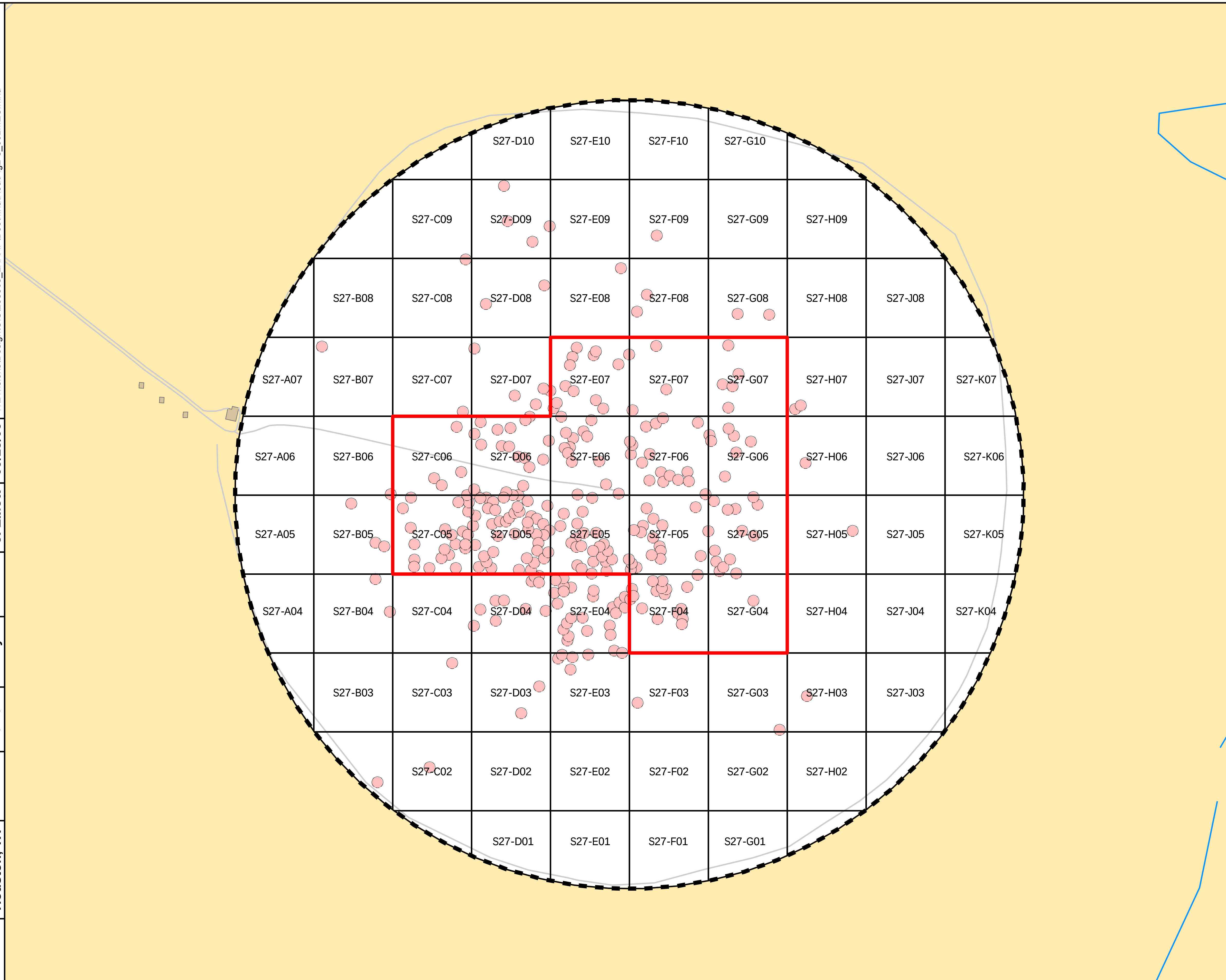
Houston, TX	B. Grod 09/03/09	A. Mayila 09/14/09	J. Elliott 09/15/09	T:\Divisions\Design\GIS\133363_LHAAP\DocMxd\Rod\Fig2-3_LHAAP_001.mxd

00112915



LEGEND

- MEC/MPPEH Items
- Road
- Stream
- South/Bomb Test Area
- Investigated Grid
- OB/OD Area
- Building
- Caddo Lake National Wildlife Refuge

1 inch = 250 feet

0 125 250 500 Feet

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TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-4

MEC/MPPEH LOCATION MAP
SOUTH TEST AREA / BOMB TEST AREA
LHAAP-001-R

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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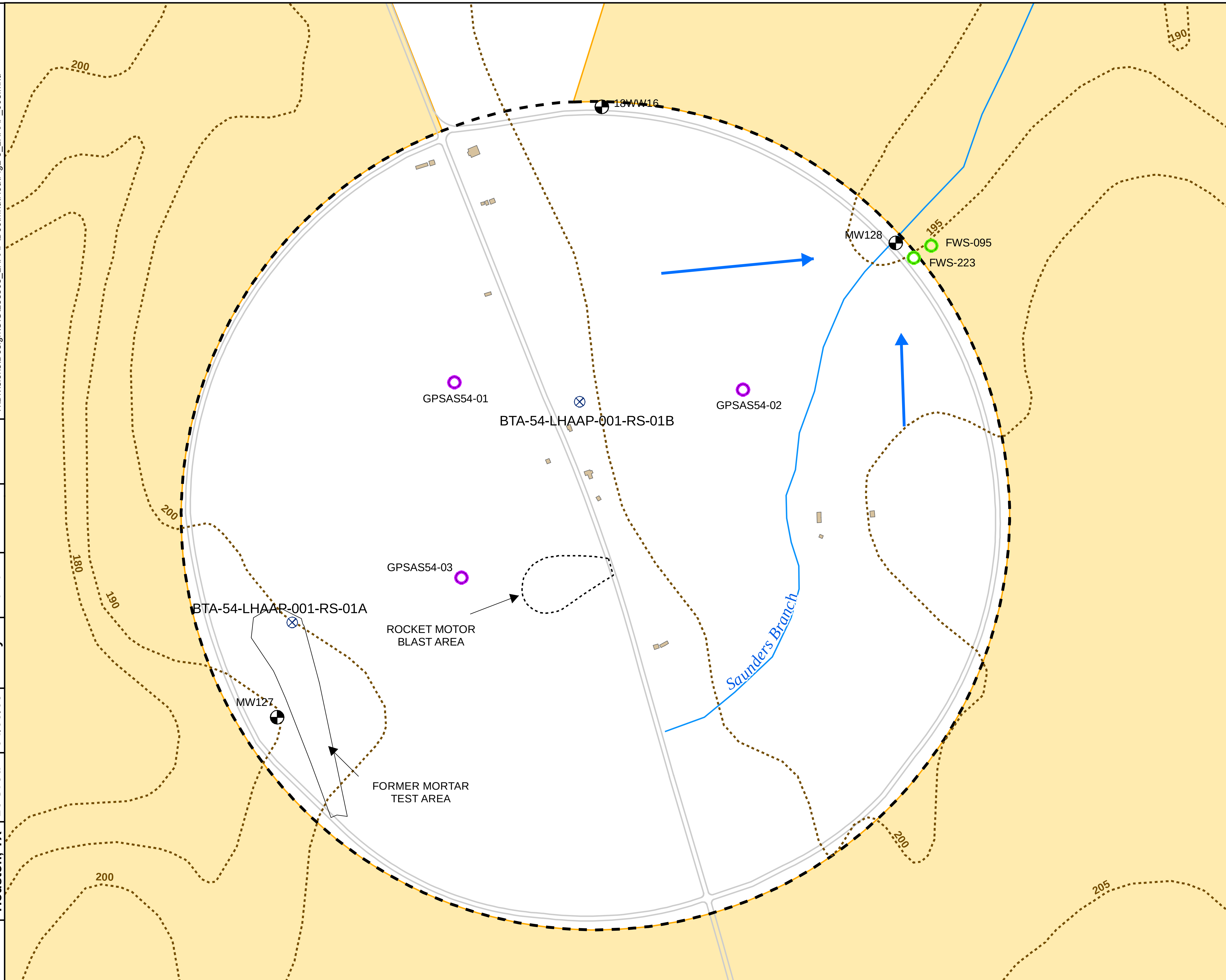
CHECKED BY	A. Mayila 09/14/09
DRAWN BY	B. Grod 09/03/09
OFFICE	Houston, TX

00112916



LEGEND

- MONITORING WELL, (STEP, 2005)
- SOIL SAMPLE, (CAPE, 2006)
- SOIL SAMPLE, (USFWS, 2003)
- GEOPROBE LOCATION, (USACE, 2001)
- Contours
- Road
- Stream
- Building
- Former Mortar Test Area
- Rocket Motor Blast Area
- Ground Signal Test Area
- Caddo Lake National Wildlife Refuge
- Surface Water Flow Direction

1 inch = 250 feet

0 125 250 500 Feet

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TULSA, OKLAHOMA

FIGURE 2-5

SAMPLING LOCATIONS
GROUND SIGNAL TEST AREA
LHAAP-003-R

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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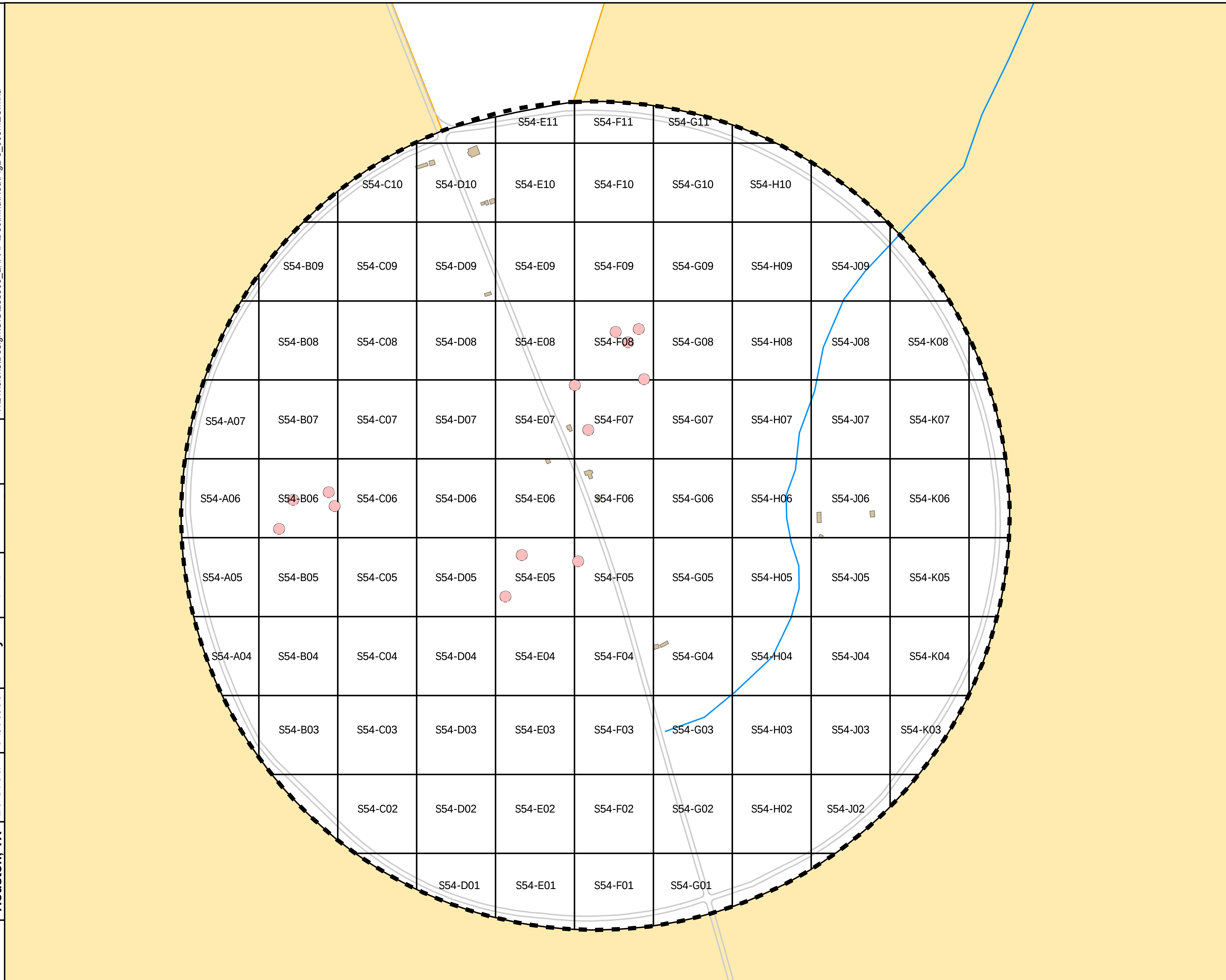
Houston, TX	B. Grod 04/09/09	A. Mayila 09/14/09	J. Elliott 09/15/09	T:\Divisions\Design\GIS\133363_LHAAP\Doc\Mxd\Rod\Fig2-5_LHAAP_003.mxd



LEGEND

- MEC/MPPEH Items
- Stream
- Road
- Ground Signal Test Area
- Investigated Grid
- Building
- Caddo Lake National Wildlife Refuge

1 inch = 250 feet

0 125 250 500 Feet

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-6

MEC/MPPEH LOCATION MAP
GROUND SIGNAL TEST AREA
LHAAP-003-R

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Grod 04/09/09	A. Mayila 09/14/09	J. Elliott 09/15/09	T:\Divisions\Design\GIS\133363_LHAAP\Doc\Mxd\Rod\Fig2-5_003MEC.mxd

N

DESCRIP	NORTHING	EASTING
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SIGN 02	3612986.7	393560.5
SIGN 03	3612956.4	393563.9
SIGN 04	3612926.3	393568.9
SIGN 05	3612896.4	393574.2
SIGN 06	3612866.9	393581.7
SIGN 07	3612839.1	393594.1
SIGN 08	3612812.3	393608.5
SIGN 09	3612785.5	393622.9
SIGN 10	3612762.6	393643.0
SIGN 11	3612742.6	393666.0
SIGN 12	3612724.3	393690.2
SIGN 13	3612708.3	393716.2
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SIGN 15	3612683.8	393771.9
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SIGN 38	3613071.3	394151.2
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SIGN 40	3613126.7	394127.2
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SIGN 42	3613173.2	394088.0
SIGN 43	3613195.6	394069.6
SIGN 44	3613211.6	394044.1
SIGN 45	3613216.5	394024.9
SIGN 46	3613221.1	394007.6
SIGN 47	3613232.4	393979.3
SIGN 48	3613244.4	393951.4
SIGN 49	3613253.3	393922.2
SIGN 50	3613257.5	393892.0
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SIGN 52	3613261.2	393831.2
SIGN 53	3613256.8	393801.1
SIGN 54	3613253.2	393770.8
SIGN 55	3613242.5	393742.2
SIGN 56	3613227.5	393715.8
SIGN 57	3613213.7	393688.6
SIGN 58	3613195.8	393664.0
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SIGN 60	3613147.5	393627.4
SIGN 61	3613121.6	393611.4
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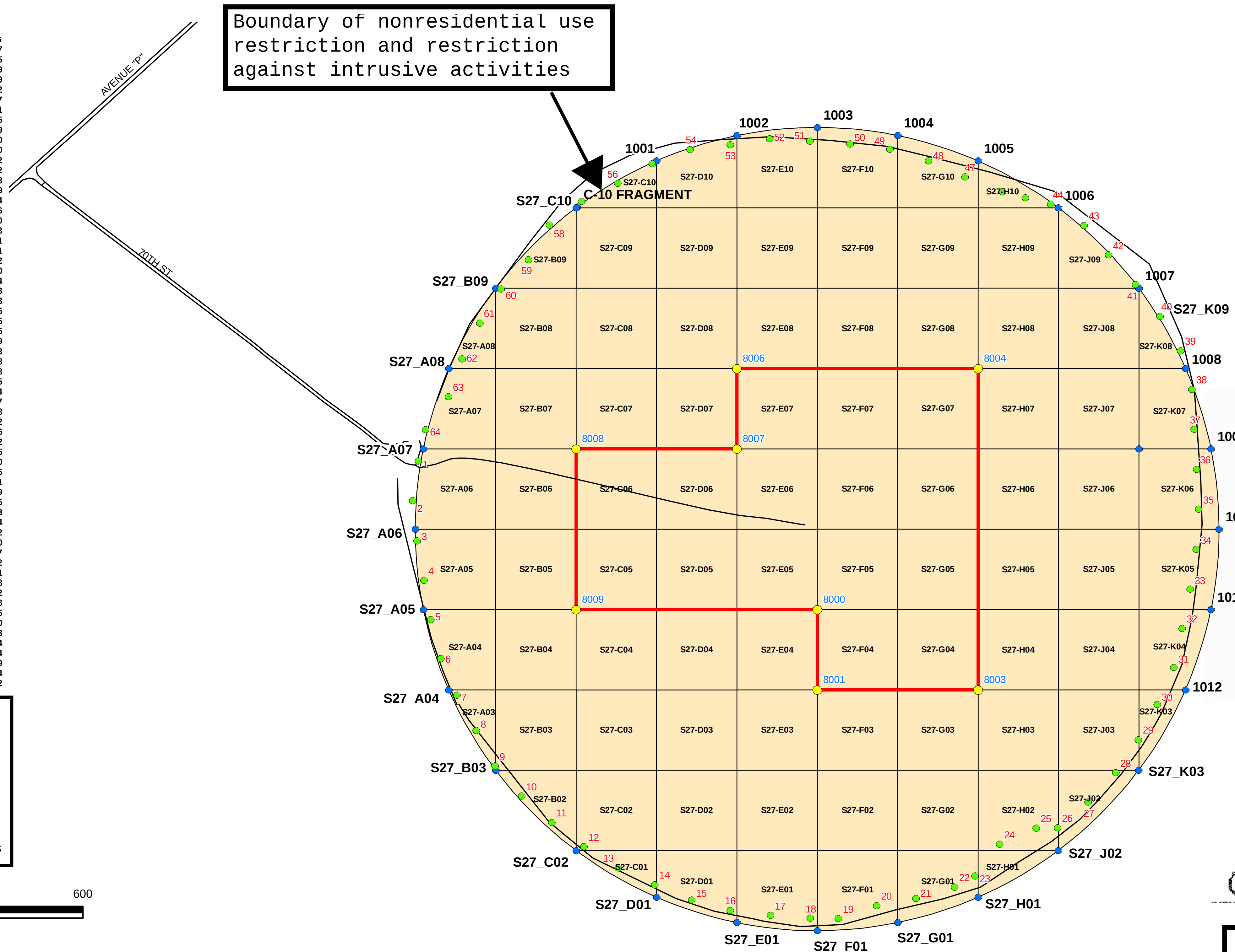


Legend

- OBOD Corners
- UXO Sign
- Boundary Stakes
- Roads
- OBOD
- Investigated Grids

0 150 300 600

Feet

Datum: NAD83 UTM
Monument: Longhorn Army Ammunition Plant
Monument BG-1 with coordinates
NORTHING-3614801.46,
EASTING-395385.09

DESCRIP	NORTHING	EASTING
8000	3612904.2	393867.3
8001	3612843.2	393867.3
8003	3612843.2	393989.2
8004	3613087.0	393989.2
8006	3613087.1	393806.4
8007	3613026.1	393806.4
8008	3613026.1	393684.4
8009	3612904.2	393684.4

DESCRIP	NORTHING	EASTING
1001	393745.4	3613244.5
1002	393806.4	3613263.8
1003	393867.3	3613269.9
1004	393928.3	3613263.8
1005	393989.2	3613244.5
1006	394050.1	3613209.0
1007	394111.0	3613148.0
1008	394146.5	3613087.0
1009	394165.8	3613026.1
1010	394171.9	3612965.1
1011	394165.8	3612904.2
1012	394146.5	3612843.2
C-10 FRAGMENT	393685.2	3613209.4
S27_A04	393588.0	3612843.2
S27_A05	393568.7	3612904.2
S27_A06	393562.5	3612965.1
S27_A07	393568.6	3613026.1
S27_A08	393587.9	3613087.1
S27_B03	393623.5	3612782.3
S27_B09	393623.5	3613148.0
S27_C02	393684.6	3612721.3
S27_C10	393684.4	3613209.0
S27_D01	393745.4	3612685.9
S27_E01	393806.4	3612666.6
S27_F01	393867.3	3612660.5
S27_G01	393928.3	3612666.7
S27_H01	393989.3	3612686.0
S27_J02	394049.9	3612721.3
S27_K03	394110.9	3612782.3
S27_K07	394111.2	3613026.1
S27_K09	394111.2	3613147.9

I, David R. Collins, Registered Professional Land Surveyor No. 1954, do hereby certify that this plat correctly represents the results of a survey made under my supervision August 4 through September 23, 2008.

Shaw

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

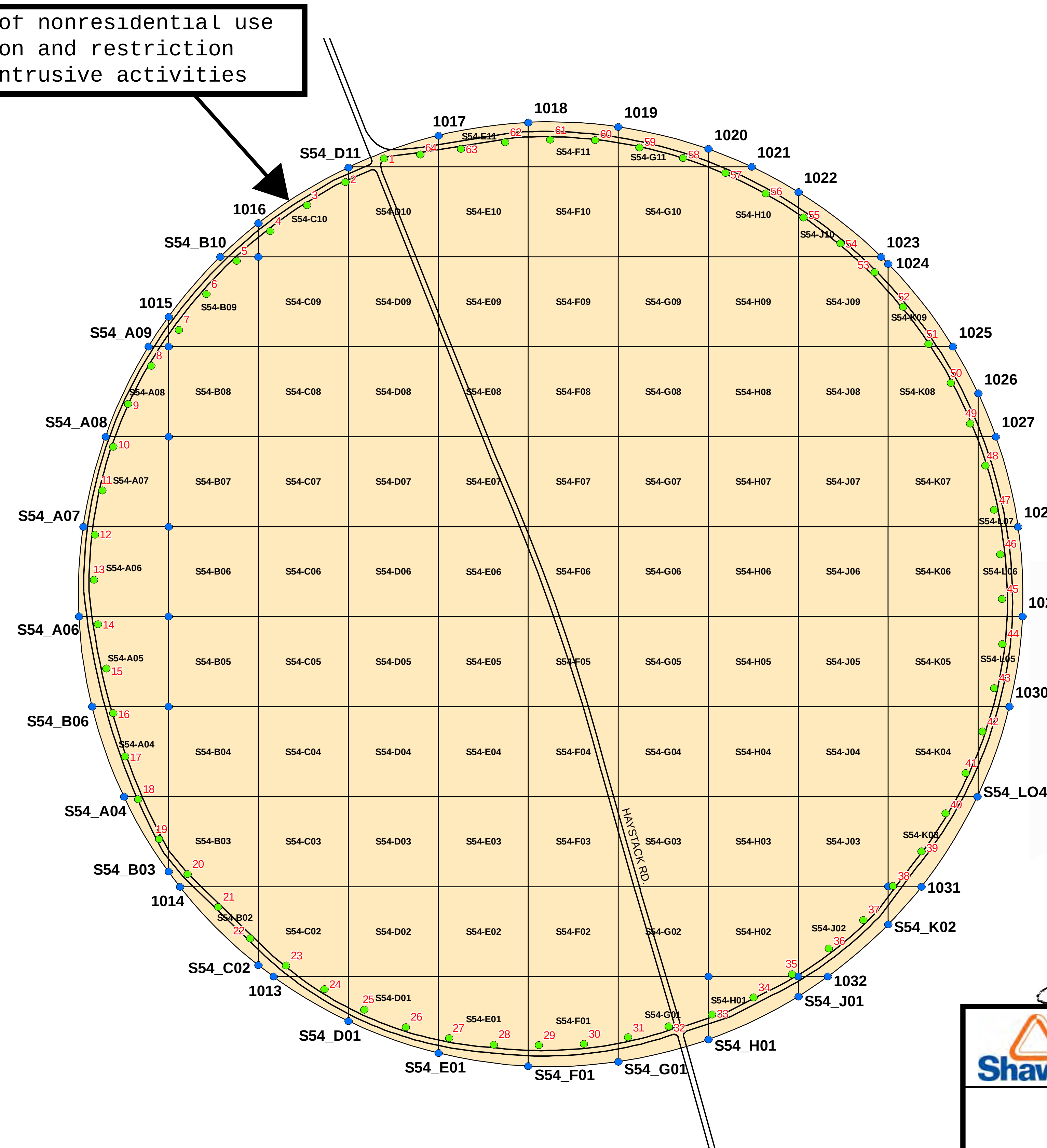
FIGURE 2-7

LUC BOUNDARY MAP
LHAAP-001-R

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

N

DESCRIP	NORTH	EAST	DESCRIP	NORTHIN	EASTING
SIGN 1	3614179.4	395143.2	1013	395068.6	3613625.2
SIGN 10	3613984.2	394959.8	1014	395005.1	3613686.2
SIGN 11	3613954.6	394952.4	1015	394997.4	3614072.1
SIGN 12	3613924.6	394947.4	1016	395058.4	3614135.6
SIGN 13	3613894.1	394947	1017	395180.3	3614195.0
SIGN 14	3613863.7	394949.6	1018	395241.3	3614203.9
SIGN 15	3613833.8	394955.1	1019	395302.2	3614200.9
SIGN 16	3613803.8	394959.8	1020	395363.2	3614185.9
SIGN 17	3613774.4	394967.8	1021	395392.4	3614173.9
SIGN 18	3613745.2	394976.7	1022	395424.1	3614156.7
SIGN 19	3613718.3	394991.2	1023	395480.2	3614112.9
SIGN 2	3614163.4	395117.3	1024	395485.1	3614108.0
SIGN 20	3613694.6	395010.3	1025	395528.9	3614051.9
SIGN 21	3613672.4	395031.1	1026	395546.1	3614020.2
SIGN 22	3613651.1	395052.8	1027	395558.0	3613991.0
SIGN 23	3613632.6	395077	1028	395573.1	3613930.0
SIGN 24	3613616.8	395103.1	1029	395576.0	3613869.1
SIGN 25	3613602.8	395130	1030	395567.2	3613808.1
SIGN 26	3613591	395158.1	1031	395507.7	3613686.2
SIGN 27	3613583.5	395187.6	1032	395444.2	3613625.2
SIGN 28	3613579.1	395217.8	S54_A04	394967.3	3613747.1
SIGN 29	3613578.7	395248.2	S54_A06	394936.8	3613869.1
SIGN 3	3614147.8	395091.2	S54_A07	394939.8	3613930.0
SIGN 30	3613579.6	395278.7	S54_A08	394954.8	3613991.0
SIGN 31	3613584.2	395308.8	S54_A09	394983.9	3614051.9
SIGN 32	3613591.4	395336.3	S54_B03	394997.4	3613696.4
SIGN 33	3613599.5	395365.6	S54_B06	394997.4	3613808.1
SIGN 34	3613611	395393.8	S54_B06	394945.7	3613808.1
SIGN 35	3613626.8	395419.8	S54_B06	394997.4	3613869.1
SIGN 36	3613644.2	395444.8	S54_B07	394997.4	3613930.0
SIGN 37	3613663.6	395468.2	S54_B08	394997.4	3613991.0
SIGN 38	3613686.5	395488.2	S54_B09	394997.4	3614051.9
SIGN 39	3613710.2	395507.5	S54_B10	395032.6	3614112.9
SIGN 4	3614130.2	395066.2	S54_C02	395058.4	3613633.0
SIGN 40	3613735.9	395523.8	S54_C10	395058.4	3614112.9
SIGN 41	3613763	395537.5	S54_D01	395119.3	3613595.1
SIGN 42	3613791.2	395548.8	S54_D11	395119.4	3614173.3
SIGN 43	3613820.6	395556.7	S54_E01	395180.3	3613573.5
SIGN 44	3613850.5	395562.3	S54_F01	395241.3	3613564.6
SIGN 45	3613880.9	395562.2	S54_G01	395302.2	3613567.6
SIGN 46	3613911.3	395561	S54_H01	395363.2	3613582.6
SIGN 47	3613941.4	395556.7	S54_H02	395363.1	3613625.2
SIGN 48	3613971.3	395550.8	S54_J01	395424.1	3613611.8
SIGN 49	3613999.9	395540.5	S54_J02	395424.1	3613625.2
SIGN 5	3614110.1	395043.4	S54_K02	395485.1	3613660.5
SIGN 50	3614027.4	395527.5	S54_K03	395485.1	3613686.2
SIGN 51	3614053.7	395512.2	S54_LO4	395545.5	3613747.1
SIGN 52	3614078.9	395495.2			
SIGN 53	3614102.3	395475.8			
SIGN 54	3614122	395452.6			
SIGN 55	3614139.3	395427.5			
SIGN 56	3614155.8	395401.9			
SIGN 57	3614169.5	395374.8			
SIGN 58	3614179.6	395346			
SIGN 59	3614186.8	395316.5			
SIGN 6	3614087.5	395022.9			
SIGN 60	3614191.9	395286.4			
SIGN 61	3614192.1	395255.9			
SIGN 62	3614190.3	395225.5			
SIGN 63	3614185.9	395195.4			
SIGN 64	3614182	395167.9			
SIGN 7	3614063.3	395004.4			
SIGN 8	3614039.1	394985.8			
SIGN 9	3614013.1	394969.9			



Legend

- UXO Signs
- Boundary Stakes
- Roads
- Investigated Grids

0 150 300 600

Feet

Datum: NAD83 UTM
Monument: Longhorn Army Ammunition Plant
Monument BG-1 with coordinates
NORTHING-3614801.46,
EASTING-395385.09

STATE OF TEXAS REGISTERED DAVID R. COLLINS 1954 PROFESSIONAL LAND SURVEYOR

I, David R. Collins, Registered Professional Land Surveyor No. 1954, do hereby certify that this plat correctly represents the results of a survey made under my supervision August 4 through September 23, 2008.

Shaw

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-8

LUC BOUNDARY MAP
LHAAP-003-R

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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 remedy at LHAAP-001-R and LHAAP-003-R 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-001-R and LHAAP-003-R 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-001-R and LHAAP-003-R, including the dates for the public comment period, the date, location, and time of the public meetings, and the location of the Administrative Record. The following documents related to community involvement were added to the Administrative Record:

- Transcript of the public meeting on July 21, 2011
- Presentation slides from the July 21, 2011 public meeting
- Questions and comments from the public during the public comment period, and the response to comments from the U.S. Army dated July 27, 2011.

Written comments were received from the general public during the public comment period and Proposed Plan meeting in July 2011 for LHAAP-001-R and LHAAP-003-R. The Proposed Plan was finalized without revision. **Appendix A** contains the public announcement for the Proposed Plan meeting and public comment period.

3.1 Stakeholder Issues and Lead Agency Responses

This section responds to significant issues raised by stakeholders including the public and community groups that were received in written or verbal form.

Question/comment: High concentrations (greater than the MCL) of metals have been found in groundwater at both sites since the early 1980s. In the most recent round of groundwater sampling (2009), high concentrations of beryllium and chromium were detected at site 001-R, and high concentrations of arsenic and chromium were detected at site 003-R.

However, the Army does not intend to monitor metals in groundwater at either site. This is despite the fact that the EPA sent the Army a letter that recommended monitoring metals in groundwater. Letters between the EPA and Army are reproduced in appendix 1.

The Army should monitor metals in groundwater at both sites.

Response: Perchlorate and white phosphorus (WP) are the data gap contaminants of concern for LHAAP-001-R and LHAAP-003-R under the Military Munitions Response Program (MMRP). Metals were addressed at sites LHAAP-27 and LHAAP-54, which are co-located with LHAAP-001-R and LHAAP-003-R respectively, under the 1998 Installation Restoration Program (IRP) ROD. Therefore any metals issues/concerns for these two sites must be addressed with respect to the 1998 IRP ROD and would not be included in this Proposed Plan. Army is in the process of reviewing the new metal results and historical results and has committed to respond to EPA and TCEQ under a path separate from the MMRP.

Question/comment: Soils at sites 001-R and 003-R are contaminated with a variety of metals (e.g., arsenic, barium, cadmium, lead). However, the Army does not plan to remove contaminated soil from either site.

According to the Army, the contaminants do not represent a threat to human health. However, there are problems with the Army's human health risk assessment (HHRA).

First, many of the soil analyses are not useful because of high detection limits (see below).

Second, the HHRA was performed in 1997. Therefore, it did not use the most recent data. The more recent data shows that some metal concentrations are significantly higher than those used in the HHRA (**Table 3-1**). Also, perchlorate was not included in the HHRA.

Table 3-1
Contaminant Concentrations Used in HHRA
Old and New Maximums

Contaminant/Site	Old Maximum (mg/kg)	New Maximum (mg/kg)
Barium/001-R	123	639
Copper/001-R	18.7	41.1
Lead/001-R	18	26.3
Nickel/001-R	2.41	18.6
Thallium/003-R	-	0.2
Perchlorate/001-R	-	28.9 (µg/kg)

The Army should remove contaminated soils from both sites.

Response: Please see response to the first comment above.

Question/comment: In some cases, the Army used detection limits for metals in soil and sediment that are higher than the standards established to protect human health (see **Table 3-2**). Thus, the Army cannot know whether these contaminants are present in concentrations that threaten human health.

Table 3-2
Detection Limits for Metals in Soil and Sediment

Contaminant	Site	Date	Detection Limit (mg/kg)	Standard (TCEQ GWP-Ind, mg/kg)
Antimony	001-R & 003-R	1982	0.76	0.6
	001-R & 003-R	1993	1	0.6
	001-R	1994	1.1-1.3	0.6
	001-R	1996	10.3-10.9	0.6
	003-R	1996/1997	1.1-1.2	0.6
Arsenic	001-R & 003-R	1982	0.3	1
	001-R & 003-R	1993	0.1-1	1
	001-R	1996	2.58-2.74	1
	003-R	1996/1997	0.596-58.7	1
	001-R & 003-R	2003	0.52-0.54	1
Beryllium	001-R & 003-R	1982	0.5	0.4
	001-R	1997	0.62-0.77	0.4
	001-R & 003-R	2003	0.20-0.22	0.4
Cadmium	001-R & 003-R	1982	0.5	0.5
	001-R & 003-R	1993	1	0.5
	001-R	1994	0.56-0.63	0.5
	001-R	1996	2.06-2.19	0.5
	003-R	1996/1997	2.22-2.38	0.5
	001-R & 003-R	2003	0.25-0.27	0.5
Thallium	001-R & 003-R	1982	3	0.2
	001-R & 003-R	1993	0.2	0.2
	001-R	1994	0.55-1.2	0.2
	001-R	1996	15.5-16.4	0.2
	003-R	1996/1997	0.6	0.2

The Army should re-sample soil and sediment at both sites. The samples should be analyzed using detection limits that are lower than the human health-based standards.

Response: Please see response to the first comment above.

Question/comment: The Army does not appear to have done the work required to determine groundwater flow directions at either site. Effective and efficient groundwater monitoring cannot be performed unless groundwater flow directions are known.

The Army should produce maps showing groundwater flow directions at each site.

Response: Hydrogeology was already addressed at sites 001-R and 003-R under the 1998 IRP ROD (see 1997 Remedial Investigation Report). Based on the Hydrogeological Assessment, the groundwater and surface flow direction at LHAAP-003-R are to the northwest and parallel to Sanders Branch and Harrison Bayou and at LHAAP-001-R groundwater flow is northerly. In addition, groundwater surface data from May 2000 (attached) for monitoring wells 127, 128 and 18WW16 at site LHAAP-003-R has been evaluated and confirms a northwest groundwater flow direction. Groundwater surface data from May 2000 for monitoring wells 27WW01, 27WW02, 27WW03, 27WW04, 131 and 132 at site LHAAP-001-R confirm a groundwater flow direction to the northeast. Maps showing groundwater flow direction at each site are attached as **Appendix B**.

Question/comment: There are six monitor wells at site 001-R, and four monitor wells at site 003-R. In addition, one-time grab samples were obtained from borings at each site.

The Army does not know whether there are a sufficient number of monitor wells at each site because it does not know whether the wells are down gradient of contaminated areas (see above comment on groundwater flow directions). The Army should evaluate the need for additional monitor wells after it has determined groundwater flow directions at each site.

Response: Please see the above response. Hydrogeology was already addressed at these sites.

Question/comment: The Army is using a groundwater standard for perchlorate of 72 μg/L. However, the EPA health reference level (HRL) for perchlorate is 15 μg/L. In addition, the EPA has decided to establish a primary drinking water standard (MCL) for perchlorate. When established, the perchlorate MCL will probably be similar to the HRL.

If the Army abandons the monitor wells based on the 72 μg/L standard, it may have to re-install monitor wells when the EPA establishes an MCL for perchlorate.

Until the EPA establishes an MCL for perchlorate, the Army should use a standard that is no greater than 15 μg/L.

Response: The Army is using the appropriate standard for comparison of perchlorate in groundwater and that is the TCEQ GW-Ind value of 72 µg/L, which is promulgated and enforceable in the State of Texas. If EPA establishes an MCL for perchlorate in the future, it will be addressed during the 5-year reviews.

Question/comment: The Army has analyzed soil and water samples for two isomers of dinitrotoluene (DNT): 2,4-DNT and 2,6-DNT. These are the most common isomers in technical grade DNT. However, there are four other isomers of DNT (2,3-DNT; 2,5-DNT; 3,4-DNT; and 3,5-DNT). All of the isomers are toxic.

At the Badger Army Ammunition Plant, high concentrations of the other isomers have been found in groundwater. In some cases, concentrations of the other isomers are significantly higher than the concentrations of 2,4-DNT and 2,6-DNT.

The Army should analyze soil and water samples for all isomers of DNT, not just the 2,4-DNT and 2,6-DNT isomers.

Response: At this time, there are no Federal or State of Texas promulgated screening levels for DNT isomers, other than for 2,4-DNT and 2,6-DNT. However, as part of the CERCLA process, the statutory five-year reviews will evaluate the effectiveness of the remedy, including any changes in ARARs concerning DNT isomers, and would recommend implementation of other measures if needed.

Question/comment: The Army has developed source-receptor conceptual site models for munitions constituents and OE at LHAAP sites 001-R and 003-R. The Army should also develop source-receptor conceptual site models for metals at both sites.

Response: Please see response to the first comment above.

Question/comment: The following documents were listed as primary reference documents in the Final Proposed Plan. However, they do not appear to have been included in the Army Administrative Record.

- CAPE, 2007b, Final Engineering Evaluation/Cost Analysis Action Memorandum Revision 1, Longhorn Army Ammunition Plant, Karnack, Texas, Signed by Thomas Lederle, BRAC Division, ACSIM, United States Army, 5 December.
- Environmental Protection Systems, Inc. (EPS), 1984, Longhorn Army Ammunition Plant Contamination Survey, June.
- EODT Technology, Inc., (EODT), 2009, Final Site Specific Final Report for the MEC Removal Action at the Former Longhorn Army Ammunition Plant, LHAAP-001-R (Site 27) and LHAAP-003-R (Site 54), Karnack, Texas, September.

The Army should ensure that all documents referred to in the Proposed Plan are included in the Administrative Record. If any document has been misfiled or mislabeled in the Administrative Record, the Army should so indicate when referring to that document.

Response: The Final Engineering Evaluation/Cost Analysis Action Memorandum, signed by Thomas Lederle 5 December 2007, is located in the Administrative Record in Volume 9, Year 2008. It is listed out of date in sequence.

The other two references appear to have been overlooked and will be incorporated into the Administrative Record.

4.0 References

CAPE, 2007, *Final Engineering Evaluation/Cost Analysis: Report, Longhorn Army Ammunition Plant, Karnack, Texas*, January.

e^{2}M, 2002, *Final U.S. Army Closed, Transferring and Transferred Range/Site Inventory for Longhorn Army Ammunition Plant, Texas*, 15 September.

e^{2}M, 2005, *Final Site Inspection Report, Military Munitions Response Program Sites, Longhorn Army Ammunition Plant, Texas*, June.

Environmental Protection Systems, Inc. (EPS), 1984, Longhorn Army Ammunition Plant Contamination Survey, June.

EODT Technology, Inc., (EODT), 2008, *Final Work Plan for the MEC Removal Action at the Former Longhorn Army Ammunition Plant, LHAAP-001-R (Site 27) and LHAAP-003-R (Site 54), Karnack, Texas, July*.

EODT, 2009, *Final Site Specific Final Report for the MEC Removal Action at the Former Longhorn Army Ammunition Plant, LHAAP-001-R (Site 27) and LHAAP-003-R (Site 54), Karnack, Texas,* September.

Shaw Environmental, Inc. (Shaw), 2007, *Installation-Wide Baseline Ecological Risk Assessment, Volume 1: Step 3 Report, Longhorn Army Ammunition Plant, Karnack, Texas, Houston, Texas,* November.

Shaw, 2011, *Munitions Constituents Data Summary Report, South Test Area/Bomb Test Area, LHAAP-001-R and Ground Signal Test Area, LHAAP-003-R, Longhorn Army Ammunition Plant, Karnack, Texas, Houston,* Texas, June.

Solutions to Environmental Problems (STEP), 2005, *Plant-wide Perchlorate Investigation, Longhorn Army Ammunition Plant, Karnack, Texas,* April.

U.S. Army, 2004, *Memorandum of Agreement Between the Department of the Army and the Department of the Interior for the Interagency Transfer of Lands at the Longhorn Army Ammunition Plant for the Caddo Lake National Wildlife Refuge, Harrison County, Texas,* signed by the Department of the Interior on April 27, 2004 and the Army on April 29, 2004.

U.S. Army, 2007, *Action Memorandum for Three Munitions Response Sites: South Test Area/Bomb Test Area, Static Test Area, and Ground Signal Test Area, Longhorn Army Ammunition Plant, Karnack, Texas,* August. Signed 5 December 2007 by Thomas E. Lederle.

U.S. Army, 2011, *Final Proposed Plan for LHAAP-001-R, South Test Area/Bomb Test Area and LHAAP-003-R,Ground Signal Test Area, Longhorn Army Ammunition Plant, Karnack, Texas,* June.

U.S. Army Corps of Engineers (USACE), Tulsa District, 1998, *Record of Decision at Group 1 Sites (Sites 11, 1, XX, 27), Longhorn Army Ammunition Plant, Karnack, Texas,* January.

U.S. Department of the Army (Army), Longhorn Army Ammunition Plant, 2011, "Army Response to EPA Letter of June 2010: Munitions Constituents Data Summary Report Response to Comments, Longhorn Army Ammunition Plant, Karnack, Texas", Letter from Rose M. Zeiler, Longhorn Army Ammunition Plant Site Manager to Stephen Tzhone, Remedial Project Manager of USEPA, Region 6, Superfund Division, March 10.

U.S. Environmental Protection Agency (USEPA), 2010, "Munitions Constituents Data Summary Report, Longhorn Army Ammunition Plant, Karnack, Texas", Letter from Stephen Tzhone, Remedial Project Manager of USEPA, Region 6, Superfund Division to Rose M. Zeiler Longhorn Army Ammunition Plant Site Manager, June 11.

U.S. Environmental Protection Agency (USEPA), 2011, "Army Response to EPA Letter of June 2010: Munitions Constituents Data Summary Report, Longhorn Army Ammunition Plant, Karnack, Texas," Letter from Stephen Tzhone, Remedial Project Manager of USEPA, Region 6, Superfund Division to Rose M. Zeiler Longhorn Army Ammunition Plant Site Manager, June 03.

U.S. Fish and Wildlife Service (USFWS), 2003, *Contaminant Investigation of Northern, Central, and Eastern Portions of Caddo Lake National Wildlife Refuge, Texas,* November.

Glossary of Terms

Administrative Record File – 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.

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.

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.

Land Use Controls – Physical, legal, or administrative mechanisms that restrict the use of, or limit access to, contaminated property in order to reduce risk to human health and the environment. Physical mechanisms encompass a variety of engineered remedies to contain or reduce contamination and/or physical barriers to limit access to property, such as fences or signs.

Material That Potentially Presents an Explosive Hazard (MPPEH) – Material potentially containing explosives or munitions (e.g., munitions containers and packaging material; munitions debris remaining after munitions use, demilitarization, or disposal; and range-related debris), or material potentially containing a high enough concentration of explosives such that the material presents an explosive hazard.

Munitions and Explosives of Concern - This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks, means:
(A) Unexploded Ordnance (UXO), as defined in 10 U.S.C. 2710 (e) (9);
(B) Discarded military munitions (DMM), as defined in 10 U.S.C. 2710 (e) (2); or
(C) Explosive munitions constituents (e.g., TNT, RDX) present in high enough concentrations to pose an explosive hazard.

Munitions Constituents - Any materials originating from unexploded ordnance, discarded military munitions, or other military munitions, including explosive and nonexplosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions.

Munitions Debris (MD) – Remnants of munitions (e.g., fragments, penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization, or disposal.

Munitions Response Site (MRS) – A discrete location within a munitions response area that is known to require a munitions response.

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.

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 decision document highlighting community concerns.

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.

Surface Media – The soil (surface or subsurface), surface water, and sediment present at a site as applicable. The source material in the surface media may be contributing to groundwater contamination.

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 Announcement

PUBLIC NOTICE
THE UNITED STATES ARMY INVITES PUBLIC COMMENT ON THE PROPOSED PLAN FOR MUNITIONS RESPONSE SITES LHAAP-001-R AND LHAAP-003-R, LONGHORN ARMY AMMUNITION PLANT, TEXAS

PUBLIC MEETING ON JULY 21, 2011
AT THE KARNACK COMMUNITY CENTER, KARNACK, TEXAS

The U.S. Army, as 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, has developed a proposed plan for the following sites: LHAAP-001-R and LHAAP-003-R. Beginning on July 13, 2011, copies of the Proposed Plan and supporting documentation will be available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670. The public comment period is July 13, 2011, through August 13, 2011. A public meeting for the public to view information and ask questions will be held on July 21, 2011 from 6:00 to 7:30 p.m. at the Karnack Community Center, Highway 134 and Spur 449, Karnack, Texas. Questions, comments, and responses on the Proposed Plan will be recorded by a court reporter during the public meeting. Written comments will be accepted throughout the public comment period.

LHAAP-001-R, the South Test Area/Bomb Test Area, is located in the southern portion of LHAAP and covers an area of approximately 79 acres. LHAAP-001-R was constructed in 1954 and used for testing photoflash bombs produced at the facility until about 1956. During the late 1950s, illuminating signal devices were also demilitarized within pits excavated within the vicinity of the test pad. During the early 1960s, leaking production items may have been demilitarized by detonation. Leaking white phosphorus (WP) munitions were supposedly disposed of although no primary source documentation concerning this effort was located. A 1984 LHAAP Contamination Survey stated the area had been relatively inactive since the early 1960s and no disposal or testing activities were carried out. LHAAP-001-R is co-located with the Installation Restoration Program (IRP) site LHAAP- 27.

LHAAP-003-R, the Ground Signal Test Area, is located in the southeastern portion of LHAAP and covers an area of approximately 80 acres. LHAAP-003-R was used intermittently starting in April 1963 for aerial and on-ground testing and destruction of a variety of devices, including pyrotechnic signal devices, red phosphorus smoke wedges, infrared flares, illuminating mortar shells and cartridges, button bombs, and various types of explosive simulators. The site was also used intermittently over a 20-year period for testing and burn-out of rocket motors. From late 1988 through 1991, the site was also used for burn-out of rocket motors in Pershing missiles. Occasionally, leaking WP munitions were burned at the site as a demilitarization activity. LHAAP-003-R is co-located with the IRP site LHAAP-54.

The Proposed Plan documents a 2008 removal action of munitions and explosives of concern (MEC) at LHAAP-001-R and LHAAP-003-R and proposes limited groundwater monitoring for perchlorate at these sites beyond the land use controls (LUCs) already in place as a result of the 2008 removal action. The purpose of the additional monitoring is to confirm perchlorate levels in groundwater are below groundwater MSC for industrial use (GW-Ind). Furthermore, implementation, maintenance, inspection, reporting and enforcement of the LUCs will continue to promote the ongoing protection of human safety against explosive hazards that may have remained at the sites in the subsurface.

The U.S. Army is soliciting public review and comment on the recommendation of limited groundwater monitoring for perchlorate for LHAAP-001-R and LHAAP-003-R. Copies of the Proposed Plan and supporting documentation are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670.

The U.S. Army encourages the public to participate in the decision-making process by offering comments on the Proposed Plan. For further information, 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.

Appendix B

Water Level Measurements for May 2000 and Maps Showing Groundwater Flow Direction

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
01MW01	5/18/00	278.47	10:27	28.51	249.96
01MW02	5/18/00	273.23	10:24	23.65	249.58
01MW03	5/18/00	260.1	10:15	13.66	246.44
01MW04	5/18/00	273.93	10:03	23.79	250.14
01MW05	5/18/00	257.08	10:10	7.65	249.43
01WW01	5/18/00	247.49	10:19	2.67	244.82
101	5/20/00	197.53	10:31	5.13	192.4
102	5/20/00	194.62	13:08	19.44	175.18
104	5/18/00	248.73	9:43	2.72	246.01
105	5/17/00	199.41	15:06	16.04	183.37
106	5/19/00	179.05	10:52	8.04	171.01
107	5/17/00	178.32	11:30	5.92	172.4
108	5/19/00	175.99	15:25	5.63	170.36
109	5/20/00	197.02	10:38	27.83	169.19
110	5/17/00	189.53	14:22	6.42	183.11
111	5/17/00	221.64	13:47	5.92	215.72
112	5/17/00	252.63	13:58	7.77	244.86
113	5/18/00	215.03	13:42	20.11	194.92
114	5/18/00	244.47	13:03	26.19	218.28
115	5/18/00	225.16	12:23	28.64	196.52
116	5/18/00	216.43	11:09	19.56	196.87
117	5/18/00	214.19	10:55	20.56	193.63
118	5/18/00	219.67	12:26	21.48	198.19
119	5/18/00	222.93	12:49	20.91	202.02
11WW01	5/18/00	208.79	17:51	15.86	192.93
11WW02	5/18/00	207.38	17:48	17.67	189.71
11WW03	5/18/00	207.06	17:45	10.87	196.19
120	5/20/00	184.19	12:58	11.3	172.89
123	5/20/00	186.21	12:49	12.38	173.83
125	5/20/00	196.28	10:42	24.57	171.71
126	5/20/00	199.37	14:45	26.58	172.79
127	5/19/00	188.91	14:37	10.06	178.85
128	5/19/00	192.26	14:43	14.85	177.41
129	5/20/00	197.24	13:06	25.89	171.35
12PZ02	5/18/00	191.86	17:40	7.32	184.54
12WW01	5/18/00	204.19	15:27	21.99	182.2
12WW02	5/18/00	202.45	15:31	20.18	182.27
12WW05	5/18/00	190.52	15:07	6.58	183.94
12WW08	5/18/00	203.54	15:14	21.07	182.47
12WW09	5/18/00	204.04	15:38	16.58	187.46
12WW10	5/18/00	203.21	15:29	20.58	182.63
12WW11	5/18/00	203.51	15:21	21.47	182.04
12WW12	5/18/00	203.04	15:17	20.56	182.48
12WW13	5/18/00	203.24	15:18	20.86	182.38
12WW14	5/18/00	193.07	15:10	10.18	182.89
12WW15	5/18/00	193.11	15:09	7.1	186.01
12WW16	5/18/00	202.43	15:24	20.76	181.67
12WW17	5/18/00	203.5	15:20	21.45	182.05
12WW18	5/18/00	204.26	15:34	22.16	182.1
12WW19	5/18/00	204.74	15:35	22.61	182.13
130	5/20/00	177.73	14:23	4.39	173.34

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
131	5/19/00	189.3	14:08	8.07	181.23
132	5/19/00	188.59	14:12	6.31	182.28
133	5/18/00	315.63	9:50	7.18	308.45
133	5/18/00	315.63	9:51	71.18	244.45
134	5/18/00	316.35	9:51	72.07	244.28
13WW01	5/18/00	207.23	15:44	25.91	181.32
14MW01	5/18/00	204.53	15:47	23.14	181.39
16PZ01	5/18/00	199.44	16:22	25.82	173.62
16PZ02	5/18/00	199.75	16:23	26.19	173.56
16PZ03	5/18/00	198.61	16:24	24.99	173.62
16PZ04	5/18/00	198.81	16:24	25.21	173.6
16PZ05	5/18/00	198.31	16:28	24.86	173.45
16PZ06	5/18/00	198.61	16:27	25.12	173.49
16PZ07	5/18/00	200.1	16:22	26.38	173.72
16PZ08	5/18/00	199.93	16:21	26.39	173.54
16PZ09	5/18/00	196.49	16:32	24.72	171.77
16PZ10	5/18/00	196.65	16:31	23.34	173.31
16PZ11	5/18/00	198.88	16:25	25.11	173.77
16PZ12	5/18/00	199	16:25	25.21	173.79
16PZ13	5/18/00	196.58	16:30	22.96	173.62
16PZ14	5/18/00	196.09	16:29	22.64	173.45
16PZ15	5/18/00	191.93	16:35	18.44	173.49
16PZ16	5/18/00	190.79	16:34	17.41	173.38
16PZ17	5/18/00	186.67	16:40	14.39	172.28
16PZ18	5/18/00	185.99	16:39	13.3	172.69
16PZ19	5/18/00	183.98	16:47	11.12	172.86
16PZ20	5/18/00	183.12	16:46	11.14	171.98
16WW05	5/18/00	204.62	15:51	25.52	179.1
16WW06	5/18/00	205.03	15:50	26.01	179.02
16WW12	5/18/00	188.81	16:53	15.62	173.19
16WW13	5/18/00	178.47	16:04	4.68	173.79
16WW14	5/18/00	198.87	17:15	23.03	175.84
16WW15	5/18/00	198.75	17:16	21.85	176.9
16WW16	5/18/00	195.64	15:57	19.54	176.1
16WW17	5/18/00	197.98	16:58	22.02	175.96
16WW18	5/18/00	185.41	16:02	8.19	177.22
16WW19	5/18/00	182.21	16:00	6.73	175.48
16WW20	5/18/00	199.17	17:18	22.79	176.38
16WW21	5/18/00	198.06	16:59	23.04	175.02
16WW22	5/18/00	200.13	17:00	26.16	173.97
16WW23	5/18/00	177.98	16:08	3.99	173.99
16WW24	5/18/00	177.95	16:07	4.31	173.64
16WW25	5/18/00	188.77	16:38	14.68	174.09
16WW26	5/18/00	188.83	16:37	15.25	173.58
16WW27	5/18/00	177.31	16:12	4.01	173.3
16WW28	5/18/00	176.97	16:11	4.69	172.28
16WW29	5/18/00	178.24	16:44	4.85	173.39
16WW30	5/18/00	178.47	16:43	5.16	173.31
16WW31	5/18/00	202.78	17:06	28.28	174.5
16WW32	5/18/00	202.86	17:05	28.4	174.46

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
16WW33	5/18/00	203.09	17:11	28.16	174.93
16WW34	5/18/00	203.08	17:09	28.17	174.91
16WW35	5/18/00	191.23	16:17	16.11	175.12
16WW36	5/18/00	190.94	16:16	15.48	175.46
16WW37	5/18/00	201.97	15:55	25.41	176.56
16WW38	5/18/00	201.92	15:56	25.24	176.68
17WW01	5/20/00	179.01	14:29	5.75	173.26
17WW02	5/20/00	177.21	14:19	3.94	173.27
17WW03	5/20/00	179.2	14:31	6.1	173.1
17WW04	5/20/00	180.21	14:26	6.93	173.28
17WW05	5/20/00	182.73	14:14	9.61	173.12
17WW06	5/20/00	179.36	14:17	5.93	173.43
17WW07	5/20/00	179.68	14:38	6.92	172.76
17WW08	5/20/00	179.94	14:37	6.58	173.36
17WW09	5/20/00	181.43	14:10	8.48	172.95
17WW10	5/20/00	181.55	14:09	8.06	173.49
17WW11	5/20/00	180.95	14:06	7.3	173.65
17WW12	5/20/00	180.32	14:05	7.35	172.97
17WW13	5/20/00	179.14	14:34	6.18	172.96
17WW14	5/20/00	181.9	14:12	8.44	173.46
18WW01	5/19/00	201.38	14:46	25.89	175.49
18WW02	5/20/00	179.54	13:38	6.62	172.92
18WW03	5/19/00	195.68	15:04	23.66	172.02
18WW04	5/19/00	183.86	15:44	13.05	170.81
18WW05	5/19/00	189.61	15:37	19.7	169.91
18WW06	5/20/00	179.74	13:37	7.43	172.31
18WW07	5/19/00	183.65	16:26	12.34	171.31
18WW08	5/19/00	177.72	16:18	6.54	171.18
18WW09	5/19/00	177.49	16:17	5.71	171.78
18WW10	5/20/00	182.36	13:48	9.99	172.37
18WW11	5/20/00	182.35	13:49	9.79	172.56
18WW14	5/19/00	186.54	14:26	13.56	172.98
18WW15	5/19/00	186.33	14:25	13.24	173.09
18WW16	5/19/00	201.97	14:48	26.42	175.55
18WW17	5/19/00	196.93	15:56	26.4	170.53
18WW18	5/19/00	196.79	15:57	24.84	171.95
18WW19	5/19/00	179.86	16:38	8.16	171.7
18WW20	5/19/00	180.66	16:37	9	171.66
27WW01	5/19/00	195.1	13:58	11.88	183.22
27WW02	5/19/00	187.35	14:03	4.73	182.62
27WW03	5/19/00	188.84	14:05	6.08	182.76
27WW04	5/19/00	186.19	14:02	3.94	182.25
29WW01	5/18/00	242.27	12:58	25.59	216.68
29WW02	5/18/00	235.77	12:40	30.09	205.68
29WW03	5/18/00	237.79	12:53	23.76	214.03
29WW04	5/18/00	236.88	12:55	44.03	192.85
29WW05	5/18/00	216.51	11:07	16.02	200.49
29WW06	5/18/00	217.84	12:05	22.78	195.06
29WW07	5/18/00	220.05	12:10	19.67	200.38
29WW08	5/18/00	220.08	12:11	29.54	190.54

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
29WW09	5/18/00	216.23	10:58	22.2	194.03
29WW10	5/18/00	212.47	11:03	20.18	192.29
29WW11	5/18/00	213.08	11:45	19.04	194.04
29WW12	5/18/00	223.27	11:58	19.78	203.49
29WW13	5/18/00	222.92	11:59	30.08	192.84
29WW14	5/18/00	220.31	12:12	26.36	193.95
29WW15	5/18/00	232.98	13:26	22.6	210.38
29WW16	5/18/00	231.53	13:27	38.09	193.44
29WW17	5/18/00	230.48	13:34	18.15	212.33
29WW18	5/18/00	231.18	13:30	16.06	215.12
29WW19	5/18/00	220.69	12:22	18.65	202.04
29WW20	5/18/00	235.7	13:20	21.85	213.85
29WW21	5/18/00	235.17	13:23	42.24	192.93
29WW22	5/18/00	236.1	13:22	22.29	213.81
29WW23	5/18/00	226.63	12:31	22.04	204.59
29WW24	5/18/00	226.14	12:32	29.37	196.77
29WW25	5/18/00	227.37	12:34	23.97	203.4
29WW26	5/18/00	237.21	13:16	26.08	211.13
29WW27	5/18/00	238.02	13:14	24.7	213.32
29WW28	5/18/00	235.38	12:41	38.59	196.79
29WW29	5/18/00	242.91	12:37	30.26	212.65
29WW30	5/18/00	241.47	13:07	27.15	214.32
29WW31	5/18/00	240.97	13:08	26.78	214.19
29WW32	5/18/00	229.09	12:44	25.07	204.02
29WW33	5/18/00	237.67	12:54	23.89	213.78
32WW01	5/18/00	219.84	13:38	31.07	188.77
32WW02	5/18/00	216.31	13:44	28.19	188.12
35AWW01	5/16/00	218.03	15:24	29.79	188.24
35AWW02	5/16/00	218.05	15:23	35.22	182.83
35AWW03	5/16/00	219.66	15:17	15.91	203.75
35AWW04	5/16/00	220.66	15:12	18.98	201.68
35BWW01	5/17/00	202.88	15:29	6.84	196.04
35BWW02	5/17/00	203.95	16:41	11.79	192.16
46WW01	5/16/00	212.82	16:02	14.54	198.28
46WW02	5/16/00	212.21	16:03	24.23	187.98
46WW03	5/16/00	212.47	16:04	28.82	183.65
46WW04	5/16/00	215.39	16:17	13.84	201.55
47WW01	5/19/00	194.4	10:08	12.53	181.87
47WW02	5/16/00	197.23	16:53	12.24	184.99
47WW03	5/19/00	195.24	10:13	15.19	180.05
47WW04	5/19/00	190.9	10:25	9.79	181.11
47WW05	5/17/00	198.55	14:55	14.96	183.59
47WW06	5/17/00	199.02	14:56	15.41	183.61
47WW07	5/17/00	199.24	14:58	15.83	183.41
47WW08	5/16/00	199.45	16:57	14.64	184.81
47WW09	5/17/00	201.04	15:56	15.46	185.58
47WW11	5/17/00	199.14	16:07	14.78	184.36
47WW12	5/17/00	202.27	15:15	15.95	186.32
47WW13	5/17/00	204.97	15:40	15.93	189.04
47WW14	5/17/00	205	15:39	16.03	188.97

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
47WW15	5/17/00	205.17	15:38	19.23	185.94
47WW16	5/17/00	203.73	15:21	15.23	188.5
47WW17	5/17/00	201.76	16:27	14.37	187.39
47WW18	5/17/00	199.69	16:14	14.52	185.17
47WW19	5/17/00	198.93	16:13	13.87	185.06
47WW20	5/17/00	198.78	16:12	15.97	182.81
47WW21	5/19/00	187.59	10:33	7.33	180.26
47WW22	5/19/00	195.62	10:40	15.47	180.15
47WW23	5/19/00	197.86	10:37	14.68	183.18
49WW01	5/17/00	232.01	14:34	20.66	211.35
49WW02	5/17/00	232.92	14:38	20.48	212.44
49WW03	5/17/00	232.09	14:47	19.11	212.98
50WW01	5/17/00	198.5	16:54	10.68	187.82
50WW02	5/17/00	200.74	16:59	13.44	187.3
50WW03	5/17/00	202.94	17:04	14.8	188.14
50WW04	5/17/00	204.51	17:07	17.32	187.19
AWD-1	5/20/00	182.27	13:02	8.99	173.28
AWD-2	5/20/00	186.95	12:52	15.52	171.43
AWD-3	5/20/00	200.13	13:14	27.93	172.2
AWD-4	5/19/00	193.85	16:12	21.44	172.41
C-01	5/20/00	193.89	14:43	21.03	172.86
C-02	5/20/00	175.95	13:42	3.42	172.53
C-03	5/19/00	196.34	15:51	24.43	171.91
C-04	5/19/00	194.64	15:48	22.85	171.79
C-05	5/19/00	180.74	15:44	9.89	170.85
C-06	5/19/00	192.22	15:09	22.39	169.83
C-07	5/19/00	196.8	14:29	23.76	173.04
C-08	5/19/00	192.65	15:02	21.37	171.28
C-09	5/19/00	202.35	14:54	29.39	172.96
C-10	5/19/00	201.86	14:55	28.59	173.27
C-4A	5/19/00	194.61	15:49	22.7	171.91
EW-1	5/20/00	198.61	11:10	28.58	170.03
G4WW01	5/19/00	201.07	11:31	18.63	182.44
G4WW02	5/19/00	199.79	11:35	17.19	182.6
G4WW03	5/19/00	200.32	11:25	17.92	182.4
LHSMW01	5/16/00	214.43	13:35	5.64	208.79
LHSMW02	5/16/00	215.43	15:32	7.33	208.1
LHSMW03	5/16/00	217.26	15:29	16.71	200.55
LHSMW04	5/16/00	216.95	15:27	16.55	200.4
LHSMW05	5/16/00	217.59	15:22	16.71	200.88
LHSMW06	5/16/00	223.18	15:15	14.68	208.5
LHSMW07	5/16/00	221.27	15:13	15.63	205.64
LHSMW08	5/16/00	207.85	15:46	16.84	191.01
LHSMW09	5/16/00	210.68	15:48	11.92	198.76
LHSMW10	5/16/00	214.58	15:44	16.22	198.36
LHSMW11	5/16/00	212.91	15:41	15.73	197.18
LHSMW12	5/16/00	209.02	15:51	11.45	197.57
LHSMW13	5/16/00	209.5	15:52	8.29	201.21
LHSMW14	5/16/00	244.78	16:13	10.78	234
LHSMW15	5/16/00	226.65	16:09	16.52	210.13

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
LHSMW16	5/16/00	232.19	16:11	8.86	223.33
LHSMW17	5/16/00	214.58	15:55	13.49	201.09
LHSMW18	5/16/00	215.35	15:57	15.04	200.31
LHSMW19	5/16/00	212.96	16:00	12.91	200.05
LHSMW20	5/16/00	209.29	16:24	14.96	194.33
LHSMW21	5/16/00	207.67	16:21	12.59	195.08
LHSMW22	5/16/00	209.6	16:25	16.64	192.96
LHSMW23	5/16/00	208.82	16:27	18.62	190.2
LHSMW24	5/16/00	203.84	16:29	15.47	188.37
LHSMW25	5/16/00	201.97	16:33	17.78	184.19
LHSMW26	5/16/00	204.72	16:35	17.93	186.79
LHSMW27	5/16/00	202.1	16:36	14.96	187.14
LHSMW28	5/16/00	205.52	17:06	16.46	189.06
LHSMW29	5/16/00	203.24	17:04	15.85	187.39
LHSMW30	5/16/00	203.74	17:02	17.07	186.67
LHSMW31	5/16/00	201.03	16:41	15.04	185.99
LHSMW32	5/16/00	200.18	16:44	13.32	186.86
LHSMW33	5/16/00	199.39	16:55	14.68	184.71
LHSMW34	5/16/00	198.59	16:46	13.74	184.85
LHSMW35	5/16/00	198.37	16:47	13.87	184.5
LHSMW36	5/16/00	196.53	16:52	12.6	183.93
LHSMW37	5/16/00	195.18	16:49	11.45	183.73
LHSMW38	5/16/00	200.84	16:39	13.68	187.16
LHSMW39	5/17/00	198.71	15:01	15.2	183.51
LHSMW40	5/17/00	199.99	15:03	16.61	183.38
LHSMW41	5/17/00	199.85	15:03	16.61	183.24
LHSMW41	5/17/00	199.85	15:08	15.42	184.43
LHSMW42	5/17/00	200.29	15:12	15.51	184.78
LHSMW43	5/17/00	200.26	15:55	14.94	185.32
LHSMW44	5/17/00	200.36	15:13	14.36	186
LHSMW45	5/17/00	201.39	15:18	14.99	186.4
LHSMW46	5/17/00	201.72	15:52	15.11	186.61
LHSMW47	5/17/00	200.54	15:48	13.41	187.13
LHSMW48	5/17/00	202.06	16:01	11.55	190.51
LHSMW49	5/17/00	201.74	15:43	11.97	189.77
LHSMW50	5/17/00	205.17	16:25	15.41	189.76
LHSMW51	5/17/00	208.5	15:23	18.32	190.18
LHSMW52	5/17/00	205.91	16:30	14.94	190.97
LHSMW53	5/17/00	197.61	16:48	11.31	186.3
LHSMW54	5/17/00	193.71	16:20	8.33	185.38
LHSMW55	5/17/00	199.76	16:24	14.19	185.57
LHSMW56	5/17/00	198.59	16:17	13.48	185.11
LHSMW57	5/17/00	200.53	16:09	5.71	194.82
LHSMW58	5/17/00	203.56	15:33	11.89	191.67
LHSMW59	5/17/00	204.18	15:31	12.56	191.62
LHSMW60	5/17/00	199.28	16:45	11.33	187.95
LHSMW61	5/19/00	198.29	10:47	21.05	177.24
LHSMW62	5/19/00	192.2	11:16	17.61	174.59
LHSMW63	5/19/00	194.06	11:12	18.89	175.17
LHSMW64	5/19/00	191.42	11:19	17.73	173.69

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
LHSMW65	5/19/00	194.31	11:04	17.27	177.04
LHSMW66	5/19/00	195.11	11:08	18.1	177.01
LHSMW67	5/17/00	185.57	11:37	12.7	172.87
LHSMW68	5/17/00	189.65	11:38	16.03	173.62
LHSMW69	5/17/00	183.27	11:41	10.62	172.65
LHSMW70	5/17/00	183.62	11:26	10.56	173.06
LHSMW71	5/17/00	183.73	11:24	12.16	171.57
MW-1	5/20/00	199.31	12:45	28.58	170.73
MW-10	5/20/00	178.12	13:40	5.74	172.38
MW-11	5/20/00	184.65	12:29	12.13	172.52
MW-12	5/20/00	178.54	12:56	6.53	172.01
MW-13	5/20/00	176.72	13:43	4.33	172.39
MW-14	5/20/00	186.19	12:59	10.82	175.37
MW-16	5/20/00	178.64	13:33	6.17	172.47
MW-17	5/20/00	179.03	13:53	6.56	172.47
MW-18	5/20/00	178.58	13:55	5.85	172.73
MW-19	5/20/00	178.6	14:01	5.81	172.79
MW-2	5/20/00	196.92	11:05	27.08	169.84
MW-20	5/20/00	186.64	13:17	10.11	176.53
MW-21	5/20/00	198.7	10:34	29.45	169.25
MW-22	5/20/00	197.51	12:43	28.99	168.52
MW-23	5/20/00	198.79	13:11	27.86	170.93
MW-3	5/20/00	196.52	10:57	25.09	171.43
MW-4	5/20/00	197.27	10:53	26.13	171.14
MW-5	5/20/00	194.97	10:46	23.14	171.83
MW-6	5/20/00	192.18	10:49	20.15	172.03
MW-7	5/20/00	188.47	13:20	16.68	171.79
MW-8	5/20/00	187.13	13:58	16.24	170.89
MW-9	5/20/00	184.73	13:22	12.97	171.76

Measurements Based on Mean Sea Level

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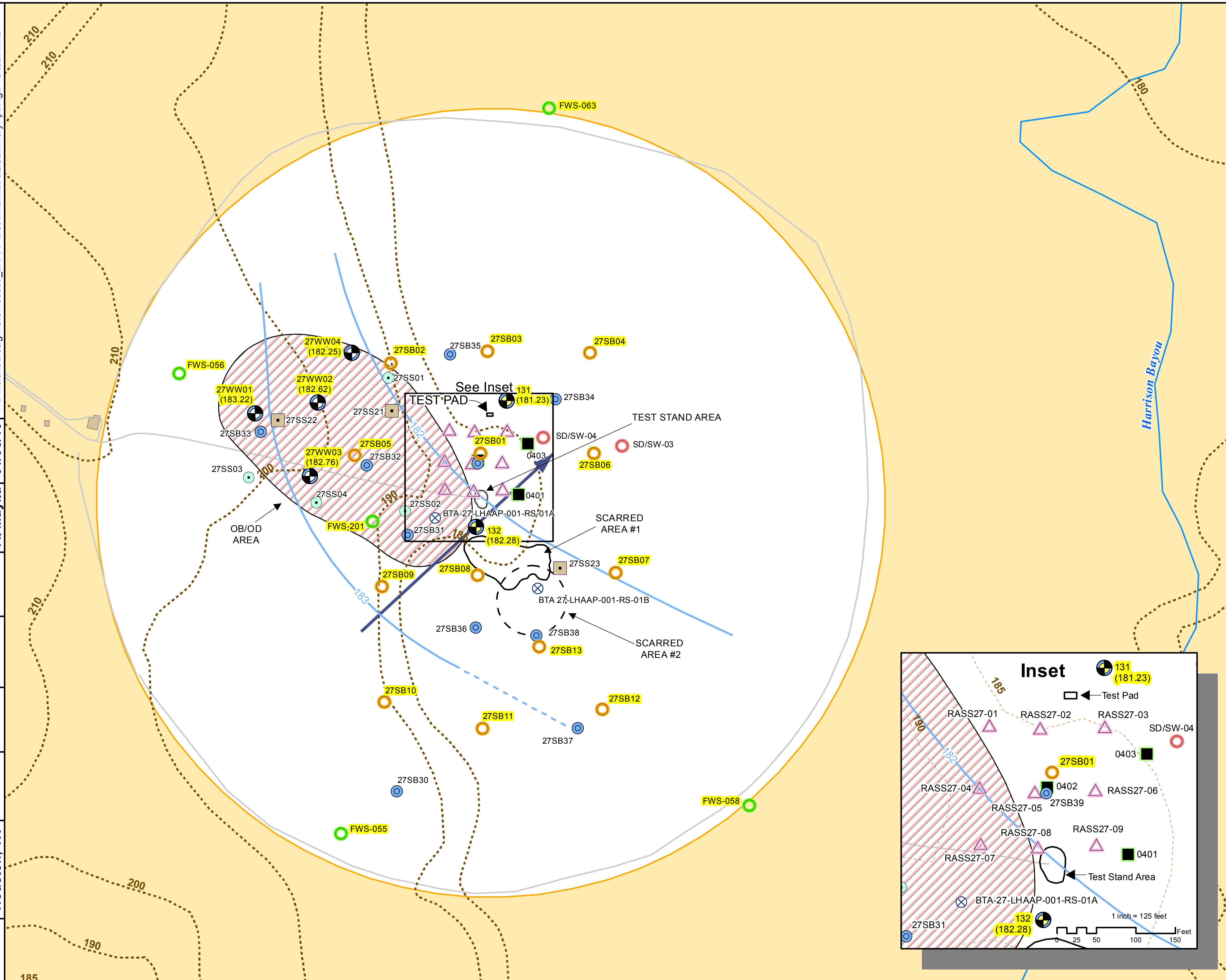

LEGEND

- SHALLOW SOIL SAMPLE, (EPS, 1982)
- MONITORING WELL, (EPS, 1982)
- MONITORING WELL, (SVERDRUP, 1994)
- MONITORING WELL, (USEPA, US ARMY, 2009)
- SOIL BORING, (EBASCO, 1993)
- SURFACE SOIL SAMPLE, (EBASCO, 1993)
- SURFACE SOIL SAMPLE, (SVERDRUP, 1994)
- SURFACE SOIL SAMPLE, (USACE, 1996/97)
- SURFACE WATER/SEDIMENT, (EBASCO, 1993)
- SOIL SAMPLE, (SVERDRUP, 2000) (STEP, 2005)
- SOIL SAMPLE, (USFWS, 2003)
- SOIL SAMPLE, (CAPE, 2006)
- 182 Groundwater Elevation Contour *Dashed where inferred.*
- Groundwater Flow Direction
- Contours
- Road
- Stream
- Test Pad
- Test Stand Area
- Scarred Area #1
- Scarred Area #2
- OB/OD Area
- Building
- Caddo Lake National Wildlife Refuge

Note: The locations of perchlorate samples for all media are highlighted to present the wide coverage of perchlorate samples.

N

1 inch = 250 feet

0 125 250 500 Feet

Shaw

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-1
SITE MAP WITH
SAMPLING LOCATIONS
SOUTH TEST AREA / BOMB TEST AREA
LHAAP-001-R
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Muske 09/12/11	N. Olson 01/06/10	A. Mayila 01/06/10	T:\Divisions\Design\GIS\133363_LHAAP\Doc\Mxd\McDataSummaryRpt\Fig2-1Site27.mxd

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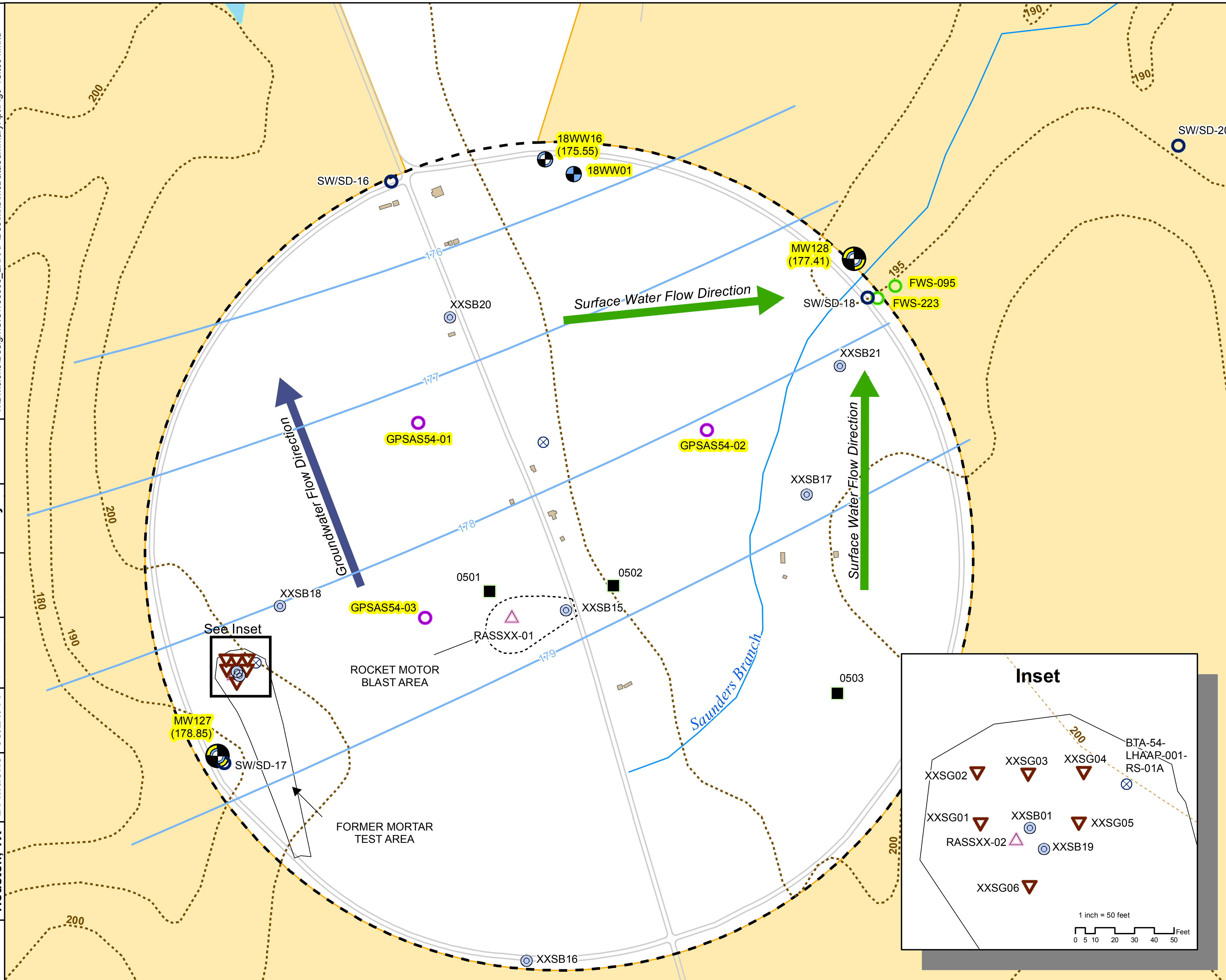

LEGEND

- MONITORING WELL, (STEP, 2005)
- MONITORING WELL, (USEPA, US ARMY, 2009)
- MONITORING WELL, (EPS 1982, EBASCO 1993)
- SHALLOW SOIL SAMPLE, (EPS, 1982)
- SOIL BORING, (EBASCO, 1993)
- SOIL GAS SAMPLE, (SVERDRUP, 1994)
- SOIL SAMPLE, (CAPE, 2006)
- SURFACE SOIL SAMPLE, (USACE, 1996/97)
- SURFACE WATER/SEDIMENT, (EBASCO, 1993)
- SOIL SAMPLE, (USFWS, 2003)
- GEOPROBE LOCATION, (USACE, 2001)
- Groundwater Elevation Contour
- Groundwater Flow Direction
- Contours
- Former Mortar Test Area
- Rocket Motor Blast Area
- Ground Signal Test Area
- Stream
- Road
- Lake
- Building
- Caddo Lake National Wildlife Refuge
- Surface Water Flow Direction

Note: The locations of perchlorate samples for all media are highlighted to present the wide coverage of perchlorate samples.

1 inch = 250 feet

0 125 250 500 Feet

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

Shaw

FIGURE 3-1
SITE MAP WITH SAMPLING LOCATIONS
GROUND SIGNAL TEST AREA
LHAAP-003-R

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Muske 09/21/11	J. Elliott 09/21/11	A. Mayila 09/21/11	T:\Divisions\Design\GIS\133363_LHAAP\Doc\Mxd\McDataSummaryRpt\Fig3-1Site54.mxd

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FINAL
RECORD OF DECISION
LHAAP-17, BURNING GROUND NO. 2/FLASHING AREA, GROUP 2
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Prepared for

U.S. Army Corps of Engineers
Tulsa District
1645 South 101st East 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**
Shaw Project No. 117591

September 2011

Table of Contents

Table of Contents (continued)

List of Tables

List of Figures

List of Appendices

Glossary of Terms

Located at the end of this ROD

Acronyms and Abbreviations

µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
BERA	baseline ecological risk assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSM	conceptual site model
DCA	dichloroethane
DCE	dichloroethene
DNT	dinitrotoluene
DPT	direct-push technology
EcoPRG	ecological preliminary remediation goal
ECP	environmental condition of property
EEQ	ecological effects quotient
EPC	exposure point concentration
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FS	feasibility study
ft^2	square feet
GWP-Ind	TCEQ soil MSC for industrial use based on groundwater protection
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
HRC®	Hydrogen Release Compound®
IRIS	Integrated Risk InformationSystem
Jacobs	Jacobs Engineering Group
LHAAP	Longhorn Army Ammunition Plant
LTM	long-term monitoring
LUC	land use control
MCL	maximum contaminant level
mg/kg	milligrams per kilogram (parts per million [ppm] – soil analyses)
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

Acronyms and Abbreviations (continued)

NOAEL	no-observed adverse effect level
NPL	National Priorities List
O&M	operation and maintenance
PEC	Planteco Environmental Consultants, LLC
Plexus	Plexus Scientific Corporation
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RFA	RCRA Facility Assessment
RfD	reference dose
RI	remedial investigation
ROD	record of decision
RRS	Risk Reduction Standards
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
Shaw	Shaw Environmental, Inc.
STEP	Solutions to Environmental Problems, Inc.
SVOC	semivolatile organic compound
TAC	Texas Administrative Code
TCDD	tetrachlorodibenzo-p-dioxin
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TEC	toxicity equivalence concentration
TNT	trinitrotoluene
TRV	toxicity reference level
U.S. Army	U.S. Department of the Army
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USC	U.S. Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VC	vinyl chloride
VOC	volatile organic compound

1.0 The Declaration

1.1 Site Name and Location

LHAAP-17, Burning Ground No. 2/Flashing Area, Group 2

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 remedy for LHAAP-17, Burning Ground No. 2/Flashing Area, 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 the site, including the remedial investigation (RI) (Jacobs Engineering Group, Inc. [Jacobs], 2001), baseline human health risk assessment (BHHRA) report (Jacobs, 2002), installation-wide baseline ecological risk assessment (BERA) report (Shaw Environmental, Inc. [Shaw], 2007a), feasibility study (FS) (Shaw, 2010), and Proposed Plan (U.S. Department of the Army [U.S. Army], 2010).

The U.S. Army is the lead agency for the environmental response actions at LHAAP. The U.S. Army is acting in partnership with the USEPA Region 6 and the Texas Commission on Environmental Quality (TCEQ), the regulatory agencies providing technical support, project review and comment, and oversight of the U.S. Army cleanup program. The USEPA and the U.S. Army jointly select the remedy and TCEQ concurs with the selected remedy in this Record of Decision (ROD).

1.3 Assessment of the Site

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

1.4 Description of the Selected Remedy

The selected remedy for LHAAP-17 protects human health and the environment by preventing human and ecological receptors from exposure to contaminated soil and contaminated groundwater. The human health scenarios evaluated were based on the hypothetical future maintenance worker. In the soil, chemicals of concern (COCs) are explosives (2,4,6-trinitrotoluene [TNT], 2,4-dinitrotoluene [DNT], 2,6-DNT) and perchlorate (potential soil COC based on groundwater concentrations); and chemicals of potential ecological concern (COPECs) are explosives (2,4,6-TNT, 2,4-DNT, 2,6-DNT); dioxins (2,3,7,8-tetrachlorodibenzo-p-dioxin [TCDD] toxicity equivalence concentration [TEC]); and barium. In the shallow groundwater zone, the COCs are perchlorate and volatile organic compounds (VOCs) (1,2-dichloroethane [DCA], 1,1-dichloroethene [DCE], cis-1,2-DCE, trichloroethene [TCE], and vinyl chloride [VC]). In the intermediate groundwater zone, the COCs are TCE and its daughter products (DCE and VC). The contaminated soil has been identified as a principal threat material. The components of the selected remedy are summarized below:

- Contaminated soil removal with off-site disposal to protect the hypothetical future maintenance worker and ecological receptors and to eliminate the soil-to-groundwater pathway.
- Extraction and treatment of groundwater until the trigger level of 20,000 micrograms per liter (µg/L) of perchlorate is reached. The trigger level in this ROD is an interim cleanup level. Upon reaching the trigger level, the remedial action will transition from the initial measure of groundwater extraction to the primary remedy of monitored natural attenuation (MNA). Reduction of the perchlorate concentration to the trigger level is anticipated to expedite MNA.
  - If the 20,000 µg/L of perchlorate level is not reached after approximately 1.5 years, a contingency remedy of in situ bioremediation will be implemented to reduce the perchlorate levels more quickly so the conditions become amenable for TCE to attenuate naturally.
- MNA to confirm protection of human health and the environment by documenting that the contaminated groundwater remains localized with minimal migration and that contaminant concentrations are being reduced to cleanup levels.
  - Performance objectives will be evaluated after 2 years of MNA. During those 2 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 long-term monitoring (LTM) will be semiannual for 3 years. In subsequent years, LTM 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 5 years until cleanup levels are achieved.

- A land use control (LUC) to prevent human exposure to contaminated groundwater by prohibiting the use of groundwater except for environmental monitoring and testing. A preliminary LUC boundary is presented in **Section 2.12.2** and a final LUC boundary will be determined during the RD/Remedial Action. When the cleanup level is achieved, the LUC will be terminated.
- A LUC restricting land use to nonresidential use only. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.
- CERCLA five-year reviews until cleanup levels are achieved.

Based on a preliminary natural attenuation evaluation and groundwater modeling, cleanup levels are expected to be met through natural attenuation in approximately 117 years (Shaw, 2010). Specifically, TCE should attenuate to its maximum contaminant level (MCL) in approximately 117 years, 1,2-DCA in 10 years, and perchlorate in 15 years without groundwater extraction and treatment. With groundwater extraction and treatment, cleanup times should be reduced. Considering the lithologic variability, particularly the lateral and vertical change from sand to clay, the time to achieve cleanup levels may vary. In the course of the remedy, the additional monitoring results will allow more accurate time estimates.

The groundwater flow rates are within the normal range for the formation material at the site. Thus, no adverse impact is expected to the surface water during the time it would take natural attenuation to reduce contaminant concentrations to cleanup levels.

The remedial design (RD) will include the specific LUCs and implementation details. The groundwater extraction and MNA performance monitoring plan will also be presented in the RD. Within 90 days of signing 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 the TCEQ) entered into the FFA for remedial activities at LHAAP on December 30, 1991. The U.S. Army will be responsible for implementation, maintenance, periodic inspection, reporting on, and enforcement of the LUCs 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 ultimately 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 the LUCs and any related transfer or lease provisions; and (5) ensuring the protectiveness 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 these sites after they have been transferred. The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or significant modification of a LUC, or in the highly unlikely event of a land use change inconsistent with the industrial/recreational use assumptions of the remedy. (There is no reasonably anticipated use of the property for other than wildlife refuge purposes.) In the event that TCEQ and/or USEPA and the U.S. Army agree with respect to any significant modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the FFA, 40 CFR 300.435(c)(2).

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 (Shaw, 2007a). Thus, the implementation of this remedy at LHAAP-17 is independent of any other remedial action at LHAAP to address human health issues. To address ecological risk, LHAAP-17 was grouped with several other sites as part of the Waste Sub-Area. The final COPECs in soil that require remedial action in the Waste Sub-Area are barium, 2,4-DNT, 2,6-DNT, 2,4,6-TNT, and dioxins (Shaw, 2010). The remedial actions at LHAAP-17 will be sufficient to remove ecological risks for the sub-area. This management strategy is considered to be endorsed by regulators as evidenced by the regulatory approval of the BERA (Shaw, 2007a).

1.5 Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, and is cost-effective. In addition, the remedy offers long-term effectiveness through excavation of soil and the implementation of LUCs, which will minimize the potential risk to the hypothetical future maintenance worker posed by the contaminated soil and groundwater. Furthermore, evaluation of MNA including routine monitoring of the attenuation until cleanup levels are met would document the effectiveness of the selected remedy. The selected remedy is easily and immediately implementable and has a moderate cost compared to the other alternatives considered for LHAAP-17 with the exception of Alternative 1 (No Action).

The groundwater extraction component of the selected remedy satisfies the statutory preference for treatment as a principal treatment element of the remedy. The MNA component does not address the statutory preference for treatment to the maximum extent practicable; MNA is a passive remedial action using natural processes.

The selected remedy would reduce the toxicity, mobility, or volume of contaminants in the groundwater through active and passive remedial actions. There is no known principal threat material or contaminant source in the LHAAP-17 groundwater.

Because hazardous substances, pollutants, or contaminants will remain at the site above levels that allow for unlimited use and unrestricted exposure, a five-year review will be conducted every 5 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 Harrison County records stating that the site is suitable for nonresidential use and that a prohibition of groundwater use (except for environmental monitoring and testing) 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. Additional information can be found in the Administrative Record for this site.

- 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 sites as a result of the selected remedy (**Section 2.6**).
- COCs and their concentrations (**Section 2.7**).
- Baseline risk represented by the COCs (**Section 2.7**).
- Cleanup levels established for COCs and the basis for these levels (**Sections 2.7.3** and **2.8**).
- Absence of source materials constituting principal threats that need to be addressed at this site (**Section 2.11**).
- Key factor(s) 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**).

00112954

1.7 Authorizing Signatures

As the lead agency, the U.S. Army issues this ROD for LHAAP-17 which documents the final selected remedy. The undersigned is the appropriate approval authority for this decision.

Thomas E. Lederle

THOMAS E. LEDERLE 29 Sep 2011

(*Name*) (*Date*)

for

Clarence D. Turner
Colonel, U.S. Army
Chief, Base Realignment and Closure Division

The United States Environmental Protection Agency approves the selected remedy as provided in the ROD for LHAAP-17.

__________________________ ____________

(*Name*) (*Date*)

Samuel Coleman, P.E.
Director
Superfund Division
U.S. Environmental Protection Agency
Region 6

2.0 Decision Summary

2.1 Site Name, Location, and Description

LHAAP-17, Burning Ground No. 2/Flashing Area, Group 2

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.

LHAAP-17, known as the Burning Ground No. 2/Flashing Area, is a 3.9-acre site located within a heavily wooded section in the southeastern portion of LHAAP (**Figure 2-2**). The site has two 185-feet by 305-feet cleared areas, separated by a gravel access road. The site is covered with grass and scattered brush, has been graded above the surrounding terrain, and is relatively flat.

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 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. In 1952, the LHAAP facility was reactivated with the opening of Plant 2, where pyrotechnic ammunition, such as photoflash bombs, simulators, hand signals, and tracers for 40 millimeter ammunition, were produced until 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 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 Force 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-17 was used as a burning ground from 1959 through 1980 (Plexus Scientific Corporation [Plexus], 2005). Bulk TNT, photo flash powder, and reject material from Universal Match Corporation operations were burned at LHAAP-17. In 1959, the materials removed from the former TNT Production Area (LHAAP-29) and the former TNT Waste Disposal Plant (LHAAP-32) during demolition were burned and/or flashed at LHAAP-17. The site was used as a flashing area to decontaminate recoverable metal byproducts until 1980, when it became inactive. Burning trenches were located around the inside perimeter of the previously fenced area and within the open area on the western boundary of the site. As each trench filled with ash, it was covered and a new trench was dug. The waste residues were reportedly removed from the trenches in 1984, and the site was allowed to revegetate (Jacobs, 2002).

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 Materials 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.

Several investigations to determine the nature and extent of contamination in the soil, groundwater, surface water, and sediments at LHAAP-17 were conducted and are listed below. Samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), metals, explosive compounds, perchlorate, pesticides, polychlorinated biphenyls, and/or dioxins/furans, depending on the focus of the investigation. For some of the earlier investigations, LHAAP sites were organized into groups, and LHAAP-17 was included in Group 2. The group designation was de-emphasized as the complexities of the individual sites became greater. The following summarizes the investigations at LHAAP-17:

- **Multi-phase investigation of Group 2 sites**: Between 1982 and 1998 numerous investigations were conducted in a phased approach by Jacobs, U.S. Army Corps of Engineers (USACE), and Environmental Protection System. Activities included installation of monitoring wells and analysis of groundwater, surface water, soil, and sediment samples. The results are documented in the RI for Group 2 sites (Jacobs, 2001). **Figures 2-3** and **2-4** show the sample locations at LHAAP-17 for soil and surface water/sediment, respectively. **Figures 2-5** and **2-6** show the well locations for the shallow and intermediate groundwater zones, respectively.

- **Plant-wide perchlorate investigation**: The groundwater investigation was conducted by Solutions to Environmental Problems, Inc. (STEP) from 2000 through 2002 (STEP, 2005).

- **Baseline Human Health Risk Assessment**: The BHHRA (Jacobs, 2002) used data from the investigations conducted through 2001, including the plant-wide perchlorate investigation results up to that time. The report concluded that the soil and groundwater at LHAAP-17 both posed unacceptable carcinogenic risk and non-carcinogenic hazard to the hypothetical future maintenance worker.

- **Environmental Site Assessment**: Media investigated in 2003 included soil and groundwater (Plexus, 2005), although no sampling was conducted at LHAAP-17 for this assessment.

- **Perchlorate treatability demonstration**: The study was conducted by Planteco Environmental Consultants, LLC (PEC) in 2003 and 2004 to demonstrate that perchlorate concentrations in soil can be reduced by soil composting. Organic amendments were added to a 1-acre area in the western portion of LHAAP-17, where the highest concentrations of perchlorate-contaminated soil were located. Decreased concentrations for perchlorate and explosive compounds were observed in the soil, as well as for perchlorate in groundwater (PEC, 2004).

- **Baseline Ecological Risk Assessment**: The BERA (Shaw, 2007a) identified COPECs for the Waste Sub-Area, which includes LHAAP-17. COPECs for the sub-area are addressed in the remedial actions for LHAAP-17. The evaluation was based on environmental investigations from 1993 to 2006.

- **Data gaps**: Additional investigations were conducted by Shaw in 2004 after the BHHRA was finalized to further delineate the extent of groundwater contamination identified during previous sampling events. The results of the 2004 investigation were presented in the *Data Gaps Investigation* (Shaw, 2007b).

- **Feasibility Study**: The FS (Shaw, 2010) was based on the available results from previous investigations. In addition, it included the natural attenuation evaluation based on sampling results from 2009, 2007, and earlier.

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.

LHAAP-17 was one of the originally listed NPL sites in the FFA. The FS for LHAAP-17 (Shaw, 2010) was issued in April 2010, and the Proposed Plan (U.S. Army, 2010) was issued in May 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-17 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-17 was released to the Administrative Record and made available to the public for review and comment on May 26, 2010. A media release was sent to radio stations KETK, KMSS, KSLA, and KTBS on May 26, 2010. The 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 May 27, 2010. The newspaper and media notices for the meeting are provided in **Appendix A**. The public comment period for the Proposed Plan began on June 10, 2010 and ended July 10, 2010. A public meeting was held on June 29, 2010 in a formal format and with a court reporter. The transcript for the meeting is part of the Administrative Record. The significant comments (oral or written) are addressed in the Responsiveness Summary, which is included in this ROD as **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 selected action at LHAAP-17 will prevent potential risks associated with exposure to contaminated groundwater. Although groundwater at LHAAP 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) [background total dissolved solids (TDS) content less than or equal to 10,000 mg/L and that occurs within a geologic zone that is sufficiently permeable to transmit water to a pumping well in usable quantities]. The U.S. Army intends to return the contaminated shallow and intermediate groundwater zones at LHAAP-17 to their potential beneficial uses, which for the purposes of this ROD is considered to be attainment of the Safe Drinking Water Act (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 TCEQ soil medium-specific concentration (MSC) for industrial use based on groundwater protection (GWP-Ind) is used in place of the MCL, in accordance with 30 TAC 335.559(d)(2). 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 selected 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 Harrison Bayou.

In addition, the selected action will include groundwater monitoring to demonstrate that the plume is not migrating at levels that present a potential impact to surface water bodies and to verify that contaminant levels are being reduced to cleanup levels when the LUC for groundwater use prohibition may be terminated.

2.5 Site Characteristics

This section of the ROD presents a brief comprehensive overview of the LHAAP-17 site characteristics with respect to the conceptual site model (CSM), 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. Detailed information about the site characteristics can be found in the RI (Jacobs, 2001).

2.5.1 Conceptual Site Model

Figure 2-7 illustrates the human health conceptual site model for LHAAP-17. The model presents the human health pathways that may impact a hypothetical future maintenance worker and are being considered for remediation. Those pathways that are likely to be incomplete or have negligible impact are not being considered for remediation. **Figure 2-8** illustrates the ecological conceptual model for LHAAP-17, which is similar to the one presented for human health in terms of the origin and fate and transport mechanisms of the contaminants present at the site. However, only exposure pathways and routes associated with soil are relevant for ecological risk assessment.

Explosive compound releases resulting from the burning of explosive type materials removed from the TNT Production Area and the TNT Waste Disposal Plant are the suspected contamination sources at LHAAP-17. Residual contamination as a result of deposition, spills, and runoff of contamination on the surface poses potential risk to the hypothetical future maintenance worker.

Contamination in the form of VOCs and perchlorate is present in groundwater at LHAAP-17 and poses potential risk to the hypothetical future maintenance worker. Perchlorate and VOC concentrations have been detected consistently throughout the shallow groundwater zone. Two VOCs (1,1-DCE and 1,2-DCA) are found only in the shallow groundwater zone. TCE has been detected in both the shallow and intermediate zones. The horizontal extent of contamination in the shallow and intermediate groundwater zones has been defined as presented in **Figures 2-9** and **2-10**, respectively.

The soil and groundwater at LHAAP-17 may pose a risk for the hypothetical future maintenance worker, and the soil may pose a risk for ecological receptors. Thus the pathways considered for remediation include soil, soil to groundwater, and future industrial groundwater use. Analytical results showing soil contamination are presented in **Figure 2-11**.

2.5.2 Overview of the Site

The site boundary of LHAAP-17 comprises approximately 3.9 acres in the southern portion of LHAAP. The surface features include two 185-feet by 305-feet cleared areas, separated by a gravel access road. The site is covered with grass and scattered brush and has been graded above the surrounding terrain. The topography is relatively flat. Surface drainage flows to ditches along the eastern and western boundaries of the site and then to Harrison Bayou, which is located to the west of LHAAP-17. The entire site is within the 100-year floodplain of the bayou. There are no surface water bodies located on the site.

2.5.3 Geology and Hydrogeology

The local geology at LHAAP-17 consists of silty, clayey and sandy units of the Wilcox Group. The uppermost unit consists predominantly of silty clay to clay extending to depths ranging from 5 to 30 feet. Underlying this layer is a gray to light brown, fine grained silty sandy unit interbedded with silty clay to clay lenses. The clay layers act as an aquitard separating the shallow zone from the intermediate zone. A thick, fine to medium grained sand layer was encountered in boring 17WW05 from 50 to 151 feet in depth without encountering the silty clay lenses. The sand layer was underlain by a dense, dark gray clayey shale.

Figures 2-5 and **2-6** illustrate the groundwater elevations in the shallow zone and intermediate zone, respectively. With the exception of monitoring wells 17WW05 and 17WW16 that were completed in the deep zone, the remainder of the monitoring wells at the site have been completed in the shallow and intermediate saturated zones. The depth of the shallow groundwater zone generally ranges from 18 to 35 feet below ground surface (bgs). The intermediate zone is less defined, but its depth has been measured to approximately 55 feet bgs. The deep groundwater zone extends to a depth of approximately 151 feet bgs. The predominant groundwater flow in the shallow and intermediate zones is generally to the northwest towards Harrison Bayou. Based on historical groundwater flows, the direction can vary more to the west or more to the north. The groundwater elevation between the shallow and intermediate zones is less than 0.1 feet at paired wells, and no distinct vertical gradient is present. The expectation is that the shallow and intermediate zone groundwater contours will be the same. However, due to different data point locations and accepted contouring protocols, slightly different contour lines were produced, but result in the same flow direction. Additional data collected during the RD phase will refine the hydrogeological conditions at the site.

2.5.4 Sampling Strategy

Several sampling events were conducted at LHAAP-17 from 1982 to 2009, 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, SVOCs, 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 dissolved oxygen, conductance, pH, oxidation-reduction potential, sulfide, methane, and chloride.

2.5.5 Nature and Extent of Contamination

Contamination was found in the soil and groundwater (shallow and intermediate zones). The COCs are toxic and carcinogenic. Principal threat waste material is present in the contaminated soil at LHAAP-17.

The COCs and COPECs for LHAAP-17 for the various media are identified below:

- Soil COCs and COPECs are explosives (2,4,6-TNT, 2,4-DNT, 2,6-DNT), dioxins (2,3,7,8-TCDD TEC), perchlorate (potential soil COC based on groundwater concentrations), and barium.

- Shallow zone groundwater COCs are perchlorate and VOCs (1,2-DCA, 1,1-DCE, cis-1,2-DCE, TCE and VC).

- Intermediate zone groundwater COCs are TCE and its daughter products (DCE and VC).

Figure 2-12 shows the approximate areas of contaminated soil that are proposed to be removed for ecological and human health risk mitigation. The maximum 2,4,6-TNT in the soil is 10,000 milligrams per kilogram (mg/kg). Other explosives, 2,4-DNT and 2,6-DNT, have maximum concentrations of 4,000 mg/kg and an estimated concentration of 27 mg/kg, respectively. Additionally, perchlorate has been detected in the soil at a maximum concentration of 7.11 mg/kg. The concentrations of 2,3,7,8-TCDD TEC and barium affecting ecological receptors are 1.9×10^{-4} mg/kg and 20,500 mg/kg, respectively.

The shallow zone plumes for perchlorate and VOCs is shown on **Figure 2-9**. The perchlorate plume, which largely encloses the VOCs plumes, has a lateral extent of approximately 160,000 square feet (ft^2), and a vertical extent of approximately 15 ft. Assuming a total porosity of 0.25, the calculated volume of contaminated groundwater is 4,500,000 gallons. The highest concentration of perchlorate detected was 160,000 μg/L at well 17WW02. The highest concentration of TCE detected in the shallow groundwater was 6,090 μg/L at well 17WW01. Other VOCs detected in the shallow groundwater are 1,2-DCA at an estimated concentration of 35.8 J μg/L and 1,1-DCE at 70 μg/L, also at 17WW01. The daughter product cis-1,2-DCE had a maximum detection of 107 μg/L. The daughter product VC has been nondetect.

The intermediate zone plume for TCE is shown on **Figure 2-10**. In this zone, the lateral extent of contamination is approximately 1,094 ft^2, and the vertical extent is approximately 27 ft. Assuming a total porosity of 0.25, the calculated volume of contaminated groundwater is 55,000 gallons. The highest concentration of TCE detected was 10.8 μg/L at 17WW17. Other COCs identified for the intermediate groundwater zone are degradation daughter products of TCE that have been nondetect or have not been detected above their MCLs. The intermediate zone does not have a perchlorate plume.

2.6 Current and Potential Future Land 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 National Wildlife Refuge boundary. Approved access for hunters is very limited.

The reasonably anticipated future use of LHAAP-17 is as part of 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 and will be used to facilitate a future transfer of LHAAP-17. 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 (16 USC 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 flow 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 drinking water aquifer (250-430 feet bgs) near LHAAP is currently used as a drinking water source. The drinking water aquifer should not be confused with the deep zone groundwater, which extends only to a depth of approximately 151 feet bgs. The deep zone groundwater and the drinking water aquifer are distinct from each other and there is no connectivity between the contaminated zone and the drinking water aquifer. There are five active water supply wells near LHAAP that are completed in the drinking water aquifer. One well is located in and owned by Caddo Lake State Park. The well is completed to a depth of 315 feet bgs 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 completed to approximately 430 feet bgs 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 all are 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 bgs.

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, near the main entrance to LHAAP. The distances from these water supply wells to LHAAP-17 are approximately 2.2 miles, 2.1 miles, and 2.6 miles, respectively. The three water supply wells were completed at a depth much greater than the zone of contamination described at LHAAP-17. 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 does not include the use of the groundwater at LHAAP-17 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 2 Sites* (Jacobs, 2002), in the *Data Gaps Investigations* (Shaw, 2007b), and in additional data collected in preparation of the *Final Feasibility Study, LHAAP-17* (Shaw, 2010). The risk assessment used data from the investigations conducted through 1998 and the plant-wide perchlorate investigation conducted in 2000. Results from the later investigations through 2009 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 CSM that is associated with the risk assessment was introduced in **Section 2.5.1**, and is presented as **Figure 2-7**.

2.7.1.1 Identification of Chemicals of Potential Concern

The BHHRA identified chemicals of potential concern (COPCs) for LHAAP-17 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 (EPCs). Analytical results for various congeners of dioxins and furans are expressed as 2,3,7,8-TCDD TEC.

2.7.1.2 Exposure Assessment

The Jacobs risk assessment (Jacobs, 2002) 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 CSM are: incidental ingestion of the surface soil (0 to 2 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, thus inhalation of VOCs from the soil (0 to 7 ft bgs) was not included in **Table 2-1**.

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 (IRIS) and Health Effects Assessment Summary Tables (HEAST).

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 $(\text{mg/kg-day})^{-1}$

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 a hazard quotient (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 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, based on the sum of all HQ's from different contaminants and exposure routes, 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

Chronic daily intake (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 1.4×10^{-3} and 1.6×10^{-3}, respectively (Jacobs, 2002). The HIs for soil and groundwater are 37 and 3,500, respectively. The carcinogenic risks and non-carcinogenic hazards for both soil and groundwater are unacceptable; therefore, the remedial action acts on both the soil and groundwater. Chemicals with a HQ greater than one in groundwater include perchlorate, TCE, and 1,2-DCA, and those in the soil include 2,4,6-TNT and 2,4-DNT. Perchlorate was the single most significant contributor to the HI in groundwater; its HQ of 3,500 eclipses the contributions from other chemicals. Chemicals with a risk greater than 1×10^{-4} in groundwater include TCE, 1,1-DCE, and 1,2-DCA, and those in soil include 2,4-DNT, 2,4,6-TNT, and 2,6-DNT.

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 seven factors that would lead to overestimations, three that would lead to underestimations, and five that could lead to either over or underestimations.

2.7.1.5 Evaluation of COPCs

To further evaluate the occurrence of COPCs, a data gap investigation was conducted (Shaw, 2007b) and additional investigations were conducted when preparing the FS (Shaw, 2010). While these investigations did not change the overall outcome of the earlier BHHRA, they determined what COCs needed to be targeted by the remedial action.

Tables 2-6 and **2-7** list chemicals in the soil that have a carcinogenic risk greater than 1×10^{-6} and those with an HQ greater than 0.1 for the hypothetical maintenance worker. **Tables 2-8** and **2-9** list the chemicals in groundwater that exceed those values for the carcinogenic risk and HQ, respectively. These tables also summarize the justifications for which of the COPCs should be classified as COCs. COPCs in soil were identified as COCs when they posed a carcinogenic risk above the acceptable range (risk greater than 1×10^{-4}) or when their HQ was greater than 1.0. COPCs in groundwater were identified as COCs when they posed a carcinogenic risk above the acceptable range (risk greater than 1×10^{-4}), when their HQ was greater than 1.0, or when the EPC was above the MCL or the GW-Ind. Recent data obtained after the BHRRA investigations was used when possible. **Table 2-10** presents the final list of COCs, along with cleanup levels.

2.7.2 Summary of Ecological Risk Assessment

The *Final Installation-Wide Baseline Ecological Risk Assessment* (Shaw, 2007a) evaluated potential hazards to ecological resources at LHAAP by conducting a screening evaluation to identify initial COPECs in the individual sub-areas and watersheds. The potential of these COPECs to adversely affect communities was evaluated for: (1) organisms that have direct contact with the COPECs (e.g., plants and earthworms growing and living in contaminated soil); and (2) organisms that may be exposed to the chemicals via food chain pathways (e.g., ingestion of an earthworm living in the contaminated soil by a shrew). Potential impacts to invertebrate and plant communities were evaluated by comparing COPEC concentrations to benchmark values available from multiple literature sources. For the food chain exposure assessment, a number of measurement receptors were selected as representative species for the various trophic levels in the food web that could be at risk from contaminants in site media. The measurement receptors that were selected and used in the food chain evaluation included the following:

- Deer Mouse
- Short-Tailed Shrew
- Raccoon
- Modified Raccoon (as a surrogate for the Louisiana Black Bear)
- Red Fox
- Townsend’s Big-Eared Bat
- Bank Swallow
- Belted Kingfisher
- American Woodcock

- Red-Tailed Hawk
- Aquatic Life (benthic invertebrates)

A food chain model was developed and used to estimate the total dose for each measurement receptor based on species-specific considerations such as diet, body weight, ingestion rates, etc., using conservative exposure estimates. Ecological hazard estimates were developed based on exposure to all media including soil in a particular sub-area and surface water and sediment from any watersheds present in the sub-areas. Two different soil depths were used for modeling exposure to ecological receptors: surface soil (0 to 0.5 foot) and total soil (0 to 3 feet). Each receptor was assumed to be exposed to one of the two depths based on its life history characteristics (e.g., burrowing animals were assumed to be exposed to total soil). Bioaccumulation of chemicals up the food chain was initially estimated using uptake factors obtained from available literature, and then refined using site-specific data obtained during the BERA. **Figure 2-8** presents the ecological conceptual model, which lays out the exposure pathways for selected species.

Ecological effects quotients (EEQ) were developed for each of the measurement receptors. EEQs are similar to HQs for human health, and are calculated by dividing the total dose that the receptor is exposed to by the toxicity reference value (TRV), which is based on a no-observed adverse effect level (NOAEL) or the lowest-observed adverse effect level concentration. If the EEQ exceeds 1 for a receptor (based on the NOAEL TRV), then that chemical is considered to have a realistic potential to cause adverse ecological impacts, and is identified as a final COPEC that should be addressed either through remediation or further investigation. As discussed in the BERA, there are several important uncertainties associated with the assumptions used in the EEQ process, and it should be noted that EEQs greater than 1 do not necessarily mean that ecological impacts have occurred, or are occurring.

Several sub-areas were established within LHAAP for the BERA. LHAAP-17 falls within the Waste Sub-Area. The final COPECs in soil that require remedial action in the Waste Sub-Area are barium, 2,4-DNT, 2,6-DNT, 2,4,6-TNT, and dioxin (2,3,7,8-TCDD TEC) because of their potential to cause adverse impacts to one or more ecological receptors. These COPECs pose a potential risk to ecological receptors due to the direct contact with soil and indirect (i.e., dietary) exposure routes. In support of the LHAAP-17 FS, an analysis was performed to determine what sample locations require remediation to meet the ecological preliminary remediation goals (EcoPRGs) developed in the BERA for the final COPECs (Shaw, 2007a) as shown on **Table 2-11**. An excel spreadsheet analysis was performed by ranking the detected concentrations of each final COPEC in the Waste Sub-Area and iteratively re-calculating the 95% upper confidence limit (UCL) on the mean after removing concentrations until the 95% UCL for the Waste Sub-Area was lower than the EcoPRG. (Note: as discussed in the BERA, the EcoPRG is not a “not to exceed” value for all concentrations; rather, it is a conservative estimate of the average concentration that results in no adverse effects, and as such is equivalent to the 95% UCL of chemical concentrations, rather than to individual sample concentrations.) The order of chemical concentrations was altered to preferentially remove LHAAP-17 samples in order to reduce the ecological risk in the Waste-Sub Area. It is assumed that the locations associated with these concentrations will be remediated. The outcome of the analysis is included on **Table 2-11** and the locations that need to be remediated for ecological risk are shown on **Figure 2-12**.

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. Actions for the groundwater are necessary to address the potential for human health risks in the unlikely event there is an attempt to use groundwater as a potable water source. Actions for soil are necessary to address human health risk including the pathway from soil to groundwater and ecological risks. **Tables 2-10** and **2-11** present the COCs and COPECs, respectively. **Table 2-10** includes cleanup levels for both soil and groundwater with groundwater COCs for the shallow zone and the intermediate zone listed separately. **Table 2-10** includes cleanup levels for daughter products of TCE, even when they are not COCs based on the risk assessment due to their low detections.

A Safe Drinking Water Act MCL has been determined for each of the groundwater COCs except for perchlorate. For the chemicals with an MCL that has been determined, the MCL is used as the cleanup level. If no MCL exists, the GW-Ind is used as the cleanup level (TCEQ, 2006), in accordance with 30 TAC 335.558 and 335.559(d)(2).

2.8 Remedial Action Objectives

The RAOs for LHAAP-17, which address contamination associated with the media at the site and take into account the future uses of LHAAP surface waters, land, and groundwater, are:

- Protection of human health by preventing human exposure to the contaminated groundwater and contaminated soil;
- Protection of human health by preventing further potential degradation of groundwater from contaminated soil;
- Protection of ecological receptors by preventing exposure to the 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

Four 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

As required by the NCP, the no action alternative provides a comparative baseline against which the action alternatives can be evaluated. Under this alternative, 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 and ecological receptors, although natural attenuation would be ongoing.

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

Alternative 2 – Excavation and Off-site Disposal for Soil; MNA and LUCs

The major components of this alternative include the following.

- Excavation and off-site disposal of impacted soil from LHAAP-17 to protect human and ecological receptors, and to eliminate the potential soil-to-groundwater pathway
- MNA to return shallow and intermediate zone groundwater to its potential beneficial use, wherever practicable
- Performance objectives to evaluate the MNA remedy performance after 2 years
- A contingency remedy to reach the RAOs if MNA is found to be ineffective
- LTM semiannually for 3 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
- A LUC for the prohibition of groundwater use except for environmental testing and monitoring until the cleanup levels are achieved and a LUC restricting land use to

nonresidential use until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

Estimated Capital Present Worth Cost: $1,400,000
Estimated O&M Present Worth Cost: $500,000
Cost Estimate Duration: 30 years
Estimated Present Worth Cost: $1,900,000

Alternative 3 – Excavation and Off-site Disposal of Soil; In Situ Bioremediation; MNA and LUCs

The major components of this alternative include the following:

- Excavation and off-site disposal of impacted soil from LHAAP-17 to protect human and ecological receptors, and to eliminate the potential soil-to-groundwater pathway
- In situ bioremediation in the shallow zone groundwater to target perchlorate contaminated groundwater, which leads to favorable conditions for MNA of TCE
- MNA with LTM in the shallow zone (after in situ bioremediation) to reduce groundwater contamination, particularly TCE and daughter products, to cleanup levels
- MNA with LTM in the intermediate zone to reduce groundwater contamination to cleanup levels
- A LUC for the prohibition of groundwater use except for environmental testing and monitoring until the cleanup levels are achieved and a LUC restricting land use to nonresidential use until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

Estimated Capital Present Worth Cost: $2,000,000
Estimated O&M Present Worth Cost: $600,000
Cost Estimate Duration: 30 years
Estimated Present Worth Cost: $2,600,000

Alternative 4 – Excavation and Off-site Disposal of Soil; Groundwater Extraction; MNA and LUCs

The major components of this alternative include the following:

- Excavation and off-site disposal of impacted soil from LHAAP-17 to protect human and ecological receptors, and to eliminate the potential soil-to-groundwater pathway
- Groundwater extraction in the shallow zone until perchlorate levels are reduced to 20,000 µg/L to make conditions favorable for MNA of TCE

- A contingency remedy of in situ bioremediation in the shallow zone followed by MNA in the event that groundwater extraction cannot reduce perchlorate levels to 20,000 µg/L in the estimated 1.5-year pumping period
- MNA with LTM to reduce groundwater contamination to cleanup levels in the shallow zone (following groundwater extraction) and in the intermediate zone
- A LUC for the prohibition of groundwater use except for environmental testing and monitoring until the cleanup levels are achieved and a LUC restricting land use to nonresidential use until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

Estimated Capital Present Worth Cost: $1,600,000
Estimated O&M Present Worth Cost: $500,000
Cost Estimate Duration: 30 years
Estimated Present Worth Cost: $2,100,000

2.9.2 Common Elements and Distinguishing Features of Each Alternative

Common Elements of Alternative 2, 3, and 4

Common elements of Alternatives 2, 3, and 4 are described below.

Soil Excavation **–** Soil contamination would be excavated at LHAAP-17 under Alternatives 2, 3 and 4 to prevent human and ecological receptors from exposure to contaminants in the soil and to eliminate the soil-to-groundwater pathway. Disposal would be at a RCRA Subtitle D-permitted landfill.

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-17 (Shaw, 2010). Monitoring activities associated with MNA would confirm 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. In Alternative 2, contaminant reduction would occur by MNA alone in both the shallow and intermediate zones. In Alternative 3, in situ bioremediation would reduce perchlorate in the shallow zone and condition the shallow zone for MNA of TCE. The treatment in the intermediate zone would be MNA alone. In Alternative 4, groundwater recovery would reduce perchlorate in the shallow zone to 20,000 µg/L, after which MNA would take over and reduce perchlorate and VOCs to cleanup levels. The treatment in the intermediate zone would be MNA alone.

MNA performance monitoring will be conducted quarterly for the first 2 years. After eight quarterly sampling events, MNA effectiveness 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).

LUCs **–** LUCs 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 LUCs. 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 for groundwater 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 LUC for prohibition of groundwater use (except for monitoring and testing) would be maintained until the concentrations of contaminants and by-product (daughter) contaminants in the groundwater have been reduced to levels below their respective cleanup levels. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

In addition, within 90 days of signature of this ROD, the Army shall request the Texas Department of Licensing and Regulation to notify well drillers of groundwater use prohibitions based on a preliminary LUC boundary. Within one-year of signature of this ROD, the U.S. Army shall: 1) request the Texas Department of Licensing and Regulation to notify well drillers of groundwater use prohibitions; and 2) notify the Harrison County Courthouse of the LUC to include a map showing the areas of groundwater use prohibition at the site, in accordance with 30 TAC 335.565.

To transfer this property (LHAAP-17), an Environmental Condition of Property (ECP) document would be prepared and the Environmental Protection Provisions from the ECP would be attached to the letter of transfer. The ECP would include the LUCs as part of the Environmental Protection Provisions. The property would be transferred subject to the LUCs identified in the ECP. These restrictions would prohibit or restrict property uses that might result in exposure to the contaminated groundwater (e.g., drilling restrictions). The U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of a LUC objective at these sites after they have been transferred. The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or significant modification of a LUC, or in the highly unlikely event of a land use change inconsistent with the industrial/recreational use assumptions of the remedy. In the event that TCEQ and/or USEPA and the U.S. Army agree with respect to any significant 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).

Inspection/Long-Term Groundwater Monitoring **–** Alternatives 2, 3, and 4 include inspection and long-term groundwater monitoring activities. Monitoring would be continued as required to evaluate the effectiveness of the remedy, to demonstrate compliance with applicable or relevant and appropriate requirements (ARARs) and RAOs, and to support five-year reviews.

Distinguishing Features of Alternatives 3 and 4

The distinguishing feature of Alternative 3 and 4 compared to Alternative 2 is the inclusion of in situ bioremediation or groundwater extraction. These actions are described below.

In situ bioremediation **–** The components of this action include:

- **Performing a treatability study.** A number of environmental conditions can slow or stop the biodegradation process. Therefore, prior to initiation of a bioremediation project, a specific microbial enhancement study and general hydrogeologic investigation will be required for the site. These studies are 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 biodegradability, phase-distribution, leaching potential, and chemical reactivity of the contaminants; the mix of contaminants in the plume; soil type and properties; pH; salinity; competing electron acceptors (e.g., sulfates, nitrates); the presence of adequate microbial populations; the presence of adequate microbial populations; and the presence or absence of inhibitory substances.

- **Retrofitting existing wells for injection.** Chlorinated solvents and perchlorate often require circulation of nutrients and other growth-stimulating additives/materials specific to the contaminants' metabolic degradation process. The wells will be used to inject these materials to accelerate microbial degradation of the plumes. It is anticipated that the material will be injected quarterly for one year, and that the injection will occur in the shallow zone at approximately 15 feet bgs.

- **Injecting 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-17 can degrade under anaerobic conditions, but microorganisms, mechanisms, and redox requirements differ. Based on results of a treatability study, appropriate nutrients and other materials will be injected into the subsurface. For this FS, it is assumed that a Hydrogen Release Compound® (HRC®), a sticky gel, will best degrade the COCs at LHAAP-17. HRC® is a polyacetate compound especially formulated for the slow release of lactate into water. The HRC® compound is typically heated to reduce its viscosity and injected with a high viscosity fluid pump. In addition to the application of HRC®, degradation of the 1,1-DCE to vinyl chloride may require the addition of a bacterial consortium. The plume will be gridded with direct-push technology (DPT) injection sites through which the various materials would be injected. For costing purposes in this FS, it is assumed that application would include 10 DPT injection points at approximately 15 feet bgs to cover the groundwater plume.

- **Sampling wells to monitor effectiveness.** Monitoring for contaminants will be performed to assess the effectiveness of the treatment. Anticipated remediation times may be short with appropriate contact of the contaminant and the injected materials. Assuming first order anaerobic degradation rates and reasonable half-lives for the COCs, the COCs could be reduced to their respective levels amenable to MNA remediation in approximately two years. Additional monitoring in the treatment zone is recommended for one to three years after reduction of the COCs to the remediation levels. Since there is considerable uncertainty about achieving sufficient contact between the contaminated groundwater and the injected material, the groundwater in the treatment zone will continue to be monitored for the maximum recommended period, three years, after reduction of the COCs to the preliminary remediation goals.

***Groundwater Extraction* –** The components of this action include:

- **Pre-Design Study.** This action in the shallow groundwater zone will begin with a pre-design study. A pump test will be conducted and hydrogeologic parameters will be measured to better design the system. During the design activities, extraction trenches will also be evaluated. Groundwater flow will be modeled to set performance evaluation parameters and to assess the likely time required for remediation.

- **Construction.** The shallow zone groundwater contamination at LHAAP-17 consists of a VOC plume and an overlapping perchlorate plume. The contamination occurs in the shallow groundwater zone where a sufficient number of groundwater monitoring wells are located throughout the site. To remediate the contaminated groundwater, it is estimated that sufficient flow can be attained by converting three of the existing monitoring wells in the shallow zone into extraction wells to extract the contaminated groundwater from the aquifers. Final number of wells and their placement will be determined in the design. A new piping system will be constructed to transport the water to the groundwater treatment plant at LHAAP-18/24.

- **Performance Monitoring.** During extraction, samples will be collected from the extraction wells to monitor the effectiveness of the action. Monthly sampling will be conducted for approximately six months during startup and initial operation of the extraction system. After six months, monitoring will be reduced to quarterly for approximately 1 year or until pumping ceases. If perchlorate concentrations have not been reduced to levels at or below 20,000 µg/L, a contingency action will be initiated pending lead agency and regulatory approval. If the 20,000 µg/L trigger value has been obtained, then MNA will be implemented.

- **Water Treatment/Surface Water Discharge.** The extracted groundwater from LHAAP-17 will be treated at the LHAAP groundwater treatment plant, which was originally built to treat groundwater containing VOCs and metals extracted from other LHAAP sites. The plant uses air stripping, carbon adsorption, and catalytic oxidation. Perchlorate treatment using a fluidized bed reactor was added in April 2001 to the treatment plant. **Figure 2-13** shows a simplified flow diagram of the primary treatment components in the existing plant. The extracted water from LHAAP-17 will be discharged from the piping into the existing 300,000-gallon equalization tank. This tank receives water from other LHAAP sites which is stored in this tank until treatment. After the water is treated, the effluent will be discharged in accordance with plant procedures to surface water. The plant presently operates at a fraction of its maximum capacity of 1 to 1.5 million gallons of water per month. The original groundwater treatment plant components have adequate capacity to accommodate the increase in volume that will be introduced to the system when the contaminated groundwater is transported through the piping system from LHAAP-17 to the plant. The system capacity is limited by effluent storage and discharge rate, and this concern was addressed. Recent mitigating measures include the replacement of the reinjection pipeline to increase the pipe diameter to 4-inches, and the installation of a sprinkler system. The capacity issue will be revaluated as necessary during the remedial action.

- **Extraction System.** Operation and maintenance will include groundwater extraction system maintenance, groundwater treatment plant operations, and environmental media monitoring. In approximately 1.5 years, the extraction wells are anticipated to remove the highest concentrations of VOCs and perchlorate from the groundwater at LHAAP-17, thus reducing the contaminant mass to make conditions favorable for MNA. During the groundwater extraction operations, the extraction wells will require regular maintenance to prevent fouling of well screens, and the extraction pumps will require routine maintenance and may also require replacement. Cleaning of the pipelines, refurbishing pumps and other maintenance activities will be needed on the groundwater collection and transport system during full-scale operation. O&M costs will include the addition of chemicals, power, and labor; equipment cleaning, tank cleaning, general system maintenance, and replacement; and regulatory monitoring and reporting. O&M activities will also be conducted at the LHAAP plant location as part of the routine plant O&M activities.

2.9.3 Expected Outcomes of Each Alternative

Alternative 1 would allow the site to remain a hazard to human and ecological receptors, since it simply leaves the site as is. Alternatives 2, 3, and 4 all provide the same outcome to mitigate exposure to human and ecological receptors by excavation and off-site disposal of the contaminated soil. Soil excavation would also eliminate the soil-to-groundwater pathway, preventing further potential degradation of groundwater from contaminated soil. Alternatives 3 and 4 have very similar outcomes though they use different treatment processes, and the main difference is that Alternative 4 takes advantage of the existing groundwater treatment plant. Alternative 2 also has the same outcome as Alternatives 3 and 4, but without the benefit of active treatment. Based on the natural attenuation evaluation (Shaw, 2010), cleanup levels should be achieved by MNA alone (Alternative 2) in approximately 117 years (117 years for TCE, and 15 years for perchlorate). Alternatives 3 and 4 would achieve cleanup levels in less time through active treatment. 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 335.559(d)(2). In addition, the monitoring activities associated with MNA would confirm 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, a LUC will prohibit the use of the site's groundwater except for environmental monitoring and testing. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

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 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 2-12** 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 four 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 because 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 soil or to the groundwater contamination and potential groundwater impacts to Harrison Bayou would not be addressed. Additionally, the soil pathway for ecological receptors would not be addressed.

Alternatives 2, 3, and 4 all satisfy the RAOs for LHAAP-17. Alternatives 2, 3, and 4 would remove the contaminated soil and provide confirmation that human health and the environment will be protected because the monitoring will be conducted to confirm that MNA is returning the contaminated shallow and intermediate groundwater zones at LHAAP-17 to their 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 for groundwater would protect human health by preventing access to the contaminated groundwater until contaminants in the groundwater attain the cleanup levels (SDWA MCLs or MSC for 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 40 CFR §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 flow into Harrison Bayou which flows 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 TCE (5 µg/L), 1,2-DCA (5 µg/L), 1,1-DCE (7 µg/L), and VC (2 µg/L) for LHAAP-17. 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, 3, and 4 comply with all chemical-specific ARARs for soil because the contaminated soil above the chemical-specific ARAR will be removed. Alternatives 2, 3, and 4 comply with all chemical-specific ARARs for groundwater because they will return the contaminated shallow and intermediate groundwater zones at LHAAP-17 to their 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 MSC for 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 335.559(d)(2). 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 complies with surface water ARARs because natural attenuation would reduce the contaminant concentrations in groundwater to the cleanup levels prior to flowing into surface water. Alternatives 3 and 4 also comply with surface water chemical specific ARARs because active remedial processes will reduce contaminant levels in groundwater to levels below water quality standards prior to flowing into surface water.

Location-specific and action-specific ARARs would not apply to Alternative 1 since no remedial activities would be conducted. Alternatives 2, 3, and 4 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 clean-up levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation, and the adequacy and reliability of controls.

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 have no effectiveness and permanence with regards to the contaminated soil, since no soil removal would be conducted.

Alternative 2 would provide a moderate degree of long-term effectiveness by removing the source soils and providing restoration of the groundwater by MNA. LUC would be required for groundwater for the protection of human health exposure.

Alternatives 3 and 4 would also provide a moderate degree of long-term effectiveness by removing the source soils and providing better long-term effectiveness by achieving cleanup levels in the shallow zone in a shorter time as compared to Alternative 2. Alternatives 3 and 4 would significantly reduce initial groundwater contaminant concentrations and thereafter rely on MNA and LUCs until the cleanup levels are achieved. Monitoring activities associated with MNA would confirm 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.

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 to permanently reduce the mass and concentration of contaminants through natural processes and; therefore, the toxicity, mobility, and volume of the contaminants. Alternatives 3 and 4 would use in situ bioremediation or groundwater extraction, followed by MNA, to achieve the same reductions in contamination that are expected from

Alternative 2. MNA is a passive remedial action, and bioremediation and groundwater extraction are active treatment processes.

Biological activity would generate daughter products that may temporarily increase toxicity or mobility of the contaminant plume. Alternatives 2, 3, and 4 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 cleanup levels to return groundwater to its potential beneficial use, wherever practicable.

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

Achievement of cleanup goals would also be expedited for Alternative 4 by implementing pumping and treatment of the contaminated groundwater to reduce perchlorate concentrations throughout the plume.

The soil excavation in Alternatives 2, 3, and 4 would reduce mobility because perchlorate would be removed from the site and placed in a permitted disposal facility. Toxicity and volume would not be reduced by the excavation portion of the alternatives as the form and quantity of the perchlorate would not be 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 would 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, 3, and 4 would be protective to the surrounding community from short-term risks except for minimal potential short-term risks during transport (possible accident when soil is transported off site) of perchlorate and explosive contaminated soil.

Alternatives 2, 3, and 4 would involve potential short-term risks to workers associated with exposure to contaminated groundwater from monitoring and/or operation of drilling/construction equipment, and with exposure to contaminated soil during excavation work.

Alternative 3 would have short-term risks to remediation workers associated with exposure while performing in situ bioremediation activities, including handling of additives/materials.

Alternatives 2, 3, and 4 include the LUCs as elements of their remedies and would provide almost immediate protection from the contaminated groundwater by prohibiting groundwater use except for environmental monitoring and testing through LUC implementation. The time period to achieve groundwater cleanup levels is the most significant difference between Alternative 1 versus Alternatives 2, 3, and 4. Alternatives 3 and 4 are expected to take less time to achieve RAOs.

Alternative 4 would have short-term risks to the workers associated with exposure during increased operations at the LHAAP groundwater treatment system, which include chemical handling (caustic acids) and operation of a high-temperature catalytic oxidizer. The implementation of Alternatives 3 and 4 would require more time than Alternative 2.

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 Alternative 1, no remedial action would be taken. Therefore, no difficulties or uncertainties would be associated with its implementation. For Alternatives 2, 3, and 4, soil excavation would require extensive coordination between excavation, sampling, transportation and disposal. The U.S. Army would be responsible for long-term maintenance and enforcement of the LUCs, long-term evaluation of MNA, long-term sampling, and long-term maintenance and operation of sampling equipment. For groundwater, Alternatives 3 and 4 are technically implementable, although less so than Alternative 2 because of the uncertainties associated with hydrogeologic conditions. Those conditions may impact the ability of in situ bioremediation or groundwater extraction to lower perchlorate concentrations quickly to levels that would be more amenable to MNA of TCE.

Alternative 3 would involve the use of in situ bioremediation, which requires specialized expertise to design and construct the in situ bioremediation treatment elements. A groundwater treatment system currently exists at LHAAP and is easily accessible to the site; therefore, groundwater extraction for Alternative 4 technically would be readily implementable.

Administratively, all of the alternatives are implementable.

2.10.7 Cost

Cost estimates are used in the CERCLA 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 developed 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 cost 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, Alternative 4, and Alternative 3. No costs are associated with Alternative 1 because no remedial activities would be conducted.

Alternative 2 has the lowest present worth and capital costs of the active remedial alternatives as no active remediation of groundwater would be implemented. Alternative 3 has the highest present worth and capital costs primarily due to the activities associated with the injection phase of in situ bioremediation. Alternative 4 may at first glance be expected to have the highest capital cost because it requires groundwater extraction and treatment. However, the presence of the existing groundwater treatment system at LHAAP greatly reduces the costs associated with Alternative 4. Compared to the selected alternative (Alternative 4), the total present worth cost of Alternative 2 is 9% less and Alternative 3 is 24% more. The capital present worth cost of Alternative 2 is 12% less and Alternative 3 is 25% more.

2.10.8 State/Support Agency Acceptance

The USEPA and TCEQ have reviewed the Proposed Plan, which presented Alternative 4 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. One set of written public comments was received during the 30-day public comment period; there were no verbal comments from the June 29, 2010 public meeting. The topics of the comments included: the trigger level for ending pump and treat, effectiveness of MNA, time required to achieve cleanup levels, and the absence of perchlorate from the COC list for the intermediate zone groundwater. Comment responses were provided and incorporated into the ROD, including clarification of the role of pump and treat in the overall remedial action, explanation of why perchlorate is only associated with the shallow zone, and reiteration of the contingency actions. The written comments received and their responses are presented in the Responsiveness Summary (**Section 3.0**).

2.11 Principal Threat Wastes

The principal threat waste at LHAAP-17 is soil contamination. The perchlorate-contaminated soil is a source material due to high concentrations of contaminants that are mobile (i.e., soil to groundwater). The perchlorate concentrations in soil are near the GWP-Ind, and perchlorate is identified as a potential soil COC because of perchlorate contaminated groundwater. Thus, perchlorate-contaminated soil is considered a principal threat waste.

2.12 The Selected Remedy

2.12.1 Summary of Rationale for the Selected Remedy

Alternative 4 (excavation and off-site disposal of soil; groundwater extraction, MNA, and LUCs) is the preferred alternative for LHAAP-17 and is consistent with the intended future use of the site as a national wildlife refuge. This alternative would satisfy the RAOs for the site through the following:

- Contaminated soil removal with off-site disposal will protect the hypothetical future maintenance worker and ecological receptors and eliminate the soil-to-groundwater pathway;
- Extraction and treatment of groundwater until the trigger level of 20,000 µg/L of perchlorate is reached will expedite MNA;
- Natural biodegradation and attenuation will reduce contaminant concentrations to cleanup levels and groundwater monitoring will confirm protection of human health and the environment by documenting that the contaminated groundwater remains localized with minimal migration and that contaminant concentrations are being reduced to cleanup levels;
- LUC for groundwater will be implemented until cleanup levels are met per 30 TAC 335.565 and 30 TAC 335.566 to ensure protection of human health by preventing exposure to groundwater. LUC restricting land use to nonresidential use until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

If the 20,000 µg/L of perchlorate level is not reached after approximately 1.5 years, the contingency remedy of in situ bioremediation described in Alternative 3 will be implemented to reduce the perchlorate levels more quickly so the conditions become amenable for TCE to attenuate naturally. The monitoring and reporting associated with MNA would continue until the cleanup levels are achieved.

By extracting contaminated groundwater, Alternative 4 intends to lower the highest concentrations of perchlorate in groundwater to levels more amenable to natural attenuation. The extracted contaminated groundwater would be conveyed to the existing on-site groundwater treatment plant for treatment. The groundwater plume is contaminated with both TCE and high concentrations of perchlorate that tend to inhibit degradation of the TCE. Removal of the perchlorate down to a concentration of 20,000 μg/L by extraction is expected to accelerate the TCE degradation by MNA. Once reduced to 20,000 μg/L, the performance of natural attenuation would be evaluated by 2 years of monitoring using data acquired from the eight quarters and from the historical sampling events of the prior 10 years. The performance objectives for groundwater remediation will be included in the RD. If it is found that the performance objectives are not met, a contingency remedy of in situ bioremediation (see Alternative 3 description for basic elements) would be implemented.

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

The selected alternative offers a high degree of long-term effectiveness, can be easily and immediately implemented, and costs less than the other most comparable alternative, Alternative 3.

The U.S. Army believes the selected alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the CERCLA §121(b) criteria used to evaluate remedial alternatives. The selected 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) utilize an active treatment as a principal element. The selected remedy addresses the statutory preference for treatment to the maximum extent possible.

The U.S. Army will present details of the soil excavation plan, groundwater extraction plan, LUC implementation plan, groundwater monitoring plan, and MNA remedy implementation in the RD for LHAAP-17.

2.12.2 Description of the Selected Remedy

The selected remedy, Alternative 4, was outlined in **Section 2.9**; that description is expanded in the following discussion. The major components of the remedy and the contingency remedies include:

- ***Soil Excavation.*** The excavation will remove explosives, barium, and dioxin contamination for off-site disposal at a RCRA Subtitle D-permitted landfill. This action will achieve the following: 1) removal of soil that is a direct risk to the hypothetical future maintenance worker, thereby protecting human health by preventing inhalation, ingestion, and dermal contact with the COCs; 2) removal of contaminated soil that is a potential source of contaminant migration to groundwater; and 3) removal of soil posing a risk to ecological receptors. The cleanup levels are presented in **Table 2-10**. The treatability demonstration study by PEC may have reduced the contaminants to the preliminary cleanup level. To verify the remaining levels of contamination and to further delineate areas of excavation for design purposes, a limited soil sampling will be conducted during the remedial design phase.

The approximate excavation locations are highlighted on **Figure 2-12**. 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 the COCs of interest. Clean borrow soil will be used as needed to backfill the excavations so they can be graded for proper drainage.

- ***Groundwater extraction.*** The desired outcome is to reduce perchlorate concentrations in the groundwater to 20,000 µg/L or lower during an operational period of 1.5 years. At these levels, it is anticipated that conditions will be favorable for MNA to take over to reduce contaminants to the cleanup levels. This component is described in **Section 2.9.2**. **Figure 2-13** presents a process flow diagram for the treatment process. The groundwater treatment plant is located at LHAAP-18/24.

- ***Contingency remedy if groundwater extraction does not reduce perchlorate levels to 20,000 µg/L in the 1.5 year extraction timeframe.*** The contingency remedy would implement in situ bioremediation. The area and the elements of the contingency remedy would be selected based on the entire data set available. The elements of an in situ bioremediation remedy are described in **Section 2.9.2**. If a contingency remedy is implemented, it will be documented in an Explanation of Significant Differences (ESD).

- ***MNA to return groundwater to its potential beneficial use, wherever practicable.*** MNA begins following groundwater extraction activities. 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 2 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, the 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 evaluation 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 involving in situ bioremediation to reach the RAOs if MNA is found to be ineffective.*** The contingency remedy will use elements of in situ bioremediation from Alternative 3 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 the 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. LTM will be implemented at a frequency of semiannual for 3 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 5 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.

- The LUC for prohibition of groundwater use (except for monitoring and testing) shall be implemented until the cleanup levels under the SDWA MCLs, are attained, or attainment of the MSC for GW-Ind, if no MCL is available. The LUC for the prohibition of groundwater use shall remain in place at the site until the hazardous substances remaining at the site are reduced below levels that would support unlimited use and unrestricted exposure. 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 preliminary boundary for the LUC is shown on **Figure 2-5**.

- The LUC restricting land use to nonresidential shall be implemented until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

The U.S. Army will be responsible for implementation, maintenance, periodic inspection, reporting on, and enforcement of the LUCs. 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 the protectiveness of the selected remedy. The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or significant modification of a LUC, or in the highly unlikely event of a land use change inconsistent with the industrial/recreational use assumptions of the remedy. In the event that TCEQ and/or EPA and the Army agree with respect to any significant 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).

LUC implementation and maintenance actions would be described in the RD for LHAAP-17. The LUCs would be included in the property transfer documents and a recordation of the area of groundwater prohibition would be filed in the Harrison County Courthouse. The LUC for groundwater will prevent human exposure to groundwater contaminated with chlorinated solvents and perchlorate through the prohibition of groundwater use. The LUC for prohibition of groundwater use except for environmental monitoring and testing 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 MSC for GW-Ind if no MCL is available). In addition, within 90 days of signature of this ROD, the Army shall request the Texas Department of Licensing and Regulation to notify well drillers of groundwater use prohibitions based on a preliminary LUC boundary. Within one-year of signature of this ROD, the U.S. Army shall: 1) request the Texas Department of Licensing and Regulation to notify well drillers of groundwater use prohibitions; and 2) notify the Harrison County Courthouse of the LUC to include a map showing the areas of groundwater use prohibition at the site, in accordance with 30 TAC 335.565.

Monitoring activities associated with the LUC would be undertaken to ensure that groundwater is not being used. Long-term operational requirements under this alternative would include maintenance of the LUCs. Groundwater monitoring will demonstrate no migration of the plume and the eventual reduction of contaminants to levels below cleanup levels. The need for continued groundwater monitoring will be evaluated every 5 years during the reviews. Sampling frequency and analytical requirements will be presented as an appendix to the RD for LHAAP-17.

2.12.3 Cost Estimate for the Selected Remedy

Table 2-13 presents the present worth analysis of the cost for the selected remedy, Alternative 4. 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 $2,090,000, using a discount rate of 2.8%. The capital cost is estimated at $1,570,000. The total O&M present value cost is estimated at approximately $520,000. The O&M cost includes evaluation of MNA, maintenance of the LUCs, and LTM through Year 30. The LTM would support the required CERCLA five-year reviews.

2.12.4 Expected Outcomes of Selected Remedy

The purpose of this response action is to attain the RAOs stated in **Section 2.8** of this document. **Table 2-10** and **2-11** present the cleanup levels for COCs and COPECs, respectively. The cleanup levels for the COCs in the groundwater are the Federal Safe Drinking Water Act MCLs, or if no MCL exists for that chemical, the cleanup level is the GW-Ind (TCEQ, 2006). The cleanup level for the COCs in the soil is the GWP-Ind. The cleanup level for the COPECs in the soil is the EcoPRGs.

The expected outcome of the selected remedy is that contaminants in soil and groundwater will be reduced to the cleanup levels. Achievement of the cleanup levels (**Tables 2-10** and **2-11**) is anticipated to be completed in less than 117 years; how much less depends on the success of the active remediation. This approximate timeframe to achieve cleanup levels is considered reasonable for the anticipated future land use as a national wildlife refuge. When the groundwater remedial action goals are achieved, the LUC for groundwater 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 confirm 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 for groundwater will prohibit the use of the site's groundwater except for environmental monitoring and testing.

As part of the evaluation of MNA, attenuation rates are computed and evaluated in accordance with the USEPA guidance material (USEPA, 1998). Time-dependent attenuation rate constants and estimated in-well cleanup times are determined based on COC concentration data over time from individual wells assuming first order degradation kinetics. Attenuation rates are calculated for the monitoring wells with the highest concentrations for which the available data allow such a calculation. Attenuation rates are based on the following formula from the USEPA guidance (USEPA, 1998):

$$C = C_o e^{-kt}$$

where: C = concentration at time t
C_o = initial concentration
k = attenuation rate constant (first order reaction)

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 4, will achieve the RAOs for LHAAP-17. For the protection of human health, the remedial action would remove soil that exceeds the cleanup levels, and it would eventually achieve the destruction of the COCs present in the groundwater plumes at LHAAP-17. Continued maintenance of the LUC for groundwater would prevent human access and exposure to groundwater that poses an unacceptable risk to human health, until COCs have sufficiently degraded to below the cleanup levels. Therefore, the residual risk upon completion of the remedial actions will be within the risk range for the hypothetical future maintenance worker. At LHAAP-17, the evaluation of historical groundwater contaminant trends indicates that natural attenuation processes are occurring at the site. This remedy provides adequate confirmation that human health and the environment are protected because monitoring would be conducted to document the effectiveness of MNA. The monitoring activities associated with MNA will ensure that COCs and by-product (daughter) contaminants in groundwater do not flow to surface water bodies at such levels that ARARs are exceeded. When cleanup levels have been achieved in groundwater, the LUC for groundwater will be removed.

For the protection of ecological receptors, the remedial action would remove soil at select areas (in addition to those areas excavated for the protection of human health) to address ecological risks. The outcome of the removal is that the soil in the Waste Sub-Area, which includes LHAAP-17, will satisfy the EcoPRGs.

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 2-14**.

Chemical-Specific ARARs

- **Soil**: Since there are no federally promulgated chemical-specific ARARs for soil (e.g., perchlorate), the ROD applies the State of Texas promulgated cleanup standards under 30 TAC 335, Subchapter S, which are used as the chemical-specific ARARs for this site. It is anticipated that removal of contaminated soils above the Texas standard will prevent any future contamination of the groundwater from soil 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. 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, and 130 – 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 2-10**. 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-17 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. MSCs provided under Texas Risk Reduction Rules (30 TAC 335.551 through 335.569) are applicable where MCLs are not available, i.e., perchlorate. This alternative will return the contaminated shallow and intermediate groundwater zones at LHAAP-17 to their 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 SDWA MCLs or MSC for 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 335.559(d)(2). 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.

Location-Specific ARARs

- **Floodplain management**: LHAAP-17 includes areas classified as part of a floodplain.

- **Wetlands**: The USACE has not made a determination that jurisdictional wetlands exist at LHAAP-17, 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: site preparation, construction, and excavation activities; waste generation, characterization, management, storage, and disposal activities; well construction; and water treatment.

- **Site preparation, construction, and excavation activities**: Certain on-site preparation, construction, and/or excavation activities will be necessary under all remediation actions to prepare the site for remediation, including the soil-moving or site-grading activities. Control of fugitive emissions and storm water runoff during implementation of these activities will be required. Airborne particulate matter resulting from construction or excavation activities is subject to the fugitive dust and opacity limits listed in 30 TAC 111, Subchapter A. No person may cause, suffer, allow, or permit visible emissions from any source to exceed an opacity of 30 percent for any 6-minute period (30 TAC 111.111[a]). Reasonable precautions must also be taken to achieve maximum control of dust to the extent practicable, including the application of water or suitable chemicals or the complete covering of materials (30 TAC 111.143 and 30 TAC 111.145). Texas has also promulgated general nuisance rules for air contaminants mandating that no person shall discharge from any source whatsoever one or more air contaminants, or combinations thereof, in such concentration and of such duration as are or may tend to be injurious to or to adversely affect human health or welfare, animal life, vegetation, or property, or as to interfere with the normal use and enjoyment of animal life, vegetation, or property (30 TAC 101.4). Storm water discharges from construction activities that disturb equal to or greater than one acre of land must comply with the substantive requirements of a USEPA National Pollutant Discharge Elimination System general permit (40 CFR 122.26; 30 TAC 205, Subchapter A; and 30 TAC 308.121), depending on the amount of acreage disturbed. Substantive requirements include implementation of good construction management techniques; phasing of large construction projects; minimal clearing; and sediment, erosion, structural, and vegetative controls to mitigate runoff and ensure that discharges meet required parameters.

- **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 in accordance with the ARARs for waste management listed in **Table 2-14** 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 or extraction 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-17 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 Clean Water Act of 1972 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 Title 53, 34079, September 2, 1988).

2.13.3 Cost-Effectiveness

The progression of present worth costs from the least expensive alternative to the most expensive alternative is as follows (provided that no contingencies are implemented): Alternative 1, Alternative 2, Alternative 4, and Alternative 3. No costs are associated with Alternative 1 because no remedial activities would be conducted. Alternative 2 has the lowest present worth and capital costs of the remediation alternatives (Alternatives 2 through 4). The present worth costs for Alternative 2 is lower than that of Alternatives 3 and 4, as it does not involve injections for bioremediation or construction for a groundwater extraction system. Compared to the selected alternative (Alternative 4), the total present worth cost of Alternative 2 is 9% less and Alternative 3 is 24% more. The capital present worth cost of Alternative 2 is 12% less and Alternative 3 is 25% more. **Table 2-13** is the cost estimate summary table for the selected remedy.

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

The U.S. Army has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site. Soil excavation would remove impacted soils and groundwater extraction and treatment would irreversibly reduce groundwater contaminant concentrations in the treated portions of the groundwater plume. When perchlorate is reduced to 20,000 µg/L, groundwater extraction will be discontinued and MNA will reduce groundwater contaminants to cleanup levels. Natural biodegradation is an irreversible treatment process that would reduce the mass and concentration of contaminants.

Alternative 4 would significantly reduce groundwater contaminant concentrations and achieve cleanup levels although the actual potential effectiveness will be controlled by the nature of the permeable water-bearing zones and the distribution and presence of COCs remaining in the groundwater in the untreated areas. The selected remedy would provide reduction in toxicity, mobility, and volume of the groundwater contaminants via active treatment. Alternative 4 would take less time to achieve remediation goals than Alternative 2 provided subsurface conditions for groundwater extraction are favorable.

Alternative 4 would provide almost immediate protection because the LUCs would be implemented quickly. Maintenance of this control would be required until natural attenuation processes reduce COC and by-product (daughter) contaminant concentrations to below cleanup levels.

2.13.5 Preference for Treatment as a Principal Element

The selected remedy would reduce the toxicity, mobility, or volume of contaminants in the groundwater through an active remedial process. By utilizing groundwater extraction as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied. There is principal threat material in the soil at LHAAP-17. The contaminated soil that is principal threat source material will be excavated to remove the contaminated material from the site. Based on the waste characteristics, the material will be disposed at an approved landfill.

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 this remedy will result in contaminants that remain on site above levels that allow unlimited use and unrestricted exposure, a review will be conducted at least every five years to confirm 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-17 was released for public comments on May 26, 2010. The Proposed Plan identified Alternative 4 as the Preferred Alternative for groundwater remediation. The U.S. Army reviewed all written comments during the public comment period (there were no verbal comments). 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: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical	Concentration Detected[1] (mg/L)		Frequency of Detection	Exposure Point Concentration (mg/L)	Statistical Measure
		Minimum	Maximum			
Ingestion, inhalation, dermal contact	*Dioxin/Furan*					
	2,3,7,8-TCDD TEC	1.84E-09	3.54E-09	---	3.54E-09	maximum
	Metals					
	Aluminum	5.00E-01	8.10E+00	11/17	8.10E+00	maximum
	Antimony	5.00E-03	1.30E-02	6/28	1.30E-02	maximum
	Cadmium	9.00E-04	9.00E-04	1/28	9.00E-04	maximum
	Chromium	1.00E-02	1.80E-01	15/28	1.80E-01	maximum
	Lead	3.00E-03	1.00E-02	14/28	1.00E-02	maximum
	Manganese	4.90E-02	3.49E+00	17/17	3.49E+00	maximum
	Nickel	4.00E-02	2.10E-01	7/28	2.10E-01	maximum
	Silver	1.00E-02	1.00E-02	1/28	1.00E-02	maximum
	Strontium	1.40E-01	3.20E+00	17/17	3.20E+00	maximum
	Thallium	1.70E-03	4.30E-03	16/28	4.30E-03	maximum
	Non-Metallic Anion					
	Perchlorate	1.0E-02	3.2E+02	21/31	3.20E+02	maximum
	Semi-Volatile Organics					
	2,4-Dinitrotoluene	---	---	0/7	3.80E-03	maximum
	2,6-Dinitrotoluene	---	---	0/7	3.80E-03	maximum
	Volatile Organics					
	1,1-Dichloroethene	3.70E-03	5.10E-02	7/28	5.10E-02	maximum
	1,2-Dichloroethane	4.90E-03	6.30E-02	8/28	6.30E-02	maximum
	Methylene chloride	1.10E-03	3.20E-03	4/28	3.20E-03	maximum
	Trichloroethene	2.90E-03	5.32E+00	13/28	5.32E+00	maximum
	Dioxin/Furan					
	2,3,7,8-TCDD TEC	1.28E-06	2.14E-04	---	2.14E-04	maximum
	Explosive					
	2,4,6-Trinitrotoluene	4.30E-01	8.40E+03	9/29	8.40E+03	maximum
	2-Amino-4,6-dinitrotoluene	5.10E-01	1.60E+01	5/29	1.60E+01	maximum
	4-Amino-2,6-dinitrotoluene	4.90E-01	4.80E+00	4/20	4.80E+00	maximum

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

Scenario Timeframe: Current
Medium: Soil
Exposure Medium: Soil (0 to 2 feet below ground surface)

Exposure Point	Chemical	Concentration Detected[1] (mg/kg)		Frequency of Detection	Exposure Point Concentration (mg/kg)	Statistical Measure
		Minimum	Maximum			
Ingestion, inhalation, dermal contact	*Metals*					
	Antimony	1.36E+00	2.51E+00	9/30	2.51E+00	maximum
	Barium	4.70E+01	2.05E+04	47/47	1.16E+03	95% UCL
	Cadmium	6.80E-01	7.33E+00	11/47	7.33E+00	maximum
	Lead	4.77E+00	5.97E+02	47/47	9.34E+01	95% UCL
	Thallium	4.80E+00	4.80E+00	1/47	4.80E+00	maximum
	Non-Metallic Anion					
	Perchlorate	3.56E-02	6.16E-01	4/4	6.16E-01	maximum
	Semi-Volatile Organics					
	2,4-Dinitrotoluene	1.90E+00	7.10E+03	4/18	2.60E+03	95% UCL
	2,6-Dinitrotoluene	1.80E+00	7.60E+02	5/18	3.18E+02	95% UCL
	Hexachlorobenzene	2.80E-01	2.80E-01	1/18	2.80E-01	maximum

Notes:
[1] Minimum/maximum detected concentration above the reporting limit

For groundwater, the maximum detected concentrations were used to estimate the exposure point concentration.
For soil, the 95% UCL values were used to estimate the exposure point concentration if the concentration exceeded the average and was below the maximum detected; otherwise, the maximum detected concentration was used to estimate the exposure point concentration.

---: No information available
95% UCL: 95% upper confidence level of the mean
mg/kg: milligrams per kilogram
mg/L: milligrams per liter
TCDD: tetrachlorodibenzo-p-dioxin
TEC: toxicity equivalence concentration

References:
Jacobs Engineering Group, Inc. (Jacobs), 2002, *Baseline Human Health and Screening Ecological Risk Assessment for the Group 2 Sites (Sites 12, 17, 18/24, 29, 32, 49, Harrison Bayou, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas*, Final, Oak Ridge, TN, August.

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, 2002).

Table 2-2
Carcinogenic Toxicity Data Summary

Pathway: Ingestion, Dermal Contact

Chemical of Concern	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Weight of Evidence/ Carcinogen Guideline Description	Source/Date
Dioxin/Furans				
2,3,7,8-TCDD TEC	1.50E+05	3.00E+05	not classified	USEPA-HEAST, 1997
Explosives				
2,4,6-Trinitrotoluene	3.00E-02	5.00E-02	C	USEPA-IRIS, 2001
2-Amino-4,6-dinitrotoluene	1.00E-02	2.00E-02	not classified	TCEQ, 2001
4-Amino-2,6-dinitrotoluene	1.00E-02	2.00E-02	not classified	TCEQ, 2001
Metals				
Aluminum	NTV	NTV	not classified	---
Antimony	NTV	NTV	not classified	---
Barium	NC	NC	D	TCEQ, 2001
Cadmium (Water)	NTV	NTV	B1	TCEQ, 2001
Chromium (Total)	NC	NC	not classified	---
Lead	NTV	NTV	not classified	---
Manganese (Non-diet)	NC	NC	D	TCEQ, 2001
Nickel	NTV	NTV	A	TCEQ, 2001
Silver	NC	NC	D	TCEQ, 2001
Strontium	NTV	NTV	not classified	---
Thallium	NC	NC	not classified	---
Non-Metallic Anions				
Perchlorate	NTV	NTV	not classified	---
Semivolatile Organics				
2,4-Dinitrotoluene	6.80E-01	8.00E-01	B2	USEPA-IRIS, 2001
2,6-Dinitrotoluene	6.80E-01	8.00E-01	B2	USEPA-IRIS, 2001
Hexachlorobenzene	1.60E+00	3.20E+00	B2	USEPA-IRIS, 2001
Volatile Organics				
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
Methylene chloride	7.50E-03	7.89E-03	B2	USEPA-IRIS, 2001
Trichloroethene	1.10E-02	1.10E-02	B2	USEPA-NCEA, 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/Furans			
2,3,7,8-TCDD TEC	3.30E+04	Not Classified	USEPA-HEAST, 1997
Explosives			
2,4,6-Trinitrotoluene	NTV	C	TCEQ, 2001
2-Amino-4,6-dinitrotoluene	NTV	Not Classified	---
4-Amino-2,6-dinitrotoluene	NTV	Not Classified	---
Metals			
Aluminum	NTV	Not Classified	---
Antimony	NTV	Not Classified	---
Barium	NC	D	TCEQ, 2001
Cadmium (Water)	1.80E+00	B1	USEPA-IRIS, 2001
Chromium (Total)	NC	Not Classified	---
Lead	NTV	Not Classified	---
Manganese (Non-diet)	NC	D	TCEQ, 2001
Nickel	4.80E-01	A	USEPA-IRIS, 2001
Silver	NC	D	TCEQ, 2001
Strontium	NTV	Not Classified	---
Thallium	NC	Not Classified	---
Non-Metallic Anions			
Perchlorate	NTV	Not Classified	---
Semivolatile Organics			
2,4-Dinitrotoluene	NTV	B2	TCEQ, 2001
2,6-Dinitrotoluene	NTV	B2	TCEQ, 2001
Hexachlorobenzene	4.60E-01	B2	USEPA-IRIS, 2001
Volatile Organics			
1,1-Dichloroethene	5.00E-02	C	USEPA-IRIS, 2001
1,2-Dichloroethane	2.60E-02	B2	USEPA-IRIS, 2001
Methylene chloride	4.70E-04	B2	USEPA-IRIS, 2001
Trichloroethene	1.70E-03	B2	USEPA-NCEA, 2001

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

Notes

--- : No information available
mg/kg-day: milligrams per kilogram per day
mg/m³: milligrams per cubic meter
NC: Chemical not classified as a carcinogen
NTV: no toxicity value available
TCDD: tetrachlorodibenzo-p-dioxin
TEC: toxicity equivalence concentration

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), 2002, *Baseline Human Health and Screening Ecological Risk Assessment for the Group 2 Sites (Sites 12, 17, 18/24, 29, 32, 49, Harrison Bayou, and Caddo Lake)*, Longhorn Army Ammunition Plant, Karnack, Texas, Final, Oak Ridge, TN, August.

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

U.S. Environmental Protection Agency (USEPA), 1993, *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons*, Office of Research and Development, EPA/600/$-93/089, July 1993.

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 in 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, 2002).

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)	Target Endpoint	Combined Uncertainty/ Modifying Factors	Source/Date
Dioxin/Furans						
2,3,7,8-TCDD TEC	chronic	NTV	NTV	NA	NA	---
Explosives						
2,4,6-Trinitrotoluene	chronic	5.00E-04	3.00E-04	Liver effects	1000/1	USEPA-IRIS, 2001
2-Amino-4,6-dinitrotoluene	chronic	1.67E-04	8.33E-05	NA	NA	TCEQ, 2001
4-Amino-2,6-dinitrotoluene	chronic	1.67E-04	8.33E-05	NA	NA	TCEQ, 2001
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
Barium	chronic	7.00E-02	4.90E-03	Increased kidney weight	3/1	USEPA-IRIS, 2001
Cadmium (Water)	chronic	5.00E-04	1.25E-05	Proteinuria	10/1	USEPA-IRIS, 2001
Chromium (Total)	chronic	1.50E+00	1.95E-02	No effects observed	100/10	USEPA-IRIS, 2001
Lead	chronic	NTV	NTV	NA	NA	---
Manganese (Non-diet)	chronic	4.70E-02	2.82E-03	Central nervous system effects	1/1	USEPA-IRIS, 2001
Nickel	chronic	2.00E-02	8.00E-04	Decreased Body Weight	300/1	USEPA-IRIS, 2001
Silver	chronic	5.00E-03	2.00E-04	Argyria	3/1	USEPA-IRIS, 2001
Strontium	chronic	6.00E-01	1.20E-01	Rachitic bone	300/1	USEPA-IRIS, 2001
Thallium	chronic	8.00E-05	8.00E-05	Blood	3000/1	USEPA-IRIS, 2001[d]
Non-Metallic Anions						
Perchlorate	chronic	9.00E-04	9.00E-04	NA	NA	USEPA, 1998
Semivolatile Organics						
2,4-Dinitrotoluene	chronic	2.00E-03	1.70E-03	Central nervous system effects	100/1	USEPA-IRIS, 2001
2,6-Dinitrotoluene	chronic	1.00E-03	8.50E-04	Central nervous system effects	3000/1	USEPA-HEAST, 1997
Hexachlorobenzene	chronic	8.00E-04	4.00E-04	Liver effects	100/1	USEPA-IRIS, 2001
Volatile Organics						
1,1-Dichloroethene	chronic	9.00E-03	9.00E-03	Hepatic lesions	1000/1	USEPA-IRIS, 2001
1,2-Dichloroethane	chronic	3.00E-02	3.00E-02	NA	NA	USEPA-NCEA, 2001
Methylene chloride	chronic	6.00E-02	5.70E-02	Liver toxicity	100/1	USEPA-IRIS, 2001
Trichloroethene	chronic	6.00E-03	6.00E-03	NA	NA	USEPA-NCEA, 2001

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

Pathway: Inhalation

Chemical of Concern	Chronic/ Subchronic	Inhalation RfC (mg/m^3)	Target Endpoint	Combined Uncertainty/ Modifying Factors	Source/Date
Dioxin/Furans					
2,3,7,8-TCDD TEC	chronic	NTV	---	---	---
Explosives					
2,4,6-Trinitrotoluene	chronic	0.0001	NA	NA	TCEQ, 2001
2-Amino-4,6-dinitrotoluene	chronic	0.0001	NA	NA	TCEQ, 2001
4-Amino-2,6-dinitrotoluene	chronic	0.0001	NA	NA	TCEQ, 2001
Metals					
Aluminum	chronic	0.0035	NA	NA	USEPA-NCEA, 2001
Antimony	chronic	0.0005	Pulmonary toxicity, chronic interstitial inflammation	300/1	USEPA-IRIS, 2001
Barium	chronic	0.00049	Fetus, developmental effects	1000/1	USEPA-HEAST, 1997
Cadmium (Water)	chronic	0.0002	NA	NA	USEPA-NCEA, 2001
Chromium (Total)	chronic	0.0001	NA	NA	TCEQ, 2001
Lead	chronic	NTV	---	---	---
Manganese (Non-diet)	chronic	0.00005	Impairment of neurobehavioral function	1000/1	USEPA-IRIS, 2001
Nickel	chronic	0.0002	Respiratory effects	NA	ATSDR, 1997
Silver	chronic	0.00001	NA	NA	TCEQ, 2001
Strontium	chronic	NTV	---	---	---
Thallium	chronic	0.0001	NA	NA	TCEQ, 2001
Non-Metallic Anions					
Perchlorate	chronic	NTV	---	---	---
Semivolatile Organics					
2,4-Dinitrotoluene	chronic	0.00015	NA	NA	TCEQ, 2001
2,6-Dinitrotoluene	chronic	0.00015	NA	NA	TCEQ, 2001
Hexachlorobenzene	chronic	NTV	---	---	---
Volatile Organics					
1,1-Dichloroethene	chronic	NTV	---	---	---
1,2-Dichloroethane	chronic	0.005	NA	NA	USEPA-NCEA, 2001
Methylene chloride	chronic	3	Liver toxicity	100/1	USEPA-HEAST, 1997
Trichloroethene	chronic	NTV	---	---	---

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

Notes

---: No information for a compound with no toxicity value (NTV)
IRIS: Integrated Risk Information System, USEPA
mg/kg-day: milligrams per kilogram per day
mg/m³: milligrams per cubic meter
NA: Information not available
NTV: No toxicity value available
RfC: Reference concentration
RfD: Reference dose
TCDD: tetrachlorodibenzo-p-diozin
TEC: toxicity equivalence concentration

References

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

Jacobs Engineering Group, Inc. (Jacobs), 2002, *Baseline Human Health and Screening Ecological Risk Assessment for the Group 2 Sites (Sites 12, 17, 18/24, 29, 32, 49, Harrison Bayou, and Caddo Lake)*, Longhorn Army Ammunition Plant, Karnack, Texas, Final, Oak Ridge, TN, August.

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 potential 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, 2002). 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
Groundwater	Groundwater	Ingestion or exposure through showering	*Dioxin/Furan*				
			2,3,7,8-TCDD TEC	1.9E-06	NE	1.5E-05	1.7E-05
			Explosive				
			2,4,6-Trinitrotoluene	ND	ND	ND	NA
			2-Amino-4,6-dinitrotoluene	ND	ND	ND	NA
			4-Amino-2,6-dinitrotoluene	ND	ND	ND	NA
			Metals				
			Aluminum	NTV	NE	NE (Kp<=0.01)	NA
			Antimony	NTV	NE	NE (Kp<=0.01)	NA
			Barium	ND	ND	ND	NA
			Cadmium	NTV	NE	NE (Kp<=0.01)	NA
			Chromium	NC	NE	NE (Kp<=0.01)	NA
			Lead	NTV	NE	NE (Kp<=0.01)	NA
			Manganese	NC	NE	NE (Kp<=0.01)	NA
			Nickel	NTV	NE	NE (Kp<=0.01)	NA
			Silver	NC	NE	NE (Kp<=0.01)	NA
			Strontium	NTV	NE	NE (Kp<=0.01)	NA
			Thallium	NC	NE	NE (Kp<=0.01)	NA
			Non-Metallic Anion				
			Perchlorate	NTV	NE	NE (Kp<=0.01)	NA
			Semi-Volatile Organics				
			2,4-Dinitrotoluene	9.0E-06	NE	NE (Kp<=0.01)	9.0E-06
			2,6-Dinitrotoluene	9.0E-06	NE	NE (Kp<=0.01)	9.0E-06
			Hexachlorobenzene	ND	ND	ND	NA
			Volatile Organics				
			1,1-Dichloroethene	1.1E-04	1.6E-04	1.4E-04	4.1E-04
			1,2-Dichloroethane	2.0E-05	1.0E-04	9.2E-06	1.3E-04
			Methylene chloride	8.4E-08	9.2E-08	NE (Kp<=0.01)	1.8E-07
			Trichloroethene	2.0E-04	5.5E-04	2.7E-04	1.0E-03
						Groundwater risk total =	1.6E-03

Table 2-4 (*continued*)
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 2 feet)	Soil and particulates	Incidental Ingestion, inhalation of particulates, and dermal contact	*Dioxin/Furan*				
			2,3,7,8-TCDD TEC	1.1E-05	3.7E-10	4.3E-06	1.6E-05
			Explosive				
			2,4,6-Trinitrotoluene	8.8E-05	NTV	9.4E-05	1.8E-04
			2-Amino-4,6-dinitrotoluene	5.6E-08	NTV	7.2E-08	1.3E-07
			4-Amino-2,6-dinitrotoluene	1.7E-08	NTV	2.1E-08	3.8E-08
			Metals				
			Aluminum	ND	ND	ND	NA
			Antimony	NTV	NTV	NTV	NA
			Barium	NC	NC	NC	NA
			Cadmium	NTV	7.0E-10	NTV	7.0E-10
			Chromium	ND	ND	ND	NA
			Lead	NTV	NTV	NTV	NA
			Manganese	ND	ND	ND	NA
			Nickel	ND	ND	ND	NA
			Silver	ND	ND	ND	NA
			Strontium	ND	ND	ND	NA
			Thallium	NC	NC	NC	NA
			Non-Metallic Anion				
			Perchlorate	NTV	NTV	NTV	NA
			Semi-Volatile Organics				
			2,4-Dinitrotoluene	6.2E-04	NTV	4.7E-04	1.1E-03
			2,6-Dinitrotoluene	7.6E-05	NTV	5.7E-05	1.3E-04
			Hexachlorobenzene	1.6E-07	6.8E-12	2.0E-07	3.6E-07
			Volatile Organics				
			1,1-Dichloroethene	ND	ND	ND	NA
			1,2-Dichloroethane	ND	ND	ND	NA
			Methylene chloride	ND	ND	ND	NA
			Trichloroethene	ND	ND	ND	NA
						Soil risk total =	1.4E-03
						Total risk (soil and groundwater) =	3.0E-03

Table 2-4 (*continued*)
Risk Characterization Summary – Carcinogens

Notes

Kp	Dermal permeability coefficient
NA	Not applicable
NC	Not classified as a carcinogen
ND	Not detected in associated media or not selected as a chemical of potential concern
NE	Not evaluated through this exposure pathway. Chemical is not identified as volatile.
NE(Kp<=0.01)	Based on USEPA Region 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
TCDD	Tetrachlorodibenzo-p-dioxin
TEC	Toxicity equivalence concentration

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 VI Risk Assessment Guidance, May 5, 1995*.

Summary of Risk Characterization

The table provides risk estimates for the significant routes of exposure at LHAAP-17. 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 3.0×10^{-3}. A risk below 1×10^{-4} is generally considered to be acceptable (USEPA, 1989). The soil risk and the groundwater risk are unacceptable.

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	Target Endpoint	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Ingestion or exposure through showering	*Dioxin/Furan*					
			2,3,7,8-TCDD TEC	NA	NTV	NE	NTV	NA
			Explosive					
			2,4,6-Trinitrotoluene	Liver effects	ND	ND	ND	NA
			2-Amino-4,6-dinitrotoluene	NA	ND	ND	ND	NA
			4-Amino-2,6-dinitrotoluene	NA	ND	ND	ND	NA
			Metals					
			Aluminum	NA	7.9E-02	NE	NE (Kp<=0.01)	7.9E-02
			Antimony	Longevity, blood glucose, and cholesterol	3.2E-01	NE	NE (Kp<=0.01)	3.2E-01
			Barium	Increased kidney weight	ND	ND	ND	NA
			Cadmium	Proteinuria	1.8E-02	NE	NE (Kp<=0.01)	1.8E-02
			Chromium	No effects observed	1.2E-03	NE	NE (Kp<=0.01)	1.2E-03
			Lead	NA	NTV	NE	NE (Kp<=0.01)	NA
			Manganese	Central nervous system effects	7.3E-01	NE	NE (Kp<=0.01)	7.3E-01
			Nickel	Decreased Body Weight	1.0E-01	NE	NE (Kp<=0.01)	1.0E-01
			Silver	Argyria	2.0E-02	NE	NE (Kp<=0.01)	2.0E-02
			Strontium	Rachitic bone	5.2E-02	NE	NE (Kp<=0.01)	5.2E-02
			Thallium	Blood	5.3E-01	NE	NE (Kp<=0.01)	5.3E-01
			Non-Metallic Anion					
			Perchlorate	NA	3.5E+03	NE	NE (Kp<=0.01)	3.5E+03
			Semi-Volatile Organics					
			2,4-Dinitrotoluene	Central nervous system effects	1.9E-02	NE	NE (Kp<=0.01)	1.9E-02
			2,6-Dinitrotoluene	Central nervous system effects	3.7E-02	NE	NE (Kp<=0.01)	3.7E-02
			Hexachlorobenzene	Liver effects	ND	ND	ND	NA
			Volatile Organics					
			1,1-Dichloroethene	Hepatic lesions	5.5E-02	NTV	7.4E-02	1.3E-01
			1,2-Dichloroethane	NA	2.1E-02	2.2E+00	9.5E-03	2.2E+00
			Methylene chloride	Liver toxicity	5.2E-04	1.8E-04	NE (Kp<=0.01)	7.0E-04
			Trichloroethene	NA	8.7E+00	NTV	1.2E+01	2.0E+01
							Groundwater Hazard Index Total =	3.5E+03

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

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

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Target Endpoint	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 to 2 feet)	Soil and particulates	Incidental ingestion, inhalation of particulates, dermal contact	*Dioxin/Furan*					
			2,3,7,8-TCDD TEC	NA	NTV	NTV	NTV	NA
			Explosive					
			2,4,6-Trinitrotoluene	Liver effects	1.6E+01	1.2E-02	1.8E+01	3.4E+01
			2-Amino-4,6-dinitrotoluene	NA	9.4E-02	2.4E-05	1.2E-01	2.1E-01
			4-Amino-2,6-dinitrotoluene	NA	2.8E-02	7.1E-06	3.6E-02	6.4E-02
			Metals					
			Aluminum	NA	ND	ND	ND	NA
			Antimony	Longevity, blood glucose, and cholesterol	6.1E-03	7.4E-07	2.6E-03	8.8E-03
			Barium	Increased kidney weight	1.6E-02	3.5E-04	1.5E-02	3.1E-02
			Cadmium	Proteinuria	7.2E-03	5.4E-06	1.8E-03	9.0E-03
			Chromium	Proteinuria	ND	ND	ND	NA
			Lead	Gastrointestinal	NTV	NTV	NTV	NA
			Manganese	NA	ND	ND	ND	NA
			Nickel	Decreased Body Weight	ND	ND	ND	NA
			Silver	Argyria	ND	ND	ND	NA
			Strontium	Rachitic bone	ND	ND	ND	NA
			Thallium	Blood	5.9E-02	7.1E-06	3.8E-03	6.2E-02
			Non-Metallic Anion					
			Perchlorate	NA	6.7E-04	NTV	4.3E-05	7.1E-04
			Semi-Volatile Organics					
			2,4-Dinitrotoluene	Central nervous system effects	1.3E+00	2.6E-03	9.6E-01	2.2E+00
			2,6-Dinitrotoluene	Central nervous system effects	3.1E-01	3.1E-04	2.3E-01	5.5E-01
			Hexachlorobenzene	Liver effects	3.4E-04	NTV	4.4E-04	7.8E-04
			Volatile Organics					
			1,1-Dichloroethene	Hepatic lesions	ND	ND	ND	NA
			1,2-Dichloroethane	NA	ND	ND	ND	NA
			Methylene chloride	Decreased hematocrit and hemoglobin in the blood	ND	ND	ND	NA
			Trichloroethene	Liver and kidney effects	ND	ND	ND	NA
Soil Hazard Index Total =								3.7E+01
Hazard Index Total (soil and groundwater) =								3.5E+03

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

Notes

Kp	Dermal permeability coefficient
NA	Not applicable
ND	Not detected in associated media or not selected as a chemical of potential concern
NE	Not evaluated through this exposure pathway. Chemical is not identified as a volatile.
NE (Kp<=0.01)	Based on USEPA Region 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
TCDD	Tetrachlorodibenzo-p-dioxin
TEC	Toxicity equivalence concentration

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 for LHAAP-17. 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 for groundwater is 3,500 and for soil is 37. Both values are unacceptable and indicate that the potential for adverse non-carcinogenic effects could occur from exposure to contaminants in those mediums.

Table 2-6
Chemicals with Carcinogenic Risk Greater than 1×10^{-6} in Soil

Chemical	Baseline Risk Assessment			Retained as COC ?
	Carcinogenic Risk in Soil [a]	EPC (mg/kg)	Soil Sample Location (Depth)	
2,4-Dinitrotuluene	1.1×10^{-3}	2602[b]	*	Yes, 1
2,4,6-Trinitrotoluene	1.8×10^{-4}	8400	17SS22 [c] (0-2 feet)	Yes, 1
2,6-Dinitrotoluene	1.3×10^{-4}	318 [b]	*	Yes, 1
2,3,7,8-TCDD TEC	1.6×10^{-5}	2.14×10^{-4}[d]	17SD12[e] (0.00 feet)	No, 2

Notes and Abbreviations:

1. *Identified as chemical of concern (COC) since carcinogenic risk is above the acceptable range*
2 *Excluded since risk is within the acceptable range and the chemical is not a COC for groundwater*

[a] *Carcinogenic risk from Baseline Risk Assessment Table C-29 (Jacobs, 2002)*
[b] *95 percent upper confidence limit (UCL) used as EPC.*
[c] *From Baseline Risk Assessment Table 3-64.*
[d] *Toxic equivalents used in developing the EPC.*
[e] *From Baseline Risk Assessment Table 3-19.*
* *No specific location, EPC calculated as 95 percent UCL as noted in the Baseline Risk Assessment Report Table 3-64*

COC *chemical of concern*
EPC *Exposure Point Concentration from Baseline Risk Assessment (Jacobs, 2002)*
mg/kg *milligrams per kilogram*
TCDD *tetrachlorodibenzo-p-dioxin*
TEC *toxicity equivalence concentration*

Table 2-7
Chemicals with Hazard Quotient Greater than 0.1 in Soil

Chemical	Baseline Risk Assessment			Retained as COC ?
	Soil Hazard Quotient [a]	EPC (mg/kg)	Soil Sample Location (Depth)	
2,4,6-Trinitrotoluene	34	8400	17SS22 [b] (0-0.5 ft)	Yes, 1
2,4-Dinitrotoluene	2.2	2602[c]	*	Yes, 1
2,6-Dinitrotoluene	0.55	318 [c]	*	No, 2
2-Amino-4,6-dinitrotoluene	0.21	16	17SB03 (0-2 feet)	No, 2

Notes and Abbreviations:

1. *Identified as COC since Hazard Quotient is greater than 1.0.*
2. *Not identified as COC since HQ is less than 1.0*

[a] *HQ from Baseline Risk Assessment Table C-26 (Jacobs, 2002)*
[b] *From Baseline Risk Assessment Table 3-64*
[c] *95 percent upper confidence limit (UCL) used as the EPC*
* *No specific location, EPC calculated as 95 percent UCL as noted in the Baseline Risk Assessment Report Table 3-64 (Jacobs, 2002)*

COC chemical of concern
EPC Exposure Point Concentration from Baseline Risk Assessment (Jacobs, 2002)
HQ hazard quotient
mg/kg milligrams per kilogram.

Table 2-8
Chemicals with Carcinogenic Risk Greater than 1×10^{-6} in Groundwater

Chemical	Baseline Risk Assessment			Data Since Risk Assessment		
	Carcinogenic Risk in Ground-water [a]	EPC (µg/L)	Well	Maximum [b] (µg/L)	Well	Adjusted Risk
Trichloroethene	1×10^{-3}	5,320	17WW01	6090	17WW01	1.1×10^{-3}
1,1-Dichloroethene	4.1×10^{-4}	51	17WW01	70	17WW01	5.6×10^{-4}
1,2-Dichloroethane	1.3×10^{-4}	63	17WW01	35.8 J	17WW01	7.4×10^{-5}
2,3,7,8-TCDD TEC	1.7×10^{-5}	3.5×10^{-6} [c]	17WW13	–	–	–
2,4-Dinitrotuluene	9×10^{-6}	3.8	17WW02	ND	17WW02	–
2,6-Dinitrotoluene	9×10^{-6}	3.8	17WW02	ND	17WW02	–

Chemical	Comparison Levels		Retained as COC?
	MCL (µg/L)	TCEQ GW-Ind (µg/L)	
Trichloroethene	5	5	Yes, 1
1,1-Dichloroethene	7	7	Yes, 1
1,2-Dichloroethane	5	5	Yes, 1
2,3,7,8-TCDD TEC	3×10^{-5}	–	No, 2
2,4-Dinitrotuluene	–	0.42	No, 3
2,6-Dinitrotoluene	–	0.42	No, 3

Notes and Abbreviations:

No adjusted risk was calculated for 2,3,7,8-TCDD TEC, 2,4-dinitrotoluene, and 2,6-dinitrotoluene because no data was collected since the risk assessment for 2,3,7,8-TCDD TEC, and concentrations since the risk assessment have been ND for 2,4-dinitrotoluene and 2,6-dinitrotoluene.
No MCL available for 2,4-dinitrotoluene and 2,6-dinitrotoluene, and no TCEQ GW-Ind available for 2,3,7,8-TCDD.

1. *Identified as COC because most recent maximum concentration is above the MCL*
2. *Excluded because the EPC and more recent results are below the MCL*
3. *Excluded because more recent results are below the TCEQ GW-Ind*

[a] *From Baseline Risk Assessment Table C-29 (Jacobs, 2002)*
[b] *Maximum data from the latest sampling event*
[c] *Toxic equivalents were used in developing the EPC*

–	not applicable
µg/L	micrograms per liter
COC	chemical of concern
EPC	exposure point concentration
MCL	Safe Drinking Water Act maximum contaminant level
MSC	medium specific concentration from Updated Examples of Risk Reduction Standard No. 2, Appendix II
ND	nondetect
TCEQ GW-Ind	Texas Commission of Environmental Quality Groundwater MSC for Industrial Use
TCDD	tetrachlorodibenzo-p-dioxin
TEC	toxicity equivalence concentration

Table 2-9
Chemicals with Hazard Quotient Greater than 0.1 in Groundwater

Chemical	Baseline Risk Assessment			Data Since Risk Assessment		
	Hazard Quotient Groundwater [a]	EPC (µg/L)	Well	Maximum [b] (µg/L)	Well	Adjusted Hazard Quotient
Perchlorate	3500	320,000	17WW06	74,000 160,000	17WW06 17WW02	809 1750
Trichloroethene	20	5,320	17WW01	5,970	17WW01	22.9
1,2-Dichloroethane	2.2	63	17WW01	44.9	17WW01	1.3
Manganese	0.73	3490	17WW01	–	–	–
Thallium	0.59	4.3	17WW13	ND (0.05)	17WW13	–
Antimony	0.32	13	17WW02	ND (0.25)	17WW02	–
1,1-Dichloroethene	0.13	51	17WW01	70	17WW01	0.2

Chemical	Comparison Levels		Retained as COC ?
	MCL (µg/L)	TCEQ GW-Ind (µg/L)	
Perchlorate	—	72	Yes, 1
Trichloroethene	5	5	Yes, 2
1,2-Dichloroethane	5	5	Yes, 2
Manganese	—	14,000	No, 3
Thallium	—	2	No, 4
Antimony	—	6	No, 4
1,1-Dichloroethene	7	7	Yes, 2

Notes and Abbreviations:

1. *Identified as a COC because HQ >1*
2. *Identified as COC because EPC is above the MCL.*
3. *Excluded because EPC is below the TCEQ GW-Ind MSC and HQ is <1.0*
4. *Excluded because more recent data results are below the TCEQ GW-Ind*

[a] *From Baseline Risk Assessment Table C-29 (Jacobs, 2002)*
[b] *Maximum data from the latest sampling event*

—	*not applicable*
COC	*chemical of concern*
EPC	*exposure point concentration*
HQ	*hazard quotient*
MSC	*medium specific concentration from Updated Examples of Risk Reduction Standard No. 2, Appendix II*
TCEQ GW-Ind	*Texas Commission of Environmental Quality Groundwater MSC for Industrial Use*
MCL	*Safe Drinking Water Act maximum contaminant level*
µg/L	*micrograms per liter*

Table 2-10
Cleanup Levels for Human Health Risk

Medium	Chemical of Concern	Cleanup Level
Shallow zone groundwater		MCL (µg/L)
	1,1-Dichloroethene	7
	1,2-Dichloroethane	5
	cis-1,2-Dichloroethene	70
	Trichloroethene	5
	Vinyl chloride	2
		GW-Ind (µg/L)
	Perchlorate	72
		MCL (µg/L)
Intermediate zone groundwater	cis-1,2-Dichloroethene	70
	Trichloroethene	5
	Vinyl chloride	2
Soil		GWP-Ind (mg/kg)
	2,4,6-Trinitrotoluene	5.1
	2,4-Dinitrotoluene	0.042
	2,6-Dinitrotoluene	0.042
	Perchlorate	7.2

Notes and Abbreviations:

GW-Ind *Texas Commission on Environmental Quality groundwater medium specific concentration for industrial use*
GWP-Ind *Texas Commission on Environmental Quality soil medium specific concentration for industrial use based on groundwater protection*
MCL *Safe Drinking Water Act maximum contaminant level*
mg/kg *milligrams per kilogram*
µg/L *micrograms per liter*

Table 2-11
Cleanup Levels for Ecological Risk in Soil (EcoPRGs)

Chemical	SS EcoPRG [a] (mg/kg)	TS EcoPRG [a] (mg/kg)	Depth [b]	Sample Location
Barium	222	—	0 - 0.5'	17SS22, 17SD04, 17SD07, 17SD08, 17SD11
	—	520	0 - 3'	17SD07
2,4-Dinitrotoluene	—	12	0 - 3'	17SB02
2,6-Dinitrotoluene	2.7	6.8	0 - 3'	17SB02
2,4,6-Trinitrotoluene	—	4.7	0 - 3'	17SS22, 17SS23, 17SB06
2,3,7,8-TCDD TEC	4×10^{-6}	4×10^{-6}	0 - 3'	17SD12

Notes and Abbreviations:

[a] *From Baseline Ecological Risk Assessment Table 16-1 (Shaw, 2007b)*
[b] *Depth and locations of remedial action for Waste Sub-Area*

EcoPRG *ecological preliminary remediation goal*
mg/kg *milligrams per kilogram*
SS *surface soil from 0-0.5 feet (applicable to deer mouse)*
TCDD *tetrachlorodibenzo-p-dioxin*
TEC *toxicity equivalence concentration*
TS *total soil from 0-3 feet (applicable to short-tailed shrew)*

Table 2-12
Comparative Analysis of Alternatives

Comparative Analysis of Alternatives Criteria	Alternative 1 No Action	Alternative 2 Excavation and Off-site Disposal of Soil; MNA and LUC for Groundwater	Alternative 3 Excavation and Off-site Disposal of Soil; In Situ Bioremediation; MNA and LUC for Groundwater	Alternative 4 Excavation and Off-site Disposal of Soil; Groundwater Extraction; MNA and LUC for Groundwater
Overall protection of human health and the environment	No protection. Does not achieve RAOs.	Achieves RAOs. Protection of human health and environment provided by excavation and maintenance of LUC. Excavation would remove soil above cleanup levels. Monitored natural attenuation activities would demonstrate that degradation of plume is occurring in groundwater.	Achieves RAOs. Protection of human health and environment provided by excavation of soil, bioremediation of shallow zone groundwater, and MNA of intermediate zone groundwater. Groundwater monitoring and LUC will remain in place until remainder of plumes degrade to cleanup levels.	Achieves RAOs. Protection of human health and environment provided by excavation of soil, extraction of shallow zone groundwater, and MNA of intermediate zone groundwater. Groundwater monitoring and LUC will remain in place until remainder of plumes degrade to cleanup levels.
Compliance with ARARs	No compliance with chemical-specific ARARs.	Complies with ARARs.	Complies with ARARs.	Complies with ARARs.
Long-term effectiveness and permanence	Not effective for soil. Natural attenuation would occur, but its progress would be unverified by monitoring. No evaluation of natural attenuation's long-term effectiveness and permanence.	Excavation would have a permanent effect of removing contaminants from the soil. MNA would verify permanent reduction of contaminant levels in the groundwater over time. LUC would be effective and reliable so long as it is maintained until cleanup levels are achieved.	Excavation would have a permanent effect of removing contaminants from the soil. Bioremediation would permanently convert contaminants to harmless compounds (chlorinated solvents also generate temporary daughter products). A treatability study may be required. Long-term monitoring would verify permanent reduction of contaminant levels in the groundwater over time. LUC would be effective and reliable so long as it is maintained until cleanup levels are achieved.	Excavation would have a permanent effect of removing contaminants from the soil. Groundwater extraction would permanently remove contaminants from groundwater which is treated at the groundwater treatment plant. Long-term monitoring would verify permanent reduction of contaminant levels in the groundwater over time. LUC would be effective and reliable so long as it is maintained until cleanup levels are achieved.

Table 2-12 *(continued)* Comparative Analysis of Alternatives

Comparative Analysis of Alternatives Criteria	Alternative 1 No Action	Alternative 2 Excavation and Off-site Disposal of Soil; MNA and LUC for Groundwater	Alternative 3 Excavation and Off-site Disposal of Soil; In Situ Bioremediation; MNA and LUC for Groundwater	Alternative 4 Excavation and Off-site Disposal of Soil; Groundwater Extraction; MNA and LUC for Groundwater
Reduction of toxicity, mobility, or volume through treatment	No active reduction.	Soil contaminants removed and disposed of without treatment. No active reduction in groundwater.	Soil contaminants removed and disposed of without treatment. Shallow zone groundwater contaminants would be treated through in situ bioremediation in the areas of highest contamination. No active reduction in intermediate zone groundwater.	Soil contaminants removed and disposed of without treatment. Shallow zone groundwater contaminants would be extracted and treated at the groundwater treatment plant. No active reduction in intermediate zone groundwater.
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.	Minimal impacts to the community, workers, or the environment from short-term activities. Provides almost immediate protection.
Implementability	Inherently implementable.	Readily implemented.	Implementable, but uncertainty exists in the effectiveness and time required to reduce contaminants to cleanup levels. Specialized knowledge required for implementation.	Implementable, but uncertainty exists in the effectiveness and time required to reduce contaminants to cleanup levels. Specialized knowledge required for implementation.
Cost • Capital present worth • O&M present worth • Total present worth	 $0 $0 $0	 $1,400,000 $500,000 $1,900,000	 $2,000,000 $600,000 $2,600,000	 $1,600,000 $500,000 $2,100,000
State acceptance	Not acceptable	Not acceptable	Acceptable	Acceptable
Community acceptance	Responded to comments			

Notes and Abbreviations:

ARAR	applicable or relevant and appropriate requirement
COC	chemical of concern
LUC	land use control
MCL	maximum contaminant level
MNA	monitored natural attenuation
O&M	operation and maintenance
RAO	remedial action objective

Table 2-13
Remediation Cost Table
Selected Remedy (Alternative 4)
Present Worth Analysis

Year	FY	Capital Costs		Operation & Maintenance Costs			Present Value (NPV)		
				Long-Term Monitoring	Groundwater Extraction	Total	Discount Rate	Capital	O&M
							2.8%		
1	2011	$1,572,880		$24,244	$200,472	$224,716	NPV	$1,572,880	$540,907
2	2012			78,259	100,236	178,495			
3	2013	0		41,696		41,696		Total NPV	$2,113,787
4	2014	0		35,206		35,206			
5	2015			71,229		71,229			
6	2016	0		24,451		24,451			
7	2017	0		13,769		13,769			
8	2018	0		13,769		13,769			
9	2019	0		13,769		13,769			
10	2020			56,294		56,294			
11	2021					0			
12	2022					0			
13	2023					0			
14	2024					0			
15	2025			59,215		59,215			
16	2026					0			
17	2027					0			
18	2028					0			
19	2029					0			
20	2030			59,215		59,215			
21	2031					0			
22	2032					0			
23	2033					0			
24	2034					0			
25	2035			59,215		59,215			
26	2036					0			
27	2037					0			
28	2038					0			
29	2039					0			
30	2040			59,215		59,215			
		$1,572,880		$609,544	$300,708	$910,252			

Table 2-13 *(continued)*
Remediation Cost Table
Selected Remedy (Alternative 4)

Notes:

MNA	monitored natural attenuation
NPV	net present value
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 include: excavation evaluation, excavation and disposal activities, flow tests, engineering support, and construction management. The soil is assumed to be classified as nonhazardous for disposal purposes.

O&M costs for groundwater extraction are based on having 3 extraction wells.

Monitoring costs are based on the assumption that sampling is conducted at 5 shallow zone wells and 3 intermediate zone wells, with one quality control sample in each zone. In the shallow zone, monitoring begins 6 months into Year 2 when groundwater extraction ends and MNA begins. The sampling frequency is quarterly for 2 years, then semiannual for 3 years, then annual for Years 7 through 10, and finally every five years (Years 15, 20, 25, and 30). Analysis of the shallow zone groundwater is for VOCs and perchlorate. In the intermediate zone, monitoring begins at the start of Year 1 when MNA begins. The sampling frequency is quarterly for 2 years (Years 1 and 2), then semiannual for 3 years (Years 3 through 5), then annual for Years 6 through 10, and finally every five years (Years 15, 20, 25, and 30). Analysis of the intermediate zone groundwater is for VOCs.

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

Table 2-14
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
		Soil
TCEQ Texas Risk Reduction Rules 30 TAC 335.558 and 335.559(d)(2)	Ensures adequate protection of human health and the environment from potential exposure to contaminants associated with releases – relevant and appropriate for remediation of contaminated soil for cross-media contamination pathways such as soil to groundwater and for hypothetical future maintenance workers.	Near surface (i.e., 0-2 feet bgs) non-residential (industrial) soils shall conform to the non-residential soil MSCs (SAI-Ind) based upon worker ingestion of soil, inhalation of particulates and volatiles and the non-residential soil-to-groundwater cross media protection concentration. The concentration of contamination in soil shall not exceed the non-residential soil-to-groundwater protection MSC (GWP-Ind). See Table 2-10 for specific numeric criteria.
		Groundwater
Federal Safe Drinking Water Act MCLs/Non-Zero MCLGs 40 CFR 141	Applicable to drinking water for a public water system—relevant and appropriate for water that could potentially be used for human consumption.	Must not exceed MCLs/non-zero MCLGs for water designated as a current or potential source of drinking water. See Table 2-10 for specific numeric criteria.
TCEQ Texas Risk Reduction Rules 30 TAC 335	Applicable to industrial groundwater—relevant and appropriate for hypothetical future maintenance worker exposure to groundwater.	If no maximum contaminant level has been promulgated, groundwater must not exceed the industrial medium-specific concentration. See Table 2-10 for specific numeric criteria.
		Floodplain
Requirements for Hazardous Waste Facilities in Floodplains Resource Conservation and Recovery Act (RCRA) 40 CFR 264.18(b)	If excavated soil is found to constitute RCRA hazardous waste, these requirements are relevant and appropriate since LHAAP-17 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 2-14 *(continued)*
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
General Site Preparation, Construction, and Excavation Activities		
Opacity Standard 30 TAC 111.111(a)(8)(A)	Fugitive emissions from land-disturbing activities (e.g., excavation, construction)—applicable.	Visible emissions shall not be permitted to exceed opacity of 30% for any 6-minute period from any source.
Fugitive Particulate Matter Standard 30 TAC 111.145	Fugitive emissions from land-disturbing activities (e.g., excavation, construction)—applicable.	No person may cause, suffer, allow, or permit a structure, road, street, alley or parking area to be constructed, altered, repaired, or demolished, or land to be cleared without taking at least the following precautions to achieve control of dust emissions: • Use of water or of suitable oil or chemicals for control of dust in the demolition of structures, in construction operations, in work performed on a road, street, alley, or parking area, or in the clearing of land; and • Use of adequate methods to prevent airborne particulate matter during sandblasting of structures or similar operations
Storm water Runoff Controls 40 CFR 122.26; 30 TAC 205, Subchapter A; 30 TAC 308.121	Storm water discharges associated with construction activities—applicable to disturbances of equal to or greater than 1 acre of land.	Specific to areas of excavation of contaminated soil. Good construction management techniques, phasing of construction projects, minimal clearing, and sediment, erosion, structural, and vegetative controls shall be implemented to mitigate storm water run-on/runoff.
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.

Table 2-14 *(continued)*
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
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.	Applicable to IDW and other waste. 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.
Wells		
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.	Adhere to substantive requirements. Wells shall be completed in accordance with the technical requirements of Section 76.1000, as appropriate.
Class V Injection Wells 30 TAC 331 Subchapters A, C, and H	Installation, operation, and closure of injection wells for in situ chemical oxidation 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.

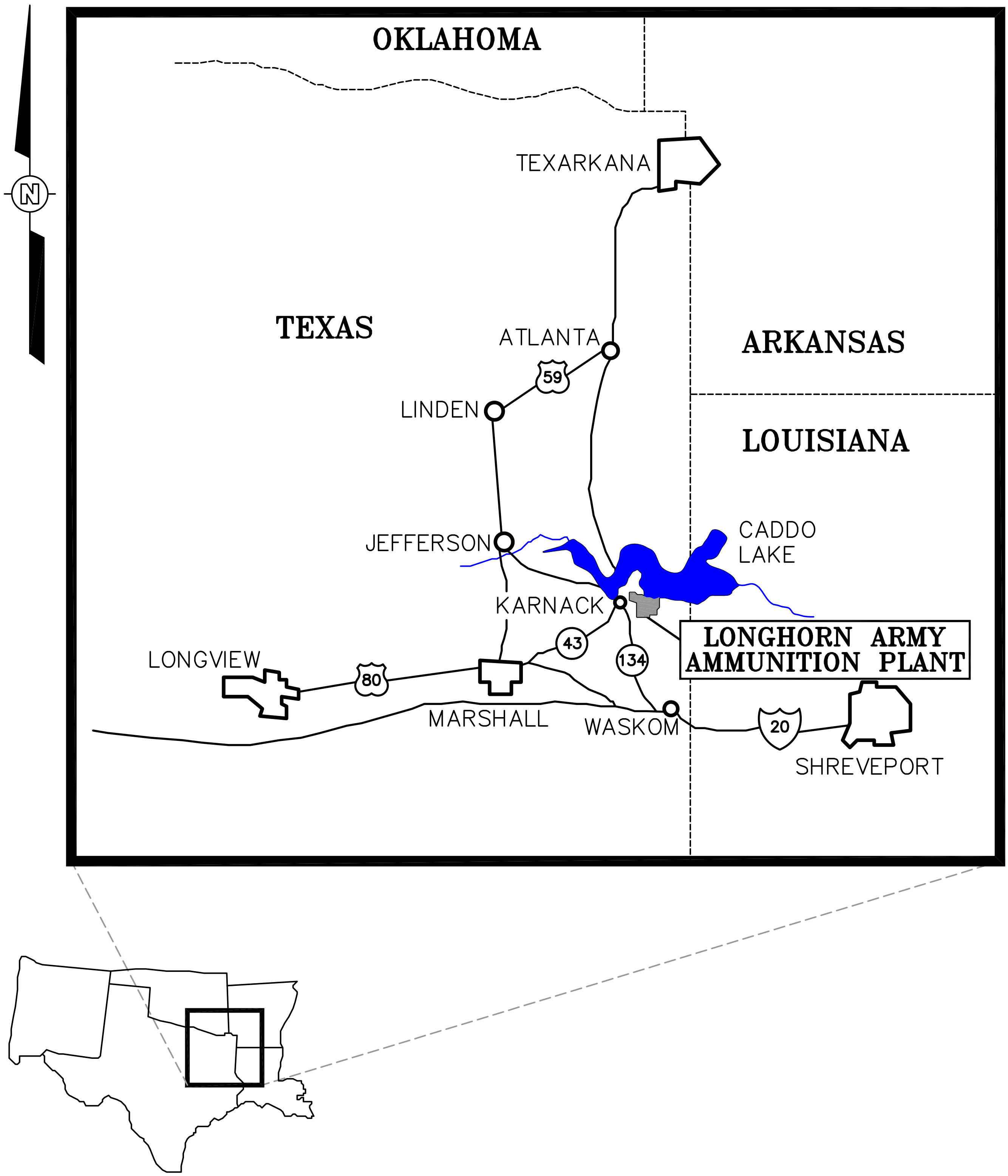
Table 2-14 *(continued)*
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
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 parts per million (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.
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 is determined to be RCRA characteristically hazardous.	Appropriate and relevant in the event of a spill. 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:

ARAR	*applicable or relevant and appropriate requirement*	*MCLG*	*maximum contaminant level goal*
bgs	*below ground surface*	*MSC*	*medium-specific concentration*
CFR	*Code of Federal Regulations*	*%*	*percent*
CWA	*Clean Water Act of 1972*	*PPE*	*personal protective equipment*
USEPA	*U.S. Environmental Protection Agency*	*ppm*	*part per million*
FR	*Federal Register*	*RCRA*	*Resource Conservation and Recovery Act of 1976*
lb/gal	*pound per gallon*	*TAC*	*Texas Administrative Code*
LHAAP	*Longhorn Army Ammunition Plant*	*TCEQ*	*Texas Commission on Environmental Quality*
MCL	*maximum contaminant level*		

00113025



"DRAWING NOT TO SCALE"

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TULSA DISTRICT
TULSA, OKLAHOMA

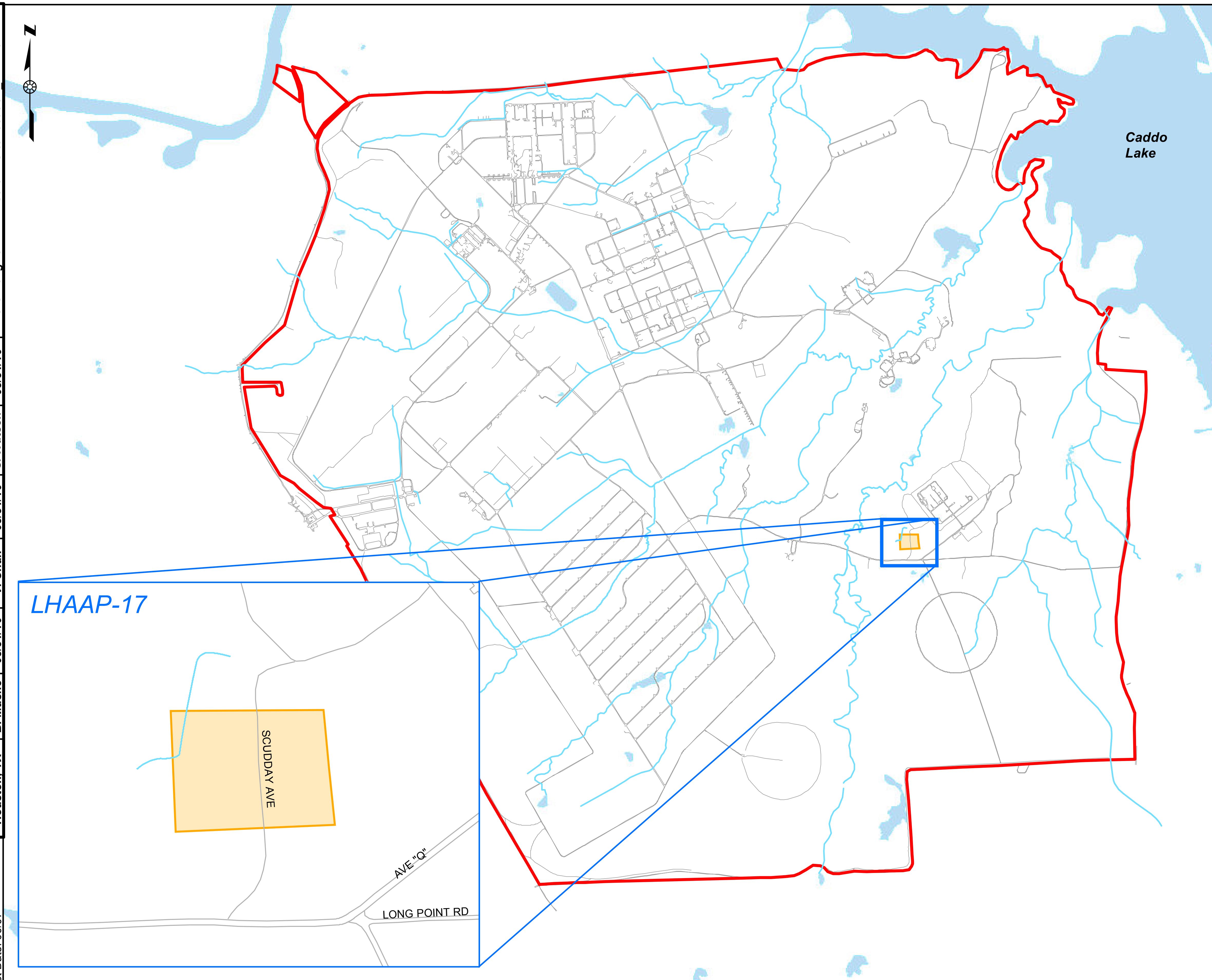
FIGURE 2–1

LHAAP LOCATION MAP

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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

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



Legend

- Stream
- LHAAP Boundary
- Road
- Site
- Lake/Pond

0 1,250 2,500 5,000 Feet

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TULSA, OKLAHOMA

FIGURE 2-2

SITE VICINITY MAP
LHAAP-17, GROUP 2

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

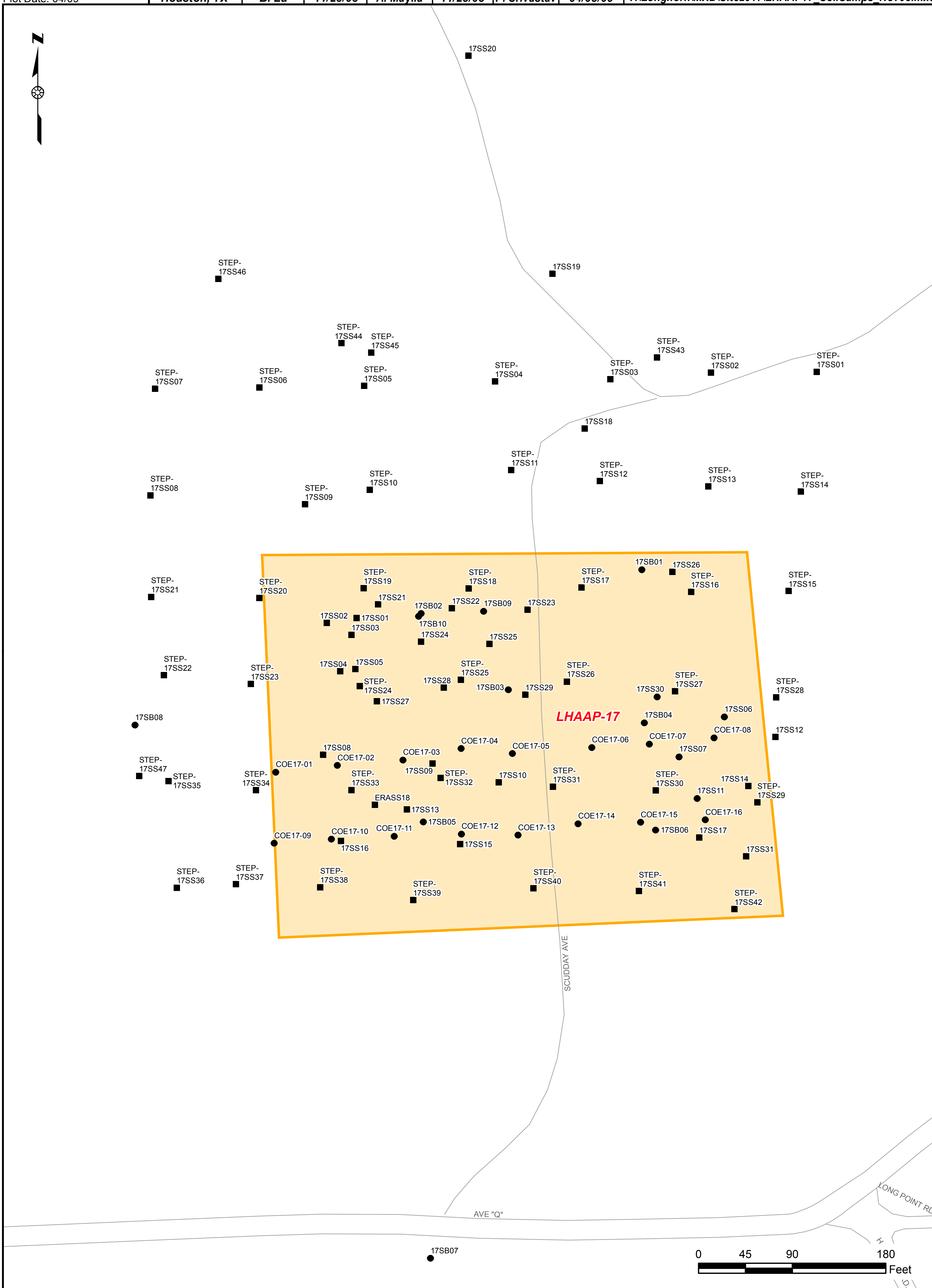
OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Muske 08/31/10	V. Chan 08/31/10	S. Watson 08/31/10	T:\GIS\Longhorn\MXD\St2917\SiteLocation_17.mxd

Plot Date: 06/07

00113027

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		FILE PATH
Houston, TX	B. Lu	11/25/08	A. Mayila	11/25/08	P. Srivastav	04/08/09	T:\Longhorn\MXD\Site2917\LHAAP17_SoilSamps_Nov08.mxd

Plot Date: 04/09



LEGEND

- ■ Surface Soil Sample
- ● Soil Boring
- Road
- Stream
- Site

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FIGURE 2-3

SOIL SAMPLE LOCATION MAP
LHAAP-17, GROUP 2

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00113028

Plot Date: 04/09

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		FILE PATH
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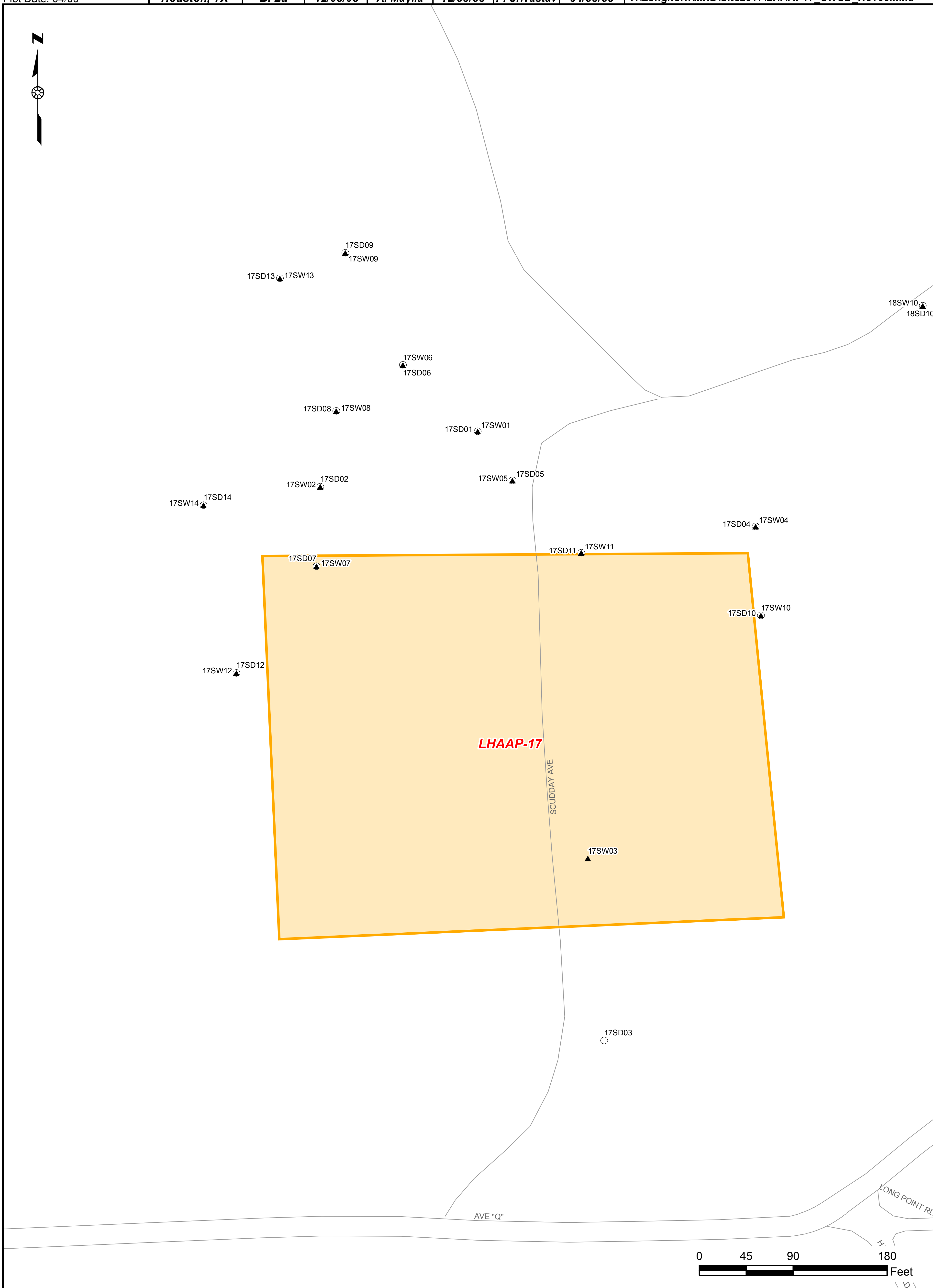

LEGEND

SWTR
Stream
SED
Site
Road

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TULSA DISTRICT
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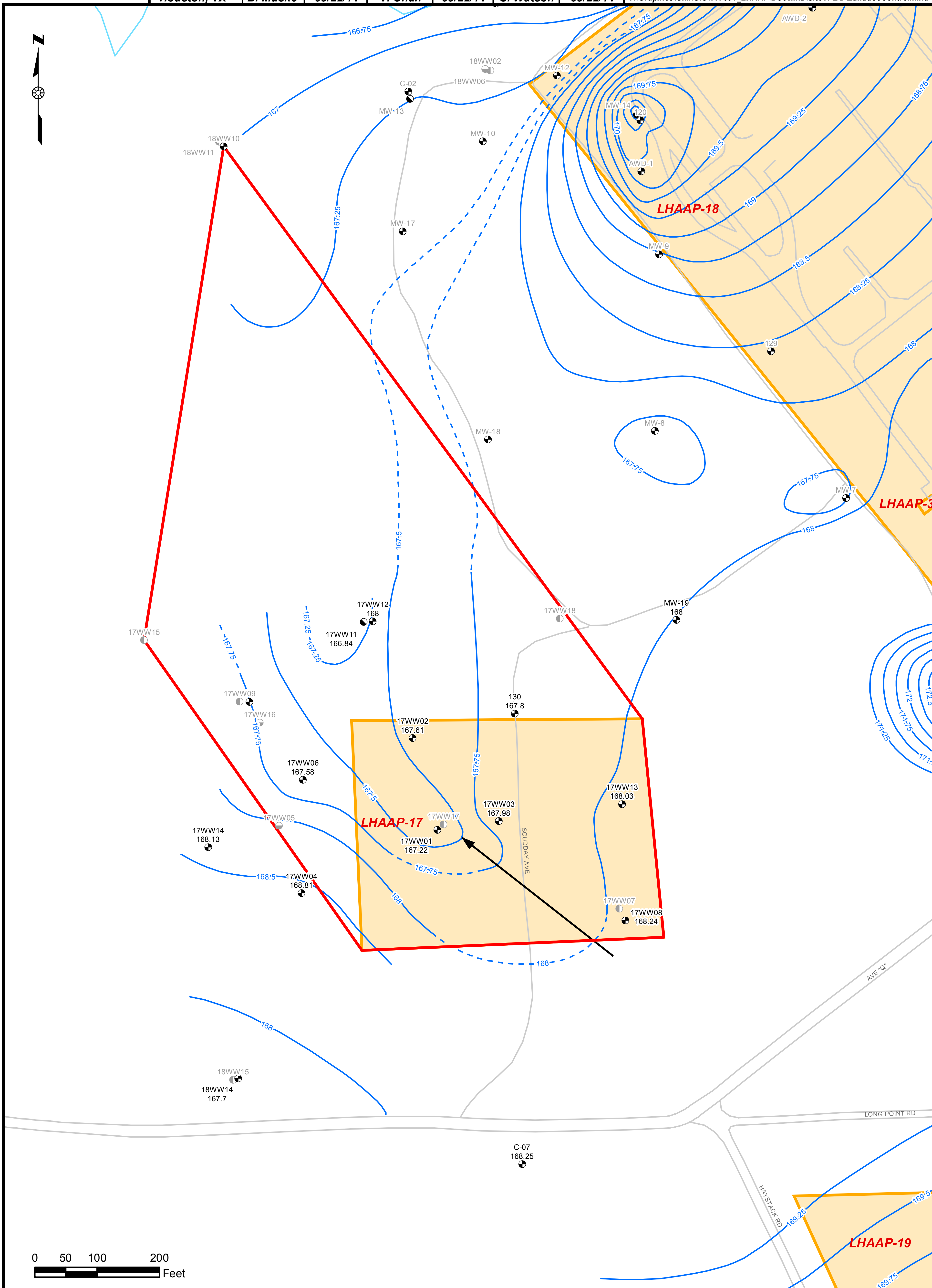
FIGURE 2-4

SURFACE WATER AND
SEDIMENT SAMPLE LOCATION MAP
LHAAP-17, GROUP 2

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00113029

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		FILE PATH
Houston, TX	*B. Muske*	*09/22/11*	*V. Chan*	*09/22/11*	*S. Watson*	*09/22/11*	*T:\Graphics\GIM\GIS\117591_LHAAP\Doc\Mxd\Site17\DD\LanduseControl.mxd*



- Shallow Monitoring Well
- Shallow/Intermediate Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- Inferred Shallow Groundwater Elevation Contour
- Shallow Groundwater Elevation Contour
- Shallow Groundwater Flow Direction
- Preliminary Land Use Control Boundary

NOTES:

1. Groundwater elevation contours based on water levels measured on November 14, 2007 at LHAAP-17 and LHAAP-18/24.

2. 17WW12 is considered to be screened in a perched zone.

3. LHAAP-18/24 and associated wells are not depicted on this map.

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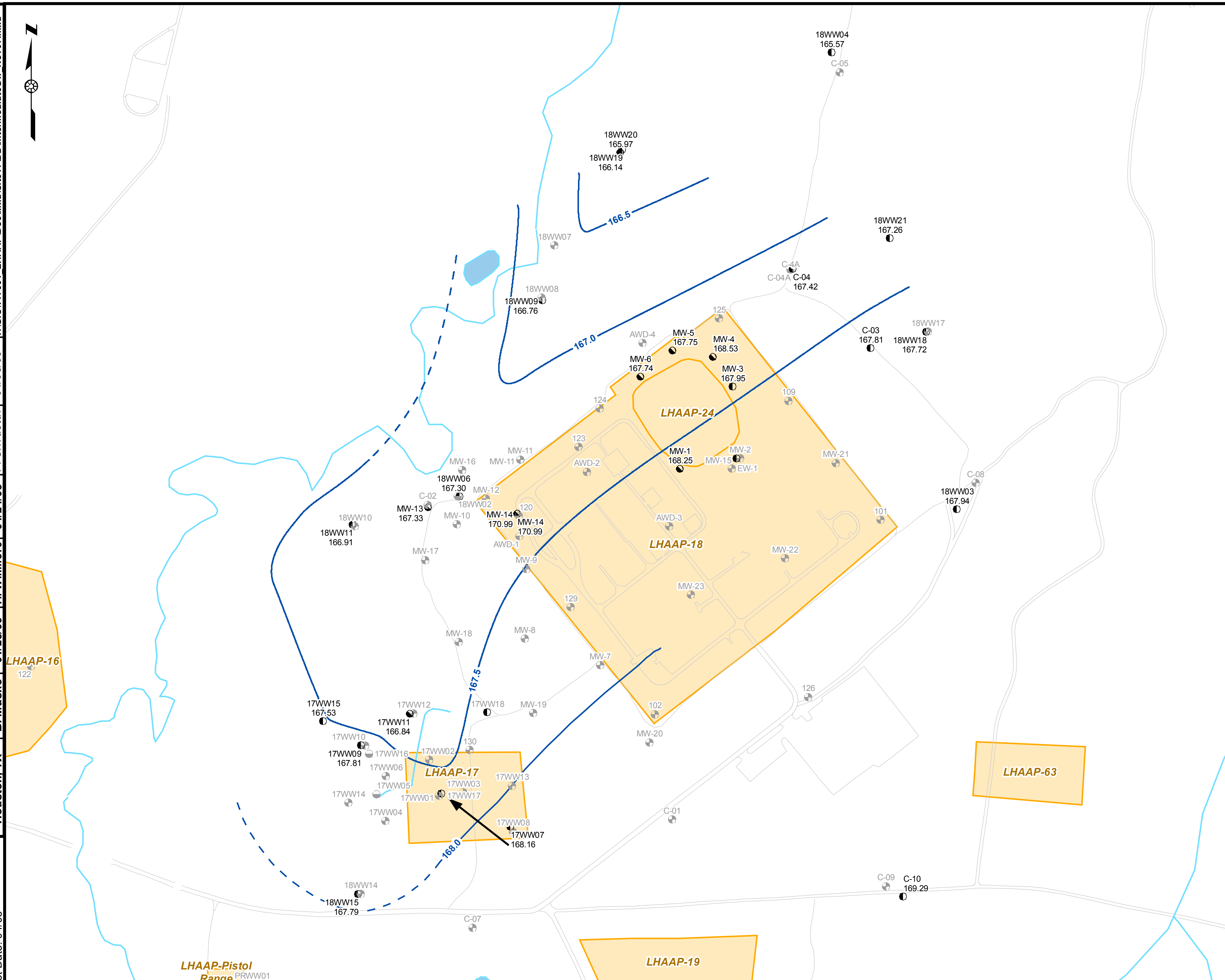
FIGURE 2-5

GROUNDWATER ELEVATION MAP
(SHALLOW ZONE)
LHAAP-17, GROUP 2

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00113030

OFFICE: Houston, TX
DRAWN BY: B. Muske 01/28/09
CHECKED BY: A. Willmore 04/24/08
APPROVED BY: P. Srivastav 04/08/09
FILE PATH: T:\GIS\117591 LHAAP\Doc\Mxd\Site17\DD\IntermediateGw Nov07.mxd



LEGEND

- Shallow Monitoring Well
- Shallow/Intermediate Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- Intermediate Groundwater Flow Direction
- Int. Groundwater Elevation Contour
- Int. Inferred Groundwater Elevation Contour
- Stream
- Road
- Site

NOTES:

1. Groundwater elevation contours based on water levels measured in November 2007 at LHAAP-17 and LHAAP-18/24.

0 237.5 475 950 Feet

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FIGURE 2-6

GROUNDWATER ELEVATION MAP
(INTERMEDIATE ZONE)
LHAAP-17, GROUP 2

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Plot Date: 04/08

00113031

PLOT DATE: 07/12/10
FORMAT REVISION 5/13/02

IMAGE	X-REF	OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
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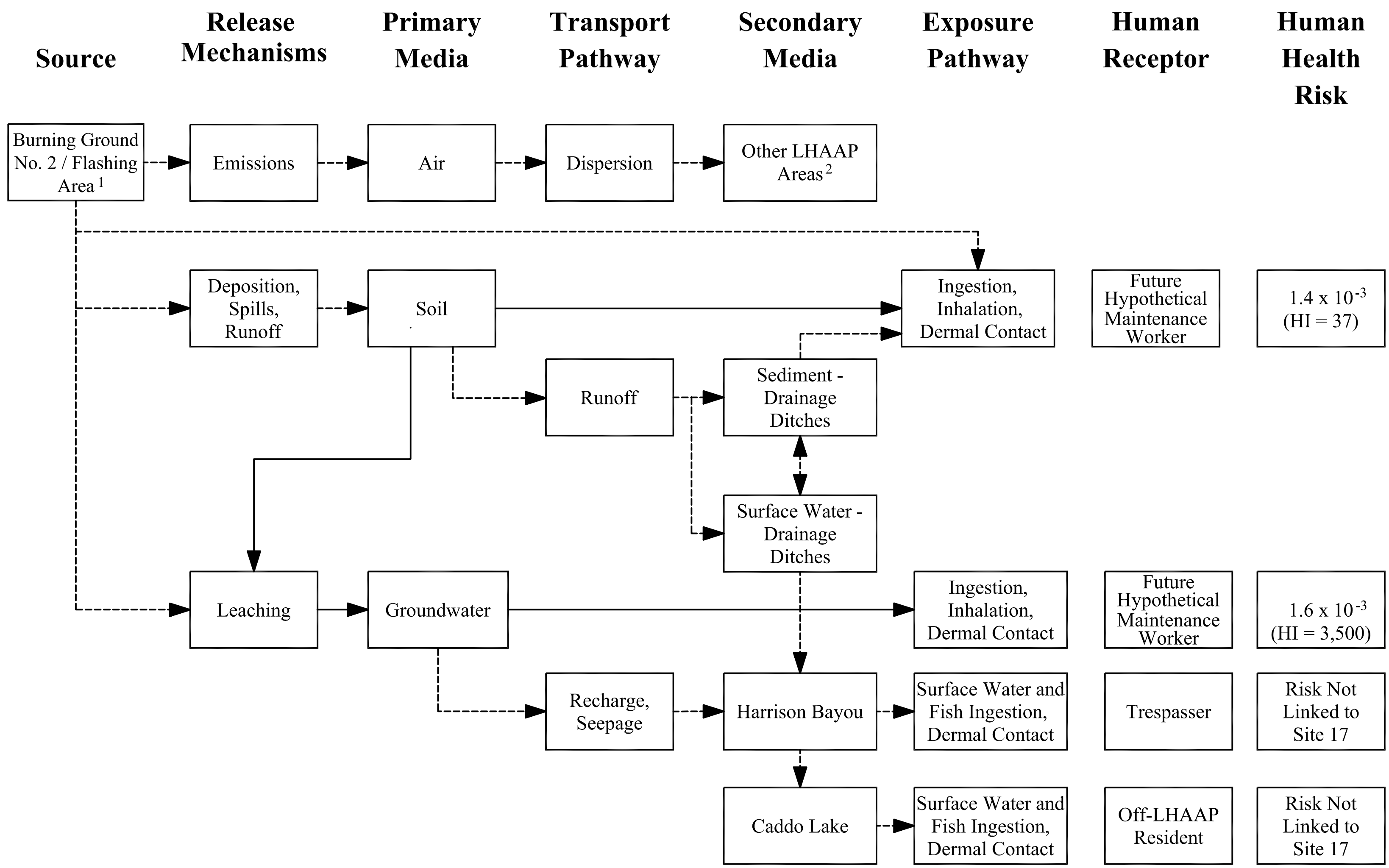

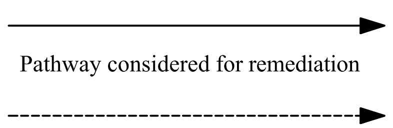

Notes:

1. The waste residues were reportedly removed in 1984. Site characterization occurred after removal.

2. Contaminants (e.g., dioxins) dispersed via air emissions to other LHAAP sites are addressed in the CERCLA documentation for those sites. No gross contamination by dioxins has been encountered at Longhorn AAP.

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FIGURE 2-7
HUMAN HEALTH CONCEPTUAL SITE MODEL
LHAAP-17, GROUP 2
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00113032

PLOT DATE: 07/12/10 FORMAT REVISION	IMAGE	X-REF	OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
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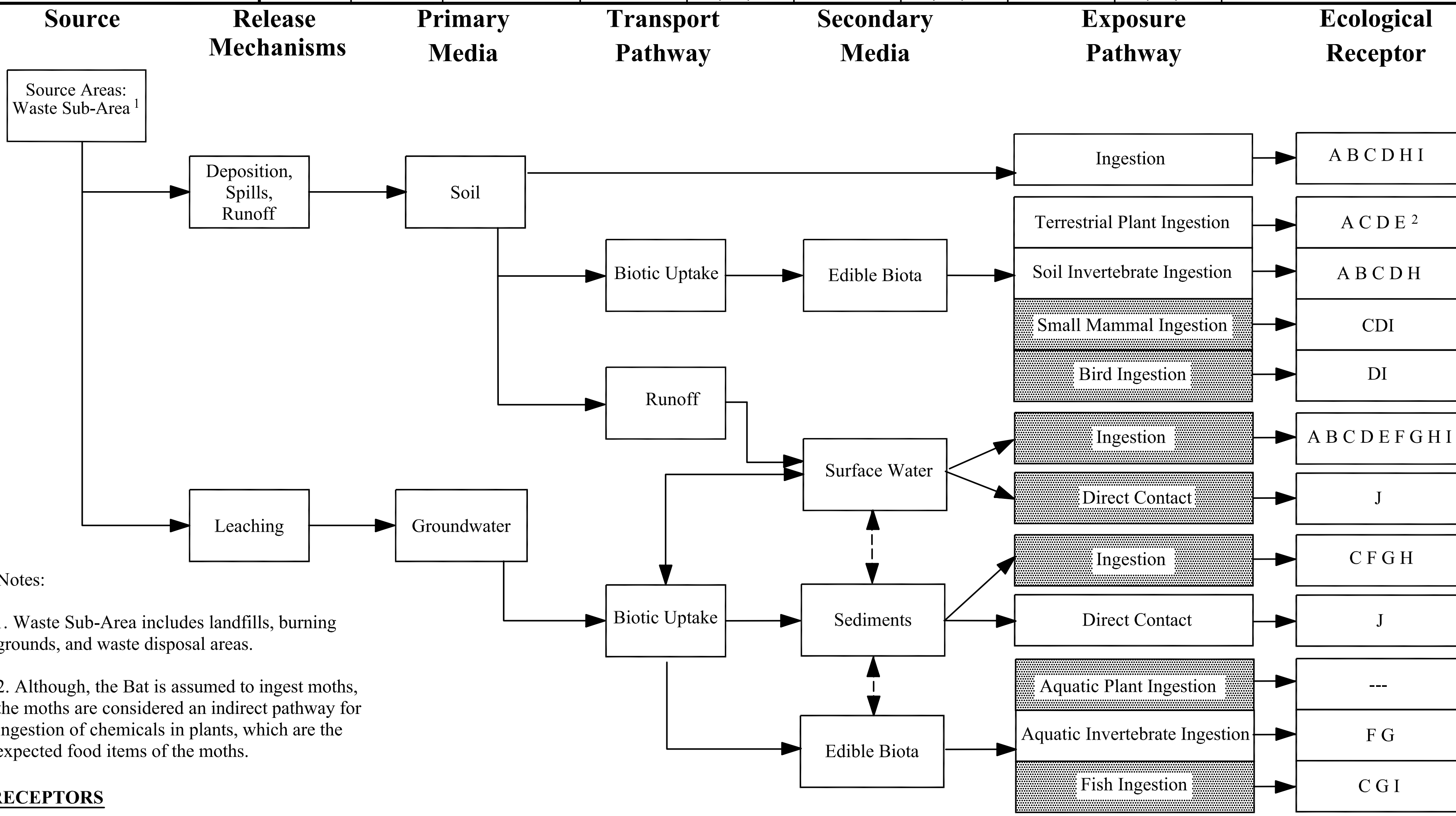


Notes:

1. Waste Sub-Area includes landfills, burning grounds, and waste disposal areas.

2. Although, the Bat is assumed to ingest moths, the moths are considered an indirect pathway for ingestion of chemicals in plants, which are the expected food items of the moths.

RECEPTORS

A. Deer Mouse
B. Short-Tailed Shrew
C. Racoon (& Racoon [Louisiana Black Bear])
D. Red Fox
E. Townsend's Big-Eared Bat
F. Bank Swallow
G. Belted Kingfisher
H. American Woodcock
I. Red-Tailed Hawk
J. Aquatic Life (benthic invertebrates)

--- = All receptors exposed to this pathway were determined not to be of concern.

Shaded cells indicate pathways that were not identified as significant, are background related, or were refined via site-specific investigations.

U.S. Army Corps of Engineers
Tulsa District
Tulsa, Oklahoma

Figure 2-8

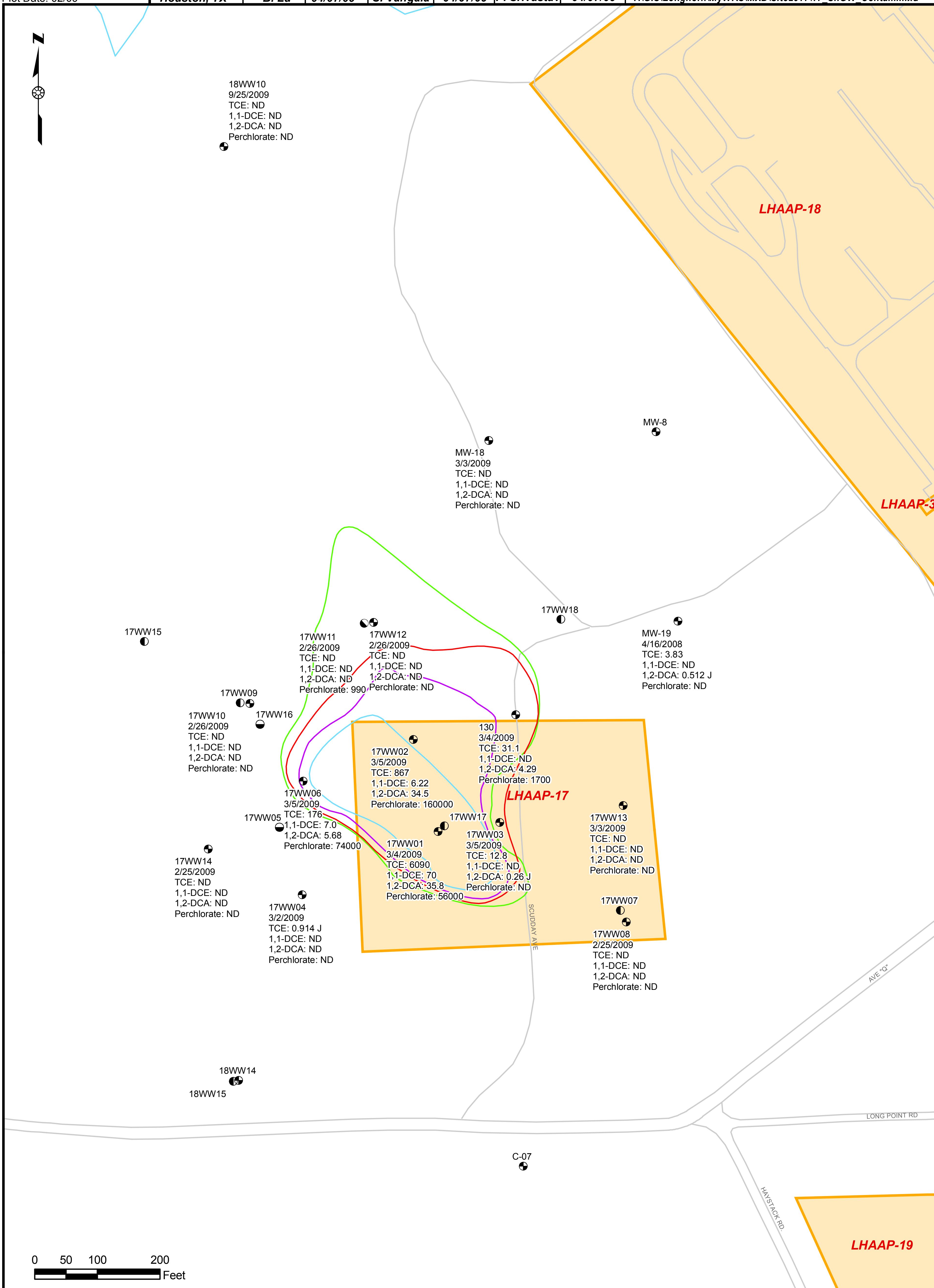
Ecological Conceptual Exposure Model
LHAAP-17, Group 2

Longhorn Army Ammunition Plant
Karnack, Texas

00113033

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		FILE PATH
Houston, TX	B. Lu	04/07/09	S. Vangala	04/07/09	P. Srivastav	04/07/09	T:\GIS\Longhorn\MyWKS\MXD\Site2917\17_ShGW_Contam.mxd

Plot Date: 02/09



- Shallow Monitoring Well
- Shallow/Intermediate
- Intermediate Monitoring
- Deep Monitoring Well
- Stream
- Road
- Site

- TCE Plume (MCL = 5 Mg/L)
- 1,1-DCE Plume (MCL = 7 Mg/L)
- 1,2-DCA Plume (MCL = 5 Mg/L)
- Perchlorate Plume (GW - Ind = 72 Mg/L)

NOTES:

1. All concentrations are reported in microgram per liter (µg/L).
2. ND - non detect
3. GW-Ind - groundwater TCEQ MSC for industrial use
4. MCL - maximum contaminant level
5. TCE - trichloroethene
6. 1,1-DCE - 1,1-dichloroethene
7. 1,2-DCA - 1,2-dichloroethane

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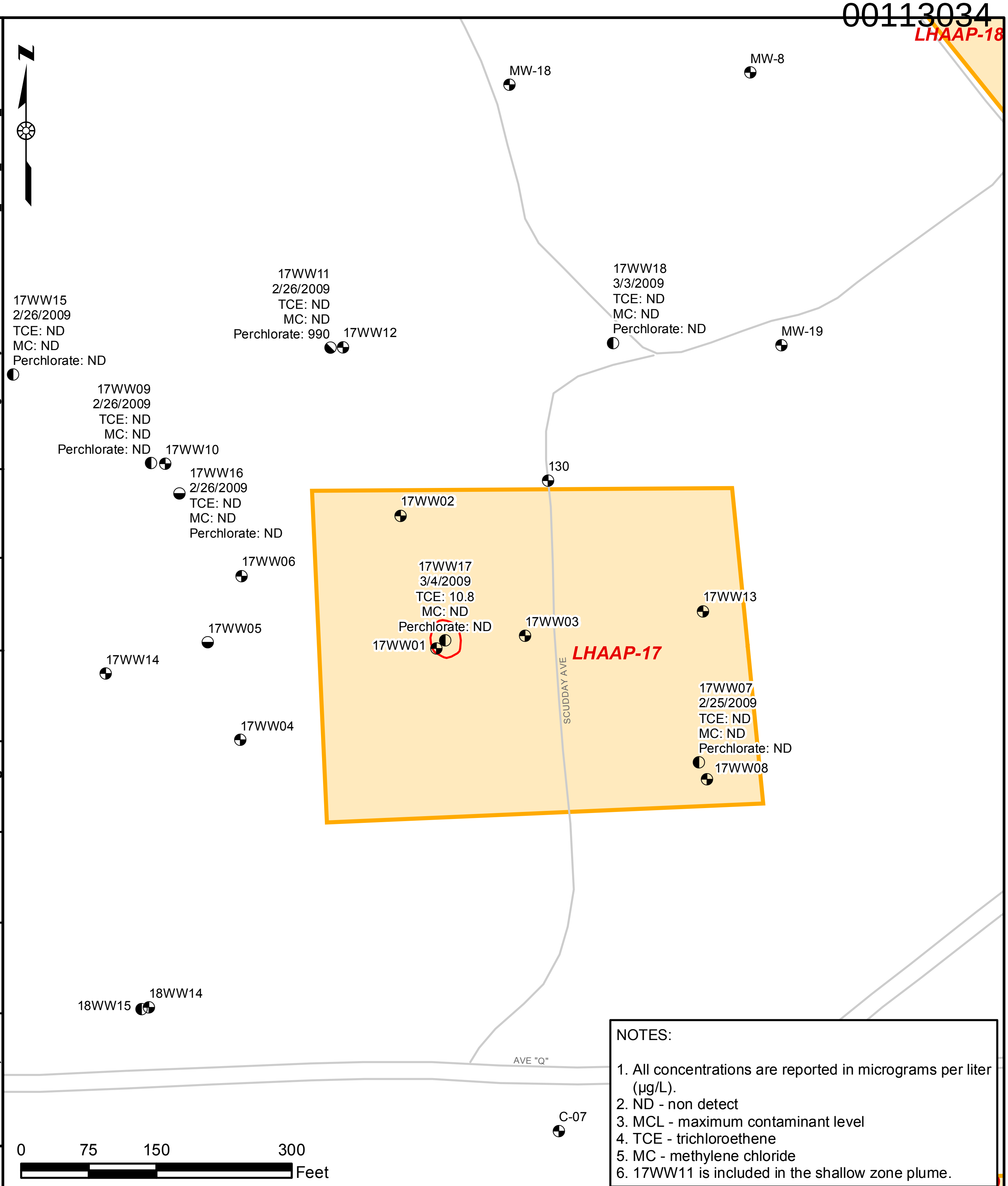
FIGURE 2-9

VOCs AND PERCHLORATE
IN SHALLOW ZONE GROUNDWATER
LHAAP-17, GROUP 2

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00113034



NOTES:

1. All concentrations are reported in micrograms per liter (µg/L).
2. ND - non detect
3. MCL - maximum contaminant level
4. TCE - trichloroethene
5. MC - methylene chloride
6. 17WW11 is included in the shallow zone plume.

FILE PATH: T:\GIS\Longhorn\MyWKS\MXD\Site29\17\17_InGW_Contam_Mar2009.mxd

APPROVED BY: P. Srivastav 04/07/09

CHECKED BY: V. Vangala 04/07/09

DRAWN BY: B. Lu 04/07/09

OFFICE: Houston, TX

LEGEND

- Shallow Monitoring Well
- Shallow/Intermediate Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- Stream
- Road
- Site
- TCE Plume (MCL = 5 µg/L)

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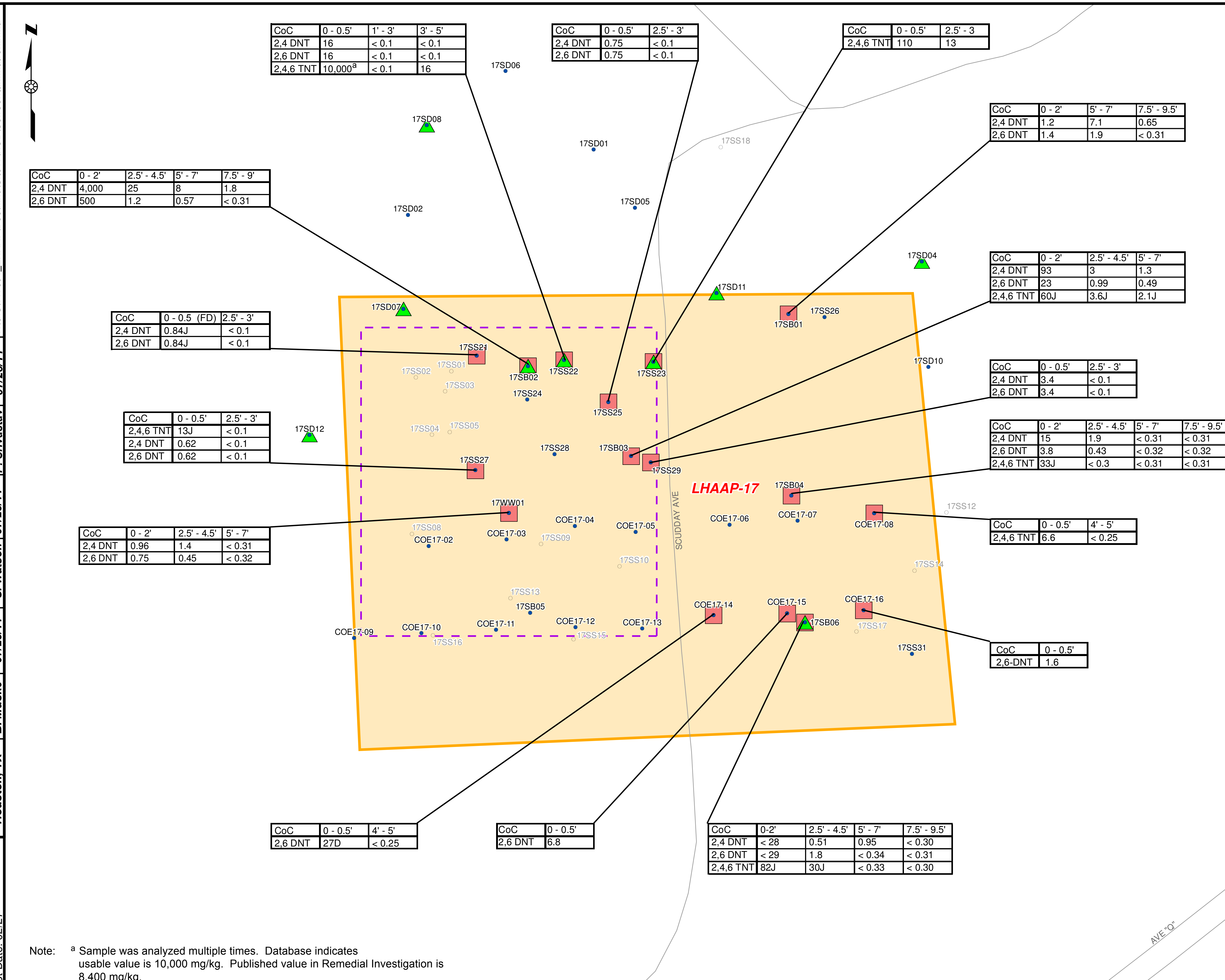
FIGURE 2-10
VOCs AND PERCHLORATE
IN INTERMEDIATE ZONE GROUNDWATER
LHAAP-17, GROUP 2

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Plot Date: 03/09



CoC	0 - 0.5'	1' - 3'	3' - 5'
2,4 DNT	16	< 0.1	< 0.1
2,6 DNT	16	< 0.1	< 0.1
2,4,6 TNT	10,000[a]	< 0.1	16

CoC	0 - 0.5'	2.5' - 3'
2,4 DNT	0.75	< 0.1
2,6 DNT	0.75	< 0.1

CoC	0 - 0.5'	2.5' - 3
2,4,6 TNT	110	13

CoC	0 - 2'	5' - 7'	7.5' - 9.5'
2,4 DNT	1.2	7.1	0.65
2,6 DNT	1.4	1.9	< 0.31

CoC	0 - 2'	2.5' - 4.5'	5' - 7'	7.5' - 9'
2,4 DNT	4,000	25	8	1.8
2,6 DNT	500	1.2	0.57	< 0.31

CoC	0 - 2'	2.5' - 4.5'	5' - 7'
2,4 DNT	93	3	1.3
2,6 DNT	23	0.99	0.49
2,4,6 TNT	60J	3.6J	2.1J

CoC	0 - 0.5 (FD)	2.5' - 3'
2,4 DNT	0.84J	< 0.1
2,6 DNT	0.84J	< 0.1

CoC	0 - 0.5'	2.5' - 3'
2,4 DNT	3.4	< 0.1
2,6 DNT	3.4	< 0.1

CoC	0 - 0.5'	2.5' - 3'
2,4,6 TNT	13J	< 0.1
2,4 DNT	0.62	< 0.1
2,6 DNT	0.62	< 0.1

CoC	0 - 2'	2.5' - 4.5'	5' - 7'	7.5' - 9.5'
2,4 DNT	15	1.9	< 0.31	< 0.31
2,6 DNT	3.8	0.43	< 0.32	< 0.32
2,4,6 TNT	33J	< 0.3	< 0.31	< 0.31

CoC	0 - 2'	2.5' - 4.5'	5' - 7'
2,4 DNT	0.96	1.4	< 0.31
2,6 DNT	0.75	0.45	< 0.32

CoC	0 - 0.5'	4' - 5'
2,4,6 TNT	6.6	< 0.25

CoC	0 - 0.5'
2,6-DNT	1.6

CoC	0 - 0.5'	4' - 5'
2,6 DNT	27D	< 0.25

CoC	0 - 0.5'
2,6 DNT	6.8

CoC	0-2'	2.5' - 4.5'	5' - 7'	7.5' - 9.5'
2,4 DNT	< 28	0.51	0.95	< 0.30
2,6 DNT	< 29	1.8	< 0.34	< 0.31
2,4,6 TNT	82J	30J	< 0.33	< 0.30

Note: [a] Sample was analyzed multiple times. Database indicates usable value is 10,000 mg/kg. Published value in Remedial Investigation is 8,400 mg/kg.

LEGEND

Sample location with contamination that poses Ecological Risk. See Table 2-11 in this Record of Decision for additional information.

Sample location with contamination that poses Human Health Risk (for soil to groundwater).

Soil sample location not posing risk.

Soil sample deemed unusable by EPA for environmental decisions (Jacobs, 2002).

Road

Approximate boundary of treatability demonstration study (PEC, 2004).

Site

TNT Trinitrotoluene
DNT Dinitrotoluene
CoC Contaminant of Concern

1. Depths are reported in feet below ground surface.
2. Soil sample concentrations in milligrams/kilograms (mg/kg).

GWP-IND

2,4,6 TNT	5.1 mg/kg
2,4 DNT	0.042 mg/kg
2,6 DNT	0.042 mg/kg

References:

Jacobs Engineering Group, Inc. (Jacobs), 2002, Baseline Human Health and Screening Ecological Risk Assessment for the Group 2 Sites (Sites 12, 17, 18/24, 29, 32, 49, Harrison Bayou, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas, Final, Oak Ridge, TN, August.

Planteco Environmental Consultants, LLC (PEC), 2004, In Situ Bioremediation of Perchlorate Contaminated Soils and Groundwater at Site-17 (Burning Ground No. 2), Longhorn Army Ammunition Plant, Karnack, Texas, Draft Final, March.

0 40 80 160 Feet

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FIGURE 2-11

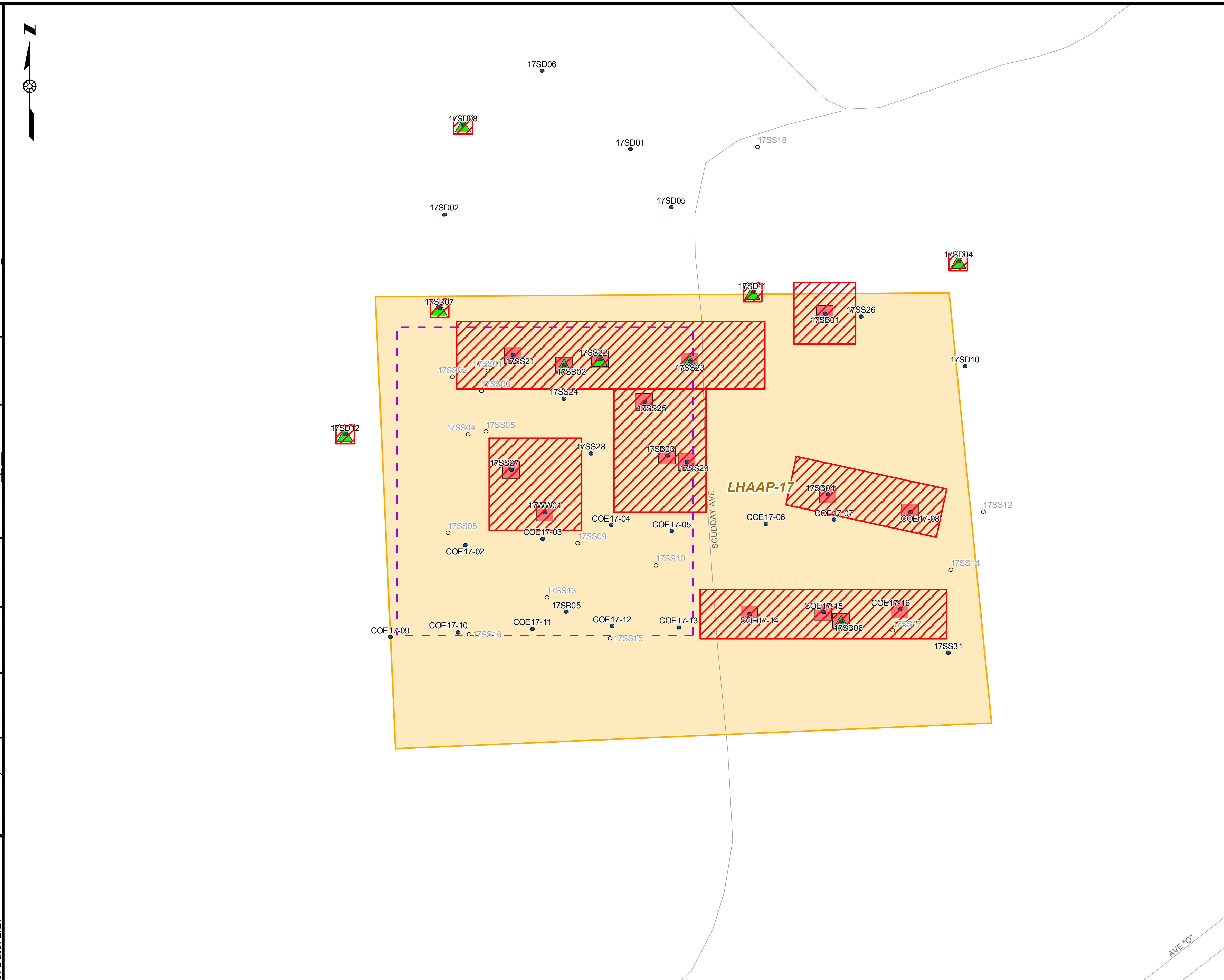
SOIL CONTAMINATION
LHAAP-17, GROUP 2

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

FILE PATH T:\GIS\17591_LHAAP\Doc\Mxd\Site17\ROD\SoilContamination.mxd
APPROVED BY P. Srivastav 07/25/11
CHECKED BY S. Watson 07/25/11
DRAWN BY B. Musk0 07/25/11
OFFICE Houston, TX

Plot Date: 02/27

00113036



LEGEND

Sample location with contamination that poses Ecological Risk. See Table 2-11 in this Record of Decision for additional information.

Sample location with contamination that poses Human Health Risk (for soil to groundwater).

Soil sample location not posing risk.

Soil sample deemed unusable by EPA for environmental decisions (Jacobs, 2002).

Road

Proposed excavation areas with average depth of 5 feet below ground surface (bgs) for Human Health Risk areas, or with a depth of up to 3 feet bgs for Ecological Risk areas.

Approximate boundary of treatability demonstration study (PEC, 2004).

Site

References:

Jacobs Engineering Group, Inc. (Jacobs), 2002, *Baseline Human Health and Screening Ecological Risk Assessment for the Group 2 Sites (Sites 12, 17, 18/24, 29, 32, 49, Harrison Bayou, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas*, Final, Oak Ridge, TN, August.

Planteco Environmental Consultants, LLC (PEC), 2004, *In Situ Bioremediation of Perchlorate Contaminated Soils and Groundwater at Site-17 (Burning Ground No. 2), Longhorn Army Ammunition Plant, Karnack, Texas*, Draft Final, March.

0 40 80 160 Feet

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FIGURE 2-12

AREAS OF SOIL REMEDIATION
LHAAP-17, GROUP 2

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Muske 08/31/10	V. Chan 08/31/10	P. Srivastav 08/31/10	T:\GIS\117591 LHAAP\Doc\Mxd\Site17\ROD\SoilRemediation.mxd

Plot Date: 2/27

00113037

PLOT DATE: 07/12/10
FORMAT REVISION 5/13/02

IMAGE	X-REF	OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		DRAWING NUMBER
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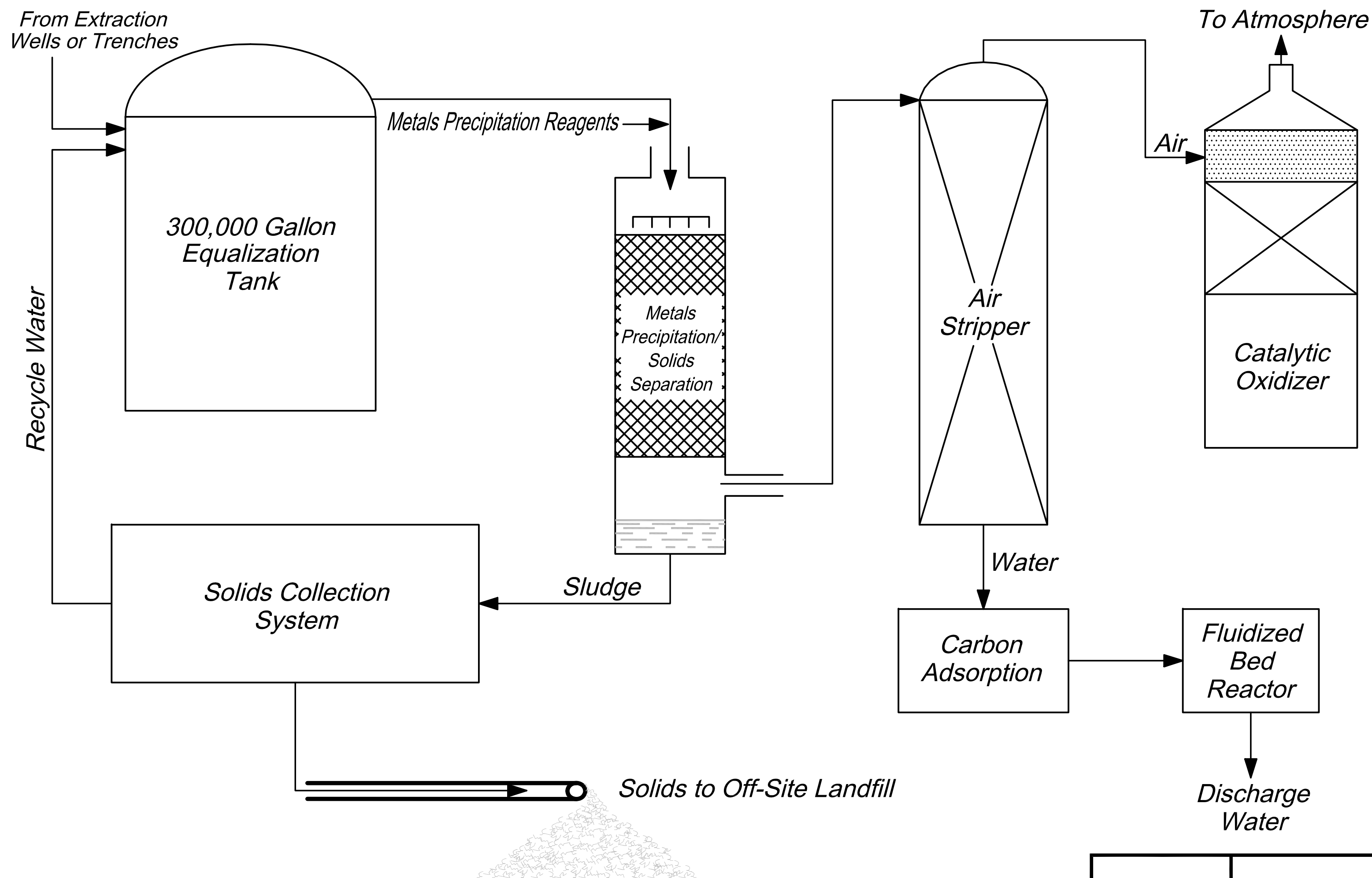

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TULSA, OKLAHOMA

FIGURE 2-13
EXISTING GROUNDWATER TREATMENT PLANT PROCESS
LHAAP-17, GROUP 2
LONGHORN ARMY AMMUNTION PLANT
KARNACK, TEXAS

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-17 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-17 through public meetings, the Administrative Record for the facility, and announcements published in the Shreveport Times and Marshall News Messenger newspapers. **Section 2.3** discusses community participation on LHAAP-17, including the dates for the public comment period, the date, location, and time of the public meetings, and the location of the Administrative Record. The following documents related to community involvement were added to the Administrative Record:

- Transcript of the public meeting on June 29, 2010
- Presentation slides from the June 29, 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 December 9, 2010.

3.1 Stakeholder Issues and Lead Agency Responses

This section responds to significant issues raised by stakeholders including the public and community groups that were received in written or verbal form. The figures that the commenter makes reference to were provided by the commenter.

Question/comment: The Army intends to stop pumping and treating groundwater once average perchlorate concentrations are reduced to 20,000 µg/L. According to the Army, high concentrations of perchlorate inhibit the natural attenuation of TCE. However, the Army has not presented any evidence to show that there are significant differences in the attenuation of TCE when the perchlorate concentration is below 20,000 µg/L. In fact, TCE concentrations are increasing at monitor wells 130 and 17WW03, even though perchlorate concentrations at these wells are well below 20,000 µg/L (see figures 1a, 1b, 2a, and 2b on the next page). On the other hand, perchlorate concentrations in monitor well 17WW06 are much higher than 20,000 µg/L, but TCE concentrations are decreasing (see figures 3a and 3b). Thus, there does not appear to be a strong relationship between perchlorate concentrations and the attenuation of TCE. The Army should not rely on a reduction in perchlorate concentrations to result in the attenuation of TCE.

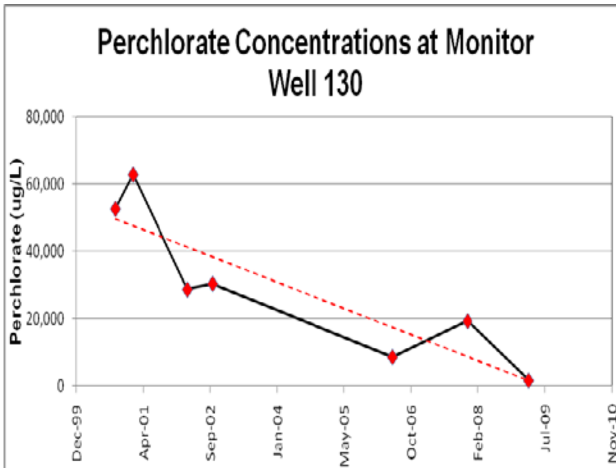

Figure 1a Data source: United States Army, 2010a, appendix A, table A-1.

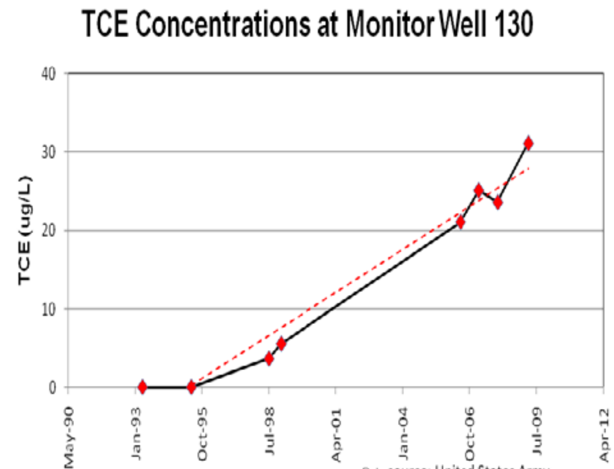

Figure 1b Data source: United States Army, 2010a, appendix A, table A-1.

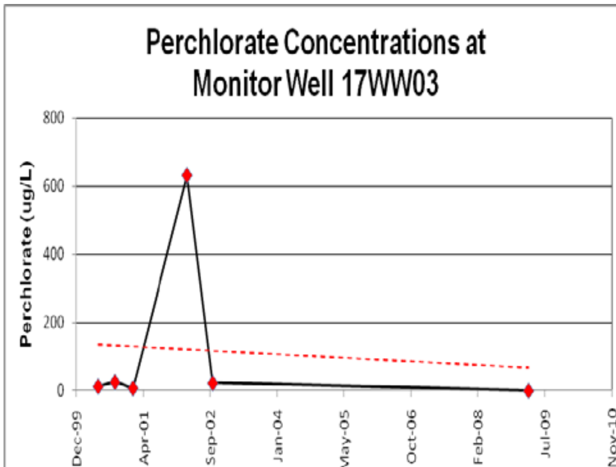

Figure 2a Data source: United States Army, 2010a, appendix A, table A-1.

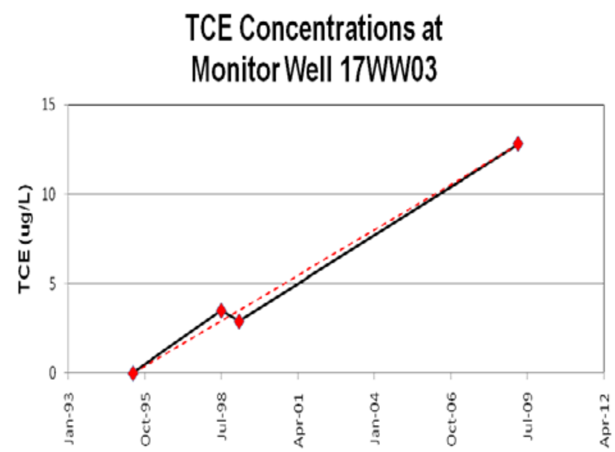

Figure 2b Data source: United States Army, 2010a, appendix A, table A-1.

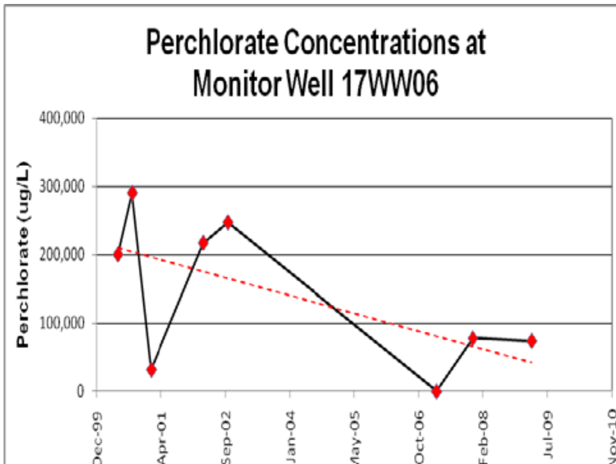

Figure 3a Data source: United States Army, 2010a, appendix A, table A-1.

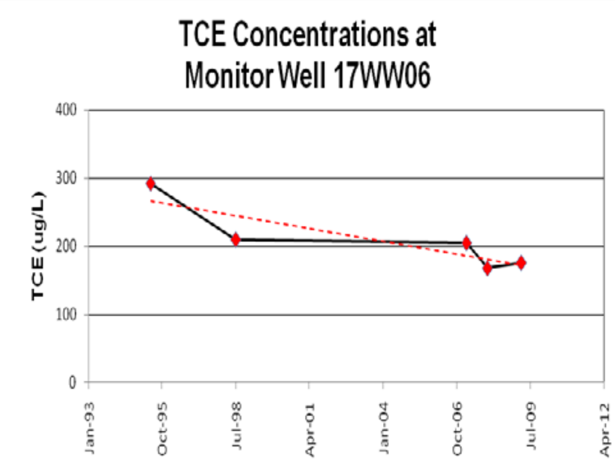

Figure 3b Data source: United States Army, 2010a, appendix A, table A-1.

Response: Studies of natural attenuation and guidance for implementing MNA presume that biologically assisted attenuation proceeds from the most easily reduced compounds to the ones that are most difficult. Perchlorate is more easily reduced than TCE. The microbes that metabolize perchlorate are ubiquitous in the natural environment, and there appears to be no potential "stalling" at daughter products (which can happen with TCE). The perchlorate concentration of 20,000 µg/L was selected based on data from LHAAP-17 and another site at Longhorn. At LHAAP-17, observation of the subsurface conditions is complicated by the perchlorate contaminated soil which may add perchlorate to the groundwater via percolation. The performance of natural attenuation to meet remedial action objectives will be evaluated after soil removal, groundwater pumping, and eight quarterly sampling events. If it is found that the performance objectives are not being met with natural attenuation, a contingent remedy such as in situ bioremediation would be implemented.

Question/comment: It appears that the Army intends to stop pump and treat once the trigger is reached, regardless of the effect that pump and treat is having on contaminant concentrations. This is not a reasonable approach to contaminant clean-up. The Army should evaluate the effectiveness of pump and treat when the trigger is reached. Then, if it is still having a substantial effect on contaminant concentrations, pump and treat should be continued. The pump and treat system should be operated as long as it is causing significant reductions in contaminant concentrations.

Response: The U.S. Army has chosen to implement pump and treat to reduce the highest contaminant concentrations at LHAAP-17 to make conditions more favorable for MNA. Contaminant removal by pump and treat methods operates with diminishing returns – as concentrations decrease, the mass removal rate also falls. Inevitably, a point is reached at which remediation by pump and treat is no longer cost effective. The pump and treat system in conjunction with the site hydrogeological conditions may also be considered ineffective if the system is incapable of reducing perchlorate concentrations at a rate that would be considered productive. As the wording in the comment implies, "substantial effect" and "significant reductions", there is some amount of interpretation involved in deciding when to turn off the pumps. However, pump and treat is not the primary remedy selected or evaluated for LHAAP-17. It is used to assist the primary remedy of MNA by reducing the highest contaminant concentrations. If the pump and treat does not effectively reduce the highest contaminant concentrations in the reasonable time allowed, a contingency remedy such as in situ bioremediation will be implemented.

Question/comment: TCE samples have been collected from 11 monitor wells in the shallow zone. TCE concentrations have exceeded the 5 µg/L MCL in six of these wells. Of these six wells TCE concentrations are rising in four, and dropping in two (see figures 1b, 2b, 3b, 4, 5, and 6). The table below shows the most recent TCE concentrations found in the six wells.

Clearly, natural attenuation is not acting to reduce TCE concentrations throughout the site. Although the Army claims that high concentrations of perchlorate are inhibiting the attenuation of TCE, this assertion is not supported by the data (see first comment). The Army should reevaluate its reliance on natural attenuation to reduce TCE concentrations at Site 17.

Most Recent TCE Concentrations in Shallow Zone Monitor Wells

Wells with increasing concentrations of TCE		**Wells with decreasing concentrations of TCE**	
Well ID	TCE (µg/L)	Well ID	TCE (µg/L)
130	31.1	17WW04	0.9
17WW01	6090	17WW06	176
17WW02	867		
17WW03	12.8		

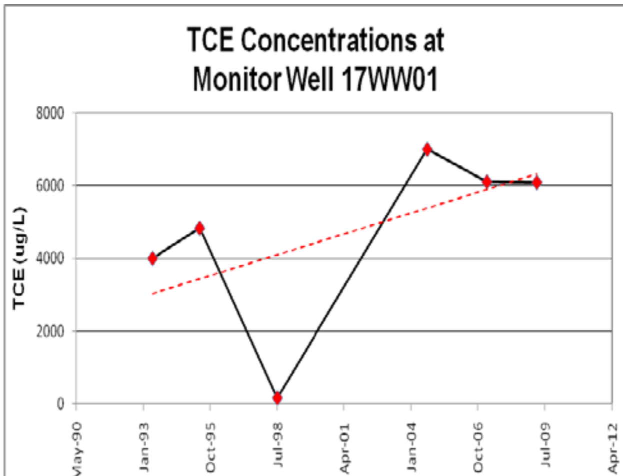

Figure 4 Data source: United States Army, 2010a, appendix A, table A-1.

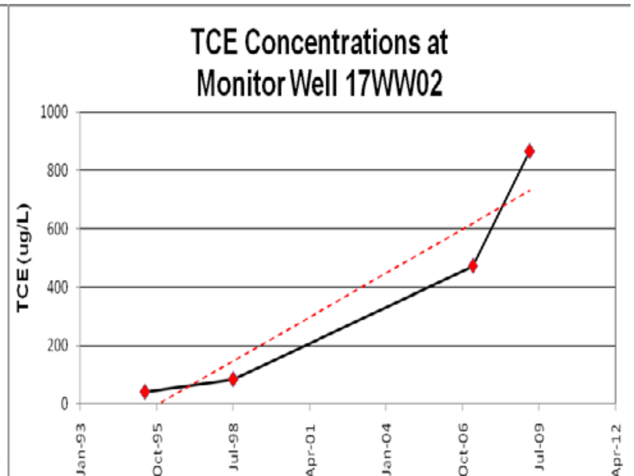

Figure 5 Data source: United States Army, 2010a, appendix A, table A-1.

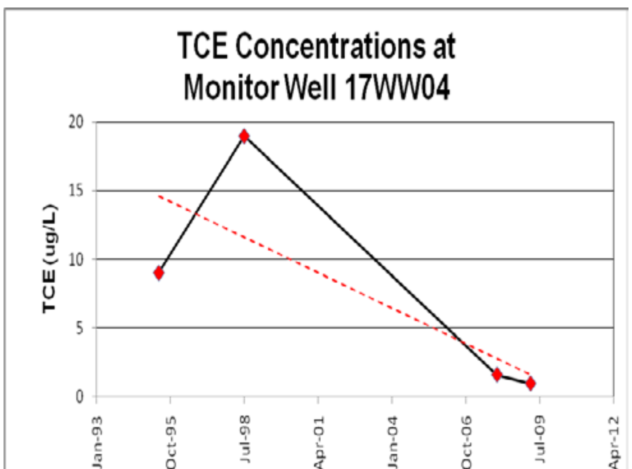

Figure 6 Data source: United States Army, 2010a, appendix A, table A-1.

Response: The most significant increase in TCE concentrations is seen at well 17WW01 between 1998 and 2004. TCE concentrations have declined in this well since 2004. Increases in TCE concentrations at wells 130, 17WW02, and 17WW03 are not as significant and may reflect seasonal variations instead of an overall increase in mass. The groundwater gradient at LHAAP-17 is fairly flat and the diffusion of TCE away from 17WW01 may cause a rise in concentrations in the surrounding wells (i.e., 17WW02 and 17WW03). Even though there are fluctuations in the wells at LHAAP-17, the plume is bounded and there does not appear to be a significant migration of the plume. Additionally, pump and treat will contain the plume and will reduce TCE concentrations (prior to MNA evaluation) as well as the perchlorate.

Under current conditions at LHAAP-17, with the addition of perchlorate from contaminated soil by percolation, natural attenuation cannot be effectively evaluated since the high perchlorate concentrations are inhibiting TCE attenuation. After contaminated soil is removed, groundwater pumping will still disturb natural conditions. It is only after soil is removed and pumping is stopped that an effective MNA evaluation may be made. When that evaluation is complete, and if it is favorable, MNA will continue as the remedy. However, if the evaluation is not favorable, another remedy (e.g., in situ bioremediation) will be implemented to reduce the TCE concentrations.

Question/comment: The Army estimates that natural attenuation will reduce TCE concentrations in the shallow groundwater zone to the clean-up level (5 µg/L) in less than 120 years. It is not reasonable to propose a plan that could require the maintenance of LUCs for a century.

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 for groundwater will prohibit access to the groundwater except for environmental testing until cleanup levels are met. Maintenance of the LUC for groundwater use prohibition 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 prohibitions.

Question/comment: The clean-up time estimate is based on data from monitor well 17WW06, where TCE concentrations are declining (see figure 3b). However, this estimate does not apply to those portions of Site 17 where TCE concentrations are increasing (see third comment). The Army should provide an estimate of clean-up time for the entire site.

Response: Although there is some uncertainty associated with the cleanup time for the entire site because of the inhibitive effects of perchlorate, the data collected during the two year period of natural attenuation monitoring (post pump and treat) will be used to remove some of the uncertainties associated with the estimate of time to achieve MCLs. The statutory five-year reviews will evaluate the effectiveness of the remedy and estimated durations to reach MCLs and would recommend implementation of other measures if needed.

Question/comment: The Army estimates that natural attenuation will reduce perchlorate concentrations to the clean-up level (72 µg/L) within 15 years. This estimate is based on perchlorate degradation rates (half-lives) calculated for eight monitor wells. However, the Army did not calculate degradation rates for two monitor wells that currently contain high perchlorate concentrations: well 17WW01 (56,000 µg/L) and well 17WW02 (160,000 µg/L). Over the entire period of record, perchlorate concentrations in these two wells have increased, although concentrations in both wells are currently decreasing (see figures 7 and 8). Wells 17WW01 and 17WW02 are important data points that the Army has not accounted for in its estimate. The Army should explain why it did not use data from these wells to estimate the clean-up time for perchlorate at Site 17.

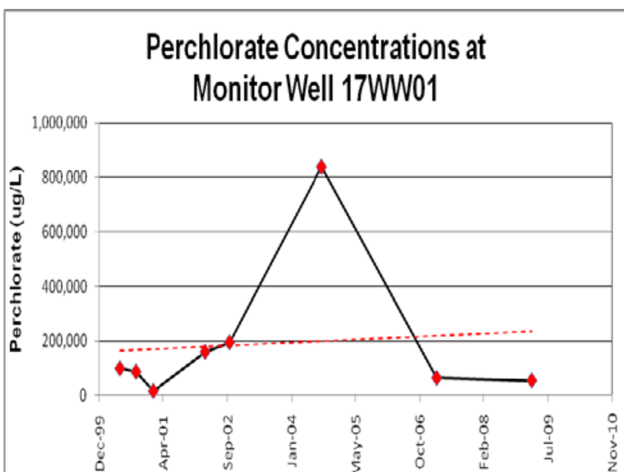

Figure 7 Data source: United States Army, 2010a, appendix A, table A-1.

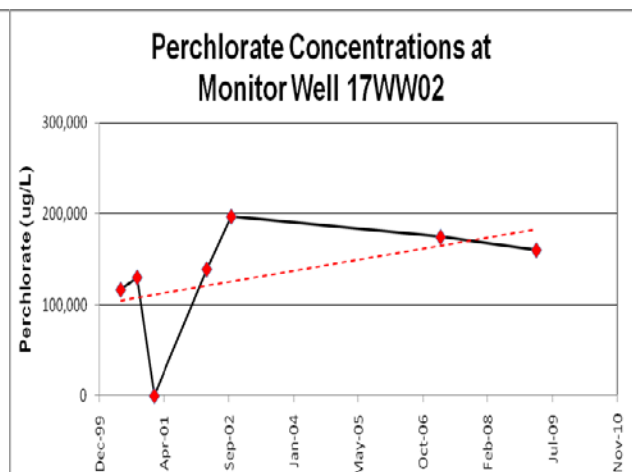

Figure 8 Data source: United States Army, 2010a, appendix A, table A-1.

Response: Data from wells 17WW01 and 17WW02 were not used because those two wells appear to be receiving additional perchlorate as it leaches into groundwater from the overlying contaminated soil. The removal of contaminated soil will end this influx, and the pump and treat activity will reduce perchlorate concentrations in the groundwater at those two wells (to

20,000 µg/L). As the perchlorate concentration at 17WW06 (74,000 µg/L) is significantly higher, the U.S. Army feels that the cleanup time estimated for perchlorate at 17WW06 by MNA provides a reasonable estimate.

Question/comment: The Army does not consider perchlorate to be a COC in the intermediate groundwater zone. However, high concentrations of perchlorate have been detected in intermediate zone monitor well 17WW11. Therefore, perchlorate should be a COC in the intermediate zone.

Response: Well 17WW11 is considered a shallow-intermediate well. There was no distinct clay layer to separate the shallow and intermediate zones. Boring logs for it and surrounding wells were inspected along with groundwater elevations, and it appears to be more reasonably connected with nearby shallow zone monitoring wells than with nearby intermediate zone monitoring wells. As a result, the well 17WW11 has been included with the shallow wells, and within the defined perchlorate plume. Also, perchlorate concentrations were below the detection limit in the intermediate groundwater zone wells (17WW07, 17WW09, 17WW15, and 17WW17).

Question/comment: The Army will present details of the soil excavation plan, the pump and treat system, the groundwater remediation performance objectives, the plan for implementing and evaluating MNA, and the LUC implementation plan, in the RD. However, the RD has not yet been produced. Given its importance, the Army should make the RD available for public review and comment as soon as practicable.

Response: The public will be provided with updates on remedial design and remedial action status through the RAB meeting and any concerns can be addressed through this forum. The RD will include performance objectives, schedule and other design criteria and will follow established regulatory guidance for MNA.

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**.

4.0 References

Jacobs Engineering Group, Inc. (Jacobs), 2001, *Remedial Investigation Report for the Group 2 Sites Remedial Investigation (Sites 12, 17, 18/24, 29, and 32) at the Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas*, Final, St. Louis, Missouri, April.

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Maley, Don, 1988, *Potential Hazardous Waste Site Preliminary Assessment, EPA Form 2070-12*, April.

Planteco Environmental Consultants, LLC (PEC), 2004, *In Situ Bioremediation of Perchlorate Contaminated Soils and Groundwater at Site-17 (Burning Ground No. 2), Longhorn Army Ammunition Plant, Karnack, Texas*, Draft Final, March.

Plexus Scientific Corporation, 2005, *Final Environmental Site Assessment, Phase I and II Report, Production Areas, Longhorn Ammunition Plant, Karnack, Texas*, Columbia, Maryland, February.

Shaw Environmental, Inc. (Shaw), 2007a, *Final Installation-Wide Baseline Ecological Risk Assessment, Longhorn Army Ammunition Plant, Karnack, Texas*, Houston, Texas, *Volume I: Step 3 Report*, January, and *Volume II: Steps 4 through 8*, November.

Shaw, 2007b, *Data Gaps Investigation Report, Longhorn Army Ammunition Plant, Karnack, Texas*, Final, Houston, Texas, April.

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U.S. Department of the Army (U.S. Army), 2004, *Memorandum of Agreement Between the Department of the Army and the Department of the Interior for the Interagency Transfer of Lands at the Longhorn Army Ammunition Plant for the Caddo Lake National Wildlife Refuge, Harrison County, Texas*, Signed by the Department of the Interior on April 27, 2004 and the U.S. Army on April 29, 2004.

U.S. Army, 2010, *Proposed Plan for LHAAP-17, Burning Ground No. 2/Flashing Area, Group 2, Longhorn Army Ammunition Plant, Karnack, Texas*, Final, May.

U.S. Army Environmental Hygiene Agency (USAEHA), 1987, *Final Groundwater Contamination Survey No. 38-26-0851-89, Evaluation of Solid Waste Management Units, Longhorn Army Ammunition Plant, Karnack, Texas*, May.

U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), 1980, *Installation Assessment of Longhorn Army Ammunition Plant, Report No. 150*, February.

U.S. Environmental Protection Agency (USEPA), 1998, *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*, EPA/600/R-98/128, Wiedemeier, T.H., M.A. Swanson, D.E. Moutoux, E.K. Gordon, J.T. Wilson, B.H. Wilson, D.H. Kampbell, P.E. Haas, R.N. Miller, J.E. Hansen, and F.H. Chapelle, Cincinnati, Ohio.

USEPA, 1999, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, OSWER Directive 9200.4.-17P, April.

USEPA, 2004, *Performance Monitoring of MNA Remedies for VOCs in Ground Water*, EPA/600/R-04/027, April.

Glossary of Terms

Glossary of Terms

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

ARARs – Applicable or relevant and appropriate requirements. Refers to the federal and state requirements that a selected remedy will attain.

Attenuation – The process by which a compound is reduced in concentration over time, through absorption, adsorption, degradation, dilution, and/or transformation.

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

Chemicals of Concern (COCs) – 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 carcinogenic risk (1 in 10,000 exposed individuals) or the calculated numerical limit of 1 for non-carcinogenic effects, a value proposed by the USEPA.

Chemical of Potential Concern (COPCs) – Those chemicals that are identified as a potential threat to human health or the environment and are evaluated further in the baseline risk assessment. COCs are a subset of the COPCs that are identified in the Remedial Investigation/Feasibility Study as needing to be addressed by the response action proposed in the Record of Decision.

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.

Contaminant Plume – A column of contamination with measurable horizontal and vertical dimensions that is suspended and moves with groundwater.

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.

Glossary of Terms (continued)

Federal Facility Agreement – A binding legal 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.

Maximum Contaminant Level (MCL) – The maximum contaminant level is the maximum permissible level of a contaminant in a public water system. MCLs are defined in the Code of Federal Regulation (40 CFR 141, National Primary Drinking Water Regulations, which implement portions of the Safe Drinking Water Act). The TCEQ has adopted MCLs as the regulatory cleanup levels for both industrial and residential uses. Any detected compound in the groundwater samples with a MCL was evaluated by comparing it to its associated MCL.

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.

Organic Compounds – Carbon compounds such as solvents, oils, and pesticides. Most are not readily dissolved in water.

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 process and consideration of public comments on the 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, transport, treatment, storage, and disposal of hazardous waste. RCRA focuses only on active and future facilities and does not address abandoned or historical sites.

Glossary of Terms (continued)

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

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. 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.

Surface Media – The soil (surface or subsurface), surface water, and sediment present at a site as applicable.

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 PLAN FOR ENVIRONMENTAL SITE LHAAP-17
LONGHORN ARMY AMMUNITION PLANT, TEXAS
PUBLIC MEETING AT KARNACK COMMUNITY CENTER JUNE 29, 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 the Proposed Plan for NPL site LHAAP-17. Although the Proposed Plan for LHAAP-17 identifies the preferred remedy for the site, the U.S. Army welcomes the public's review and comments. The public comment period is June 10, 2010 through July 10, 2010. The public meeting will be held on June 29, 2010 at the Karnack Community Center, Highway 134 and Spur 449, Karnack, Texas. Questions, comments, and responses on the Proposed Plan will be recorded by a court reporter during the public meeting. Copies of the Proposed Plan and supporting documentation are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670. A summary of the site, including a discussion of various alternatives that were evaluated, are provided below.

Longhorn Army Ammunition Plant (LHAAP) is an inactive, government-owned, formerly contractor-operated and -maintained industrial facility located in central-east Texas in the northeastern corner of Harrison County. The installation occupies nearly 8,416 acres between State Highway 43 at Karnack, Texas, and the western shore of Caddo Lake. LHAAP was established in December 1941 near the beginning of World War II for the manufacture of trinitrotoluene. Other past industrial operations at the installation included the use of secondary explosives, rocket motor propellants, and various pyrotechnics, such as illuminating and signal flares and ammunition.

LHAAP-17, Burning Ground No. 2/Flashing Area, is located in the west-central portion of LHAAP and covers an area of approximately 3.9 acres. The site was used as a burning ground from 1959 through 1980 and as a flashing area to decontaminate recoverable metal byproducts. Four alternatives were evaluated for addressing the contaminated soil and groundwater at the site: 1) no action; 2) excavation and off-site disposal for soil; monitored natural attenuation (MNA) and land use controls (LUCs) for groundwater; 3) excavation and off-site disposal for soil; in situ bioremediation; MNA and LUCs for groundwater; and 4) excavation and off-site disposal for soil; groundwater extraction, MNA and LUCs for groundwater. Based on available information, the preferred remedy is alternative 4 which would remove contaminated soil from LHAAP-17 with off-site disposal; reduce groundwater contamination throughout the shallow zone groundwater contaminant plume via groundwater extraction; MNA to assure protection of human health and the environment by documenting that the contaminated groundwater remains localized and that contaminant concentrations are being reduced to MCLs; and LUCs to protect human health by preventing human exposure to contaminated groundwater.

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 a Proposed Plan for the environmental site LHAAP-17, Burning Ground No. 2/Flashing Area, at the Longhorn Army Ammunition Plant. The Proposed Plan is the document that describes LHAAP-17 and its proposed remedies. The Proposed Plan was developed to facilitate public involvement in the remedy selection process.

Copies of the Proposed Plan and other supporting documentation for LHAAP-17 are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670. The public comment period is June 10, 2010 through July 10, 2010.

A public meeting will be held on June 29, 2010, from 6:00 to 8:00 p.m. at the Karnack Community Center, Highway 134 and Spur 449, Karnack, Texas, 75661.

All written public comments on the Proposed Plan must be postmarked on or before July 10, 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 July 10, 2010.

00113054

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS TX 75202-2733

OCT 13 2011

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final MMRP Record of Decision (ROD)
LHAAP-001-R South Test Area/Bomb Test Area
LHAAP-003-R Ground Signal Test Area
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler:

The Environmental Protection Agency (EPA) has completed its review of the *Draft Final MMRP ROD (LHAAP-001-R South Test Area/Bomb Test Area, LHAAP-003-R Ground Signal Test Area)* submitted on September 27, 2011, and have the following comments:

1. Overall ROD, Table 2-4: Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-001-R and LHAAP-003-R 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). Therefore, the appropriate standard to be applied at LHAAP-001-R and LHAAP-003-R should be the State of Texas Groundwater MSC for Residential Use, which for perchlorate is at 26 ug/L, per 40 CFR 300.430(a)(iii)(F), and 300.430(f)(1)(ii)(B) .

   The ROD language needs to reflect this State of Texas groundwater designation and the appropriate residential standard in order to be consistent with the EPA July 2011 OSWER Directive 9283.1-34, EPA June 2009 OSWER Directive 9283.1-33, and the DoD April 2009 Perchlorate Release Management Policy.

   - EPA July 2011 OSWER Directive 9283.1-34, Groundwater Road Map Recommended Process for Restoring Contaminated Groundwater at Superfund Sites: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/gwroadmapfinal.pdf

   - EPA June 2009 OSWER Directive 9283.1-33: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf

   - DoD April 2009 Perchlorate Release Management Policy: http://www.denix.osd.mil/cmrmd/upload/dod_perchlorate_policy_04_20_09.pdf

   - TCEQ March 2006 MSC and risk-based screening levels tables: http://www.tceq.texas.gov/assets/public/remediation/rrr/msc-rbscn_2006.xls

2. Table of Contents: The 'Section 2.10.2 Compliance with ARARs' is missing and subsequent sections mis-numbered.

3. Section 1.5, Section 2.14.5: Revise to state that: "Although the statutory preference for treatment was not fully satisfied, the MEC removal action removed…"

4. Section 2.2.2: The last two sentences of this section should either be deleted or explained to reflect that the MMRP sites LHAAP-001-R and LHAAP-003-R are now NPL sites under the FFA and that EPA is the lead regulatory agency for these sites.

5. Section 2.5.2.2, first sentence: Please refer to the ROD as the 1998 NFA ROD.

6. Section 2.12.1: Before the first sentence in this Section add the following sentence, "Notwithstanding any other provision in this ROD, all remedial action selections made at Sites LHAAP-001-R and LHAAP-003-R shall comply with CERCLA Sections 113, 117, 120(e), 121, 40 C.F.R. §§ 300.430(f) and 300.820, and the FFA.

7. IC Checklist #4: The ROD confuses the term "LUC" and "objective" and includes inconsistent and unclear objectives. The LUC objectives appear to be partially listed in section 1.4, p. 1-2, although they are also generally described in 2.12.1. and 2.9.1. Note that the list includes signs and education programs and these are LUCs, not objectives. Please replace the listing on in section 1.4, p. 1-2 as follows: "The LUC objectives are: **1) to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells, 2) to prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds, and 3) prohibit intrusive activities such as digging or any other activity which could result in detonation of explosive hazards."**

8. IC Checklist #5: LUCs. The "LUC" means the legal or administrative mechanism by which the LUC objective is implemented. In this case, the property appears to be still under Army control, then the Army should identify the current mechanism (some sort of internal Army procedures) and the future mechanism (ensure the controls are maintained by USFWS in the document transferring property). The signs and education programs mentioned in several places are also part of the LUCs and should be included, as well as the TAC restriction.

9. IC Checklist #6: Duration language-- missing. Please include the following: "Land Use Controls will be maintained until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure."

10. IC Checklist #7: Responsibility language. The language in Section 2.12.2, page. 2-25 is ok. But the reference to monitoring in Section 1.4, page 1-2 and in Section 2.12.2, page 2-26 and must be modified as EPA does not consider the 5YR a substitute for **LUC** monitoring: "~~Monitoring in the form of~~ Five-Year Reviews will be conducted to ensure that the LUCs are specified, implemented, monitored, reported on, and enforced in an efficient, cost effective…"

In addition, on page 1-3, first paragraph: "The U.S. Army will remain responsible for implementation, maintenance, periodic inspection, reporting on and enforcement of the LUCs ~~in accordance with the LUC plan in Appendix I of the removal action work plan (EODT, 2008)~~."

11. IC Checklist #8: Remedy integrity. This problematic language appears in Sections 1-4 and 2.12.2 (Page 2-25) and must be changed to: "4) reservation of authority to change, modify, or terminate the LUC <u>with approval from EPA and consultation from TCEQ</u> and any related transfer or lease provisions; and (5) ensuring the integrity of the selected remedy…"

12. IC Checklist #9: Commitment to provide RD for implementation actions. In Section 1.4 next to the last paragraph there is a reference to the removal MEC work plan for LUC implementation details. The removal workplan will not suffice as it is not a primary document. Please include language from the Checklist or the language or as follows: "A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 90 days of ROD signature, the Army shall prepare and submit to EPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections."

13. IC Checklist #14: Modification/termination of LUC. The problematic language appears in Section 1.4, page 1-3 and in section 2.12.2, page 2-26. Please modify as follows: "In the event that T~~CEQ and/or~~ USEPA and the U.S. Army agree with respect to any ~~significant~~ modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the Federal Facility Agreement (FFA) and 40 CFR. §300.435(c)(2)."

    Again, the qualifier ("significant") must come out because EPA MUST agree with any change to a remedy (no matter what its significance) due to our statutory authority to jointly select remedies which is all the Army has no matter what. TCEQ needs to come out because Texas' agreement is not needed to modify the remedy. The statement above, as written, gives Texas an equal role in remedy selection which is not provided by the statute. Finally the "and/or" language could be read to state that EPA's agreement is not necessary.

14. Pages 1-3 and 2-25 (1st 2 bullets), please make it clear that it is the Army who notifies the county and insert a deadline, for example: "In addition, within 90 days of signature of this ROD, the Army shall: 1) request the Texas Department of Licensing and Regulation ~~will be requested~~ to notify well drillers of groundwater restrictions;and2)~~the Army shall~~ notify the ~~a notification of the LUC with the~~ Harrison County Courthouse of the LUC to include ~~would include~~ a map showing the areas of groundwater restriction at the site, in accordance with 30 TAC 335.565."

15. Section 2.12.1, Section 2.12.2: The language (i.e.: The details and description of the LUC…" on page 2-24 and page 2-26 is confusing in that it seems to state that the LUC implementation actions are already in an approved remedial design. This language need to be clarified to reflect that: "A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 90 days of ROD signature, the Army shall

prepare and submit to EPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections."

Under Section VIII.C.2. and Section XV.B. of the Federal Facilities Agreement, EPA may invoke Dispute Resolution for any unresolved comments. Please feel free to contact me at (214) 665-8409, or by email at tzhone.stephen@epa.gov, if there are any questions or comments.

Sincerely,

Carlos A. Sanchez
for
Stephen L. Tzhone
Remedial Project Manager

cc: Ms. Fay Duke, TCEQ
Mr. Richard Mayer, EPA R6
Mr. George Malone, EPA R6
Ms. Sally Dalzell, EPA FFEO
Ms. Allison Abernathy, EPA FFRRO
Mr. Timothy Mott, EPA FFRRO
Ms. Ellen Treimel, EPA FFRRO

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS TX 75202-2733

OCT 1 3 2011

CERTIFIED MAIL-RETURN RECEIPT REQUESTED

Colonel Clarence D. Turner
Department of the Army
Assistant Chief of Staff for Installation Management
600 Army Pentagon
Washington, DC 20310-0600

Re: Notice of Violations and Stipulated Penalty Assessment
Army Commitments on FY2011 Records of Decisions
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Colonel Turner:

This letter notifies the Army that it has failed to comply with the requirements of the Longhorn Army Ammunition Plant (LHAAP) Federal Facility Agreement (FFA). In addition, this letter assesses stipulated penalties for those violations and describes the dispute resolution process for the Environmental Protection Agency's (EPA's) determinations.

The Army submitted an updated Site schedule with FY2011 commitments on July 28, 2011. EPA approved the schedule on August 5, 2011. Under the approved schedule, the Army is required to complete Records of Decision (RODs) for four sites by the end of FY2011 (i.e., September 30, 2011). The four sites subject to this notice of violation and penalty assessment are:

- LHAAP-16: Old Landfill
- LHAAP-17: No. 2 Flashing Area Burning Ground
- LHAAP-001-R-01 MMRP: South Test Area/Bomb Test Area
- LHAAP-003-R-01 MMRP: Ground Signal Test Area

As of the date of this letter, the above listed sites do not have approved RODs. The violations commenced before September 30, 2011, and are continuing violations of the EPA approved Site schedule until these RODs comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Contingency Plan (NCP), and EPA guidance, as required by the FFA.

It is important to note that the Army has a history of failing to submit adequate documents by the Site schedule deadlines at the LHAAP facility. On September 23, 2009, EPA issued the Army a notice of violation concerning twelve sites at the LHAAP facility for failure to comply with 2009 deadlines. The four sites subject to this notice of violation and stipulated penalty assessment were also subject to the September 23, 2009, notice of violation.

In this case, EPA agreed to multiple extensions on Primary Documents for LHAAP-16 and LHAAP-17 throughout 2010 and 2011. The above extensions were approved by EPA on February 4, 2010, February 26, 2010, April 2, 2010, and August 5, 2011. These deadlines were extended for the Army in order to accommodate the Army in fulfilling its ROD commitments for FY2011. The EPA received draft final RODs for the four sites subject to this notification, on September 27, 2011, (for MMRP-1, MMRP-3) and on September 29, 2011, (for LHAAP-16, LHAAP-17). The EPA also received nearly identical documents, titled "final" and bearing the Army's signature, on September 29, 2011.

Unfortunately, even with the above extensions, the Army submitted draft RODs that were substantially deficient and flawed in terms of the analysis required under CERCLA and the NCP, requiring voluminous EPA comments (e.g., thirty-seven EPA Region 6 comments for the LHAAP-16 Draft ROD were sent to the Army on August 17, 2011; comments regarding missing analysis required under the NCP remedial action selection criteria, land use controls, and remedy selection authority for LHAAP-001-R and LHAAP-003-R Draft ROD were sent to the Army on August 31, 2011; and land use controls and remedy selection authority comments from EPA HQs on LHAAP-16 and LHAAP-17 on August 29, 2011).

Despite EPA's comments addressing these flaws, the submitted draft final RODs do not comply with CERCLA, the NCP, and EPA guidance, as required by the FFA. The same holds true for the submitted "final" Army-signed RODs. These inconsistencies are the basis for this assessment of stipulated penalties because they constitute failures to submit a primary document in accordance with the requirements of the FFA and/or failures to comply with a term or condition of the FFA which relates to an operable 'unit' or final remedial action.

Under Longhorn FFA Section XIX.C. and CERCLA 120(e)(4)(A), the Army and EPA jointly select the remedy, and if they are unable to agree, the remedy will be selected by EPA. The September 29 RODs signed only by the Army cannot constitute the selected remedy as they are inconsistent with the statutory requirement that we both sign. The EPA cannot sign the RODs because they are inadequate as identified in EPA's numerous comments on the RODs.

Under Section XXIV.A. of the FFA, the EPA may take enforcement action and assess stipulated penalties if the Army fails to submit primary documents, such as these RODs, pursuant to the appropriate timetable or deadline in accordance with the requirements of the FFA, or fails to comply with a term or condition of the FFA which relates to an operable 'unit' or final remedial action. A stipulated penalty in an amount of $5,000 for the first week (or part thereof), and $10,000 for each additional week (or part thereof) is being assessed for each of the four sites' draft final ROD failure to comply with the FFA requirement that the draft final RODs be consistent with CERCLA, the NCP, and EPA guidance.

As a matter of convenience, the starting date for the calculation of the stipulated penalties is September 30, 2011, although the date that Army submitted each noncompliant draft final ROD (September 27, 2011 for MMRP-1 and MMRP-3; September 29, 2011 for LHAAP-16 and LHAAP-17) precedes it. The assessment of stipulated penalties and the penalty amount will continue to run and accrue for as long as the violations remain unresolved. Although the amount of the stipulated penalty is not subject to dispute resolution, the Army may submit mitigating factors it would like EPA to consider within fifteen days after receipt of this letter. The Army may also submit a revised Site schedule it would like EPA to consider within fifteen days after receipt of this letter.

Under Section XXIV.B. of the FFA, the Army has fifteen days after receipt of this letter to invoke dispute resolution by submitting a written statement of dispute explaining whether these violations did in fact occur. If the Army does not submit its written statement of dispute within the time-frame provided under the FFA, then stipulated penalties are due and owning from the starting date of September 30, 2011, and will continue to accrue for as long as the violations continue. The due date for payment of stipulated penalties will be thirty days from the date EPA sends the Army written notification concerning the final penalty amount assessed.

EPA will be available to informally discuss and meet with you to address your questions within the fifteen day time-frame provided above. If there are any questions regarding this matter, please feel free to contact Mr. Charles Faultry (214.665.2731), Mr. Carlos Sanchez (214.665.8507), or Mr. Stephen Tzhone (214.665.8409) of my staff.

Sincerely,

Samuel Coleman

Samuel Coleman, P.E.
Director
Superfund Division

cc: Reggie Cheatham
EPA FFRRO

David Kling
EPA FFEO

Enclosures (4)

1. Army FY11 schedule update and request letter (July 28, 2011) and EPA schedule approval letter (August 5, 2011).
2. First EPA NOV letter on schedule and commitments (September 23, 2009).
3. EPA extensions on Primary Documents for LHAAP-16 and LHAAP-17 (February 4, 2010, February 26, 2010, April 2, 2010; August 5, 2011).
4. EPA Region 6 and HQs comments LHAAP-16, LHAAP-17, LHAAP-001-R, LHAAP-003-R (August 17, 2011; August 29, 2011; August 31, 2011).

ENCLOSURE 1:

Army FY11 schedule update and request letter (July 28, 2011) and EPA schedule approval letter (August 5, 2011).

00113062

DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

July 28, 2011

DAIM-ODB-LO

Mr. Carlos Sanchez
US Environmental Protection Agency
Superfund Division (6SF-AT)
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Update for FY11 LHAAP Site List Schedule, Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas, 5 July 2010

Dear Mr. Sanchez,

The above-referenced document is submitted to EPA for approval. Differences from the August 2010 schedule are noted below:

LHAAP-003: From SEP 2011 to JUN 2012 – Change in regulatory approach to include a proposed plan and record of decision

LHAAP-004: From SEP 2011 to JUN 2012 – During soil removal action, new groundwater data indicated need for groundwater feasibility study

LHAAP-018: From SEP 2011 to JUN 2012 - Requirement by TCEQ and EPA for collection of additional field data has delayed the schedule and some additional delay due to a change in contractor

LHAAP-024: From SEP 2011 to JUN 2012 - Requirement by TCEQ and EPA for collection of additional field data has delayed the schedule and some additional delay due to a change in contractor

LHAAP-029: From SEP 2011 to NOV 2011 – Comments received from Wisconsin Group regarding unregulated DNT isomers has sparked interest among some RAB members – additional two months to address comments and present to RAB at September (quarterly) meeting

LHAAP-047: From SEP 2011 to JUN 2012 - Requirement by TCEQ and EPA for collection of additional field data has delayed the schedule and some additional delay due to a change in contractor

LHAAP-001-R: From SEP 2012 to SEP 2011 – Resolved path forward regarding metals

LHAAP-001-R: From SEP 2012 to SEP 2011 – Resolved path forward regarding metals

In summary, the updated schedule reflects 4 Records of Decision with signature in FY11.

The point of contact for this action is the undersigned. I may be contacted at 479-635-0110, or by email at rose.zeiler@us.army.mil.

Sincerely,

Rose M. Zeiler

Rose M. Zeiler, Ph.D.
Longhorn AAP Site Manager

One Enclosure
Copies furnished:
Fay Duke, TCEQ

LONGHORN ARMY AMMUNITION PLANT FY10 TARGETED GPRA GOALS

					Completion Dates										
					Interim Action or Removal Action				Final Action						
Site ID (DSERTS)	RMIS #	DERPMIS		SITE DESCRIPTION	RI/FS or EE/CA	ROD/DD or AM	RA Starts	RA Completions	RI/FS Starts	ROD/DD		RA Completions	Site Construction Completions		
Army Terminology					RI/FS or EE/CA	ROD/DD or AM	RD	RA	RI/FS	ROD/DD	RD	RA	RIP	RA(O)	RC
LHAAP-001	1	1	X	Inert Burning Ground						Jan-98					Jan-98
LHAAP-002	2	2		Vacuum Truck Overnight Parking Lot					Jan-09	Apr-10					Apr-10
LHAAP-003	3	3	XX	Building 722 - Paint Shop					Jan-09	Jun-12			Jun-12		Jun-12
LHAAP-004	4	4	XX	Pilot Waste Water Treatment Plant	Feb-09	Jul-09	Jul-09	Jan-10	Sep-11	Jun-12	Nov-12	Feb-13	Jul-13		
LHAAP-005	5	5		Power House Boiler Pond											
LHAAP-006	6	6		Building 54F Solvent						Dec-08					Dec-08
LHAAP-007	7	7		Building 50G Drum Processsing						Dec-08					Dec-08
LHAAP-008	8	8		Sewage Treatment Plant		Dec-08				Nov-08					
LHAAP-009	9	9		Building 31-W Drum Storage						Nov-99					
LHAAP-011	11	10	X	Suspected TNT Burial Site at P&Q Avenue						Jan-98					Jan-98
LHAAP-012	12	11	X	Active Landfill		Sep-95		Jul-06		Jul-06	Jun-07	Jun-07	Oct-07	Sep-40	Sep-40
LHAAP-013	13	12	X	Suspected TNT Burial Site Between Active and Old Landfill						Feb-96					
LHAAP-014	14	13	X	Area 54W Burial Site						Feb-96					
LHAAP-015	15	14		Area 49-W Drum Storage						Oct-99					
LHAAP-016	16	15	X	Old Landfill		Sep-95		Sep-11	Mar-10	Sep-11	Feb-12	May-12	Oct-12	Sep-15	
LHAAP-017	17	16	X	No. 2 Flashing Area Burning Ground					Apr-10	Sep-11	Feb-12	May-12	Oct-12	Sep-15	
LHAAP-018	18	17	X	Burning Ground/Rocket Motor Washout Pond		May-95		Jun-12	Aug-11	Jun-12	Aug-12	Nov-12	Apr-13	Sep-15	
------------	18	38		24X Holding Area											
------------	18	39		25X Washout Pad											
------------	18	40		Air Curtain Destructor											
------------	18	41		Open Burning Cage											
------------	18	42		Open Burning Pan											
------------	18	44		Building 41-X											
------------	18	62		Building 43-X											
LHAAP-019	19	63		Construction Materials Landfill											
LHAAP-023	23	23		Building 707 Storage for PCBs											Sep-00
LHAAP-024	24	43	X	Former Unlined Evaporation Pond		May-95		Jun-12	Aug-11	Jun-12	Aug-12	Nov-12	Apr-13	Sep-15	
LHAAP-027	27	19	X	South Test Area/Bomb Test Area						Jan-98					
LHAAP-029	29	21	X	Former TNT Production Area					Apr-10	Nov-11	Feb-12	May-12	Oct-12	Sep-15	
LHAAP-032	32	24	X	Former TNT Waste Disposal Plant						Aug-08					Aug-08
LHAAP-034	34	34		Building 701 - PCB Storage											Jul-00
LHAAP-035	35	35		Process Wastewater Sumps - Various					Apr-09	Apr-10					Apr-10
LHAAP-036	36	36		Explosive Waste Pads					Apr-09	Apr-10					Apr-10
LHAAP-037	37	37	XX	Quality Assurance Laboratory Building 29-A					Sep-08	Jun-10	Aug-11	Oct-11	Apr-12	Sep-40	Sep-40
LHAAP-045	45	45		Magazine Area											
LHAAP-046	46	46	XX	Plant 2/Pyrotechnic Operation					Jan-10	Sep-10	Aug-11	Nov-11	Feb-14	Sep-15	
LHAAP-047	47	47	XX	Plant 3/ Produces Hand Signal Assemblies					Aug-11	Jun-12	Aug-12	Nov-12	Oct-12	Apr-16	
LHAAP-048	48	48		Y-Area						Nov-08					
LHAAP-049	29	49	XX	Former Acid Plant						Sep-10			Sep-10		Sep-10
LHAAP-050	50	50	XX	Former Waste Disposal Facility					Jan-10	Sep-10	Aug-11	Oct-11	Feb-14	Sep-15	
LHAAP-051	51	51		Photographic Laboratory/Building 60-B						Dec-08					Oct-08

00113065

LONGHORN ARMY AMMUNITION PLANT FY10 TARGETED GPRA GOALS

					Completion Dates										
					Interim Action or Removal Action				Final Action						
Site ID (DSERTS)	**RMIS #**	**DERPMIS**		**SITE DESCRIPTION**	**RI/FS or EE/CA**	**ROD/DD or AM**	**RA Starts**	**RA Completions**	**RI/FS Starts**	**ROD/DD**		**RA Completions**	**Site Construction Completions**		
LHAAP-052	52	52		Magazine Washout Area											
LHAAP-053	53	53		Static Test Area						Nov-08					
LHAAP-054	54	54	**X**	Ground Signal Test Area						Jan-98	Jan-98				Jan-98
LHAAP-055	55	55		Septic Tanks						Dec-08					Dec-08
LHAAP-056	56	56		Vehicle Wash Rack and Oil/Water Separator											
LHAAP-057	57	57		Rubble Burial Site											
LHAAP-058	58	58	**XX**	Maintenance Complex					Jan-10	Sep-10	Aug-11	Nov-11	Feb-14	Sep-15	
LHAAP-059	59	59		Storage Building 725						Sep-08					
LHAAP-060	60	60		Former Storage Building #411 and #714					Aug-08	Dec-08					Dec-08
LHAAP-061	61	61		Potable Water Treatment Sediment Ponds											
LHAAP-063	63	63		Burial Pits											
LHAAP-064	64	64		Transformer Storage Area						Dec-08					Dec-08
LHAAP-065	65	65		Building #209						Sep-11					
LHAAP-066	66	66		Transformer at Building 401						Dec-08					Dec-08
LHAAP-067	67	67	**XX**	Above Ground Storage Tank					Sep-08	Jun-10	Aug-11	Oct-11	Apr-12	Sep-40	Sep-40
LHAAP-068	68	68		Building 51-F						Dec-08					Dec-08
LHAAP-069	69	69		Underground Storage Tank											
LHAAP-070				Loading Dock Magazine Area											Aug-04
LHAAP-071				Oil Spill at Bldg 813											Aug-04
Pistol Range			**XX**	Pistol Range	Feb-09	Jul-09	Jul-09	Dec-09		Sep-10			Sep-10		Sep-15
LHAAP-001-R-01			**XX**	South Test Area/Bomb Test Area (MMRP)					Sep-11	Sep-11					Sep-15
LHAAP-002-R-01				Static Test Area (MMRP)						Nov-08					
LHAAP-003-R-01			**XX**	Ground Signal Test Area (MMRP)					Sep-11	Sep-11					Sep-15

X Site identified in FFA

XX Additional sites identified as NPL

Legend

RI/FS- Remedial Investigation/Feasibility Study

ROD/DD-Record of Decision/Decision Document: Required for interim and final remedial actions, RODs for NPL sites, DDs for non-NPL sites, prepared prior to construction and remedial design phases

RA denotes Army phase completion of Remedial Action Construction.

RA Completions- Remedial Action Complete

Site Construction Completions- Remedy is in Place and Remedial Action Completion Report is Final.

RA(O)-Remedial Action Operation

RC-Response Complete: All cleanup objectives have been met (remediation completed) with the exception of the Long Term Management phase if required

Grey shading indicates phases complete

Yellow shading indicates site requires additional documentation

*** Note: EPA Target shown may not align with Army Phase Completion Terminology.

00113066

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS TX 75202-2733

AUG 05 2011

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Update for FY11 LHAAP Site List Schedule
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler,

The U.S. Environmental Protection Agency (EPA) has reviewed the *Update for FY11 LHAAP Site List Schedule, Longhorn Army Ammunition Plant, Karnack, Texas,* dated July 28, 2011, and approves of the submitted schedule.

This approved schedule will now serve as the site-wide enforcement schedule between the EPA and the Army from the date of this letter. Please feel free to contact me at (214) 665-8507, or Mr. Stephen Tzhone at (214) 665-8409, if there are any questions or comments.

Sincerely,

Carlos A. Sanchez

Carlos Sanchez, Chief
Superfund Remedial AR/TX Section

cc: Ms. Fay Duke, TCEQ
Mr. Paul Bruckwicki, FWS

ENCLOSURE 2:

First EPA NOV letter on schedule and commitments (September 23, 2009).

00113068

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

SEP 23 2009

Colonel Clarence D. Turner
Department of the Army
Assistant Chief of Staff for Installation Management
ATTN: COL Clarence D. Turner
600 Army Pentagon
Washington, DC 20310-0600

Re: Site Schedule and Commitments
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Colonel Turner:

The U.S. Environmental Protection Agency (EPA) goals are to clean up the environment at sites that pose a risk to human health and the environment. The EPA selects remedies in the Records of Decision (RODs) at these sites to meet the goals of protecting human health and the environment.

The EPA met with the Army on July 30, 2009, to deliver the final interpretation of EPA's groundwater restoration policy. Furthermore, in a letter dated August 12, 2009 (Enclosure 1), the EPA reiterated our agreement to the latest schedule submitted by the Army on May 19, 2009. The schedule indicated that the Longhorn Army Ammunition Plant Site would complete and submit twelve (12) RODs in FY2009 (Enclosure 2), i.e.:

- LHAAP-16: Old Landfill
- LHAAP-17: No. 2 Flashing Area Burning Ground
- LHAAP-29: Former TNT Production Area
- LHAAP-37: Quality Assurance Laboratory Building 29-A
- LHAAP-46: Plant 2/Pyrotechnic Operation
- LHAAP-49: Former Acid Pit
- LHAAP-50: Former Waste Disposal Facility
- LHAAP-58: Maintenance Complex
- LHAAP-67: Above Ground Storage Tank
- LHAAP-Pistol Range: Pistol Range
- LHAAP-001-R-01 MMRP: South Test Area/Bomb Test Area
- LHAAP-003-R-01 MMRP: Ground Signal Test Area

The EPA and the Texas Commission on Environmental Quality (TCEQ) require a minimum of thirty (30) days to review and comment on draft RODs. On September 15, 2009, the EPA informed the Army that it is evident that the Army's commitments for selecting cleanup remedies at the twelve sites by the end of September (FY2009) would not be met and that the Army would be in violation of the Site schedule agreed to by the parties to the Federal Facilities Agreement (i.e., Army, EPA, and State of Texas). This letter serves as a notification of that violation.

Under Section XXIV of the Federal Facilities Agreement, the EPA may take enforcement action that result in stipulated penalties if the Army fails to submit primary documents, such as RODs, pursuant to the appropriate timetable or deadline. Therefore, the EPA requests that the Army:

- Submit a revised schedule within fourteen days of receipt of this letter, representing an official time extension request on the previously agreed upon schedule, that will account for when the original FY2009 and FY2010 commitments will be met.

- Provide a detailed list of any potential impediments that would further delay the completion of the original FY2009 and FY2010 commitments, and specific actions needed to resolve these impediments.

If there are any questions regarding this matter, please feel free to contact Mr. Charles Faultry (214.665.2731), Mr. Carlos Sanchez (214.665.8507), or Mr. Stephen Tzhone (214.665.8409) of my staff.

Sincerely yours,

Sam Coleman

Samuel Coleman, P.E.
Director
Superfund Division

cc: John Reeder, EPA FFRRO
David Kling, EPA FFEO

Enclosures (2)

1: 8/12/2009 Letter, EPA to Army
2: List of FY2009 ROD Sites

ENCLOSURE 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

AUG 12 2009

Mr. Thomas E. Lederle
Assistant Chief of Staff for Installation Management
ATTN: Tom Lederle (DAIM-BD)
600 Pentagon
Washington, DC 20310-0600

Re: Site Schedule
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Mr. Lederle:

The U.S. Environmental Protection Agency (EPA) plans its Superfund Government Performance Results Act (GPRA) goals based on achieving milestones at Superfund sites. This letter represents a notification that the commitments at the Longhorn Army Ammunition Plant Superfund Site are represented by the site schedule, which in turn serves as part of the planning process for these Superfund GPRA goals.

Enclosed is the current site schedule submitted on May 19, 2009, and agreed upon on June 16, 2009 (see Enclosures). If there are any questions regarding this matter, please feel free to contact Mr. Carlos Sanchez at (214) 665-8507 or Mr. Stephen Tzhone of my staff at (214) 665-8409.

Sincerely yours,

Carlos A. Sanchez
for Charles Faultry
Associate Director
Superfund Remedial Branch (6SF-R)

Enclosures (3)
1: Site Schedule
2: 5/19/2009 Longhorn Managers Meeting Minutes
3: 6/16/2009 Longhorn Managers Meeting Minutes

00113072

						Completion Dates											
						Interim Action				Final Action							
Site ID (DSERTS)	RMIS #	DERPMIS		SITE DESCRIPTION	SI	RI/FS	ROD/DD	RD	RA	RI/FS	ROD/DD	RD	RA	RA(C)	RIP (Completion Report)	RA(O)	RC
LHAAP-001	1	1	X	Inert Burning Ground							Jan-98						Jan-98
LHAAP-002	2	2		Vacuum Truck Overnight Parking Lot	Jun-08					Jan-09	Jul-09						Jul-09
LHAAP-003	3	3		Building 722 - Paint Shop	May-08					Jan-09	Jul-09				Sep-09		Sep-09
LHAAP-004	4	4	XX	Pilot Waste Water Treatment Plant						Feb-09	Dec-09	Jun-09	Aug-09	Aug-09	Dec-09 (NFA ROD)		Sep-15
LHAAP-005	5	5		Power House Boiler Pond													
LHAAP-006	6	6		Building 54F Solvent	Dec-07						Dec-08						Dec-08
LHAAP-007	7	7		Building 50G Drum Processsing	Dec-07						Dec-08						Dec-08
LHAAP-008	8	8		Sewage Treatment Plant			Dec-08				Nov-08						
LHAAP-009	9	9		Building 31-W Drum Storage							Nov-99						
LHAAP-011	11	10	X	Suspected TNT Burial Site at P&Q Avenue							Jan-98						Jan-98
LHAAP-012	12	11	X	Active Landfill			Sep-95		Jul-06		Jul-06	Jun-07		Jun-07	Oct-07	Sep-39	Sep-39
LHAAP-013	13	12	X	Suspected TNT Burial Site Between Active and Old Landfill							Feb-96						
LHAAP-014	14	13	X	Area 54W Burial Site							Feb-96						
LHAAP-015	15	14		Area 49-W Drum Storage							Oct-99						
LHAAP-016	16	15	X	Old Landfill			Sep-95		Sep-09	Feb-09	Sep-09	Dec-09	Jan-10	Jan-10	Jan-10	Sep-15	
LHAAP-017	17	16	X	No. 2 Flashing Area Burning Ground						May-09	Sep-09	Jan-10	Mar-10	Mar-10	May-10	Sep-15	
LHAAP-018	18	17	X	Burning Ground/Rocket Motor Washout Pond			May-95		Mar-10	May-09	Mar-10	Jul-10	Sep-10	Sep-10	Dec-10	Sep-15	
------------	18	38		24X Holding Area													
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------------	18	40		Air Curtain Destructor													
------------	18	41		Open Burning Cage													
------------	18	42		Open Burning Pan													
------------	18	44		Building 41-X													
------------	18	62		Building 43-X													
LHAAP-019	19	63		Construction Materials Landfill													
LHAAP-023	23	23		Building 707 Storage for PCBs													
LHAAP-024	24	43	X	Former Unlined Evaporation Pond			May-95		Mar-10	May-09	Mar-10	Jul-10	Sep-10	Sep-10	Dec-10	Sep-15	
LHAAP-027	27	19	X	South Test Area/Bomb Test Area							Jan-98						
LHAAP-029	29	21	X	Former TNT Production Area						May-09	Sep-09	Jan-10	Mar-10	Mar-10	May-10	Sep-15	
LHAAP-032	32	24	X	Former TNT Waste Disposal Plant							Aug-08						Aug-08
LHAAP-034	34	34		Building 701 - PCB Storage													Jul-00
LHAAP-035	35	35		Process Wastewater Sumps - Various	Jun-08					Apr-09	Aug-09						Aug-09
LHAAP-036	36	36		Explosive Waste Pads	Jun-08					Apr-09	Aug-09						Aug-09
LHAAP-037	37	37	XX	Quality Assurance Laboratory Building 29-A						Sep-08	Sep-09	Sep-08			Oct-08	Sep-39	Sep-39
LHAAP-045	45	45		Magazine Area	Sep-04												
LHAAP-046	46	46	XX	Plant 2/Pyrotechnic Operation						Feb-09	Sep-09	Jan-10	Mar-10	Mar-10	May-10	Sep-15	
LHAAP-047	47	47	XX	Plant 3/ Produces Hand Signal Assemblies						Jun-09	Mar-10	Jun-10	Jul-10	Jul-10	Oct-10	Sep-15	
LHAAP-048	48	48		Y-Area							Nov-08						
LHAAP-049	29	49	XX	Former Acid Plant						Feb-09	Sep-09				Sep-09		Sep-09
LHAAP-050	50	50	XX	Former Waste Disposal Facility						Jun-09	Sep-09	Jan-10	Mar-10	Mar-10	May-10	Sep-15	
LHAAP-051	51	51		Photographic Laboratory/Building 60-B							Dec-08						Oct-08

						Completion Dates											
						Interim Action				Final Action							
Site ID (DSERTS)	RMIS #	DERPMIS		SITE DESCRIPTION	SI	RI/FS	ROD/DD	RD	RA	RI/FS	ROD/DD	RD	RA	RA(C)	RIP (Completion Report)	RA(O)	RC
LHAAP-052	52	52		Magazine Washout Area													
LHAAP-053	53	53		Static Test Area							Nov-08						
LHAAP-054	54	54	X	Ground Signal Test Area							Jan-98	Jan-98					Jan-98
LHAAP-055	55	55		Septic Tanks							Dec-08						Dec-08
LHAAP-056	56	56		Vehicle Wash Rack and Oil/Water Separator													
LHAAP-057	57	57		Rubble Burial Site													
LHAAP-058	58	58	XX	Maintenance Complex						Feb-09	Sep-09	Jan-10	Mar-10	Mar-10	Jul-10	Sep-15	
LHAAP-059	59	59		Storage Building 725							Sep-08						
LHAAP-060	60	60		Former Storage Building #411 and #714	Jul-08					Aug-08	Dec-08						Dec-08
LHAAP-061	61	61		Potable Water Treatment Sediment Ponds													
LHAAP-063	63	63		Burial Pits													
LHAAP-064	64	64		Transformer Storage Area	May-08						Dec-08						Dec-08
LHAAP-065	65	65		Building #209							Mar-09						
LHAAP-066	66	66		Transformer at Building 401	May-08						Dec-08						Dec-08
LHAAP-067	67	67	XX	Above Ground Storage Tank						Sep-08	Sep-09			Sep-08		Sep-39	Sep-39
LHAAP-068	68	68		Building 51-F	May-08						Dec-08						Dec-08
LHAAP-069	69	69		Underground Storage Tank													
LHAAP-070				Loading Dock Magazine Area	Sep-95												Aug-04
LHAAP-071				Oil Spill at Bldg 813	Sep-95												Aug-04
Pistol Range			XX	Pistol Range							Sep-09	Sep-09		Dec-09	Jun-10		Sep-15
LHAAP-001-R-01			XX	South Test Area/Bomb Test Area (MMRP)						Sep-09	Sep-09						Sep-15
LHAAP-002-R-01			XX	Static Test Area (MMRP)													Oct-07
LHAAP-003-R-01			XX	Ground Signal Test Area (MMRP)						Sep-09	Sep-09						Sep-15

X Site identified in FFA
XX Additional sites identified as NPL

Legend
SI- Site Investigation
RI/FS- Remedial Investigation/Feasibility Study
ROD/DD-Record of Decision/Decision Document: Required for interim and final remedial actions, RODs for NPL sites, DDs for non-NPL sites, prepared prior to construction and remedial design phases
RD-Remedial Design
RA- Remedial Action
RA(C)-Remedial Action Construction
RIP-Remedy in Place: End of remedial action (construction) phase and beginning of remedial action (operations) phase
RA(O)-Remedial Action Operation
RC-Response Complete: All cleanup objectives have been met (remediation completed) with the exception of the Long Term Management phase if required
TBD- To Be Determined

Shaw® Shaw Environmental, Inc.

Subject:	**Draft Final Minutes, Monthly Managers Meeting, Longhorn Army Ammunition Plant (LHAAP)**
Location of Meeting:	**Teleconference**
Date of Meeting:	**May 19, 2009; 1:00 PM – 2:10 PM**

Meeting Participants:

BRAC:	Rose M. Zeiler
USACE-Tulsa:	Aaron Williams, John Lambert
Shaw:	Praveen Srivastav, Greg Jones, Kay Everett, Susan Watson
USEPA Region 6:	Steve Tzhone
TCEQ:	Fay Duke, Dale Vodak
USFWS:	Barry Forsythe

Previous Action Items

Army

- Update site status spreadsheet/schedule and provide to EPA before May meeting. *(Completed)*
- Put Site Status supporting information into memo format and submit to regulators. *(In progress)*

EPA

- Provide comments to Army on the site schedule before the June meeting. *(In progress)*

TCEQ

- Check with TCEQ management regarding how to identify small sites (i.e., the industrial sumps under LHAAP-35/36 and the sanitary septic systems under LHAAP-55) that are closed under industrial cleanup levels within larger areas that have been closed under residential cleanup levels. *(In Progress)*

Shaw

- Provide site status spreadsheet to the Army before meeting in May for review and revision before the June RAB. *(Completed)*
- Provide TCEQ with electronic tables from the FS for LHAAP-29. *(Completed)*
- Provide the MNA evaluation for LHAAP-58. *(Completed)*
- Provide the Army with 5-Year Review recommendations table with additional column for completion date. *(Completed)*

<u>Defense Environmental Restoration Program (DERP) PBC Update</u> **Praveen Srivastav**

Document Status/Environmental Sites (Table)

Praveen Srivastav briefly went over the document status/environmental sites table. The Decision Document for LHAAP-02 is in progress with groundwater monitoring issues to be resolved. RTCs for the Draft Final SI Report for LHAAP-03 have been submitted to the Army. After regulatory review and concurrence with responses, the Final document will be submitted. A Draft Action Memo for the Pistol Range and LHAAP-04 has been submitted to the Army for review and signatures. The Draft Final Removal Action Work Plan for the Pistol Range and LHAAP-04 is in preparation. Surveying and county notification requirements for sites LHAAP-06, -07, -51, -55, -64, -66, and -68 are on hold until additional clarification is made on how to survey smaller sump and septic tank sites. The comment resolution for the Draft Final Feasibility Study (FS) Addendum for LHAAP-16 is in progress. The RTCs for the Draft Final FS for LHAAP-17 are in preparation; revisions will include a “trigger” for turning off the extraction system. The Draft FS for LHAAP-18/24 is currently in comment resolution with the Army. The Draft Final FS for LHAAP-29 is in regulatory review with EPA comments pending. Responses to the DF FS for LHAAP-46 have been submitted for Army’s review. Responses to Army’s comments for the Draft FS for LHAAP-47 are in progress. Shaw collected a new round of samples from the wells at LHAAP-49 and the results reported prior to the meeting. Arsenic concentration was 12.8 µg/L and nitrate/nitrite concentration was below MCL. EPA and TCEQ agreed that all groundwater issues have been addressed and no further action for groundwater or soil is required. They agreed that the SE Report can be finalized with proposed plan and ROD to follow. RTCs to the Draft Final FS for LHAAP-50 were submitted to the EPA and TCEQ. MNA evaluation for LHAAP-58 was submitted to regulators, and the RTCs are in Army review. Surveying and county notification requirements for LHAAP-60 will be scheduled at the same time as other site surveys are conducted. The draft Decision Document for LHAAP-35/36 is in preparation.

Praveen also provided an additional table showing the tracking details of each document for the sites targeted for Sept 2009 RODs.

Praveen referred everyone to the two LHAAP-02 figures that were supplied in the handouts. A discussion followed regarding the path forward for site LHAAP-02. The group discussed the difficulty of obtaining useful SPLP results and the location of the nearest well. Praveen indicated that the groundwater protection issue can be addressed by either installing and sampling a well in the area, since the existing well 35AWW03 does not have much water, or by collecting sediment samples for SPLP. He pointed out a potential problem with SPLP sampling that the total metal results may not match those of original samples collected by USACHPPM. Fay said she would need to consider the existing data further.

Groundwater Treatment Plant Update
Normal operations continued. Steve Tzhone said he had comments on the last couple of groundwater treatment operation quarterly reports. He indicated that he did not expect these changes to be made to the existing reports, but asked that the comments be incorporated in future reports.

Path Forward for LHAAP-49
Praveen indicated that May 2009 data was emailed prior to the meeting. EPA submitted concurrence before the meeting and suggested steps for path forward. Fay said that TCEQ would provide an email indicating concurrence.

Path Forward for LHAAP-04 and Pistol Range
No public comments were received on the EE/CA for either site. Removal of the soil at these two sites is currently being planned for June, assuming that the demolition activities occurring adjacent to LHAAP-04 at the Power House will be completed by then. The draft final work plan will be available to the regulators by the end of this week.

Feasibility Study Meeting in Austin on April 27-28/Recap
The group felt that much was accomplished at the meeting. Praveen asked that everyone review the minutes of that meeting and provide any comments. Shaw had submitted the minutes to all participants during the week after the meeting.

Five Year Review Follow-up Table
Steve said that he will look at this table and call if he has questions. He indicated that this task will be conducted every quarter because Longhorn has been flagged for follow-up on the 5-Year Reviews, and that this information will go to the inspector general.

DERP Total Environmental Restoration Contract (TERC) Update **Rose Zeiler**

Status of Draft Final ROD for Sites 37/67
Steve and Rose indicated that regional legal staff at EPA (George Malone) and BRAC were trying to resolve the language for the ROD. If they can't finalize it at their level, then George Malone of EPA will send it up to EPA HQ. Steve asked if a deadline should be proposed, but Rose suggested giving them a few more days before considering that. It was noted that HQ has already been notified, although George is still trying to resolve the issue. Rose still expects the ROD to be signed this year. There is agreement between EPA and Army that MCLs should be included in the RODs as ARARs, and that they are ARARs because they are "relevant and appropriate" (as opposed to "applicable"). However, there appear to be differences about the wording of the RAOs that drive the need to include the MCLs.

BRAC-Funded Site Operations **John Lambert**

LHAAP-19—Demolition Landfill Progress
The work plan is in regulatory review.

MMRP **John Lambert**
Status of Regulatory Review
John said he is awaiting regulatory comments on the Removal Action Report and the MC Data Summary Report.

DF MEC Removal Action Report and DF MC Data Summary Report
Fay mentioned she had some questions on some of the data. Rose indicated that perchlorate is the only contaminant she needed to review since that was the only data gap. Steve suggested he would like to follow up with Fay before submitting comments. Fay reminded participants that she no longer has MEC contractors to assist on review of these reports.

Transfer Update **Rose Zeiler**

Electrical ROW Lease to USFWS
Rose indicated that the license for the electrical right-of-way at LHAAP-49 had been signed.

Transfer of LHAAP-12 Parcel
Rose said she has not heard anything from USFWS on the LHAAP-12 transfer.

ECOP VI
ECOP VI should be finished by the end of the fiscal year. Rose indicated that LHAAP-48 and -53 are suitable for unrestricted use, but that co-located Sites 35/36 and 55 are not.

Other Issues **Rose Zeiler**

2009 IAP Schedule
There was a status change on the table regarding LHAAP-56 and -69. The status for LHAAP-65 is still TBD. The schedule is still under internal review. An Army 2009 IAP data validation call will be conducted on Thursday. Fay indicated that she had not reviewed the document.
Public meetings for the sites will be done separately from the upcoming quarterly RAB since most of the sites probably will not be at the proposed plan stage yet. Tom Lederle with BRAC is expected to visit the site and attend the RAB meeting.

Powerhouse Demolition Status
The schedule of the Powerhouse demolition was discussed briefly at the beginning of the meeting. The demolition is currently in progress. Heavy truck traffic is expected from the end of May until

early June in conjunction with removing the debris. John Lambert noted that a vial of mercury was found behind some bricks.

June Meetings
The next monthly manager's meeting will be held at Longhorn on June 16, 2009 at 2 PM. The RAB meeting date is June 16 at 6:30 PM.

Meeting Adjourned

Action Items:

Army
- Update site status spreadsheet/schedule and provide to public at the June meeting.

EPA
- Provide comments to Army on the site schedule before the June meeting.

TCEQ
- Check with TCEQ management regarding how to identify small sites (i.e., the industrial sumps under LHAAP-35/36 and the sanitary septic systems under LHAAP-55) that are closed to industrial levels within larger areas that have been closed to residential levels.

Shaw® Shaw Environmental, Inc.

Subject:	**Draft Final Minutes, Monthly Managers Meeting, Longhorn Army Ammunition Plant (LHAAP)**
Location of Meeting:	**Longhorn AAP at USFWS Office**
Date of Meeting:	**June 16, 2009; 2:00 PM – 3:10 PM**

Meeting Participants:

BRAC:	Rose M. Zeiler, Tom Lederle
USAEC:	Matthew Mechenes
USACE-Tulsa:	Aaron Williams, John Lambert, Scottie Fiehler
Shaw:	Greg Jones, Kay Everett
USEPA Region 6:	Raji Josiam, Terry Burton
TCEQ:	Fay Duke
USFWS:	Barry Forsythe (phone)
USGS:	Kent Becher (phone)

Previous Action Items

Army

- Update site status spreadsheet/schedule before June meeting and provide to public. Updated and ready for distribution for the RAB meeting.
- Put Site Status supporting information into Memo format and submit to regulators. *Memo has been submitted by Tulsa to RMZ where it is in review*

EPA

- Provide comments to Army on the site schedule before the June meeting. No comments.

TCEQ

- Check with TCEQ management regarding how to identify small sites (i.e., the industrial sumps under LHAAP-35/36 and the sanitary septic systems under LHAAP-55) that are closed under industrial cleanup levels within larger areas that have been closed under residential cleanup levels. *(Fay Duke stated that each small site, closed under industrial, must be surveyed. Fay asked about the sumps at LHAAP-56 and LHAAP-65. COR indicated that the LHAAP-65 site sumps were not originally part of Shaw's scope under LHAAP-35/36 and would be addressed by Army. LHAAP-56 was previously evaluated under the assessment for LHAAP-35/36. Army asked when Shaw can get the NFA sites on the schedule for surveying. Greg Jones indicated the task can probably be implemented by the end of July through the first of August.)*

<u>Defense Environmental Restoration Program (DERP) PBC Update</u> **Greg Jones**

Document Status/Environmental Sites (Table)
Greg Jones briefly went over the document status/environmental sites table. The Decision Document for LHAAP-02 is in progress with groundwater monitoring issues to be resolved. RTCs for the Draft Final SI Report for LHAAP-03 have been submitted to the TCEQ. After regulatory review and concurrence with responses, the Final document will be submitted. A Draft Action Memoramdum for the Pistol Range and LHAAP-04 has been submitted to the Army for review and comments received. The final memo will be signed by the Army and issued to EPA and TCEQ for their files. The Draft Final Removal Action Work Plan for the Pistol Range and LHAAP-04 is in regulatory review. Comments have been received from the TCEQ. Surveying and county notification requirements for sites LHAAP-06, -07, -51, -55, -64, -66, and -68 had been on hold pending clarification on how to survey smaller sump and septic tank sites; however, with additional discussion from the TCEQ, these sites can now be scheduled. The comment resolution for the Draft Final Feasibility Study (FS) Addendum for LHAAP-16 is in progress. The RTCs for the Draft Final FS for LHAAP-17 are in preparation; responses will include revised text for alternatives and a "trigger" for turning off the extraction system. The Draft FS for LHAAP-18/24 is currently in comment resolution with the Army. The Draft Final FS for LHAAP-29 is in regulatory review with EPA comments pending. A new well was installed and sampled at LHAAP-29 in the groundwater zone below the intermediate zone. Responses to the DF FS for LHAAP-46 have been submitted for Army's review. Army comments have been received for the Draft FS for LHAAP-47, and response preparation is in progress. A new round of groundwater sampling was conducted at LHAAP-49. The Site Evaluation Report for LHAAP-49 is being finalized this week; the Draft Proposed Plan should be issued by the end of the month. Regulatory comments were received for the Draft Final FS for LHAAP-50 and revised comments were submitted to the Army for review. The MNA evaluation for LHAAP-58 was submitted to regulators, and the revised RTCs are in Army review. Surveying and county notification requirements for LHAAP-60 will be scheduled at the same time as other site surveys are conducted. Army comments to the draft Decision Document for LHAAP-35/36 have been received and are being addressed.

Rose Zeiler indicated that site surveys for the TERC sites have been completed. When the rest of the NFA site surveys are completed, Rose requested that Shaw coordinate with BRAC to schedule one visit to the county office to file the deed notification requirements.

Path Forward for LHAAP-04 and Pistol Range
Shaw collected and analyzed samples beneath the slab at LHAAP-04. The objective was to determine if perchlorate or mercury was present in the soil beneath the slab at concentrations that would require removal. Results will be available shortly. Shaw also collected samples near the power poles. If the results are favorable, then the poles may be left in place. If contamination is found, the poles will need to be moved.

Feasibility Study Meeting in Austin on April 27-28/Recap
The draft meeting minutes have been developed and provided to the group for any questions or comments.

John Lambert acknowledged that Shaw has tried to work through remedies and has gone beyond their original proposal for some of the Longhorn sites. He also emphasized that everyone at the meeting performed well by moving quickly on what they were asked to do. However, disagreement regarding some of the proposed remedies has impacted the schedule regarding moving these sites through the feasibility study and later stages. John indicated that the disagreement came from higher level management at the Army, which does not agree with utilizing a two-component remedy, when the MNA remedy's effectiveness is not fully resolved by all parties. This is becoming a contractual issue. The issue impacts several sites that were previously expected to have their RODs by the end of the fiscal year. Raji Josiam said that she would inform Steve Tzhone of possible schedule impacts.

Five-Year Review Follow-up Table
Greg asked if there were any comments regarding that Five-Year Review Follow-up Table that Army had distributed prior to the previous meeting. Army indicated that they were preparing a draft of the Explanation of Significant Differences (ESD). The purpose of that ESD is to address the use of ICTs alone (rather than a combination of both ICTs and extraction wells) for groundwater extraction at LHAAP-18/24 as part of the Interim Remedial Action.

Groundwater Treatment Plant Update
Normal operations continued. Since the last meeting, a new main compressor has been installed.

Perimeter Well and Surface Water Monitoring
Results for the last perimeter well and creek sampling event were handed out and discussed. Nothing out of the ordinary was reported.

DERP Total Environmental Restoration Contract (TERC) Update **Rose Zeiler**

ROD for Sites 37/67
Rose indicated that regional legal staff at EPA (George Malone) and BRAC were trying to resolve the language for the ROD.

<u>MMRP</u> **John Lambert**

The Army has received all regulatory comments on the MMRP documents. In regards to the MC Data Summary Report, the Army is considering how best to approach the white phosphorus and perchlorate issues in order to move forward. John said that the Army is concerned about the appropriateness of addressing constituents that were already addressed by the HTRW ROD in 1998. Rose added that the Technical Planning Process (TPP) had identified only two constituents that need to be addressed - white phosphorus and perchlorate, and that perchlorate was dropped for two of the sites.

<u>Other Environmental Restoration Issues/Concerns</u> **Rose Zeiler**

Construction Debris Landfill
The feedback from ECC is that everything has been pulled into one work plan. It is plausible that the documents should come back in early July. The cover on Landfill 19 is expected to be seeded with native vegetation (e.g. or tall grass prairie or other native grass).

2010 IAP
This will be finalized in June and will be placed on the website after that time.

Road Maintenance
USFWS is determining which roads at the facility should be maintained. If Shaw has any related requests, they may provide input for consideration.

<u>Transfer Update</u> **Rose Zeiler**

Powerhouse Demolition
The schedule of the Powerhouse demolition was discussed briefly. The demolition is currently in progress and the contractor expects to complete it this month. Scottie Fiehler mentioned that more asbestos was encountered than expected. The contractor found some asbestos-containing insulation exterior to the bricks of the furnace.

Transfer of LHAAP-12 Parcel
There is nothing new to report regarding the transfer of this parcel.

ECOP VI
There are some issues to the ECOP; however, Rose anticipates the parcels in ECOP VI to be transferred by the end of the fiscal year.

The next monthly manager's meeting will be held via teleconference on July 14, 2009 at 2 PM. [*The time was subsequently changed to 9 AM.*]

Meeting Adjourned

Action Items:

Army

- RMZ to forward MMRP LUC notification language to Fay Duke.
- Aaron to coordinate with FWS and contractor to ensure appropriate native vegetation is seeded on Landfill 19

ENCLOSURE 2

LIST OF FY2009 ROD SITES (HIGHLIGHTED)

						Completion Dates											
						Interim Action				Final Action							
Site ID (DSERTS)	RMIS #	DERPMIS		SITE DESCRIPTION	SI	RI/FS	ROD/DD	RD	RA	RI/FS	ROD/DD	RD	RA	RA(C)	RIP (Completion Report)	RA(O)	RC
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LHAAP-003	3	3		Building 722 - Paint Shop	May-08					Jan-09	Jul-09				Sep-09		Sep-09
LHAAP-004	4	4	XX	Pilot Waste Water Treatment Plant						Feb-09	Dec-09	Jun-09	Aug-09	Aug-09	Dec-09 (NFA ROD)		Sep-15
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LHAAP-017	17	16	X	No. 2 Flashing Area Burning Ground						May-09	Sep-09	Jan-10	Mar-10	Mar-10	May-10	Sep-15	
LHAAP-018	18	17	X	Burning Ground/Rocket Motor Washout Pond			May-95		Mar-10	May-09	Mar-10	Jul-10	Sep-10	Sep-10	Dec-10	Sep-15	
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------------	18	62		Building 43-X													
LHAAP-019	19	63		Construction Materials Landfill													
LHAAP-023	23	23		Building 707 Storage for PCBs													
LHAAP-024	24	43	X	Former Unlined Evaporation Pond			May-95		Mar-10	May-09	Mar-10	Jul-10	Sep-10	Sep-10	Dec-10	Sep-15	
LHAAP-027	27	19	X	South Test Area/Bomb Test Area							Jan-98						
LHAAP-029	29	21	X	Former TNT Production Area						May-09	Sep-09	Jan-10	Mar-10	Mar-10	May-10	Sep-15	
LHAAP-032	32	24	X	Former TNT Waste Disposal Plant							Aug-08						Aug-08
LHAAP-034	34	34		Building 701 - PCB Storage													Jul-00
LHAAP-035	35	35		Process Wastewater Sumps - Various	Jun-08					Apr-09	Aug-09						Aug-09
LHAAP-036	36	36		Explosive Waste Pads	Jun-08					Apr-09	Aug-09						Aug-09
LHAAP-037	37	37	XX	Quality Assurance Laboratory Building 29-A						Sep-08	Sep-09	Sep-08			Oct-08	Sep-39	Sep-39
LHAAP-045	45	45		Magazine Area	Sep-04												
LHAAP-046	46	46	XX	Plant 2/Pyrotechnic Operation						Feb-09	Sep-09	Jan-10	Mar-10	Mar-10	May-10	Sep-15	
LHAAP-047	47	47	XX	Plant 3/ Produces Hand Signal Assemblies						Jun-09	Mar-10	Jun-10	Jul-10	Jul-10	Oct-10	Sep-15	
LHAAP-048	48	48		Y-Area							Nov-08						
LHAAP-049	29	49	XX	Former Acid Plant						Feb-09	Sep-09				Sep-09		Sep-09
LHAAP-050	50	50	XX	Former Waste Disposal Facility						Jun-09	Sep-09	Jan-10	Mar-10	Mar-10	May-10	Sep-15	
LHAAP-051	51	51		Photographic Laboratory/Building 60-B							Dec-08						Oct-08
LHAAP-052	52	52		Magazine Washout Area													
LHAAP-053	53	53		Static Test Area							Nov-08						
LHAAP-054	54	54	X	Ground Signal Test Area							Jan-98	Jan-98					Jan-98
LHAAP-055	55	55		Septic Tanks							Dec-08						Dec-08
LHAAP-056	56	56		Vehicle Wash Rack and Oil/Water Separator													
LHAAP-057	57	57		Rubble Burial Site													
LHAAP-058	58	58	XX	Maintenance Complex						Feb-09	Sep-09	Jan-10	Mar-10	Mar-10	Jul-10	Sep-15	
LHAAP-059	59	59		Storage Building 725							Sep-08						
LHAAP-060	60	60		Former Storage Building #411 and #714	Jul-08					Aug-08	Dec-08						Dec-08
LHAAP-061	61	61		Potable Water Treatment Sediment Ponds													
LHAAP-063	63	63		Burial Pits													
LHAAP-064	64	64		Transformer Storage Area	May-08						Dec-08						Dec-08
LHAAP-065	65	65		Building #209							Mar-09						
LHAAP-066	66	66		Transformer at Building 401	May-08						Dec-08						Dec-08
LHAAP-067	67	67	XX	Above Ground Storage Tank						Sep-08	Sep-09			Sep-08		Sep-39	Sep-39
LHAAP-068	68	68		Building 51-F	May-08						Dec-08						Dec-08
LHAAP-069	69	69		Underground Storage Tank													
LHAAP-070				Loading Dock Magazine Area	Sep-95												Aug-04
LHAAP-071				Oil Spill at Bldg 813	Sep-95												Aug-04
Pistol Range			XX	Pistol Range							Sep-09	Sep-09		Dec-09	Jun-10		Sep-15
LHAAP-001-R-01			XX	South Test Area/Bomb Test Area (MMRP)						Sep-09	Sep-09						Sep-15
LHAAP-002-R-01			XX	Static Test Area (MMRP)													Oct-07
LHAAP-003-R-01			XX	Ground Signal Test Area (MMRP)						Sep-09	Sep-09						Sep-15

X Site identified in FFA

XX Additional sites identified as NPL

Legend

SI- Site Investigation

RI/FS- Remedial Investigation/Feasibility Study

ROD/DD-Record of Decision/Decision Document: Required for interim and final remedial actions, RODs for NPL sites, DDs for non-NPL sites, prepared prior to construction and remedial design phases

RD-Remedial Design

RA- Remedial Action

RA(C)-Remedial Action Construction

RIP-Remedy in Place: End of remedial action (construction) phase and beginning of remedial action (operations) phase

RA(O)-Remedial Action Operation

RC-Response Complete: All cleanup objectives have been met (remediation completed) with the exception of the Long Term Management phase if required

TBD- To Be Determined

ENCLOSURE 3:

EPA extensions on Primary Documents for LHAAP-16 and LHAAP-17 (February 4, 2010; February 26, 2010; April 2, 2010; August 5, 2011).

00113087

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

FEB 04 2010

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Request for Schedule Extension, Draft Final Addendum to the Final Feasibility Study for LHAAP-16, Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler,

The EPA has reviewed the *Request for Schedule Extension, Draft Final Addendum to the Final Feasibility Study for LHAAP-16, Longhorn Army Ammunition Plant, Karnack, Texas,* dated January 29, 2010, and agrees to the terms as specified in the request.

Please submit a revised schedule reflecting the change, prior to the next managers meeting on February 23, 2010. If there are any questions or comments, please feel free to contact me at (214) 665-8409.

Sincerely,

Stephen L. Tzhone, RPM

cc: Fay Duke, Texas Commission on Environmental Quality

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

FEB 26 2010

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Request for Schedule Extension, Final Feasibility Studies for LHAAP-17 and LHAAP-29, Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler,

The EPA has reviewed the *Request for Schedule Extension, Final Feasibility Studies for LHAAP-17 and LHAAP-29, Longhorn Army Ammunition Plant, Karnack, Texas,* dated February 25, 2010, and agrees to the terms as specified in the request.

Please submit a revised schedule reflecting the changes, prior to the next managers meeting in March 2010. Please feel free to contact me at (214) 665-8409, or by email at tzhone.stephen@epa.gov, if there are any questions or comments.

Sincerely,

Stephen L. Tzhone, RPM

cc: Fay Duke, Texas Commission on Environmental Quality

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

APR 02 2010

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Request for Schedule Extension, Final Feasibility Studies for LHAAP-17 and LHAAP-29, Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler,

The EPA has reviewed the *Request for Second Schedule Extension, Final Feasibility Studies for LHAAP-17 and LHAAP-29, Longhorn Army Ammunition Plant, Karnack, Texas,* dated March 30, 2010, and agrees to the terms as specified in the request.

Please submit a revised schedule reflecting the changes, prior to the next managers meeting in April 2010. Please feel free to contact me at (214) 665-8409, or by email at tzhone.stephen@epa.gov, if there are any questions or comments.

Sincerely,

Stephen L. Tzhone, RPM

cc: Fay Duke, Texas Commission on Environmental Quality

00113090

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS TX 75202-2733

AUG 05 2011

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Update for FY11 LHAAP Site List Schedule
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler,

The U.S. Environmental Protection Agency (EPA) has reviewed the *Update for FY11 LHAAP Site List Schedule, Longhorn Army Ammunition Plant, Karnack, Texas,* dated July 28, 2011, and approves of the submitted schedule.

This approved schedule will now serve as the site-wide enforcement schedule between the EPA and the Army from the date of this letter. Please feel free to contact me at (214) 665-8507, or Mr. Stephen Tzhone at (214) 665-8409, if there are any questions or comments.

Sincerely,

Carlos A. Sanchez

Carlos Sanchez, Chief
Superfund Remedial AR/TX Section

cc: Ms. Fay Duke, TCEQ
Mr. Paul Bruckwicki, FWS

ENCLOSURE 4:

EPA Region 6 and HQ comments LHAAP-16, LHAAP-17, LHAAP-001-R, LHAAP-003-R (August 17, 2011; August 29, 2011; August 31, 2011).

1. Section 1.4, Page 1-2, Description of the Selected Remedy, 3rd Bullet - This bullet should be revised to read, "Installation of a biobarrier in the downgradient portion of the contaminant plume to prevent contaminated groundwater from discharging into Harrison Bayou, which flows into Caddo Lake, at concentrations that would cause surface waters to exceed Texas Surface Water Quality standards, the SDWA MCLs, and Texas Media-Specific Concentration (MSC) levels. A second biobarrier will be installed at the edge of the landfill to control potential migration of volatile organic compounds (VOCs) from the landfill. The purpose of the biobarriers in conjunction with natural attenuation will be to reduce groundwater contaminant and by-product contaminant concentrations to levels that will prevent surface waters from exceeding surface water cleanup levels, to reduce groundwater contaminant and by-product contaminant concentrations to levels that attain groundwater cleanup standards, to reduce the potential migration of contaminants and by-product contaminants from the landfill, and to reduce groundwater contaminant and by-product contaminant mass."

General Comment - Delete the word, "passive" whenever it is used before the word "biobarrier," as the use of biobarriers constitute "treatment" in accordance with CERCLA's statutory preference for treatment.

The word "passive" is used many times in this section and should be deleted.

Other areas to delete the word "passive" can be found on pp. 2-22, 2-23,2-25, 2-27, 2-30, 2-36, 2-38, 2-40, 2-42, 2-43, 2-45, 2-46, 2-47, 2-48, 2-50, 2-51, 2-53, 2-55, 2-57, 2-58.

2. Section 1.4, Page 1-3, Description of the Selected Remedy, 4th Bullet on p. 1-3 - Replace the first sentence of this bullet to read, "Surface water monitoring will also be conducted to confirm that surface water standards are not exceeded in Harrison Bayou, which flows in Caddo Lake.

3. Section 1.4, Page 1-3, Description of the Selected Remedy, 5th Bullet on p. 1-3 - Replace this bullet with the following, "LUCs to prevent human exposure to landfill waste and contaminated groundwater. The LUCs will remain in place as long as the landfill waste remains at the Site. In addition, LUCs restricting the use of groundwater to environmental monitoring and testing only, will remain in place until the contaminated groundwater attains groundwater cleanup levels in order to prevent human exposure to the contaminated groundwater. The above LUCs will remain in place until the contaminated soil, subsurface soil and groundwater attain cleanup standards/levels to allow for unlimited use and unrestricted exposure."

4. Section 1.4, Page 1-4 - Description of the Selected Remedy, 2nd Paragraph - This paragraph should be modified to show that there will be "LUCs" and not just LUC.

As such, throughout this section as well as the remainder of the ROD, LUC should be modified to read "LUCs."

5. Section 1.4, Page 1 - 5, Statutory Determinations - This section should be modified by deleting all references in the section that refers to MNA as "passive treatment." MNA is a passive remedial action - not treatment.

In addition, delete the word "passive" every time it is used before the word "biobarrier." See comment # 1.

6. Section 2.2.1, Page 2-2, History of Site Activities, 4th Para. - After the phrase, "Harrison Bayou," include the following: ", which flows into Caddo Lake."

7. Section 2.4, Page 2-6 - Scope and Role of Response Action, Second Paragraph - Delete the existing language and modify the second paragraph to read, "The selected remedial action will treat the contaminated groundwater plume to prevent the migration of groundwater contaminants to Harrison Bayou, which flows into Caddo Lake, a major source of drinking water. In addition, the selected remedial action will include groundwater monitoring to demonstrate that the contaminants and by-product contaminants are not migrating into Harrison Bayou, which flows into Caddo Lake, at or above surface water standards. For purposes of this ROD, surface water standards (i.e., cleanup levels) include the Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available, the Texas MSCs for GW-Res as authorized under 30 TAC 335.559(b).

Please note that the ARARs table 2-10 and table 2-7 will have to be modified to include the above ARARs and standards.

Same Section, Page 2-7, Second Para. on the page - Modify the second paragraph on page 2-7, beginning with sentence 5 and through the end of the paragraph with, "Installation of biobarriers will control the potential migration of contaminants and by-product contaminants from the landfill, and will reduce the groundwater contamination mass, thus providing additional protection to Harrison Bayou and Caddo Lake. Natural attenuation will further reduce groundwater contaminants and by-product contaminants respective concentrations. The LUCs to be implemented include groundwater use restrictions and land use restrictions to protect and maintain the integrity of the existing landfill cover system. The LUCs will continue to remain in place until the contaminated soil, subsurface soil and groundwater attain cleanup standards/levels to allow for unlimited use and unrestricted exposure. Without the selected remedial action, the potential for the contaminated groundwater to seep into Harrison Bayou, which flows into Caddo Lake, at levels that equal or exceed surface water standards constitutes an unacceptable risk to human health and the environment. Caddo Lake is a major source of drinking water, also used for fish consumption and recreation."

Delete the existing language for the above paragraph, starting at sentence 5.

8. Section 2.5.1, Page 2-8, Conceptual Site Model, Last Para. of the Section - Delete the last paragraph of this section and modify/replace with, "The contaminants in the shallow groundwater migrate toward and discharge by seepage into Harrison Bayou, which flows into Caddo Lake, a major source of drinking water. The discharge of contaminated groundwater into Harrison Bayou, which flows into Caddo Lake, represents a groundwater to surface water pathway of exposure that is identified and addressed by the selected remedial action."

***it appears that there is a groundwater to surface water pathway of exposure. Are there risks related to wildlife, plant-life and aquatic life due to contaminated groundwater discharging into Harrison Bayou? If so, were those risks documented to be acceptable or unacceptable risks?**

9. Section 2.6.2, Page 2-11, Current and Future Surface Water Uses - The first paragraph of this section should be modified to reflect that the surface water discussed here is Harrison Bayou. As such, delete the existing language and replace with,

"Harrison Bayou, which is located on and adjacent to LHAAP, currently supports wildlife and aquatic life and flows into Caddo Lake. Humans have limited access to parts of Harrison Bayou during animal hunts, but there is no routine use of Harrison Bayou located at the LHAAP Site. Harrison Bayou does not carry adequate numbers and size of fish to support either sport or subsistence fishing. During the dry summer months, Harrison Bayou ceases to flow and dries up. The eastern portion of the LHAAP-16 landfill Site is located within Harrison Bayou's 100-year flood-plain. When flowing, Harrison Bayou discharges into

Caddo Lake, a large recreational lake covering 51 square miles with a mean depth of 6 feet. The watershed of the lake encompasses approximately 2,700 square miles. Caddo Lake is used extensively for fishing and boating, and is a major drinking water supply for multiple cities in Louisiana including Vivian, Oil City, Mooringsport, South Shore, Blanchard, Shreveport, and Bossier City."

10. Section 2.7.1.4, Page 2-15, Risk Characterization, Last Para. - At the end of the last paragraph in this Section, add the following sentence. Five-Year Reviews will be conducted at the Site in a manner consistent with the 1991 FFA, CERCLA Section 121(c), the NCP, and EPA's Five-Year Review Guidance per CERCLA Section 120(a).

11. Section 2.7.3, Summary of Ecological Risk Assessment, Pages 2-18 - 2-19 – ***This section seems to only address ecological risks pertaining to soils. Are there risks related to wildlife, plant-life and aquatic life due to contaminated groundwater discharging into Harrison Bayou? If so, were those risks documented to be acceptable or unacceptable risks?**

12. Section 2.7.4, Page 2-19, Basis of Action, Second Paragraph - Delete the second paragraph of this Section and modify/replace with, "As it concerns the contaminated groundwater at LHAAP-16, a SDWA MCL has been identified for each COC with the exception of perchlorate, manganese and nickel. For those COCs and by-product (i.e., daughter) contaminants that have an MCL, the MCL constitutes the groundwater cleanup level to be attained. If no MCL exists for a COC or by-product contaminant found in the contaminated groundwater, the MSCs for GW-Ind as authorized under 30 TAC 335.559(d), constitutes the groundwater cleanup standard to be attained. With respect to the surface waters impacted by contaminated groundwater discharging into Harrison Bayou, which flows into Caddo Lake (a drinking water source), the Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available the Texas MSCs for GW-Res as authorized under 30 TAC 335.559(b), constitute the surface water cleanup levels/standards to be attained at the Site."

13. Section 2.9.1, Page 2-20, Description of Remedy Components, Alternative 1 - This Section discusses how the existing landfill cap would be maintained, which is okay. But, because this alternative is part of the selected remedial action (alternative 7), the ARARs section and the ARARs table 2-10 will have to be modified to reflect that there are certain requirements concerning the closure and post-closure care for landfills. 40 C.F.R. §§ 264.111 and 264.300 - 310 are relevant and appropriate requirements here, and the standards will have to be met.

14. Section 2.9.1, Page 2-22, Alternative 4 - The title for this alternative is misleading, and the word "passive" should be deleted. A more descriptive title for the groundwater portion of this title should simply read, "In Situ Permeable Reactive Barrier." I recommend the above change be made throughout this document.

The above comment also applies to the titles for Alternative 5a and 5b on page 2-23.

15. Section 2.9.1, Page 2-23, Alternative 5(b), Bullet one - The contingency action language under the first bullet addresses the possibility of excavating, handling and disposal of hazardous landfill waste is simply incorrect. The removal and management of such waste as a hazardous waste under this alternative is simply an ARAR under 40 C.F.R. §§ 264.110 - 120 and 264.300-310. In addition, the hazardous waste analysis, treatment and disposal requirements are ARARs under 40 C.F.R. Parts 262 and 268, for this particular alternative.

16. Section 2.9.1, Page 2-23, Alternative 7, Bullet six - Delete the first paragraph of this bullet and replace/modify with the following, "MNA of the shallow and intermediate groundwater zones to further reduce the concentrations of contaminants and by-product contaminants in the groundwater so that the

contaminated groundwater attains groundwater cleanup levels/standards, and the surface water (i.e., Harrison Bayou which flows into Caddo Lake) impacted by the contaminated groundwater attains surface water cleanup levels/standards."

17. Section 2.9.2, Page 2-26, Common Elements of Alternatives 1 through 7, LUCs, First Para., Fourth Sentence - Modify this sentence to read, "The LUCs would prevent human exposure to landfill contents and residual groundwater contamination that may present an unacceptable risk to human health and the environment, and would preclude .... ."

18. Section 2.9.2, Page 2-27, Common Elements of Alternatives 1 through 7, MNA, First Para., the Sentence just before the Last Sentence of the Para. - Modify this sentence to read, "MNA would take over within the areas of the selected remedial action employing biobarriers, so long as the monitoring and sampling data indicate that MNA would serve as an appropriate remedy in lieu of the biobarriers."

19. Section 2.9.2, Page 2-27, Common Elements of Alternatives 1 through 7, Inspection/Long-Term Groundwater Monitoring, Third Sentence - Modify the third sentence to read, "Further groundwater and surface water monitoring would be used to evaluate contaminant and by-product contaminant migration, confirm that the COCs and by-product contaminants in the groundwater plumes degrade in a manner to achieve attainment of groundwater cleanup standards/levels, and to verify that contaminant levels in Harrison Bayou, which flows into Caddo Lake, are below the surface water cleanup standards/levels."

20. Section 2.9.2, Page 2-29, Distinguishing Features of the Alternatives, Performance Monitoring, Second Para., Second Sentence - Modify/Replace this sentence to read, "The groundwater extraction system would need to operate until the contaminated groundwater at LHAAP-16 has attained the SDWA MCLs and Texas MSCs for GW-Ind. For those COCs and by-product (i.e., daughter) contaminants that have an MCL, the MCL constitutes the groundwater cleanup level to be attained. If no MCL exists for any COC found in the contaminated groundwater, the Texas MSCs for GW-Ind, as authorized under 30 TAC 335.559(d) constitutes the groundwater cleanup standard/level to be attained. With respect to the surface waters impacted by contaminated groundwater discharging into Harrison Bayou, which flows into Caddo Lake (a drinking water source), the Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available the Texas MSCs for GW-Res, as authorized under 30 TAC 335.559(b), constitute the surface water cleanup levels/standards to be attained at the Site."

21. Section 2.9.2, Page 2-30, Distinguishing Features of the Alternatives, Passive Groundwater Treatment - Modify/Replace this heading to read, "In Situ Permeable Reactive Barrier."

Also delete all use of the word "passive" as it relates to barrier system used in this section.

Fist Para. of this Section - The second to the last sentence of the first paragraph ends with "Harrison Bayou." Modify the sentence to end with, ... "Harrison Bayou, which flows into Caddo Lake."

22. Section 2.9.2, Page 2-32, Distinguishing Features of the Alternatives, Permeable Reactive Barrier - Modify/Replace this heading to read, "In Situ Permeable Reactive Barrier."

Also delete all use of the word "passive" as it relates to barrier system used in this section.

First Para. of this Section, Page 2-33 - Modify the first sentence of the first paragraph. After the words, "Harrison Bayou" include the following, " , which flows into Caddo Lake."

Same Section, Second Para., Page 2-33 - After the third sentence of this paragraph, include the following sentence, "Note however, these soils would be subject to the waste analysis and land disposal restriction requirements found in 40 C.F.R. §§ 262.11 and 268.7.

23. Section 2.9.2, Page 2-36, Distinguishing Features of the Alternatives, Passive Biobarrier - Modify/Replace this heading to read, "Biobarriers."

Also delete all use of the word "passive" as it relates to the biobarriers used in this section.

Fist Para. of this Section - Modify the first sentence of this section to read, "A biobarrier would be installed in the downgradient portion of the groundwater plume to prevent the contaminated groundwater from discharging into Harrison Bayou, which flows into Caddo Lake, at concentrations that fail to attain the Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available the Texas MSCs for GW-Res, as authorized under 30 TAC 335.559(b)."

24. Section 2.9.3, Pages 2-36 - 2-37, Expected Outcomes of Each Alternative - Modify this section to read, "Alternative 1 would allow the site to remain a hazard to human health due to the potential ingestion of contaminated groundwater; and the environment, because no remedial activities would be conducted and there would be no LUCs except for cap maintenance. Note however, the landfill cap maintenance would comply with RCRA landfill closure and post-closure care regulations. Alternatives 2 through 7 all provide engineering controls, treatment, containment, or removal and disposal of the waste material to levels protective of human receptors and the environment, including the groundwater at the Site, and Harrison Bayou, which flows into Caddo Lake. The six remedial action alternatives have very similar outcomes of preventing exposure to landfill wastes and contaminated groundwater by utilizing the landfill cap and LUCs. Alternatives 2, 3, 4, 6, and 7 would maintain the surface water standards of Harrison Bayou, which flows into Caddo Lake, through a variety of treatment processes. Alternative 2 takes advantage of the existing groundwater treatment plant. Alternatives 3b, 4, 5a, 5 and 7 would achieve groundwater and surface water cleanup levels/standards in less time through utilization of active treatment. The similar outcomes include restoration of the contaminated groundwater by attainment of the SDWA MCL for those COCs and by-product (i.e., daughter) contaminants that have a MCL, to the extent practicable, and consistent with 40 C.F.R. § 300.430(e)(2)(i)(B & C). Because no SDWA MCL exists for some COCs including perchlorate, manganese and nickel, the MSCs (GW-Ind) as authorized under 30 TAC 335.559(d) constitutes the groundwater cleanup standard to be attained. Similar outcomes also include the attainment of surface water standards in surface waters impacted by the contaminated groundwater discharges at LHAAP. As such, the Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available the Texas MSCs (GW-Res) as authorized under 30 TAC 335.559(b), constitute the surface water cleanup levels/standards to be attained at Harrison Bayou, which flows into Caddo Lake (a drinking water source). In addition, the groundwater and surface water monitoring activities associated with Alternatives 2 through 7 would confirm the protection of human health and the environment by documenting the return of groundwater to its potential beneficial use as a drinking water supply, by documenting the reduction of contaminant mass, and protection of the surface water through containment of the plume. The LUCs will remain in place until the contaminated soil, subsurface soil and groundwater attain cleanup levels to allow for unlimited use and unrestricted exposure. Without these remedial action alternatives, the potential risk for seepage of contaminated groundwater into Harrison Bayou, which flows into Caddo Lake, at levels that equal or exceed surface water standards constitutes an unacceptable risk to human health and the environment. Caddo Lake is a major source of drinking water."

Same Section - The phrase, "Summary of Comparative Analysis of Alternatives" should have been a heading for a new section or subsection.

25. Section 2.9.4, Page 2-38, Overall Protection of Human Health and the Environment - In the first paragraph on p. 2-38, modify the second sentence as follows, "Alternative 2 maintains the current actions of capping and groundwater extraction to contain the contaminated groundwater plume and prevent it from further impacting Harrison Bayou, which flows into Caddo Lake, a drinking water source."

Also delete all use of the word "passive" as it relates to the biobarriers used in this section.

26. Section 2.9.5, Pages 2-38 - 2-39, Compliance with ARARs - Modify/Replace the Second paragraph with the following, " Because contaminated groundwater has discharged into Harrison Bayou, which flows into Caddo Lake (a drinking water supply), chemical-specific ARARs for surface water consumption are applicable, relevant and appropriate. Specifically, Texas Surface Water Quality Standards as set forth in 30 TAC 307.6(d)(1) for TCE (5ug/L), 1,2-DCA (5 ug/L), 1,1-DCE (7 ug/L), 1,1,2-TCA (5 ug/L), vinyl chloride (2 ug/L), arsenic (10 ug/L), and thallium (2 ug/L) will be attained at the Site. The Texas Surface Water Quality standards are equivalent to the SDWA MCLs. When the Texas Surface Water Quality standards are not available, the SDWA MCLs constitute the cleanup standards/levels to be attained per 30 TAC 335.559(b). The MCLs for cis-1,2-DCE (70 ug/L), methylene chloride (5 ug/L), and chromium (100 ug/L) will be attained at the Site. When no SDWA MCLs are available the Texas MSC (GW-Res) is the standard used for surface waters such as Harrison Bayou, which flow into a major drinking water source, Caddo Lake. The MSC (GW-Res) for nickel (730 ug/L), perchlorate (26 ug/L) and manganese (7,820 ug/L) will be attained at the Site.

27. Section 2.9.6, Page 2-40, Long-term Effectiveness and Permanence - Second Paragraph - Modify/Replace the first sentence of this paragraph with, " The permeable reactive barriers used in Alternatives 5a and 5b to avoid the potential risk that the contaminated groundwater seeping into surface water could cause Harrison Bayou, which flows into Caddo Lake, to exceed surface water standards, may be effective and relatively reliable with long-term maintenance and monitoring."

Also delete all use of the word "passive" as it relates to the biobarriers and treatment used in this section.

Also replace the phrase "drain passively" and replace with "drain by use of gravity."

Same Section, Page 2-41 - Is it necessary to include "(if they can be found)" in the language in this section discussing the location of hot spots? If not, delete the language, as it seems that Army does not either have the money or fortitude to locate the hot spots in question.

28. Section 2.9.7, Page 2-42, Reduction of Toxicity, Mobility, or Volume through Treatment, Last Paragraph, Last Sentence - Replace the last sentence with, "If the excavated material is RCRA-characteristic, treatment of such materials to meet the LDRs would satisfy the CERCLA Section 121(b), statutory preference for treatment.

Also delete all use of the word "passive" as it relates to the biobarriers used in this section.

28. Section 2.9.8, Page 2-43, Short-term Effectiveness, Last Paragraph - Modify the 3rd sentence in the last paragraph for this section to read, "However, the shallow groundwater zone plume is still migrating along the groundwater flow direction toward Harrison Bayou, which flows into the drinking water source, Caddo Lake."

Also delete all use of the word "passive" as it relates to the biobarriers used in this section; do the same on p. 2-45 (Implementability Section); do the same as it relates to treatment components on p. 2-46 (Cost Section).

29. Section 2.10, Page 2-47, Principle Threat Wastes, First Para. - Modify/Replace the first paragraph to read, "LHAAP-16 was used primarily as a solid and industrial waste landfill. Placement of the landfill cap prevents rainfall from further infiltrating and leaching contaminants from principle threat wastes and source material disposed in the landfill. However, contaminated groundwater beneath the landfill area continues to migrate. A groundwater extraction and treatment system was voluntarily installed in 1996 to prevent the groundwater plume with elevated levels of contaminants, from migrating to Harrison Bayou, which flows into Caddo Lake."

30. Section 2.11.1, Page 2-47, Summary of Rationale for the Selected Remedy -

Capping comment - This comment serves as a reminder concerning a previous comment (i.e., #13) made with respect to capping requirements. Note that the ARARs section and the ARARs table 2-10 will have to be modified to reflect that there are certain requirements concerning the closure and post-closure care for landfills. 40 C.F.R. §§ 264.111 and 264.300 - 310 are relevant and appropriate requirements here, and the standards must be attained.

Same Section, Second Bullet - Modify/Replace with, "Treatment of the groundwater by in situ bioremediation in the more contaminated areas and installation of biobarriers will reduce contaminant mass and control contaminated groundwater from migrating into Harrison Bayou, which flows into Caddo Lake. The above selected remedial actions employing treatment along with MNA, will ultimately restore the groundwater to attain groundwater cleanup standards/levels.

Same Section, Page 2-48, Third Bullet - Modify/Replace with, "MNA for areas inside and outside the influence of the selected remedies employing treatment will assure protection of human health and environment by documenting that further reductive dechlorination is occurring within the groundwater plume and that contaminant and by-product contaminant concentrations are being reduced to attain surface water and groundwater standards/levels."

Same Section, Page 2-48, Last Two Bullets - Modify/Replace with, " LUCs will remain in place as long as the landfill waste remains at the Site. In addition, LUCs restricting the use of groundwater to environmental monitoring and testing only, will remain in place until the contaminated groundwater attains groundwater cleanup standards/levels in order to prevent human exposure to the contaminated groundwater. The above LUCs will remain in place until the contaminated soil, subsurface soil and groundwater attain cleanup standards/levels to allow for unlimited use and unrestricted exposure."

Same Section, Page 2-48, First Paragraph on p. 2-48 - Modify/Replace with, "Groundwater and surface water monitoring will be conducted to confirm that COCs and by-product contaminants concentrations in the groundwater plume are declining through treatment and natural processes, and that Harrison Bayou, which flows into Caddo Lake, is protected from groundwater discharges that fail to attain surface water and groundwater cleanup standards/levels. In situ bioremediation and biobarriers constitute treatment measures designed to reduce the COCs and by-products contaminant mass, and protect Harrison Bayou and Caddo Lake from contaminant and by-product contaminant discharges above cleanup standards/levels." Monitoring will continue until it is demonstrated that there is no further release or threat of releases of contaminated groundwater into the surface water, and the groundwater supports unlimited use and unrestricted exposure."

Same Section, Page 2-48, Second Paragraph, First Sentence on p. 2-48 - Modify/Replace with, "The selected remedies employing treatment will significantly reduce contaminant concentrations. The remedies employing treatment, along with MNA, will ultimately restore the groundwater to attain groundwater cleanup standards/levels."

Same Section - Delete the word, "passive" in this section when it is connected to the use of biobarriers.

31. Section 2.11.2, Page 2-49, Description of the Selected Remedy -

Bullet One, Cap maintenance - This comment serves as a reminder concerning a previous comment (i.e., #13) made with respect to capping requirements. Note that this section, the ARARs section and the ARARs table 2-10 will have to be modified to reflect that there are certain requirements concerning the closure and post-closure care for landfills. 40 C.F.R. §§ 264.111 and 264.300 - 310 are relevant and appropriate requirements here, and the standards must be met.

Bullet Two - Modify/Replace with, "The LUCs will restrict access to contaminated groundwater for environmental monitoring and testing only, will preserve the integrity of the landfill cap, and restrict intrusive activities (e.g., digging) that would degrade or alter the cap. The LUCs will remain in place as long as the landfill waste remains at the Site. LUCs restricting the use of groundwater to environmental monitoring and testing only, will remain in place until the contaminated groundwater attains groundwater cleanup levels in order to prevent human exposure to the contaminated groundwater. LUCs will remain in place until the contaminated soil, subsurface soil and groundwater attain cleanup standards/levels that support unlimited use and unrestricted exposure. Without the selected remedial action, including the LUCs, the potential for the contaminated groundwater located beneath the landfill to seep into Harrison Bayou, which flows into Caddo Lake, at levels that equal or exceed surface water standards, constitutes an unacceptable risk to human health and the environment. Caddo Lake is a major source of drinking water, and is also used for fish consumption and recreation. LUC implementation details will be included in the RD. Within 90 days of the signing of the ROD, the U.S. Army will prepare and submit the RD to EPA consistent with the scheduling requirements found in the 1991 FFA. The recordation notification for the Site which will be filed with Harrison County will include a description of the LUCs. The boundary of the LUCs will enclose the Site boundaries and the groundwater plume boundaries shown in Figure 2-3."

Same Section, Page 2-49, Second Paragraph - Replace the phrase, "The Army would be responsible" with "The Army will be responsible ..."

Also, in item number (5) in this paragraph, replace the language with "(5) ensuring that the LUC objectives are met to protect the integrity of the selected remedy."

Same Section, Page 2-49, Second Paragraph - At the end of the paragraph add, "The Army shall retain the ultimate responsibility for remedy integrity as provided in the 1991 FFA and CERCLA Section 120."

Same Section, Page 2-50, First Paragraph - This paragraph should be modified to address the duration of the LUCs as provided in my previous comments under this item (i.e., # 31). The LUCs will remain in place as long as the landfill and the cap are in place at the Site, and until the contaminated soil, subsurface soil and groundwater attain cleanup standards/levels that support unlimited use and unrestricted exposure.

Same Section, Page 2-50, Fourth Paragraph - Modify/Replace the fourth paragraph, first sentence, with "The need for continued groundwater and surface water monitoring will be evaluated very five years during the reviews required under CERCLA Section 121(c)."

Same Section - delete the word, "passive" when it is used in connection with the word "biobarrier."

Same Section, Page 2-51, First Paragraph - Modify/Replace the phrase, "TCE daughter products" with "TCE daughter by-products ..."

Same Section, Page 2-51, Passive Biobarriers Sub-heading - Delete the word, "passive" when it is used in connection with the word "biobarrier." Also, delete the word, "passive" when it is used in connection with the word "biobarrier" on the remainder of the page.

Same Section, Page 2-51, Passive Biobarriers Sub-heading, Second Sentence - Modify/Replace the second sentence to read, "A biobarrier will be installed in the downgradient portion of the contaminant plume to prevent contaminated groundwater from discharging into Harrison Bayou and Caddo Lake at concentrations that would cause surface water to exceed Texas Surface Water Quality Standards, SDWA MCL standards, and Texas MSC for GW-Res standards..

Also in the same Sub-heading, include the phrase "COC and by-product concentrations ..." in the beginning of the second to last sentence of this sub-heading. In the last sentence of the sub-heading, include the phrase "COCs and by-products downgradient ..."

Same Section, Page 2-51, MNA to return groundwater to its potential beneficial use, wherever practicable Sub-heading, Sixth Sentence - Modify/Replace the sixth sentence with, "Therefore, MNA is proposed for LHAAP-16 in conjunction with in situ bioremediation to enhance reductive dechlorination within the groundwater plume. Biobarriers will prevent the discharge of contaminants and by-product contaminants into the surface water (i.e., Harrison Bayou, which flows into Caddo Lake)."

Same Section, Page 2-52, Third Circle - Modify the phrase "daughter products" to read "contaminants and daughter by-product contaminants."

Same Section, Pages 2-52 - 2-53, Groundwater and Surface Water Monitoring Sub-heading - In the first sentence, modify the language concerning the protection of Harrison Bayou to read, "... and to protect surface water in Harrison Bayou, which flows into Caddo Lake, from not attaining Texas Surface Water Quality Standards, SDWA MCLs and the Texas MSC for GW-Res standards."

Same Section, Page 2-53, Long-Term Operations Sub-heading, Last Three Sentences - Modify/Replace the last three sentences with, "Groundwater use restrictions will remain in place until groundwater COC and by-product contaminants concentrations drop to levels below the SDWA MCLs and Texas MSCs for GW-Ind, and support unrestricted use of the groundwater. Groundwater and surface water monitoring will be implemented at least every 5 years as provided under CERCLA Section 121(c). Monitoring will continue until the sampling data and information demonstrate that there are no releases or further threat of releases of groundwater contamination that fail to attain the SDWA MCLs and Texas MSCs for GW-Ind, and that no releases or threat of releases of contaminated groundwater into Harrison Bayou at levels that fail to attain the Texas Surface Water Quality Standards, the SDWA MCLs, and the Texas MSCs for GW-Res are present."

Section 2.11.3, Page 2-53, Cost Estimate for the Selected Remedy - Modify/Replace "LUC" in this section of "LUCs."

Also, delete the use of the word, "passive" before the word, "biobarrier."

32. Section 2.11.4, Page 2-53 - 2-54, Expected Outcomes of the Selected Remedy, First Paragraph - Modify/Replace first paragraph of this section to read, "The purpose of this response action is to attain the RAOs stated in Section 2.8 of this ROD. The groundwater will be restored to attain groundwater cleanup standards/levels. With respect to the COCs and by-product contaminants found in the groundwater at the Site, the groundwater cleanup standards/levels include attainment of the SDWA MCL for those COCs

and by-product (i.e., daughter) contaminants that have a MCL, to the extent practicable, and consistent with 40 C.F.R. § 300.430(e)(2)(i)(B & C). Because no SDWA MCL exists for some COCs and by-product contaminants including perchlorate, manganese and nickel, the MSCs (GW-Ind) as authorized under 30 TAC 335.559(d) constitutes the groundwater cleanup standard to be attained (Table 2-7). (***all ARARs tables must be modified to include ARARs listed in these comments).** Surface water standards in surface waters impacted by the contaminated groundwater discharges at LHAAP will be attained as well. The Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available the Texas MSCs (GW-Res) as authorized under 30 TAC 335.559(b), constitute the surface water cleanup standards/levels to be attained at Harrison Bayou, which flows into Caddo Lake (a drinking water source).

The expected outcome of the selected remedy is that the contaminants and by-product contaminants in the groundwater will be reduced to attain the SDWA MCLs and Texas MSCs for GW-Ind, and that any groundwater plume discharging into Harrison Bayou will be at concentrations that attain the Texas Surface Water Quality Standards, the SDWA MCLs and the Texas MSCs for GW-Res. Achievement of the groundwater cleanup standards/levels is anticipated to be completed in approximately ~~280~~ 30 - 75 years. **(*it may be appropriate to delete the 280 year time-frame throughout this document [e.g., pp. 1-3, 2-54, 2-55] and include a more realistic time-frame based upon the active treatment employed and MNA [e.g. see p. 2-51; 30 - 75 year time-frame estimate], versus using a time-frame based solely on MNA).** The actual time frame depends on the success of the active remediation, but for cost estimating purposes, it was assumed that five-year reviews will continue until Year 30. When the groundwater cleanup levels have been attained, and the groundwater supports unrestricted use without limitations, the groundwater LUC restriction will be removed. However, the LUCs to protect the landfill remedy will remain in place as long as the landfill waste remains at the Site. The landfill LUCs will remain in place until the contaminated soil, and subsurface soil attain cleanup standards/levels that support unlimited use and unrestricted exposure.

Same Section, Page 2-54, Second Paragraph, Last Sentence - The last sentence of the second paragraph should be modified to read "Groundwater LUCs will remain in place until groundwater COC and by-product contaminants concentrations drop to levels below the SDWA MCLs and Texas MSCs, that support unrestricted and unlimited use of the groundwater. The groundwater LUCs will limit the use of the Site's groundwater to environmental monitoring and testing."

33. Section 2.12.1, Page 2-54 - 2-55, Protection of Human Health and the Environment, First Paragraph, First Sentence - Modify/Replace the first sentence to read, "The selected remedy, Alternative 7 will achieve the RAOs for LHAAP-16 by protecting human health from exposure to landfill waste and contaminated groundwater, reducing the COC and by-product contaminant concentrations within the groundwater plume to attain groundwater cleanup standards/levels, and reducing surface water quality impacts to Harrison Bayou (which flows into Caddo Lake) such that surface water standards/levels are attained.

Same Section, First Paragraph, Last Two Sentences - Modify/Replace the last two sentences with, "If LHAAP is transferred out of federal control, this ROD will be modified consistent with the CERCLA Section 117 and 40 C.F.R. § 300.435(c), to address prohibitions and/or restrictions concerning property uses (e.g., drinking water well installation), in order to prevent exposure to landfill waste or contaminated groundwater. The LUCs associated with the contaminated groundwater would be required until COCs and by-product contaminants attained the SDWA MCLs and Texas MSCs for GW-Ind, and supported unlimited use and unrestricted exposure."

Same Section, Page 2-55, Second Paragraph - delete the word "passive" when used in conjunction with biobarriers.

Same Section, Page 2-55, Second Paragraph, Last Two Sentences - Modify/Replace with, "Further monitoring would be used to evaluate contaminant and by-product contaminant migration, confirm that the COCs and by-product (daughter) contaminants in the groundwater plumes continue to degrade, and verify that contaminant and by-product contaminant concentration levels in Harrison Bayou do not exceed the attainment standards/levels of the Texas Surface Water Quality Standards, SDWA MCLs and Texas MSC for GW-Res standards. The eventual groundwater concentration remedial action objective is to restore the contaminated groundwater to its potential beneficial use, which in this case is, the attainment of the SDWA MCLs and Texas MSCs for GW-Ind for all COCs and by-product contaminants.

34. Section 2.12.2, Page 2-55 - 2-56, Compliance with ARARs, Chemical-Specific ARARs - Modify/Replace this specific section with, "The chemical-specific ARAR is the attainment of the SDWA MCL for all groundwater COCs and by-product contaminants. For those COCs and by-product contaminants that do not have an MCL, the Texas MSCs for GW-Ind as authorized under 30 TAC 335.559(d) constitutes the groundwater chemical-specific ARAR to be attained. The selected remedial action employs treatment including in situ bioremediation and biobarriers, and passive remedial action (i.e., MNA) to return the contaminated shallow and intermediate groundwater zones at LHAAP-16 to its potential beneficial use as a drinking water, wherever practicable. For purposes of this ROD, attainment of the SDWA MCL or the Texas MSC for GW-Ind if no MCL is available, constitutes a return of the contaminated groundwater to it potential beneficial use as a drinking water. If a return to potential beneficial uses is not practicable based upon 40 C.F.R.§ 300.430(f)(1)(ii)(C), this alternative would still meet the NCP remedy selection requirements by reducing or controlling exposure to the contaminated groundwater consistent with 40 C.F.R.§ 300.430(e)(9). With respect to the surface waters impacted by the contaminated groundwater discharging into Harrison Bayou, which flows into Caddo Lake (a drinking water source), the Texas Surface Water Quality Standards found at 30 TAC 307, or if those standards are not available, the SDWA MCLs, or if MCLs are not available the Texas MSCs for GW-Res as authorized under 30 TAC 335.559(b), constitute the surface water cleanup levels/standards to be attained at the Site."

Note that Table 2-7 should be modified to reference all groundwater and surface water standards addressed in this comment. In addition, the GW-Res for Manganese seems to be included under the UTL column, and looks like an error - it is hard to follow the appropriate standard; the column for GW-Res for Manganese should be modified to fit under the GW-Res column for other contaminants.

35. Same Section, Page 2-56, Action-Specific ARARs - This section fails to address ARARs relevant to the landfill located at the Site. This comment serves as a reminder concerning a previous comment (i.e., #13) made with respect to landfill closure/post-closure requirements. Note that this section, and the ARARs table 2-10 will have to be modified to reflect that there are certain requirements concerning the closure and post-closure care for landfills. 40 C.F.R. §§ 264.111 and 264.300 - 310 are relevant and appropriate requirements here, and the standards must met.

Also, Table 2-10 will have to be modified to include the RCRA treatment and disposal requirements for all wastewater and debris generated at the Site, in addition to the contaminated groundwater managed at the Site. Any disposal (i.e., including spills will have to satisfy) the RCRA land disposal waste analysis, treatment and disposal standards under 40 C.F.R. §§ 262 and 268. As stated earlier, the ARARs table does not address surface water standards; it does address groundwater standards.

36. Section 2.12.4, Page 2-57, Utilization of Permanent Solutions - Delete the word "passive" before use with biobarriers.

37. Section 2.12.5, Page 2-58, Preference for Treatment - Delete the word "passive" before use with biobarriers. This section clearly satisfies the statutory preference for treatment but fails to make such a

statement. Include the following statement at the beginning of the Section."The selected remedy satisfies the statutory preference for treatment as a principal element of the remedy."

Longhorn: additional EPA comments on LHAAP -16 ROD

Stephen Tzhone to: Zeiler, Rose Ms CIV USA OSA, 'Lambert, John R SWT', Williams, Aaron K SWT, Srivastav, Praveen, Watson, Susan, 08/17/2011 10:42 PM

Cc: Fay Duke, "Dale Vodak", Terry Burton, Forsythe.Barry, kdbecher

From: Stephen Tzhone/R6/USEPA/US
To: "Zeiler, Rose Ms CIV USA OSA" <rose.zeiler@us.army.mil>, "'Lambert, John R SWT'" <John.R.Lambert@SWT03.usace.army.mil>, "Williams, Aaron K SWT" <Aaron.K.Williams@usace.army.mil>, "Srivastav, Praveen"
Cc: Fay Duke <Fay.Duke@tceq.texas.gov>, "Dale Vodak" <Dale.Vodak@tceq.texas.gov>, Terry Burton/R6/USEPA/US@EPA, Forsythe.Barry@epamail.epa.gov, kdbecher@usgs.gov

Hi Rose,

Here are the additional EPA comments on LHAAP-16 ROD:

additional EPA comments on LHAAP-16 ROD.docx

Thanks,

Stephen L. Tzhone
Superfund Remedial Project Manager
USEPA Region 6 (6SF-RA)
214.665.8409
tzhone.stephen@epa.gov

"Zeiler, Rose Ms CIV USA OSA" Rose M. Zeiler, Ph.D., Site Manager 08/16/2011 06:02:26 AM

From: "Zeiler, Rose Ms CIV USA OSA" <rose.zeiler@us.army.mil>
To: Stephen Tzhone/R6/USEPA/US@EPA
Date: 08/16/2011 06:02 AM
Subject: Anything from George on Site 16 ROD?

Rose M. Zeiler, Ph.D.,
Site Manager
Longhorn Army Ammunition Plant
479-635-0110 (0112 – fax)

Stephen Tzhone Hi Rose, The responses to the current RTCs are... 08/03/2011 03:07:08 PM

From: Stephen Tzhone/R6/USEPA/US
To: "Zeiler, Rose Ms CIV USA OSA" <rose.zeiler@us.army.mil>
Cc: "Wlilams, Aaron" <aaron.k.williams@usace.army.mil>, Fay Duke <fay.duke@tceq.texas.gov>, "Lambert, John R SWT" <John.R.Lambert@SWT03.usace.army.mil>
Date: 08/03/2011 03:07 PM
Subject: Re: Site 16 ROD RTCs

Hi Rose,

The responses to the current RTCs are agreeable to EPA, but there will be additional comments forthcoming on the LHAAP-16 ROD (mainly on ARARs and more uniform acknowledgement of surface water pathway). George is finishing them up and I will send to you

Thanks,

Stephen L. Tzhone
Superfund Remedial Project Manager
USEPA Region 6 (6SF-RA)
214.665.8409
tzhone.stephen@epa.gov

"Zeiler, Rose Ms CIV USA OSA" Hi Steve - Any idea when we migh... 08/03/2011 02:36:02 PM

From: "Zeiler, Rose Ms CIV USA OSA" <rose.zeiler@us.army.mil>
To: Stephen Tzhone/R6/USEPA/US@EPA
Cc: Fay Duke <fay.duke@tceq.texas.gov>, "Lambert, John R SWT" <John.R.Lambert@SWT03.usace.army.mil>, "Wililams, Aaron" <aaron.k.williams@usace.army.mil>
Date: 08/03/2011 02:36 PM
Subject: Site 16 ROD RTCs

Hi Steve - Any idea when we might get feedback on the RTCs?
Thanks,
Rose

Rose M. Zeiler, Ph.D.,
Site Manager
Longhorn Army Ammunition Plant
479-635-0110 (0112 – fax)

Fw: LUC Team Comments on Longhorn LHAAP -16 and LHAAP-17 RODs

Stephen Tzhone to: Zeiler, Rose Ms CIV USA OSA, 'Lambert, John R SWT', Williams, Aaron K SWT, Srivastav, Praveen, Watson, Susan, 08/29/2011 10:04 AM

Cc: Fay Duke, "Dale Vodak", Terry Burton, Forsythe.Barry, kdbecher

From: Stephen Tzhone/R6/USEPA/US

To: "Zeiler, Rose Ms CIV USA OSA" <rose.zeiler@us.army.mil>, "'Lambert, John R SWT'" <John.R.Lambert@SWT03.usace.army.mil>, "Williams, Aaron K SWT" <Aaron.K.Williams@usace.army.mil>, "Srivastav, Praveen"

Cc: Fay Duke <Fay.Duke@tceq.texas.gov>, "Dale Vodak" <Dale.Vodak@tceq.texas.gov>, Terry Burton/R6/USEPA/US@EPA, Forsythe.Barry@epamail.epa.gov, kdbecher@usgs.gov

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Allison Abernathy | Dear Steve: Thank you for sending up your RO... | 08/29/2011 08:45:02 AM

From: Allison Abernathy/DC/USEPA/US
To: Stephen Tzhone/R6/USEPA/US@EPA
Cc: Sally Dalzell/DC/USEPA/US@EPA, Monica McEaddy/DC/USEPA/US@EPA, Gracie Pendleton/DC/USEPA/US@EPA
Date: 08/29/2011 08:45 AM
Subject: Longhorn 16 & 17 RODs

Dear Steve:

Thank you for sending up your ROD to headquarters for the LUC Team's review.

The following are our comments on LHAAP -17

1. On page 1-1, under 1.2, 3rd full paragraph, last sentence. Please make the following changes to account for EPA's statutory role in selecting (not concurring with) the remedy:

The USEPA and the Army jointly select the remedy and TCEQ concurs with the selected remedy in this Record of Decision (ROD).

2. Checklist Item I, the maps do not contain an item in the key indicating the LUC boundary. Please add it to one of the map keys; otherwise the reader is guessing that the "site boundary" is the same as the LUC boundary (and it may not be). Also, please clarify whether the whole of LHAAP-29 is owned by the USFWS. On P. 2-9 it notes that most, but not all of LHAAP was transferred to the USFWS to become the Caddo Lake National Wildlife Refuge yet in Section 2.9.2, p. 2-20, it refers into a future transfer but does not name the transferee.

3. Page 1-3, 2nd to the last bullet, last sentence, please modify as follows because the ROD seems imply that the LUC will be terminated automatically and you may want additional sampling to confirm the answer or EPA may disagree that the level has been "achieved:"

- When EPA and the Army determine that the cleanup level is achieved, the LUC will be terminated.

4. Checklist item 2. Site risks and land uses. Please see section 2.6.3, p. 2-10. We are concerned

about the unclear analysis of the site risks and groundwater use. In section 2.6.3, in the first paragraph, there are a number of statements about active wells and depths, but the average reader will not know at what depth the wells are completed and also the aquifer and overlying GW zone may vary in depth. Also, the depths given are inconsistent as they are not always "bgs" and its not clear whether that is an oversight or intentional. In the second paragraph, a number of active wells are discussed but in this case the depths are not given and instead lateral distances are given. This section should be clarified with the reference to each well clearly stating whether the well is completed in the aquifer or the contaminated deep GW. Also,

5. Checklist Item 4, page 2-20 and 2-33, please modify the gw objective to make it clear that except for monitoring and testing groundwater use is prohibited until cleanup levels are met: This will be more clear than "restricted." Also, please add a LUC objective to preserve the groundwater monitoring system and prohibit residential, etc., uses as suggested below.

- **LUC for ~~restriction~~ prohibition of groundwater use (except for monitoring and testing) until the cleanup levels are attained.**

o LUC to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells.

o LUC to prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds.

completing the wells to different depths may not be sufficient to ensure no cross contamination. Please clarify in the text that there is no connectivity between the contaminated zone and the aquifer.

6. Checklist item 5. It is not clear what the LUC will be. Part of the confusion is that its not clear who owns the property-- see our comment #2 about property ownership. This need to be clarified and the LUC must be identified.

7. Checklist item 6. Duration. We see that the duration is listed on p. 2-34 for the GW LUC objective, but as noted in our comment above, we think you need to provide other objectives, so please use the following language which would apply to all the objectives: : “Land Use Controls will be maintained until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure."

8. Checklist Item 7, please modify the following statement from page 1-3, 3rd paragraph, 5th sentence (this will make it consistent with the ROD language that shows up on page 2-33) in the first sentence following the last bullet. We have already experienced attempts to limit a military service's responsibility to "report" to EPA and the state:

The U.S. Army will be responsible for implementation, maintenance, periodic inspection, reporting on and enforcement of the LUC ~~in~~ accordance with the RD.

9. Checklist Item 8, please use the checklist language and delete the listing that shows up on page 1-3, conclusion of the last full paragraph, and 2-33, at the end of the last full paragraph. This listing makes it very complicated and it is also troublesome and inconsistent with EPA's

authority. For example, the Army seems to be forgetting that it does NOT have independent authority to modify a remedy. The Army does not have the authority referenced in number (4) to reserve. This was not the only problem with the listing, but we provide it to give you an idea of what we observed.

10. On page 1-4, top of the page, and on page 2-34, under 2.12.2, top of the page, the Army must get EPA concurrence on the modification and termination of LUCs as stated above. The Army should not be able to determine if a proposed modification is "significant" as EPA may not agree. There should be no qualifier as EPA, by law, selects or modifies a chosen remedy (not just significant or insignificant changes to a remedy). EPA relies on the land use restriction found in the ROD to find that the remedy is protective. The Army cannot independently decide whether a land use change will be inconsistent with the LUC objectives and industrial use assumptions of the remedy. EPA may disagree. Finally, the way the Army has structured the language, the Army never has to tell us of the change (if the Army deems the change insignificant) and such change could result in a huge environmental problem. EPA cannot allow that. Please delete the second and third sentences and substitute the following language as seen below:

The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~.

11. Page 2-20, 1st full paragraph, page 2-34, 2nd paragraph, please make it clear that it is the Amy who notifies the county and insert a deadline. ~~If it's the Army (and it seems like it would be better to have the Army do it rather than request Texas to do it), please make the following change:~~

In addition, within 90 days of signature of this ROD, the Army shall: 1) request the Texas Department of Licensing and Regulation ~~will be requested~~ to notify well drillers of groundwater restrictions; and 2) ~~the Army shall~~ notify the ~~a notification of the LUC with the~~ Harrison County Courthouse of the LUC to include ~~would include~~ a map showing the areas of groundwater restriction at the site, in accordance with 30 TAC 335.565.

The following are our comments on LHAAP -16

1. On page 1-1, under 1.2, 3rd full paragraph, last sentence. Please make the following changes to account for EPA's statutory role in selecting (not concurring with) the remedy:

The USEPA and the Army jointly select the remedy and TCEQ concurs with the selected remedy in this Record of Decision (ROD).

2. Please clarify whether the whole of LHAAP-29 is owned by the USFWS. In Section 2.6.2, p. 2-11 it notes that most, but not all of LHAAP was transferred to the USFWS to become ethe Caddo Lake National Wildlife Refuge yet in Section 2.9.2, p. 2-26, it refers into a future transfer but does not name the transferee.

3. Checklist item 2. Site risks and land uses. Please see section 2.6.3, p. 2-11. We are concerned about the unclear analysis of the site risks and groundwater use. In section 2.6.3, in the first paragraph, there are a number of statements about active wells and depths, but the average reader will not know at what depth the wells are completed and also the aquifer and overlying GW zone may vary in depth. Also, the depths given are inconsistent as they are not always "bgs" and its not clear whether that is an oversight or intentional. In the second paragraph, a number of active wells are discussed but in this case the depths are not given and instead lateral distances are given. This section should be clarified with the reference to each well clearly stating whether the well is completed in the aquifer or the contaminated deep GW. Also, completing the wells to different depths may not be sufficient to ensure no cross contamination. Please clarify in the text that there is no connectivity between the contaminated zone and the aquifer.

4. Checklist Item 4, page page 2-22 (top of page) and page 2-49, 2nd bullet. Please modify the gw objective to make it clear that except for monitoring and testing groundwater use is prohibited until cleanup levels are met: This will be more clear than "restricted." Also, please add a LUC objective to preserve the groundwater monitoring system and prohibit residential, etc., uses as suggested below. Also, we are not clear on p. 2-50 about the LUC objective for release to surface water. How will a LUC prevent release to surface water?

- **LUC for ~~restriction~~ prohibition of groundwater use (except for monitoring and testing) until the cleanup levels are attained.**

o LUC to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells.

- LUC to **maintain the integrity of** the landfill cap.

o LUC to prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds.

- **Is a LUC objective needed for release to surface water?**

5. Checklist item 5. It is not clear what the LUC will be. Part of the confusion is that its not clear who owns the property-- see our comment #2 about property ownership. This need to be clarified and the LUC must be identified.

6. Checklist item 6. Duration. We see that duration language is Section 1.4, p. 1-3, next to the last bullet, however, we believe that additional LUCs are needed (see our comment #4).Therefore it would be simpler to use the standard checklist language because it will address all possible LUC objectives: "Land Use Controls will be maintained until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure." Additionally, there is another duration listed on p. 2-50, 1st paragraph, 3rd sentence, for releases into surface water.

7. Checklist Item 7, please modify the following statement from page 1-3, 2nd paragraph, 5th sentence from the top of the page. We have already experienced attempts to limit a military service's responsibility to "report" to EPA and the state:

The U.S. Army will be responsible for implementation, maintenance, periodic inspection, reporting on and enforcement of the LUC ~~i~~n accordance with the RD.

8. Checklist Item 8, please use the checklist language and delete the listing that shows up on page 1-4, second paragraph, line 9, conclusion of the 2nd paragraph, and 2-49, last paragraph. This listing makes it very complicated and it is also troublesome and inconsistent with EPA's authority. For example, the Army seems to be forgetting that it does NOT have independent authority to modify a remedy. The Army does not have the authority referenced in number (4) to reserve. This was not the only problem with the listing, but we provide it to give you an idea of what we observed.

9. Page 2-26, 1st paragraph, last sentence and page 2-50 1st paragraph,4th sentence, please make it clear that it is the Amy who notifies the county and insert a deadline. ~~If it's the Army (and it seems like it would be better to have the Army do it rather than request Texas to do it), please make the following change:~~

In addition, within 90 days of signature of this ROD, the Army shall: 1) request the Texas Department of Licensing and Regulation ~~will be requested~~ to notify well drillers of groundwater restrictions; and 2) ~~the Army shall~~ notify the ~~a notification of the LUC with the~~ Harrison County Courthouse of the LUC to include ~~would include~~ a map showing the areas of groundwater restriction at the site, in accordance with 30 TAC 335.565.

10. Please also modify the following sentence on page 1-4, second full paragraph (towards the end of the paragraph) and on page 2-26, under 2.9.2, 2nd full paragraph, second to last sentence as shown below. The Army must get EPA concurrence on the modification and termination of LUCs as stated above. The Army should not be able to determine if a proposed modification is "significant" as EPA may not agree. There should be no qualifier as EPA, by law, selects or modifies a chosen remedy (not just significant or insignificant changes to a remedy). EPA relies on the land use restriction found in the ROD to find that the remedy is protective. The Army cannot independently decide whether a land use change will be inconsistent with the LUC objectives and industrial use assumptions of the remedy. EPA may disagree. Finally, the way the Army has structured the language, the Army never has to tell us of the change (if the Army deems the change insignificant) and such change could result in a huge environmental problem. EPA cannot allow that. Please delete the second and third sentences and substitute the following language as seen below:

The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~.

Allison Abernathy
phone 703-603-0052
Fax 703-603-0043
Website: http://www.epa.gov/fedfac

00113111

Longhorn: EPA legal comments for Draft Final MMRP Sites ROD for LHAAP 001-R and LHAAP-003-R

Stephen Tzhone to: Zeiler, Rose Ms CIV USA OSA, Lambert, John R SWT, Williams, Aaron K SWT, Elliott, John, Mayila, Agnes, Srivastav, 08/31/2011 01:52 PM
Cc: Fay Duke, Richard Mayer

From: Stephen Tzhone/R6/USEPA/US
To: "Zeiler, Rose Ms CIV USA OSA" <rose.zeiler@us.army.mil>, "Lambert, John R SWT" <John.R.Lambert@SWT03.usace.army.mil>, "Williams, Aaron K SWT" <Aaron.K.Williams@usace.army.mil>, "Elliott, John" <John.Elliott@shawgrp.com>, "Mayila,
Cc: Fay Duke <Fay.Duke@tceq.texas.gov>, Richard Mayer/R6/USEPA/US@EPA

Hi Rose:

Please address these comments from EPA legal on the MMRP ROD for for LHAAP 001-R and LHAAP-003-R. Let me know if we need to have a call to discuss.

---

1) The ROD needs to be specific that it is an institutional controls/LUCs ROD, and not imply that it is a no action ROD. As written, the draft ROD does not purport to select LUCs as the selected remedy, but instead, selects no action when it is fairly clear that the long-term implementation of LUCs is the selected remedy for the LHAAP MMRP Sites. It is not permissible to use the removal program to circumvent compliance with remedial action selection requirements. In other words, long-term LUCs are remedial actions, not removal actions. Thus, long-term LUCs should be selected remedial actions to be properly documented in the ROD (see below comments) so that EPA, if necessary, can take an enforcement action against the Army for failure to properly implement and enforce LUCs.

2) This draft ROD states "this decision presents the continued land use controls (LUCs) already in place as a result of removal actions at ... in 2008." However, the LUCs at the Site do not appear to be incorporated into an enforceable mechanism (*although the Army could enforce a LUC per a future property transfer agreement, EPA has no mechanism to take an enforcement action against Army for failure to implement and enforce LUCs under a removal action). Also, the LUCs have not been recorded in the deed records for the Site per the language provided in the draft ROD.

3) In light of the fact that institutional controls are basically the sole remedy here (*note: 40 C.F.R. § 300.430(a)(1)(iii)(D) makes it clear that, while not preferred, institutional controls may serve as the sole remedial action selection under certain circumstances (e.g., active measures are determined impracticable)) , the Army's ROD should include language clearly identifying the LUCs/institutional controls; clearly identifying the purposes of the controls or why they are needed; clearly delineating who is responsible for implementing, enforcement, monitoring, reporting on, and notifying stakeholders concerning the LUCs in place, and events that impact the LUCs; and address the LUC/IC checklist items 1-9 (*see recent comments from EPA HQ LUC team on LHAAP-16, LHAAP-17, LHAAP-29). The ROD should also include language stating that the details and description of the LUCs and the roles/responsibilities will be included in the remedial design workplan.

4) This draft ROD does not include the necessary analysis required under the NCP to constitute a CERCLA remedial action decision. The no action alternative, and nine remedy selection criteria analysis will have to be addressed in the ROD in order to satisfy the CERCLA remedy selection and decision document requirements found in the NCP. As such, the following sections should be included in this ROD: Assessment of the Site; ROD Data Certification Checklist; Remedial Action Objectives; Description of Alternatives; Comparative Analysis of Alternatives; Principle Threat Waste; Selected Remedy; and Statutory Determinations. Also, the long-term and permanent use of ICs/LUCs require compliance with the remedial action selection criteria (i.e., Threshold, Primary, and Modifying Criteria). The long-term effectiveness and permanence of ICs and LUCs are included under the Primary Criteria.

5) The administrative record should reflect that an RI/FS or a munitions constituents (MC), debris (MD) and munitions and explosives of concern (MEC) investigation, and a Risk Hazard Assessment for MEC and MC were conducted. The above information should be found in the administrative record which forms the basis for the selection of the selected remedy. A Risk Hazard Assessment should provide important insight concerning the risks presented by the Site if no remedial action, including institutional controls, is applied to the Site.

6) The remedy seems like it should also include engineered controls/engineered LUCs such as fencing. Pursuant to the removal action performed, it is clear signs have been installed to warn people that explosive hazard materials and unexploded ordnance (UXO) may remain in certain areas. Although MEC and explosive hazard materials were located and removed from the Sites, these areas should be fenced because MEC and explosive hazard materials may remain at the LHAAP MMRP Sites. Any fencing should also have a plan (i.e., an O&M Plan) establishing a process for the protection and maintenance of the fencing in light of the fact that this property will more likely than not be transferred to the U.S. Fish and Wildlife Service.

Thanks,

Stephen L. Tzhone
Superfund Remedial Project Manager
USEPA Region 6 (6SF-RA)
214.665.8409
tzhone.stephen@epa.gov

"Elliott, John" Steve and Fay- Attached please find the Draft Fi... 08/19/2011 03:33:10 PM

From:	"Elliott, John" <John.Elliott@shawgrp.com>
To:	Stephen Tzhone/R6/USEPA/US@EPA, "Fay.duke@tceq.texas.gov" <Fay.duke@tceq.texas.gov>
Cc:	"Zeiler, Rose Ms CIV USA OSA" <rose.zeiler@us.army.mil>, "Williams, Aaron K SWT" <Aaron.K.Williams@usace.army.mil>, "Lambert, John R SWT" <John.R.Lambert@SWT03.usace.army.mil>, "Mayila, Agnes" <Agnes.Mayila@shawgrp.com>
Date:	08/19/2011 03:33 PM
Subject:	Draft Final ROD for LHAAP 001-R and LHAAP-003-R

Steve and Fay-

Attached please find the Draft Final ROD for LHAAP 001-R and LHAAP-003-R. Please contact me if you have any questions or require additional information. Thank you.

Draft Final ROD LHAAP-001-R and 003-R.docx Figs 2-1 thru 2-6.pdf

John C. Elliott, PMP
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Federal Services/Project Management
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www.shawgrp.com

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EPA/Army Longhorn Meeting:
EPA R6 10th Floor East Conference Room
October 18, 2011, 3-4pm Central

Agenda:

1) Introductions

2) Current status of Longhorn RODs and Issues

3) EPA NOV and Stipulated Penalties Letter

4) Path Forward

Participants:

703 545 2488
Tom Lederle, Army BRAC Industrial Branch Chief

(214) 665-2731
Charles Faultry, Superfund Remedial Associate Director

214/665-8507
Carlos Sanchez, Superfund AR/TX Section Chief

George Malone, Site Attorney

214. 665. 8409
Stephen Tzhone, Remedial Project Manager

00113115

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS TX 75202-2733

OCT 20 2011

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final Record of Decision (ROD)
LHAAP-16: Old Landfill
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler:

The EPA has completed its review of the *Draft Final ROD (LHAAP-16: Old Landfill)* submitted on September 29, 2011, and have the following comments:

1. Overall ROD, Table 2-7, Table 2-10: Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-16 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). Therefore, the appropriate standards to be applied at LHAAP-16 should be the State of Texas Groundwater MSC for Residential Use, which for nickel is at 730 ug/L, perchlorate at 26 ug/L, and manganese at 7,820 ug/L (95% UTL Background), per 40 CFR 300.430(a)(iii)(F), and 300.430(f)(1)(ii)(B) .

   The ROD language needs to reflect this State of Texas groundwater designation and the appropriate residential standards in order to be consistent with the EPA July 2011 OSWER Directive 9283.1-34, EPA June 2009 OSWER Directive 9283.1-33, and the DoD April 2009 Perchlorate Release Management Policy.

   - EPA July 2011 OSWER Directive 9283.1-34, Groundwater Road Map Recommended Process for Restoring Contaminated Groundwater at Superfund Sites: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/gwroadmapfinal.pdf

   - EPA June 2009 OSWER Directive 9283.1-33: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf

   - DoD April 2009 Perchlorate Release Management Policy: http://www.denix.osd.mil/cmrmd/upload/dod_perchlorate_policy_04_20_09.pdf

   - TCEQ March 2006 MSC and risk-based screening levels tables: http://www.tceq.texas.gov/assets/public/remediation/rrr/msc-rbscn_2006.xls

00113116

2. Section 2.9.1, page 2-26. Section 2.12.2, page 2-55. For LTM, Groundwater and Surface Water Monitoring, and Long-Term Operations, monitoring after the next five year review should be on an annual basis unless the five year review recommends otherwise.

   Example, page 2-26: "LTM semiannually for 3 years, annually until the next five-year review, then ~~once every 5 years to remedy performance.~~ annually thereafter until recommended otherwise by the five-year review."

   Example, page 2-55: "Surface water and wells will then be sampled annually until the next five-year review and ~~every 5 years~~ annually thereafter until ~~indicated by the data.~~ recommended otherwise by the five- year review."

3. The Army proposed replacement of Section 2.12.1 with the following language (along with related changes in Section 2.12.2 and Section 2.12.4) is acceptable to EPA: "The MNA was selected as one component of the remedy based on available groundwater evidence as presented in the Addendum to the FS (Shaw, 2010). A tiered approach using three lines of evidence was used to examine the occurrence of natural attenuation. The first line of evidence evaluated reductions in COC concentrations over time and with distance, the second line of evidence evaluated geochemical indicators, while the third line of evidence entailed estimation of natural attenuation rates. Historical decreases in concentrations of chlorinated solvents and perchlorate in individual wells were observed in both shallow and intermediate groundwater, including the detection of daughter by-products that suggest the occurrence of complete reductive dechlorination. These results indicated the shallow and intermediate contaminant plumes are stable in certain areas (at the source area and side-downgradient in the plumes); however, there were increases in other well locations in the shallow groundwater that suggest a portion of the plume is migrating toward Harrison Bayou. The intermediate groundwater zone plume was relatively more stable than the shallow groundwater with less migration. Geochemical conditions were adequate for perchlorate degradation (as evidenced by non-detect nitrate/nitrite levels), but methanogenic conditions (needed for chlorinated ethene degradation) were not detected consistently throughout the site. Thus, natural attenuation was considered feasible for much of the site, but not as a sole remedy for the entire site. Additional evaluation, including the installation of additional monitoring wells, will be implemented as part of the MNA component. MNA, together with the in situ bioremediation and biobarriers, will ultimately restore the groundwater to attain groundwater cleanup standards/levels; this is anticipated to be completed in approximately 280 years. This approximate timeframe to achieve cleanup levels is considered reasonable based on the anticipated future land use of the site as a national wildlife refuge and the fact that there is no current or anticipated future use of groundwater as a drinking water supply. Thus, MNA is an appropriate component of the remedy for those regions outside the influence of the active remedies because it will protect human health and the environment and will document that further reductive dechlorination is occurring within the groundwater plume and that contaminant concentrations are being reduced to attain groundwater standards/levels."

4. Section 2.12.2, page 2-51. Under Cap Maintenance, please provide the rationale for 40 CFR 264.310(b)(2) to not be included as an ARAR.

5. Table 2-10, page 2-88. Under Post Closure Care, please clarify if all items under 40 CFR 264.310(b) are ARARs, or only the specific ones identified in Section 2.12.2.

6. IC Checklist #4 (LUC Objectives): Section 2.9.1. Section 2.12.2. We are appreciative that the Army has agreed to modify the groundwater LUC and add the prohibition on residential land use as we requested. Regarding the LUC to maintain the remedy integrity, we appreciate the offer to prohibit intrusive activities but there are other activities which could damage the wells.

   Please add either one of the following LUC objectives to address this issue:

   "LUC to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells. "

   or:

   "LUC to prohibit intrusive or any other activities which could damage the landfill cap and the groundwater monitoring system."

7. IC Checklist #6 (LUC Duration): Because additional LUCs will be added, the Army must either add the general LUC checklist language to memorialize its understanding that LUCs are to remain in place until unlimited use and unrestricted exposure is reached for all of them or the Army needs to develop a specific duration statement for each separate LUC. It appears that the Army would prefer to have a separate statement for each LUC which is fine, but please send us the statements so that we can review.

8. IC Checklist #8 (Remedy Integrity): Section 1.4, page 1-4. Section 2.12.2, page 2-52. The Army does not have independent authority to modify a remedy. See CERCLA Section 120 (e)(4). Please make the following edits: "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 ultimately 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 the LUC and any related transfer or lease provisions ;~~ and ~~(5)~~(4) ensuring the protectiveness 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 these sites after they have been transferred."

9. Section 1.4, page 1-4. Section 2.9.2, page 2-27. Section 2.12.2, page 2-52. The Army must get EPA concurrence on any modification and/or termination of LUCs. The LUC is part of the remedy which, by law, is both selected by Army and EPA. Thus, the Army shall not unilaterally make decisions on any modifications and/or terminations of LUCs, including whether a proposed modification is 'significant'. Please make the following edits: "The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~."

10. Regarding previous Army comments on the term 'support agency', in the event of a dispute, EPA independently selects the remedy as an <u>oversight agency</u>.

Under Section VIII.C.2. and Section XV.B. of the Federal Facilities Agreement, EPA may invoke Dispute Resolution for any unresolved comments. Please feel free to contact me at (214) 665-8409, or by email at tzhone.stephen@epa.gov, if there are any questions or comments.

Sincerely,

Stephen L. Tzhone
Remedial Project Manager

cc: Ms. Fay Duke, TCEQ
Mr. George Malone, EPA R6
Ms. Ellen Treimel, EPA FFRRO
Ms. Caitlin Meisenbach, EPA FFEO

00113119

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

OCT 20 2011

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final Record of Decision (ROD)
LHAAP-17: No. 2 Flashing Area Burning Ground
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler:

The EPA has completed its review of the *Draft Final ROD (LHAAP-17: No. 2 Flashing Area Burning Ground)* submitted on September 29, 2011, and have the following comments:

1. Overall ROD, Table 2-10, Table 2-14: Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-16 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). Therefore, the appropriate standard to be applied at LHAAP-17 should be the State of Texas Groundwater MSC for Residential Use, which for perchlorate is at 26 ug/L, per 40 CFR 300.430(a)(iii)(F), and 300.430(f)(1)(ii)(B) .

   The ROD language needs to reflect this State of Texas groundwater designation and the appropriate residential standard in order to be consistent with the EPA July 2011 OSWER Directive 9283.1-34, EPA June 2009 OSWER Directive 9283.1-33, and the DoD April 2009 Perchlorate Release Management Policy.

   - EPA July 2011 OSWER Directive 9283.1-34, Groundwater Road Map Recommended Process for Restoring Contaminated Groundwater at Superfund Sites: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/gwroadmapfinal.pdf

   - EPA June 2009 OSWER Directive 9283.1-33: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf

   - DoD April 2009 Perchlorate Release Management Policy: http://www.denix.osd.mil/cmrmd/upload/dod_perchlorate_policy_04_20_09.pdf

   - TCEQ March 2006 MSC and risk-based screening levels tables: http://www.tceq.texas.gov/assets/public/remediation/rrr/msc-rbscn_2006.xls

2. Section 1.4, page 1-2. Section 2.12.2, page 2-33. For LTM, monitoring after the next five year review should be on an annual basis unless the five year review recommends otherwise.

   Example, page 1-2: "In subsequent years, LTM will be annual until the next five-year review and annually thereafter until recommended otherwise by the five-year review. The monitoring and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue ~~every 5 years~~ until cleanup levels are achieved and annually until recommended otherwise by the five-year review."

   Example, page 2-33: "Continue LTM ~~every 5 years~~ annually thereafter until recommended otherwise by the five-year review to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen."

3. IC Checklist #4 (LUC Objectives): Section 2.9.1. Section 2.12.2. We are appreciative that the Army has agreed to modify the groundwater LUC and add the prohibition on residential land use as we requested. Regarding the LUC to maintain the remedy integrity, we appreciate the offer to prohibit intrusive activities but there are other activities which could damage the wells.

   Please add either one of the following LUC objectives to address this issue:

   "LUC to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells. "

   or:

   "LUC to prohibit intrusive or any other activities which could damage the landfill cap and the groundwater monitoring system."

4. IC Checklist #6 (LUC Duration): Because additional LUCs will be added, the Army must either add the general LUC checklist language to memorialize its understanding that LUCs are to remain in place until unlimited use and unrestricted exposure is reached for all of them or the Army needs to develop a specific duration statement for each separate LUC. It appears that the Army would prefer to have a separate statement for each LUC which is fine, but please send us the statements so that we can review.

5. IC Checklist #8 (Remedy Integrity): Section 1.4, page 1-3. Section 2.12.2, page 2-33. The Army does not have independent authority to modify a remedy. See CERCLA Section 120 (e)(4). Please make the following edits: "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 ultimately 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 the LUC and any related transfer or lease provisions ;~~ and ~~(5)~~(4) ensuring the protectiveness 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 these sites after they have been transferred."

6. Section 1.4, page 1-4. Section 2.9.2, page 2-20. Section 2.12.2, page 2-34. The Army must get EPA concurrence on any modification and/or termination of LUCs. The LUC is part of the remedy which, by law, is both selected by Army and EPA. Thus, the Army shall not unilaterally make decisions on any modifications and/or terminations of LUCs, including whether a proposed modification is 'significant'. Please make the following edits: "The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~."

7. Regarding previous Army comments on the term 'support agency', in the event of a dispute, EPA independently selects the remedy as an oversight agency.

Under Section VIII.C.2. and Section XV.B. of the Federal Facilities Agreement, EPA may invoke Dispute Resolution for any unresolved comments. Please feel free to contact me at (214) 665-8409, or by email at tzhone.stephen@epa.gov, if there are any questions or comments.

Sincerely,

Stephen L. Tzhone
Remedial Project Manager

cc: Ms. Fay Duke, TCEQ
Mr. George Malone, EPA R6
Ms. Ellen Treimel, EPA FFRRO
Ms. Caitlin Meisenbach, EPA FFEO

00113122

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

October 24, 2011

Ms. Rose Zeiler
Army / BRAC Site Manager
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final ROD
LHAAP-16: Old Landfill
Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas

Dear Ms. Zeiler:

The Texas Commission on Environmental Quality (TCEQ) has completed its review of the *Draft Final ROD for LHAAP-16, Old Landfill* submitted on September 29, 2011. We generally concur with the changes. However, we do not concur with your response to our previous comment regarding the frequency of the long term monitoring.

Long term monitoring requirements pertaining to surface water and groundwater sampling are specified in Section 2.9.1 and Section 2.12.1. In general, sampling will be conducted semi-annually for three years, annually until the next five-year review and every five years thereafter. We believe that the reduced monitoring frequency to every five year is unsupported at this time. The reduced monitoring frequency should be based on data collected and analyzed and changes in monitoring frequency can be recommended and incorporated in the five-year review.

If you have any questions or need additional information, please feel free to contact me at (512) 239-2443.

Sincerely,

Fay Duke, Project Manager
Team 2, Superfund Section
Remediation Division

FD/cw

cc: Mr. Stephen L. Tzhone, U. S. Environmental Protection Agency Region 6, Dallas, TX

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

October 24, 2011

Ms. Rose Zeiler
Army / BRAC Site Manager
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final ROD
LHAAP-17: No. 2 Flashing Area Burning Ground
Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas

Dear Ms. Zeiler:

The Texas Commission on Environmental Quality (TCEQ) has completed its review of the *Draft Final ROD for LHAAP-17: No. 2 Flashing Area Burning Ground* submitted on September 29, 2011. We have the following comment:

Long term monitoring requirements pertaining to groundwater sampling are specified in Section 12.12.1. In general, sampling will be conducted semi-annually for three years, annually until the next five-year review and every five years thereafter. We believe that the reduced monitoring frequency to every five years is unsupported at this time. The reduced monitoring frequency should be based on data collected and analyzed and changes in monitoring frequency can be recommended and incorporated in the five-year review.

If you have any questions or need additional information, please feel free to contact me at (512) 239-2443.

Sincerely,

Fay Duke, Project Manager
Team 2, Superfund Section
Remediation Division

FD/cw

cc: Mr. Stephen L. Tzhone, U. S. Environmental Protection Agency Region 6, Dallas, TX

Bryan W. Shaw, Ph.D., *Chairman*
Buddy Garcia, *Commissioner*
Carlos Rubinstein, *Commissioner*
Mark R. Vickery, P.G., *Executive Director*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

October 24, 2011

Ms. Rose Zeiler
Army / BRAC Site Manager
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final MMRP Record of Decision (ROD)
LHAAP-001-R South Test Area/Bomb Test Area
LHAAP-003-R Ground Signal Test Area
Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas

Dear Ms. Zeiler:

The Texas Commission on Environmental Quality (TCEQ) has completed its review of the evaluations of the *Draft Final MMRP ROD (LHAAP-001-R South Test Area/Bomb Test Area, LHAAP-003-R Ground Signal Test Area)* submitted on September 27, 2011. We concur with the changes and have no further comments.

If you have any questions or need additional information, please feel free to contact me at (512) 239-2443.

Sincerely,

Fay Duke

Fay Duke, Project Manager
Team 2, Superfund Section
Remediation Division

FD/cw

cc: Mr. Stephen L. Tzhone, U. S. Environmental Protection Agency Region 6, Dallas, TX

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT CHIEF OF STAFF FOR INSTALLATION MANAGEMENT
600 ARMY PENTAGON
WASHINGTON, DC 20310-0600

OCT 27 2011

Stephen L. Tzhone
Superfund Remedial Project Manager
USEPA Region 6 (6SF-RA)
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Re: Notice of Violations and Stipulated Penalty Assessment
Army Commitments on FY2011 Records of Decision
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Mr. Tzhone:

This letter notifies the U.S. Environmental Protection Agency (EPA) Region 6 (Region 6) that the U.S. Department of the Army (Army), under Subsection XXIV.B of the 1991 Federal Facilities Agreement (FFA) between the Army, Region 6, and the Texas Commission on Environmental Quality (TCEQ) as successor to the Texas Water Commission, is invoking dispute resolution on the question of whether the failures cited as the basis for the stipulated penalties assessed in EPA's October 13, 2011 "Notice of Violations and Stipulated Penalty Assessment" (NOV letter) did in fact occur. According to the NOV letter, EPA's complaint is that the Army did not comply with the FFA by having "approved" Record of Decisions (RODs) for four sites (LHAAP-16, LHAAP 17, LHAAP-001-R-01, and LHAAP-003-R-01) on or before September 30, 2011. This implies that the due date for the RODs could have only been met if Army submitted the RODs in a form acceptable to EPA for finalization. Army strongly rejects EPA's interpretation of the FFA. Both the spirit and the letter of the FFA provide that Army is responsible for preparing RODs that are *jointly* finalized (i.e., "signed") with EPA. The FFA includes a required consultation process for doing so. If that process is not successful, the RODs are subject to EPA initiating dispute resolution and not to EPA approval.

1. <u>Army is in compliance with the FFA</u>.

Army complied with the FFA by submitting the three *draft* RODs within the deadline established pursuant to Section XVI. Subsection XIX.A requires that the remedy selection documents (e.g., RODs) be prepared in accordance with the consultation procedures contained in Section VIII. Paragraph VIII.G.1 requires that Army complete and transmit the *draft* RODs to EPA and TCEQ on or before the deadline established under Subsection XVI.A. Subsection XVI.A similarly requires the submittal of *draft* primary documents by the established deadline. EPA admits in the NOV letter that the deadline was September 30, 2011. Army submitted the *draft* RODs on the following dates, all of which are prior to the Section XVI deadline for submitting the *draft* RODs:

LHAAP-17	1/26/2011
LHAAP-16	7/21/2011
LHAAP-001-R-01/ LHAAP-003-R-01	8/19/2001

During the Subsection VIII.G consultation process EPA submitted comments on the draft RODs well beyond the allowable time for commenting and in repeated iterations not conforming to the FFA Consultation process over periods of months. (See attached chart.) The Army provided responses to multiple sets of comments, modified the RODs as appropriate, and submitted these as the draft final RODs required by the FFA, as well as signed final RODs for receipt by September 30, 2011 in order to meet EPA Region 6's internal performance goals.

The NOV letter also indicates that the RODs were not completed by the Section XVI deadline because these RODs were not acceptable to EPA. Under the FFA, there are four mechanisms by which the RODs could have been completed: (1) if no party invokes dispute resolution regarding the draft final RODs (Subsection VIII.I); (2) within twenty-one days following completion of the dispute resolution process initiated after the draft final RODs were submitted (Subsection VIII.I); (3) when finalized jointly by Army and EPA (Subsection XIX.C); or (4) when finalized by the EPA Administrator (Subsection XIX.C).

None of the above support EPA's asserted requirement that Army was required to submit RODs incorporating all EPA comments. This is made abundantly clear by inclusion of Subsection VIII.H of the FFA, appropriately titled "<u>Availability of Dispute Resolution for Draft Final Primary Documents:</u>." This provision, which immediately precedes the Subsection entitled "Finalization of Reports," requires that a party who decides to non-concur must dispute a draft final primary document. This dispute resolution step would be unnecessary if Army were required under Subsection VIII.G to submit draft final documents in which EPA concurs. Paragraph VIII.G.5 instead requires only that the draft final document be "the product of consensus *to the maximum extent possible*" (emphasis added).

There is consensus between Region 6 and Army because Region 6 has informed Army that it concurs in the remedy described in the RODs as well as Army's responses to Region 6's comments. There is a lack of consensus only with respect to as yet unspecified Army responses to comments that EPA HQ submitted beyond the time allowed by Subsection VIII.G. The submission of a draft final ROD signed by the Army with responses to comments has always been the parties' interpretation of this requirement at LHAAP. Region 6 was in possession of three timely submitted, FFA-compliant RODs addressing remedy selection at all four sites. Region 6 also had Army's responses to EPA HQ and Region 6 comments. By September 30, 2011, Region 6 was therefore in a position to finalize the RODs in accordance with Section VIII and XIX of the FFA. If Region 6 was not able to do so, then invoking Section XV dispute resolution was the correct course under the FFA.

2. <u>The assessment of the stipulated penalties is contrary to the FFA</u>.

On September 27, 2011, EPA's Remedial Project Manager (RPM) verbally requested that Army designate the three ROD's "Draft Final" to facilitate Region 6 invoking informal dispute resolution under Subsections VIII.H and XV.C of the FFA. Army submitted the Draft Final RODs as required by Section VIII.G.5 of the FFA and also submitted the signed RODs in order to ensure that EPA could meet its performance goal of signing the RODs in Fiscal Year 2011. However, Army received the NOV letter despite what it believed to be the parties' agreement that these documents met the FFA requirements for Draft Final RODs.

Subsection XIX.A requires that the ROD be prepared in accordance with the consultation procedures contained in Section VIII. Subsection VIII.G describes the <u>required</u> process that should have been followed for review and comment of the RODs. This process is simple and specific. Paragraph VIII.G.1 requires submittal of *draft* RODs on or before the Section XVI deadline. Paragraph VIII.G.2 allows EPA and TCEQ to submit specific written comments with citations to pertinent supporting authorities and references "so that the Army may respond to the comment and, *if appropriate*, make changes to the draft report[s]" (emphasis added). Paragraph VIII.G.5 then requires Army to issue the Draft Final RODs including responses to comments. Subsection VIII.H allows a non-concurring party to dispute a Draft Final ROD, and Subsection VIII.I requires that Army finalize the Draft Final RODs in accordance with the results of the dispute resolution. A non-concurring party must therefore invoke Section XV dispute resolution if it wishes to challenge the draft final version of a primary document. There is no FFA provision allowing EPA to assess stipulated penalties because Army has not satisfactorily incorporated each and every one of EPA's comments.

Conversely, the process described above neither required nor allowed Army to invoke dispute resolution during the consultation process. It is clear from the above-enumerated steps that the appropriate Army response to an EPA or TCEQ comment to which it disagreed was the preparation of a reasoned response to that comment and the submission of a draft final ROD. This is what Army did. Subsection VIII.H does not require invoking dispute resolution prior to submission of the Draft Final ROD.

Finally, the FFA does not provide for the assessment of stipulated penalties for the violations alleged. As previously stated, the NOV Letter alleges that Army did not submit RODs in a form acceptable to EPA by the date contained in the enforceable schedule. Subsection XXIV.A states that EPA may assess stipulated penalties if "Army fails to submit a ... ROD ... pursuant to the appropriate timetable or deadline in accordance with the requirements of this Agreement." Even if the schedule deadline contained in Enclosure 1 of the NOV letter were for the submittal of final RODs, those deadlines would not be "in accordance with the requirements of this Agreement" because Section XVI provides deadlines only for the submittal of *draft* primary documents prior to the review and comment provisions of Section VIII.G. The assessment of stipulated penalties for allegedly missing any other schedule date or failure to submit a draft final ROD acceptable to EPA would therefore not be allowed. The stipulated penalties that may be assessed by EPA under the FFA are only available in conformance with the terms and conditions of the FFA. Army satisfied the draft primary document submission deadlines for all three of these RODs, and therefore no stipulated penalties may be assessed on Army under the terms of the FFA.

For the above described reasons, Army disputes the Region 6 letter of October 13, 2011, and its attempted assessment of stipulated penalties that are contrary to the Longhorn AAP FFA provisions governing the completion of primary documents. Army requests that the Project Managers and/or their immediate supervisors meet and attempt to informally resolve this dispute as provided in Subsection XV.A of the FFA. Please contact Dr. Rose Zeiler at 479-635-0110 or at rose.zeiler@us.army.mil to schedule a meeting as soon as possible.

Sincerely,

Thomas E. Lederle

THOMAS E. LEDERLE
Industrial Branch Chief
ACSIM BRAC Division

Encl
CF:
Ms. Fay Duke, TCEQ

00113129

Review Timeline for LHAAP-16, -17, -R-001 and -R-003 RODs

ACTION	**LHAAP-16**	**LHAAP-17**	**LHAAP-001-R-01 and LHAAP-003-R-01**
Army Submits Draft ROD	**6/21/2011**	**1/26/2011**	**8/19/2011**
Draft ROD Comment Dues Dates	**7/21/2011**	**2/25/2011**	**9/18/2011**
Region 6 RPM Comments Submitted *(Days beyond submittal deadline)* Army Responses Submitted **EPA Region Concurrence**	7/18/2011 *(timely)* 7/29/2011 **8/3/2011**	 **3/7/2011**	8/31/2011 *(timely)* 9/6/2011 **9/7/2011**
Region 6 Legal Comments Submitted *(Days beyond submittal deadline)* Army Responses Submitted **Region 6 Legal Concurrence**	8/17/2011 *(28 days)* 9/23/2011 **9/26-27/2011**	4/1/2011 *(36 days)* 6/8/2011 **7/20/2011** **7/27/2011**[2]	
EPA Region 6 concurs with Army's Responses to All EPA Comments	**9/16/2011**	**9/16/2011**	
EPA HQ LUC Comments Submitted *(Days beyond submittal deadline)* Army Responses Submitted EPA HQ LUC Non-concurrence with Follow-on Comment on Army's Reponses *(Days beyond submittal deadline)* Army Responses Submitted	8/29/2011 *(39 days)* 9/12/2011 ----- 9/19/2011 *(60 days)* 9/28/2011	8/29/2011 *(185 days)* 9/12/2011 ------ 9/19/2011 *(206 days)* 9/28/2011	
EPA HQ MNA Comments Submitted[3] *(Days beyond submittal deadline)* Second set EPA HQ MNA Additional Comments Submitted[3] *(Days beyond submittal deadline)*	9/20/2011 *(62 days)* 9/29/2011 *(71 days)*	9/20/2011 *(207 days)* 9/29/2011 *(216 days)*	
Army Submits Draft Final ROD at Region's Request	**9/29/2011**	**9/29/2011**	**9/27/2011**

00113130

Review Timeline for LHAAP-16, -17, -R-001 and -R-003 RODs

1. Comment received after submission of the Draft Final ROD.
2. Concurrence included approval of the draft ROD submitted on 7/26/2011 to Region 6 for signature as a Final ROD. An unexecuted copy of the Final ROD was provided to EPA on 8/4/2011.
3. These comments were submitted too close to 30 September to allow an official response. A two-week extension was requested, but no response to the request was received.

00113131

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS TX 75202-2733

OCT 2 7 2011

CERTIFIED MAIL-RETURN RECEIPT REQUESTED

Colonel Clarence D. Turner
Department of the Army
Assistant Chief of Staff for Installation Management
600 Army Pentagon
Washington, DC 20310-0600

RE: Written Statement of Dispute
Longhorn Army Ammunition Plant (LHAAP)
Federal Facility Agreement (FFA) Under CERCLA Section 120

Dear Colonel Turner:

The United States Environmental Protection Agency Region 6 (EPA) is submitting a written statement of dispute pursuant to Section XV (Dispute Resolution) of the LHAAP FFA to invoke dispute resolution under FFA's formal dispute resolution process. The EPA is disputing the Army's compliance with the terms and conditions of the FFA concerning four sites. The four sites subject to dispute resolution include:

- LHAAP-16: Old Landfill
- LHAAP-17: No. 2 Flashing Area Burning Ground
- LHAAP-001-R-01 MMRP: South Test Area/Bomb Test Area
- LHAAP-003-R-01 MMRP: Ground Signal Test Area

Pursuant to Section XVI (Deadlines) of the FFA, the Army submitted an updated site schedule, and their FY2011 commitments on July 28, 2011. EPA approved the schedule on August 5, 2011. Under the approved schedule, the Army was required to complete Records of Decision (RODs) for the four sites by September 30, 2011. Before approving the above schedule, EPA agreed to multiple extensions on Primary Documents (i.e., RODs) for LHAAP-16 and LHAAP-17 throughout 2010 and 2011. The above extensions were approved by EPA on February 4, 2010, February 26, 2010, April 2, 2010, and August 5, 2011. These deadlines were granted in order to help the Army in fulfilling its ROD commitments for FY2011.

The EPA received draft final RODs for the four sites subject to this notification, on September 27, 2011 (for MMRP-1, MMRP-3), and on September 29, 2011 (for LHAAP-16, LHAAP-17). Also, the EPA received nearly identical documents, titled "final" and bearing the Army's signature, with a signature date of September 29, 2011.

As of the date of this letter, the above listed sites do not have approved RODs. Despite the additional time provided, the Army submitted draft RODs that were either incomplete, substantially deficient or included flawed analysis not in compliance with CERCLA and the NCP, requiring voluminous EPA comments (e.g., thirty-seven EPA comments for the LHAAP-16 draft ROD were sent to the Army on August 17, 2011; comments regarding missing analysis required under the NCP remedial action selection criteria, land use controls, and remedy selection authority for LHAAP-001-R and LHAAP-003-R Draft ROD were sent to the Army on August 31, 2011; and land use controls and remedy selection authority comments on LHAAP-16 and LHAAP-17 on August 29, 2011).

While the Army has agreed to address some of the issues noted above, most issues remain outstanding and are disputed under the FFA. The issues in dispute concern the Army's failure to include appropriate land use controls language in the RODs regarding the appropriate controls for the engineered remedies; the length of time that the controls will remain in place (e.g., duration of land use controls); implementation of land use controls; failure to provide an enforceable deadline for submitting the LUCs Remedial Design; and language that contravenes EPA's statutory remedy selection authority. EPA is also disputing Army's principal threat waste determination. In addition, the RODs do not properly identify applicable, relevant and appropriate requirements (ARARs) under Resource Conservation and Recovery Act (RCRA) nor do they identify ARARs for restoration of groundwater to beneficial use which has been determined to be residential drinking water. The issues in dispute have the potential to have a detrimental effect on the CERCLA program in terms of remedy selection authority, remedy selection criteria, and remedy selection documentation.

The enclosed formal Statement of Dispute fully explains the nature of the dispute, the work affected by the dispute, EPA's position, and the information relied upon by EPA. Having engaged in an informal dispute resolution process, including a meeting on October 18, 2011, the EPA elevates the above matters for formal dispute resolution.

As provided in Paragraphs A through E, Dispute Resolution section of the FFA, upon receipt of the Statement of Dispute, the Dispute Resolution Committee (DRC) shall have 21 days to resolve the dispute and issue a written decision signed by all the parties. The FFA designates the members of the DRC for the Army, the State of Texas and EPA. If the DRC is unable to resolve the dispute within the 21-day period, then the dispute shall be forwarded to the Senior Executive Committee (SEC). The SEC shall have 21 days to unanimously resolve the dispute. If the SEC is unable to resolve the dispute, the EPA Region 6 Administrator shall issue a written position regarding the dispute.

The EPA's goals in resolving this dispute are addressed in the enclosed Statement of Dispute with the primary driver of ensuring that remedies at Longhorn are protective of human health and the environment. In summary, the Army must correct the deficiencies in the RODs to ensure the remedies are protective of human health and the environment. Thus in draft final RODs for all four sites, the Army must ensure that it complies with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Contingency Plan (NCP), and EPA guidance, as required by the FFA. In addition, the Army must ensure that future submissions of draft RODs will be complete, and include language and analysis that comply with CERCLA, the NCP, EPA Policy, and the FFA. Given the complexity of the documents and the numerous deficiencies, EPA plans to follow this statement of dispute with additional details for the DRC shortly.

Should you have any questions or need to arrange a meeting with DRC for this dispute matter, please feel free to call me at 214.665.3110, or contact Charles Faultry at 214.665.2731, Carlos Sanchez at 214.665.8507 or Mr. Stephen Tzhone at 214.665.8409.

Sincerely,

Samuel Coleman, P.E.
Director
Superfund Division

Enclosures (3):
1. Statement of Dispute
2. EPA Comment Letters on Draft Final RODs (October 2011)
3. Army Longhorn Response to Comments (September 28, 2011)

cc: Reggie Cheatham
EPA Federal Facilities Restoration and Reuse Office

David Kling
EPA Federal Facilities Enforcement Office

Maureen Sullivan
Office of the Secretary of Defense Installations and Environment

John Tesner
Office of the Deputy Assistant Secretary of the Army (Environment, Safety and Occupational Health)

Beth Seaton
TCEQ Remediation Division

ENCLOSURE 1:

Statement of Dispute

STATEMENT OF DISPUTE

I. Nature of Dispute:

Based on U.S. Environmental Protection Agency (EPA) review of the draft final Record of Decisions (RODs) for LHAAP-16, LHAAP-17, LHAAP-001-R, and LHAAP-003-R, and discussions prior and subsequent to the Army's September 27, and September 29, 2011 submittal of these draft final RODs, EPA continues to have fundamental concerns regarding the Army's failure to incorporate standards, controls and requirements consistent with the 1991 Federal Facilities Agreement (FFA) into these draft final primary reports.

The standards, controls and requirements at issue here include: the Army's failure to include appropriate land use controls language regarding appropriate restrictions for the engineered remedies; the length of time that the controls will remain in place (e.g., duration of land use controls); identification and implementation of land use controls; failure to provide an enforceable deadline for submitting the LUCs Remedial Design; and language that contravenes EPA's statutory remedy selection authority. In addition, the RODs do not properly identify applicable, relevant and appropriate requirements (ARARs) under Resource Conservation and Recovery Act (RCRA), the Safe Drinking Water Act and the Texas Groundwater Risk Reduction Rules.

As a result of these and other concerns related to the primary reports in question, EPA is initiating formal Dispute Resolution for the draft final RODs at these four sites. Consistent with Section XIX, Selection, Design and Implementation of Remedial Actions, the EPA finds that the Army has failed and continues to fail to comply with Subsections A and C of Section XIX of the FFA. Section A in part, states, "[t]he parties agree to perform the tasks, obligations and responsibilities described in this Section in accordance with CERCLA and CERCLA guidance and policy; the NCP; ...and all terms and conditions of this Agreement including documents prepared and incorporated in accordance with Section VIII (Consultation)." Section D in part, states "... [f]ollowing consideration of comments by T[CEQ], the ROD will be finalized jointly by the Army and EPA, or if they are unable to reach agreement about the selection of the remedial action, by the EPA Administrator." The RODs at issue here are tasks and obligations under FFA, as they constitute primary reports required under Section VIII. (Consultation with EPA and TCEQ). The information provided below discusses the issues in dispute, EPA's position, the goals of the dispute, and the worked affected. For further details on the unresolved comments that are at issue in this dispute, please see the enclosed document with Army's response to EPA's comments.

II. Work Affected by the Dispute:

The completion of the Final RODs for LHAAP-16, LHAAP-17, LHAAP-001-R, and LHAAP-003-R, as well as, subsequent Remedial Designs (RDs) and Remedial Actions (RAs) related to these sites, are delayed due to the inadequate RODs and EPA's initiation of this formal dispute resolution.

The completion of RODs, RDs, and RAs on LHAAP-03, LHAAP-04, LHAAP-18, LHAAP-24, LHAAP-29, and LHAAP-47 may also be delayed by this formal dispute resolution.
Resolution of the issues in dispute discussed below will occur during formal dispute resolution.

III. Issues in Dispute:

1. Issue 1: When there is no Federal Maximum Contaminant Level (MCL) for a specific contaminant (e.g., perchlorate), the Texas GWD-Res is the applicable, relevant and appropriate (ARAR) standard to be utilized for groundwaters determined to be a current or potential source of drinking water. Groundwater at the sites in question is designated as potential drinking water sources by the State of Texas in accordance with Texas regulation. As provided in the National Contingency Plan (NCP), it is appropriate to return contaminated groundwaters to their beneficial uses wherever practicable.

   EPA Position: As a result of the designated use of these contaminated groundwaters as potential drinking water sources, the MCLs at 40 CFR 141, are ARARs under 40 CFR 300.430(e)(2)(i)(B & C). In the event that there is no Federal MCL for that contaminant, the Texas standard for GWD-Res (i.e., 30 TAC 335.559(b)) establishes a health based MCL that constitutes an ARAR for groundwater restoration for those contaminants. CERCLA Section 121(d) provides that on-site remedial actions must comply with the substantive requirements of environmental laws. The NCP, at 40 CFR 300.430(f)(1)(ii), also provides that on-site remedial actions must comply with ARARs or obtain a waiver. As a result, any failure to incorporate the Texas MCL groundwater standard noted above for contaminants that do not have a Federal MCL into the relevant primary reports is a violation of the FFA at Sections VIII and XIX.

   The following EPA and Texas policies guide this issue as well:

   EPA July 2011 OSWER Directive 9283.1-34, Groundwater Road Map Recommended Process for Restoring Contaminated Groundwater at Superfund Sites:
   http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/gwroadmapfinal.pdf

   EPA June 2009 OSWER Directive 9283.1-33:
   http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf

   TCEQ March 2006 MSC and risk-based screening levels tables:
   http://www.tceq.texas.gov/assets/public/remediation/rrr/msc-rbscn_2006.xls

2. Issue 2: Adequate LUC objectives are missing from the RODs. The RODs should include objectives designed to protect the integrity of the groundwater monitoring system and landfill caps. This is because the groundwater monitoring system and the landfill caps are integral engineering components of the final remedies. The remedial systems must be protected from intrusive or other activities which could damage the engineered portion of the remedy. Additionally, to ensure protectiveness, the relevant RODs should also include a LUC objective to prohibit development and/or other intrusive activities such as digging which could result in detonation of explosive hazards or exposure to other contaminants.

   EPA Position: CERCLA Section 121(d)(2)(B) refers to the use of enforceable measures (e.g., ICs) as part of the remedial action selection alternatives at sites. In addition, 40 CFR 300.430(a)(1)(iii) provides that institutional controls may be needed in combination with the use of treatment; and engineering controls in order for the selected remedy to be protective of human health and the environment. The NCP Preamble (at pp. 55 FR 8701 - 8702) makes clear that the nine criteria evaluation under 40 CFR 300.430(e)(9)(iii), encompass the CERCLA 121(b)(1) remedy selection statutory requirements. This particular NCP Preamble discussion specifically addresses the long-term effectiveness factor that must be assessed under CERCLA section 121(b)(1). The trade-offs among alternatives with respect to the long-term effectiveness and permanence they afford, and the reductions in toxicity, mobility, or volume they achieve through treatment, are the most important considerations in the balancing step by which the remedy is selected. Outside of the threshold criteria for remedy selection found at 40 CFR 300.430(f)(1), the long-term effectiveness primary balancing criteria is one of the most important remedy selection factors.

Also note that NCP Preamble (at p. 55 FR 8720) provides that the long-term effectiveness analysis focuses on any residual risk remaining at the site after the completion of the remedial action. This analysis includes consideration of the degree of threat posed by the hazardous substances remaining at the site and the "adequacy and reliability" of any controls (e.g., engineering or institutional controls) used to manage the hazardous substances remaining at the site. The criterion is founded on CERCLA's mandates to select remedies that are protective of human health and the environment that maintain protection over time. In this case, it is imperative that the groundwater monitoring system includes protections and restrictions designed to ensure that the movement (i.e., whether the movement shows a decrease or an increase in size and plume stability) of contaminated groundwater is not presenting unnecessary risk to human health and the environment. Without a groundwater monitoring system that is reliable for 280 years (i.e., the estimated time-frame for the contaminated groundwater to attain drinking water standards for the LHAAP-16 plume), then the selected remedies may not be protective of human health and the environment.

The NCP Preamble (at pp. 55 FR 8706-8707) demonstrates that although EPA believes institutional controls should be used be used to provide protection to human health and the environment, it also recognized that special precautions must be made to assure that the controls are reliable. An example of a special precaution is included in 40 CFR 300.510(c) to require states to assure institutional controls implemented as part of a remedial action at a fund-lead site are in place, reliable, and will remain in place. Finally, EPA has addressed remedy selection and the LUC issues noted above in relevant policy documents including "A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Documents," pp. 6-6, 6-26-27, 6-48, and "Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups," pp. 3 - 4, 7 - 9.

For example, EPA has drafted language for inclusion in the relevant primary reports at issue. One of two language options noted below, or their equivalent, may be utilized to address this LUC objective issue:

“LUC to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells. “

or

“LUC to prohibit intrusive or any other activities which could damage the landfill cap and the groundwater monitoring system.”

In addition, for other examples, please see the October 2011 letters from EPA to the Army which conveyed EPA's detailed comments on the RODs.

The following EPA policies guide this issue as well:

EPA November 2010 Interim Final OSWER 9355.0-89 EPA-540-R-09-001, Institutional Controls**:** A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites: http://www.epa.gov/superfund/policy/ic/pdfs/PIME-IC-Guidance-Interim.pdf

EPA October 2006, Sample Federal Facility Land Use Control ROD Checklist with Suggested Language: http://www.epa.gov/fedfac/documents/icchecklist.pdf

EPA September 2000, OSWER 9355.0-74fs-p, Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups: http://www.epa.gov/superfund/policy/ic/guide/guide.pdf

3. Issue 3: The ROD must ensure that LUCs (individually or together) are to remain in place until unlimited use and unrestricted exposure is reached for each engineering component of the remedy.

   EPA Position: By way of example, as noted above, because the groundwater monitoring system is an integral engineering component of the selected remedy, the duration associated with the LUC objective for protecting the integrity of the groundwater monitoring system must be identified in the ROD as to be in place until unlimited use and unrestricted exposure is reached. For similar reasons provided in issue #2 note that NCP Preamble (at p. 55 FR 8720) provides that the long-term effectiveness analysis focuses on any residual risk remaining at the site after the completion of the remedial action. This analysis includes consideration of the degree of threat posed by the hazardous substances remaining at the site and the "adequacy and reliability" of any controls (e.g., engineering or institutional controls) used to manage the hazardous substances remaining at the site. The criterion is founded on CERCLA's mandates to select remedies that are protective of human health and the environment that maintain protection over time. Similarly, for the other objectives described in item 2 above, the RODs must ensure that all components of the remedy are durable over time. Note that the statutory criteria and NCP provisions cited in issue #2 are also relevant to this particular issue.

   The following EPA policies guide this issue as well:

   EPA November 2010 Interim Final OSWER 9355.0-89 EPA-540-R-09-001, Institutional Controls**:** A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites: http://www.epa.gov/superfund/policy/ic/pdfs/PIME-IC-Guidance-Interim.pdf

   EPA October 2006, Sample Federal Facility Land Use Control ROD Checklist with Suggested Language: http://www.epa.gov/fedfac/documents/icchecklist.pdf

EPA September 2000, OSWER 9355.0-74fs-p, Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups: http://www.epa.gov/superfund/policy/ic/guide/guide.pdf

4. Issue 4: The Army does not have independent authority to modify a remedy. The LUC is part of the remedy which, under CERCLA, is both selected by Army and EPA. In the event of dispute, the EPA Administrator selects the remedy. Thus, the Army cannot unilaterally make modify or terminate a LUC remedy.

EPA Position: Section XIX, Selection, Design and Implementation of Remedial Actions of the FFA, in relevant part, states "... [f]ollowing consideration of comments by TWC, the ROD will be finalized jointly by the Army and EPA, or if they are unable to reach agreement about the selection of the remedial action, by the EPA Administrator." CERCLA Section 120(e)(4) and 40 CFR 300.430(f)(5)(iii), contain substantially the same language as noted above. Remedy selection authority as provided in CERCLA applies regardless of whether the Army currently owns the property. The FFA conveys the same principle. For example, in Section XXVI, Transfer of Property, the FFA provides that "no change in ownership or conveyance of any property interest in LHAAP shall in any way alter the status of the Parties under this Agreement." The FFA also provides that "Notice ...of any transfer of ownership or property interest shall not relieve the Army of its obligation to perform under this Agreement." As such, any language included in the draft final primary reports that is inconsistent with the above requirements is a violation of the FFA. The transfer or potential transfer of the LHAAP property or sites in question does not change the Army's obligations and responsibilities under the FFA or CERCLA. The FFA requires that the Army follow EPA policy. The relevant guidance or policy for this particular issue includes, "A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Documents," at pp. 6-6, 6-26-27, 6-48. The following examples include language that must be deleted from the draft final RODs, as the language is inconsistent with the FFA, CERCLA Section 120(e)(4) and the NCP at 40 CFR 300.430(f)(5)(iii). In the below examples, EPA modified Army language to make it consistent with CERCLA, the NCP, and the FFA. The Army may propose other language that would ensure that the Army does not independently modify or terminate a LUC without EPA concurrence as that is modifying or terminating a CERCLA remedy. To date, the Army has not proposed an alternative that meets these concerns.

Example (a): "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 ultimately 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 the LUC and any related transfer or lease provisions ;~~ and ~~(5)~~(4) ensuring the protectiveness 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 these sites after they have been transferred."

Example (b): "The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~."

The following EPA policies guide this issue as well:

EPA November 2010 Interim Final OSWER 9355.0-89 EPA-540-R-09-001, Institutional Controls**:** A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites: http://www.epa.gov/superfund/policy/ic/pdfs/PIME-IC-Guidance-Interim.pdf

EPA October 2006, Sample Federal Facility Land Use Control ROD Checklist with Suggested Language: http://www.epa.gov/fedfac/documents/icchecklist.pdf
EPA September 2000, OSWER 9355.0-74fs-p, Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups: http://www.epa.gov/superfund/policy/ic/guide/guide.pdf

5. Issue 5: The identification of ARARs and rationale for exclusion. The presence of the LHAAP-16 landfill requires attainment of landfill post closure requirements as ARARs.

   EPA Position: The Army has not provided the rationale for excluding items under 40 CFR 264.310(b) as ARARs. As provided in the NCP Preamble (at pp. 55 FR 8701 - 8702), it is clear that the nine criteria evaluation under 40 CFR 300.430(e)(9)(iii), encompasses the CERCLA 121(b)(1) remedy selection statutory requirements. CERCLA selected remedies must satisfy the threshold criteria of protecting human health and the environment, and compliance with ARARs under 40 CFR 300.430(f)(1). At issue here is the selected remedy's compliance with ARARs under hazardous waste management regulations. CERCLA Section 121(d) provides that on-site remedial actions must comply with the substantive requirements of environmental laws. Under 40 CFR 300.430(f)(1)(ii), on-site remedial actions must comply with ARARs or obtain a waiver. Any failure to include an ARAR without obtaining an EPA approval of an ARAR waiver request fails to comply with the FFA at Section XIX, CERCLA Sections 120 and 121, 40 CFR 300.430(f)(1)(ii), and EPA ARARs policy and guidance (i.e., ARARs Q's & A's: General Policy, RCRA, CWA, SDWA, Post-ROD Information and Contingency Waivers - July 1991).

6. Issue 6: The selection of LUCs ("LUC" means the legal or administrative mechanism by which the LUC objective is implemented) in the RODs. The RODs must identify the legal or administrative mechanism by which the LUC objective is implemented. Thus, the RODs must specifically identify and select LUCs as remedial action components.

   EPA Position: As provided in previous issues identified herein (i.e., issues ## 2, 3, and 4) CERCLA selected remedies must comply with the nine criteria evaluation under 40 CFR 300.430(e)(9)(iii), which encompass the CERCLA 121(b)(1) remedy selection statutory requirements. The LUC mechanism must be identified in the RODs so that EPA is assured that the remedy can be implemented as required by the NCP. It is especially important to identify the LUCs at complex sites such as Longhorn where the property will be transferred, In this case, because the property is still under Army control, then the Army should identify the current mechanism (some sort of internal Army procedures) and the future mechanism (ensure the controls are maintained by USFWS in the document transferring property). If the transferee is unable or unwilling to implement the LUCs, a different remedy may need to be chosen in order to ensure protectiveness. The requirement that the LUCs be identified as part of the RODs (i.e., the selected remedial action) ensures that the LUCs are part of an enforceable selected remedy that will be protective of human health and the environment over the short-term and long-term life of the selected remedy.

The following EPA policies guide this issue as well:

EPA November 2010 Interim Final OSWER 9355.0-89 EPA-540-R-09-001, Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites: http://www.epa.gov/superfund/policy/ic/pdfs/PIME-IC-Guidance-Interim.pdf

EPA October 2006, Sample Federal Facility Land Use Control ROD Checklist with Suggested Language: http://www.epa.gov/fedfac/documents/icchecklist.pdf

EPA September 2000, OSWER 9355.0-74fs-p, Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups: http://www.epa.gov/superfund/policy/ic/guide/guide.pdf

7. Issue 7: Currently, references to the MEC removal work plan for LUC implementation details are not appropriate as the removal work plan is not enforceable under the FFA.

   EPA Position: As provided in previous issues identified herein (i.e., issues ## 2, 3, 4, and 6) CERCLA selected remedies must comply with the nine criteria evaluation under 40 CFR 300.430(e)(9)(iii), which encompass the CERCLA 121(b)(1) remedy selection statutory requirements. One of the factors that must be assessed includes the short-term effectiveness. Thus the submission of a Remedial Design by a date certain (EPA suggests 90 days after the ROD) will assist in ensuring that the selected remedy will be protective in the short term. As mentioned earlier, the NCP Preamble specifically addresses the long-term effectiveness factor that must be assessed under CERCLA section 121(b)(1). Institutional controls may be used to provide protection to human health and the environment and special precautions must be made to assure that the controls are reliable. Submission of the LUC Implementation Plan in the RD is required a primary document under the FFA, Section VIII. EPA would also agree to including LUC implementation items in the ROD, if the Army would prefer. However, to date, the Army has preferred to include them in the Remedial Design and/or Remedial Action Work Plan.

   As such, the MMRP ROD for LHAAP-001-R and LHAAP-003-R must either include the LUC implementation items in the ROD or provide them as a LUC component of the Remedial Design or Remedial Action Workplan. Because the Army has historically provided these details in an enforceable remedial design, EPA has suggested the following: "A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 90 days of ROD signature, the Army shall prepare and submit to EPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections." EPA's suggested language, or similar language, is in every Federal agency ROD since 2004 (the initial year EPA issued the LUC Checklist) except those for the Air Force which includes LUC implementation components in the ROD.

   The following EPA policies guide this issue as well:

EPA November 2010 Interim Final OSWER 9355.0-89 EPA-540-R-09-001, Institutional Controls**:** A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites: http://www.epa.gov/superfund/policy/ic/pdfs/PIME-IC-Guidance-Interim.pdf

EPA October 2006, Sample Federal Facility Land Use Control ROD Checklist with Suggested Language: http://www.epa.gov/fedfac/documents/icchecklist.pdf

EPA September 2000, OSWER 9355.0-74fs-p, Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups: http://www.epa.gov/superfund/policy/ic/guide/guide.pdf

8. Issue 8: The identification of principal threat wastes at the Site. It should be clear that any munitions and explosives of concern (MEC) found at the MMRP ROD sites in the future will be evaluated to determine if they constitute principal threat wastes.

   EPA Position: The NCP, at 40 CFR 300.430(a)(1), establishes that EPA anticipated the use of treatment to address principal threats posed at CERCLA sites. The above NCP provision is consistent CERCLA's statutory preference to include treatment in selected remedial actions under CERCLA Section 121(b). EPA defines source material as material that act as a reservoir for migration of contamination to ground water, to surface water, to air, or acts as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. Because MEC has already been treated and removed from the MRS sites, it is clear that at least some of the MEC would have presented a significant risk to human health or the environment had exposure occurred. The EPA believes that the MEC removal report and investigations support the Agency's determination.

   The Agency's determination is not only supported by the above statutory and regulatory authority cited herein, but also the Agency's policy titled "A Guide to Principal Threat and Low Level Threat Wastes" November 1991. CERCLA Section 120(a) and the FFA at Section XIX also require federal facilities to comply with the Agency's statutes, regulations, and policies concerning sites containing hazardous substances, and the selection of remedial actions to address releases of hazardous substances. In addition, the EPA's policy concerning munitions response actions ("EPA Munitions Response Guidelines, Interim Final" July 2010) provides a detailed analysis concerning response measures authorized under CERCLA at munitions sites. The EPA Munitions Response Guidelines also support the Agency determination to clarify the principal threat waste issue, as the characterization of wastes serves as a integral component in addressing CERCLA's statutory preference for utilizing treatment in selected remedial actions.

   An example of addressing this issue for the MMRP ROD for LHAAP-001-R and LHAAP-003-R may include: "While all known MEC was removed from these two MRS sites, if any MEC is discovered at the sites in the future the MEC will be evaluated for its potential designation as a principal threat waste;" and removal of the statement, "~~There are no known principal threat wastes at these two MRS sites.~~"

IV. Goals of the Dispute:

The EPA's goals in resolving this dispute include the following: 1) The Army modifying the inadequate RODs to ensure they are protective of human health and the environment in the draft final RODs for all four sites to comply with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Contingency Plan (NCP), and EPA guidance, as required by the FFA; and 2) The Army agreeing to ensure that future submissions of draft RODs will be protective and comply with CERCLA, the NCP, EPA Policy, and the FFA.

ENCLOSURE 2:

EPA Comments on Draft Final MMRP ROD/LHAAP-001-R and LHAAP-003-R (October 13, 2011).

EPA Comments on Draft Final LHAAP-16 ROD (October 20, 2011).

EPA Comments on Draft Final LHAAP-17 ROD (October 20, 2011).

00113145

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
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DALLAS TX 75202-2733

OCT 13 2011

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final MMRP Record of Decision (ROD)
LHAAP-001-R South Test Area/Bomb Test Area
LHAAP-003-R Ground Signal Test Area
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler:

The Environmental Protection Agency (EPA) has completed its review of the *Draft Final MMRP ROD (LHAAP-001-R South Test Area/Bomb Test Area, LHAAP-003-R Ground Signal Test Area)* submitted on September 27, 2011, and have the following comments:

1. Overall ROD, Table 2-4: Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-001-R and LHAAP-003-R 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). Therefore, the appropriate standard to be applied at LHAAP-001-R and LHAAP-003-R should be the State of Texas Groundwater MSC for Residential Use, which for perchlorate is at 26 ug/L, per 40 CFR 300.430(a)(iii)(F), and 300.430(f)(1)(ii)(B) .

   The ROD language needs to reflect this State of Texas groundwater designation and the appropriate residential standard in order to be consistent with the EPA July 2011 OSWER Directive 9283.1-34, EPA June 2009 OSWER Directive 9283.1-33, and the DoD April 2009 Perchlorate Release Management Policy.

   - EPA July 2011 OSWER Directive 9283.1-34, Groundwater Road Map Recommended Process for Restoring Contaminated Groundwater at Superfund Sites: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/gwroadmapfinal.pdf

   - EPA June 2009 OSWER Directive 9283.1-33: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf

   - DoD April 2009 Perchlorate Release Management Policy: http://www.denix.osd.mil/cmrmd/upload/dod_perchlorate_policy_04_20_09.pdf

   - TCEQ March 2006 MSC and risk-based screening levels tables: http://www.tceq.texas.gov/assets/public/remediation/rrr/msc-rbscn_2006.xls

2. Table of Contents: The 'Section 2.10.2 Compliance with ARARs' is missing and subsequent sections mis-numbered.

3. Section 1.5, Section 2.14.5: Revise to state that: "Although the statutory preference for treatment was not fully satisfied, the MEC removal action removed…"

4. Section 2.2.2: The last two sentences of this section should either be deleted or explained to reflect that the MMRP sites LHAAP-001-R and LHAAP-003-R are now NPL sites under the FFA and that EPA is the lead regulatory agency for these sites.

5. Section 2.5.2.2, first sentence: Please refer to the ROD as the 1998 NFA ROD.

6. Section 2.12.1: Before the first sentence in this Section add the following sentence, "Notwithstanding any other provision in this ROD, all remedial action selections made at Sites LHAAP-001-R and LHAAP-003-R shall comply with CERCLA Sections 113, 117, 120(e), 121, 40 C.F.R. §§ 300.430(f) and 300.820, and the FFA.

7. IC Checklist #4: The ROD confuses the term "LUC" and "objective" and includes inconsistent and unclear objectives. The LUC objectives appear to be partially listed in section 1.4, p. 1-2, although they are also generally described in 2.12.1. and 2.9.1. Note that the list includes signs and education programs and these are LUCs, not objectives. Please replace the listing on in section 1.4, p. 1-2 as follows: "The LUC objectives are: **1) to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells, 2) to prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds, and 3) prohibit intrusive activities such as digging or any other activity which could result in detonation of explosive hazards."**

8. IC Checklist #5: LUCs. The "LUC" means the legal or administrative mechanism by which the LUC objective is implemented. In this case, the property appears to be still under Army control, then the Army should identify the current mechanism (some sort of internal Army procedures) and the future mechanism (ensure the controls are maintained by USFWS in the document transferring property). The signs and education programs mentioned in several places are also part of the LUCs and should be included, as well as the TAC restriction.

9. IC Checklist #6: Duration language-- missing. Please include the following: "Land Use Controls will be maintained until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure."

10. IC Checklist #7: Responsibility language. The language in Section 2.12.2, page. 2-25 is ok. But the reference to monitoring in Section 1.4, page 1-2 and in Section 2.12.2, page 2-26 and must be modified as EPA does not consider the 5YR a substitute for **LUC** monitoring: "~~Monitoring in the form of~~ Five-Year Reviews will be conducted to ensure that the LUCs are specified, implemented, monitored, reported on, and enforced in an efficient, cost effective…"

In addition, on page 1-3, first paragraph: "The U.S. Army will remain responsible for implementation, maintenance, periodic inspection, reporting on and enforcement of the LUCs ~~in accordance with the LUC plan in Appendix I of the removal action work plan (EODT, 2008)~~."

11. IC Checklist #8: Remedy integrity. This problematic language appears in Sections 1-4 and 2.12.2 (Page 2-25) and must be changed to: "4) reservation of authority to change, modify, or terminate the LUC with approval from EPA and consultation from TCEQ and any related transfer or lease provisions; and (5) ensuring the integrity of the selected remedy…"

12. IC Checklist #9: Commitment to provide RD for implementation actions. In Section 1.4 next to the last paragraph there is a reference to the removal MEC work plan for LUC implementation details. The removal workplan will not suffice as it is not a primary document. Please include language from the Checklist or the language or as follows: "A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 90 days of ROD signature, the Army shall prepare and submit to EPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections."

13. IC Checklist #14: Modification/termination of LUC. The problematic language appears in Section 1.4, page 1-3 and in section 2.12.2, page 2-26. Please modify as follows: "In the event that T~~CEQ and/or~~ USEPA and the U.S. Army agree with respect to any ~~significant~~ modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the Federal Facility Agreement (FFA) and 40 CFR. §300.435(c)(2)."

    Again, the qualifier ("significant") must come out because EPA MUST agree with any change to a remedy (no matter what its significance) due to our statutory authority to jointly select remedies which is all the Army has no matter what. TCEQ needs to come out because Texas' agreement is not needed to modify the remedy. The statement above, as written, gives Texas an equal role in remedy selection which is not provided by the statute. Finally the "and/or" language could be read to state that EPA's agreement is not necessary.

14. Pages 1-3 and 2-25 (1st 2 bullets), please make it clear that it is the Army who notifies the county and insert a deadline, for example: "In addition, within 90 days of signature of this ROD, the Army shall: 1) request the Texas Department of Licensing and Regulation ~~will be requested~~ to notify well drillers of groundwater restrictions;and2)~~the Army shall~~ notify the ~~a notification of the LUC with the~~ Harrison County Courthouse of the LUC to include ~~would include~~ a map showing the areas of groundwater restriction at the site, in accordance with 30 TAC 335.565."

15. Section 2.12.1, Section 2.12.2: The language (i.e.: The details and description of the LUC…" on page 2-24 and page 2-26 is confusing in that it seems to state that the LUC implementation actions are already in an approved remedial design. This language need to be clarified to reflect that: "A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 90 days of ROD signature, the Army shall

prepare and submit to EPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections."

Under Section VIII.C.2. and Section XV.B. of the Federal Facilities Agreement, EPA may invoke Dispute Resolution for any unresolved comments. Please feel free to contact me at (214) 665-8409, or by email at tzhone.stephen@epa.gov, if there are any questions or comments.

Sincerely,

Carlos A. Sanchez
for
Stephen L. Tzhone
Remedial Project Manager

cc: Ms. Fay Duke, TCEQ
Mr. Richard Mayer, EPA R6
Mr. George Malone, EPA R6
Ms. Sally Dalzell, EPA FFEO
Ms. Allison Abernathy, EPA FFRRO
Mr. Timothy Mott, EPA FFRRO
Ms. Ellen Treimel, EPA FFRRO

00113149

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OCT 20 2011

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final Record of Decision (ROD)
LHAAP-16: Old Landfill
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler:

The EPA has completed its review of the *Draft Final ROD (LHAAP-16: Old Landfill)* submitted on September 29, 2011, and have the following comments:

1. Overall ROD, Table 2-7, Table 2-10: Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-16 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). Therefore, the appropriate standards to be applied at LHAAP-16 should be the State of Texas Groundwater MSC for Residential Use, which for nickel is at 730 ug/L, perchlorate at 26 ug/L, and manganese at 7,820 ug/L (95% UTL Background), per 40 CFR 300.430(a)(iii)(F), and 300.430(f)(1)(ii)(B) .

   The ROD language needs to reflect this State of Texas groundwater designation and the appropriate residential standards in order to be consistent with the EPA July 2011 OSWER Directive 9283.1-34, EPA June 2009 OSWER Directive 9283.1-33, and the DoD April 2009 Perchlorate Release Management Policy.

   - EPA July 2011 OSWER Directive 9283.1-34, Groundwater Road Map Recommended Process for Restoring Contaminated Groundwater at Superfund Sites: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/gwroadmapfinal.pdf

   - EPA June 2009 OSWER Directive 9283.1-33: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf

   - DoD April 2009 Perchlorate Release Management Policy: http://www.denix.osd.mil/cmrmd/upload/dod_perchlorate_policy_04_20_09.pdf

   - TCEQ March 2006 MSC and risk-based screening levels tables: http://www.tceq.texas.gov/assets/public/remediation/rrr/msc-rbscn_2006.xls

2. Section 2.9.1, page 2-26. Section 2.12.2, page 2-55. For LTM, Groundwater and Surface Water Monitoring, and Long-Term Operations, monitoring after the next five year review should be on an annual basis unless the five year review recommends otherwise.

   Example, page 2-26: "LTM semiannually for 3 years, annually until the next five-year review, then ~~once every 5 years to remedy performance.~~ annually thereafter until recommended otherwise by the five-year review."

   Example, page 2-55: "Surface water and wells will then be sampled annually until the next five-year review and ~~every 5 years~~ annually thereafter until ~~indicated by the data.~~ recommended otherwise by the five- year review."

3. The Army proposed replacement of Section 2.12.1 with the following language (along with related changes in Section 2.12.2 and Section 2.12.4) is acceptable to EPA: "The MNA was selected as one component of the remedy based on available groundwater evidence as presented in the Addendum to the FS (Shaw, 2010). A tiered approach using three lines of evidence was used to examine the occurrence of natural attenuation. The first line of evidence evaluated reductions in COC concentrations over time and with distance, the second line of evidence evaluated geochemical indicators, while the third line of evidence entailed estimation of natural attenuation rates. Historical decreases in concentrations of chlorinated solvents and perchlorate in individual wells were observed in both shallow and intermediate groundwater, including the detection of daughter by-products that suggest the occurrence of complete reductive dechlorination. These results indicated the shallow and intermediate contaminant plumes are stable in certain areas (at the source area and side-downgradient in the plumes); however, there were increases in other well locations in the shallow groundwater that suggest a portion of the plume is migrating toward Harrison Bayou. The intermediate groundwater zone plume was relatively more stable than the shallow groundwater with less migration. Geochemical conditions were adequate for perchlorate degradation (as evidenced by non-detect nitrate/nitrite levels), but methanogenic conditions (needed for chlorinated ethene degradation) were not detected consistently throughout the site. Thus, natural attenuation was considered feasible for much of the site, but not as a sole remedy for the entire site. Additional evaluation, including the installation of additional monitoring wells, will be implemented as part of the MNA component. MNA, together with the in situ bioremediation and biobarriers, will ultimately restore the groundwater to attain groundwater cleanup standards/levels; this is anticipated to be completed in approximately 280 years. This approximate timeframe to achieve cleanup levels is considered reasonable based on the anticipated future land use of the site as a national wildlife refuge and the fact that there is no current or anticipated future use of groundwater as a drinking water supply. Thus, MNA is an appropriate component of the remedy for those regions outside the influence of the active remedies because it will protect human health and the environment and will document that further reductive dechlorination is occurring within the groundwater plume and that contaminant concentrations are being reduced to attain groundwater standards/levels."

4. Section 2.12.2, page 2-51. Under Cap Maintenance, please provide the rationale for 40 CFR 264.310(b)(2) to not be included as an ARAR.

5. Table 2-10, page 2-88. Under Post Closure Care, please clarify if all items under 40 CFR 264.310(b) are ARARs, or only the specific ones identified in Section 2.12.2.

6. IC Checklist #4 (LUC Objectives): Section 2.9.1. Section 2.12.2. We are appreciative that the Army has agreed to modify the groundwater LUC and add the prohibition on residential land use as we requested. Regarding the LUC to maintain the remedy integrity, we appreciate the offer to prohibit intrusive activities but there are other activities which could damage the wells.

   Please add either one of the following LUC objectives to address this issue:

   "LUC to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells. "

   or:

   "LUC to prohibit intrusive or any other activities which could damage the landfill cap and the groundwater monitoring system."

7. IC Checklist #6 (LUC Duration): Because additional LUCs will be added, the Army must either add the general LUC checklist language to memorialize its understanding that LUCs are to remain in place until unlimited use and unrestricted exposure is reached for all of them or the Army needs to develop a specific duration statement for each separate LUC. It appears that the Army would prefer to have a separate statement for each LUC which is fine, but please send us the statements so that we can review.

8. IC Checklist #8 (Remedy Integrity): Section 1.4, page 1-4. Section 2.12.2, page 2-52. The Army does not have independent authority to modify a remedy. See CERCLA Section 120 (e)(4). Please make the following edits: "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 ultimately 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 the LUC and any related transfer or lease provisions ;~~ and ~~(5)~~(4) ensuring the protectiveness 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 these sites after they have been transferred."

9. Section 1.4, page 1-4. Section 2.9.2, page 2-27. Section 2.12.2, page 2-52. The Army must get EPA concurrence on any modification and/or termination of LUCs. The LUC is part of the remedy which, by law, is both selected by Army and EPA. Thus, the Army shall not unilaterally make decisions on any modifications and/or terminations of LUCs, including whether a proposed modification is 'significant'. Please make the following edits: "The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~."

10. Regarding previous Army comments on the term 'support agency', in the event of a dispute, EPA independently selects the remedy as an <u>oversight agency</u>.

Under Section VIII.C.2. and Section XV.B. of the Federal Facilities Agreement, EPA may invoke Dispute Resolution for any unresolved comments. Please feel free to contact me at (214) 665-8409, or by email at tzhone.stephen@epa.gov, if there are any questions or comments.

Sincerely,

Stephen L. Tzhone
Remedial Project Manager

cc: Ms. Fay Duke, TCEQ
Mr. George Malone, EPA R6
Ms. Ellen Treimel, EPA FFRRO
Ms. Caitlin Meisenbach, EPA FFEO

00113153

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

OCT 20 2011

Ms. Rose M. Zeiler, Ph.D.
Department of the Army
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final Record of Decision (ROD)
LHAAP-17: No. 2 Flashing Area Burning Ground
Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Zeiler:

The EPA has completed its review of the *Draft Final ROD (LHAAP-17: No. 2 Flashing Area Burning Ground)* submitted on September 29, 2011, and have the following comments:

1. Overall ROD, Table 2-10, Table 2-14: Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-16 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). Therefore, the appropriate standard to be applied at LHAAP-17 should be the State of Texas Groundwater MSC for Residential Use, which for perchlorate is at 26 ug/L, per 40 CFR 300.430(a)(iii)(F), and 300.430(f)(1)(ii)(B) .

   The ROD language needs to reflect this State of Texas groundwater designation and the appropriate residential standard in order to be consistent with the EPA July 2011 OSWER Directive 9283.1-34, EPA June 2009 OSWER Directive 9283.1-33, and the DoD April 2009 Perchlorate Release Management Policy.

   - EPA July 2011 OSWER Directive 9283.1-34, Groundwater Road Map Recommended Process for Restoring Contaminated Groundwater at Superfund Sites: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/gwroadmapfinal.pdf

   - EPA June 2009 OSWER Directive 9283.1-33: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf

   - DoD April 2009 Perchlorate Release Management Policy: http://www.denix.osd.mil/cmrmd/upload/dod_perchlorate_policy_04_20_09.pdf

   - TCEQ March 2006 MSC and risk-based screening levels tables: http://www.tceq.texas.gov/assets/public/remediation/rrr/msc-rbscn_2006.xls

2. Section 1.4, page 1-2. Section 2.12.2, page 2-33. For LTM, monitoring after the next five year review should be on an annual basis unless the five year review recommends otherwise.

   Example, page 1-2: "In subsequent years, LTM will be annual until the next five-year review and annually thereafter until recommended otherwise by the five-year review. The monitoring and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue ~~every 5 years~~ until cleanup levels are achieved and annually until recommended otherwise by the five-year review."

   Example, page 2-33: "Continue LTM ~~every 5 years~~ annually thereafter until recommended otherwise by the five-year review to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen."

3. IC Checklist #4 (LUC Objectives): Section 2.9.1. Section 2.12.2. We are appreciative that the Army has agreed to modify the groundwater LUC and add the prohibition on residential land use as we requested. Regarding the LUC to maintain the remedy integrity, we appreciate the offer to prohibit intrusive activities but there are other activities which could damage the wells.

   Please add either one of the following LUC objectives to address this issue:

   "LUC to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells. "

   or:

   "LUC to prohibit intrusive or any other activities which could damage the landfill cap and the groundwater monitoring system."

4. IC Checklist #6 (LUC Duration): Because additional LUCs will be added, the Army must either add the general LUC checklist language to memorialize its understanding that LUCs are to remain in place until unlimited use and unrestricted exposure is reached for all of them or the Army needs to develop a specific duration statement for each separate LUC. It appears that the Army would prefer to have a separate statement for each LUC which is fine, but please send us the statements so that we can review.

5. IC Checklist #8 (Remedy Integrity): Section 1.4, page 1-3. Section 2.12.2, page 2-33. The Army does not have independent authority to modify a remedy. See CERCLA Section 120 (e)(4). Please make the following edits: "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 ultimately 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 the LUC and any related transfer or lease provisions ;~~ and ~~(5)~~(4) ensuring the protectiveness 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 these sites after they have been transferred."

6. Section 1.4, page 1-4. Section 2.9.2, page 2-20. Section 2.12.2, page 2-34. The Army must get EPA concurrence on any modification and/or termination of LUCs. The LUC is part of the remedy which, by law, is both selected by Army and EPA. Thus, the Army shall not unilaterally make decisions on any modifications and/or terminations of LUCs, including whether a proposed modification is 'significant'. Please make the following edits: "The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~."

7. Regarding previous Army comments on the term 'support agency', in the event of a dispute, EPA independently selects the remedy as an <u>oversight agency</u>.

Under Section VIII.C.2. and Section XV.B. of the Federal Facilities Agreement, EPA may invoke Dispute Resolution for any unresolved comments. Please feel free to contact me at (214) 665-8409, or by email at tzhone.stephen@epa.gov, if there are any questions or comments.

Sincerely,

Stephen L. Tzhone
Remedial Project Manager

cc: Ms. Fay Duke, TCEQ
Mr. George Malone, EPA R6
Ms. Ellen Treimel, EPA FFRRO
Ms. Caitlin Meisenbach, EPA FFEO

ENCLOSURE 3:

Army Longhorn Response to EPA LUC Comments on LHAAP-16 and LHAAP-17 RODs (September 28, 2011).

Longhorn Response to EPA LUC Comments on LHAAP -16 and LHAAP-17 RODs

Zeiler, Rose Ms CIV USA OSA to: Stephen Tzhone 09/28/2011 10:25 AM
Cc: Fay Duke, "Lambert, John R SWT", "Wililams, Aaron"

From: "Zeiler, Rose Ms CIV USA OSA" <rose.zeiler@us.army.mil>
To: Stephen Tzhone/R6/USEPA/US@EPA
Cc: Fay Duke <fay.duke@tceq.texas.gov>, "Lambert, John R SWT" <John.R.Lambert@SWT03.usace.army.mil>, "Wililams, Aaron" <aaron.k.williams@usace.army.mil>

History: This message has been replied to.

1 attachment

Longhorn Response to Comments 28 SEP 2011.docx

Steve,

Please see the attached RTCs.

Army has provided substantive responses to all the EPA comments and believes there are no differences that affect the selected remedy or the protectiveness of the selected remedy. Army will proceed with completion of the document since EPA Region 6 has requested that the ROD be signed by the end of FY11.

Rose

Rose M. Zeiler, Ph.D.,
Site Manager
Longhorn Army Ammunition Plant
479-635-0110 (0112 – fax)

Region 6. Please note that our responses are keyed to the specific comment as numbered in our prior comments.

Longhorn OU 16

Comment #4, CL. 4 Objectives. We are appreciative that the Army has agreed to modify the groundwater LUC and add the prohibition on residential land use as we requested. Regarding the LUC to maintain the remedy integrity, we appreciate the offer to prohibit intrusive activities but there are other activities which could damage the wells. For instance at the Cameron Station BRAC site in Virginia a groundwater well was damaged when heavy equipment was driven over it. Strictly speaking, this was not an "intrusive activity' however the well was damaged.

Additionally, we would like to point out that the language we proposed has been used many times in Army documents. Please see page 2-22 of the Army's June 2009 Picatinny Area C Groundwater ROD where this precise language on maintaining a gw monitoring remedy.

Please add either one of the following objectives to address this issue:

"LUC to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells. "

or:

"LUC to prohibit intrusive or any other activities which could damage the landfill cap and the groundwater monitoring system."

Army Response: Protection of the groundwater monitoring system will be addressed in post-ROD documents specifying the protective measures such as bollards, pads, protective casing, and locks. These documents will be provided to the federal agency with jurisdiction over the property, which will be the USF&WS. It is Army's understanding that implementation of these types of controls through the inclusion within site management documents has been acceptable to EPA in the past.

The early 1990's incident at Cameron Station involved a below-grade well located within a public roadway that was paved over by a paving contractor. While it is debatable whether recordation in county land records would have prevented this incident (Army replaced the well), the cited incident is unlike wells located on an environmental site owned by the United States and under the management of a federal agency. Whether the language proposed has or has not been used in some other circumstance is not relevant to this particular situation which differs from Picatinny. If EPA is correct that the exact language has been incorporated in the Picatinny ROD, that language was not recorded as a land use restriction as such would be contrary to GSA regulations and policy which prevents the placement of restrictions on federal real property titles.

In this particular situation, DOI, the agency with future jurisdiction, will be made aware of protective measures for the groundwater monitoring system via post-ROD documents. Army does not understand how placing a note in the county land records would improve DOI's awareness.

Comment # 5. Cl 5. LUC We think that the Army has misunderstood our comment. The "LUC"means the legal or administrative mechanism by which the LUC objective is implemented. In this case, if the property is still under Army control, then the Army should identify the current mechanism (some sort of internal Army procedures) and the future mechanism (ensure the controls are maintained by USFWS in the document transferring property).

Army Response: The LUCs will be incorporated into the documents transferring jurisdiction of the property to the Department of the Interior. The USF&WS will also be provided the Site-Wide LUC Management Plan.

Comment # 6. CL 6. Duration Because additional LUCs will be added, the Army must either add the general LUC checklist language to memorialize its understanding that LUCs are to remain in place until UUUE is reached for all of them or the Army needs to develop a specific duration statement for each separate LUC. It appears that the Army would prefer to have a separate statement for each LUC which is fine, but please send us the statements so that we can review.

Army Response: A description of the durations for the relevant LUCs are included in the ROD. See Army's prior responses to Comment #4 relative to the request for additional LUCs.

Comment #8. Cl 8. Remedy Integrity. The listing on pp. 1-4 and 2-49 is not equivalent to the Checklist language. Note also, that the language we requested has appeared in Army RODs all over the country. See Seneca Army Depot Activity ROD for OUs 59 and 71.

Additionally, the language we struck below is inaccurate because the Army does not have independent authority to modify a remedy. See CERCLA Section 120 (e)(4). Please make the following edits:

"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 ultimately 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 the LUC and any related transfer or lease provisions ;~~ and (4) 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 these sites after they have been transferred."

Army Response: Army disagrees that the stricken language contained in point (4) asserts an independent authority to change the remedy. That language retains Army's authority to protect and if necessary modify the remedy to maintain its protectiveness following transfer of jurisdiction to the DOI. The language does not address the issue of whether this authority is or is not independent of EPA. Additionally, Army cannot agree to the compromise language ("reservation of authority to change, modify, or terminate the LUC with approval from EPA and consultation from TCEQ and any related transfer or lease provisions") offered in Mr. Tzhone's September 20, 2011 E-mail. Besides limiting Army's statutory authority that is independent of EPA's statutory authority, the subject language will be included in the documents transferring jurisdiction from Army to DOI. USEPA is no part of that transfer and therefore granting USEPA jurisdictional powers interferes with the proper functioning of the federal government. The language used in the ROD is appropriate to address the Army's responsibilities in this particular situation.

Army has no particular objection to striking the text "that the LUC objectives are met to protect," but believes that the word "protectiveness" is more appropriate than the word "integrity" because LUCs, in this instance, are intended to function either as the primary remedy or to protect the integrity of other remedy components. Army is fully aware of its responsibility to ensure the integrity of the selected remedy, which is the purpose of the retention of Army authority in point (4). Army will revise point (5) to read "…ensuring the protectiveness of the selected remedy."

Comment #9. Notification of state and county. A year is a long time to wait before notifying the state and county. We understand that the boundaries are not set. However, rather than risk that someone will be allowed to use groundwater that is not protective, it is prudent to notify the state and county within 90 days of ROD signature, with language that the boundaries are subject to change. Please send a preliminary notice and then update it in a year.

Army Response: Army currently has jurisdiction over this federal property and has no intention or need to use groundwater. Army is unaware that DOI has any similar desire or need. Clearly, any third party who would drill a well in this location would be trespassing on federal property, illegally appropriating a federally owned right (the water right), and would have to do so without the federal government's knowledge. As noted in the original response to comment, the notification will be placed in the county land records prior to transfer of jurisdiction. Army has no objection to notifying the Texas Department of Licensing and Regulation within 90-days of signing the ROD since drillers do not in any event have access to the property.

Comment #10. Modification/Termination of LUCs. Region 6- the following revision must be made. Nationally, we do not agree to a qualifier in terms of letting the Army determine whether it needs to seek our approval to modify or terminate any LUC. The LUC is part of the remedy which, by law, we both select. In the event of a dispute, EPA independently selects the remedy. Thus, the Army cannot unilaterally make this decision. Regarding its response that EPA is a support agency, in this instance EPA is an oversight agency rather than a mere support agency. Additionally, this language has been used in Army RODs nationally there is no justification from departing from it here.

"The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~."

Army Response: The current language in the ROD is in accordance with 40 CFR 300.435(c)(2), which requires consultation with EPA in the event of a significant change. Clearly, termination of a LUC would be a significant change. Whether the language has been used nationally or not, in this instance the property will continue in federal ownership but under the jurisdiction of an agency other than Army, which is an atypical situation.

The term "support agency" is defined in the NCP at 40 CFR 300.5, and used throughout Subpart E of the NCP, Hazardous Substance Response, to differentiate the lead agency, acting under authority delegated by the President in Executive Order 12580 and related delegations, from the support agency, usually either EPA or a State environmental regulator but possibly other Federal agencies, who provide technical support to the lead agency with regard to the conduct of response actions, including regulatory review and consultation. It is the correct term to refer to EPA's role in the response actions being conducted by the Army at LHAAP.

Longhorn 17

Comment #2, Map. The Army has agreed to add a preliminary LUC boundary and notes that the final boundary will be determined later. Please revise the following language on p. 1-3 to ensure that the public knows that the LUC boundary is subject to change: "A land use control (LUC) to prevent human exposure to contaminated groundwater by restricting the use of groundwater to environmental monitoring and testing only. A preliminary LUC boundary is provided on Figure 2-5 and a final LUC boundary will be determined during the RD/RA. When the cleanup level is achieved, the LUC will be terminated.

Army Response: Army will revise the language as requested.

Comment # 5, CL 4. LUC objective. Because additional LUCs will be added, the Army must either add the general LUC checklist language to memorialize its understanding that LUCs are to remain in place until UUUE is reached for all of them or the Army needs to develop a specific duration statement for each separate LUC. It appears that the Army would prefer to have a separate statement for each LUC which is fine, but please send us the statements so that we can review.

Army Response: Army has already agreed to revise the groundwater LUC language as requested in the original comment.

Protection of the groundwater monitoring system will be addressed in post-ROD documents specifying the protective measures such as bollards, pads, protective casing, and locks. These documents will be provided to the federal agency with jurisdiction over the property, which will be the USF&WS. It is Army's understanding that implementation of these types of controls through the inclusion within site management documents has been acceptable to EPA in the past.

In this particular situation, DOI, the agency with future jurisdiction, will be made aware of protective measures for the groundwater monitoring system via post-ROD documents. Army does not understand how placing a note in the county land records would improve DOI's awareness.

With respect to the notice that no residential use is allowed, the following language used in LHAAP 16 has been added:

> ***The LUC restriction of land use to non- residential will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.***

Comment #6. Cl 5. LUC. We think that the Army has misunderstood our comment. The "LUC"means the legal or administrative mechanism by which the LUC objective is implemented. In this case, if the property is still under Army control, then the Army should identify the current mechanism (some sort of internal Army procedures) and the future mechanism (ensure the controls are maintained by USFWS in the document transferring property).

Army Response: The LUCs will be incorporated into the documents transferring jurisdiction of the property to the Department of the Interior. The USF&WS will also be provided the Site-Wide LUC Management Plan.

Comment #7. Cl. 6 Duration. We think the Army has misunderstood our comment. The LUC duration on p. 2-34 does not address the duration for prohibiting non residential development or for the intrusive activities. We suggest the following revision to the Army's language on p. 2-34 to address this gap:

" The LUCs ~~for the restriction of groundwater use~~ shall remain in place at the site unless the hazardous substances remaining at the site are reduced below levels that would support unlimited use and unrestricted exposure."

Army Response: There is no restriction on intrusive activities at LHAAP 17. With respect to the notice that no residential use is allowed, the following language used in LHAAP 16 has been added:

> ***The LUC restriction of land use to non- residential will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.***

Comment # 9. Cl 8 Remedy Integrity. The listing on pp. 1-3 and 2-33 is not equivalent to the Checklist language. Note also, that the language we requested has appeared in Army RODs all over the country. See Seneca Army Depot Activity ROD for OUs 59 and 71.

Additionally, the language we struck below is in accurate because the Army does not have independent authority to modify a remedy. Please make the following edit:

"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 ultimately 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 the LUC and any related transfer or lease provisions ;~~ and (4) 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 these sites after they have been transferred."

Army Response: Army disagrees that the stricken language contained in point (4) asserts an independent authority to change the remedy. That language retains Army's authority to protect and if necessary modify the remedy to maintain its protectiveness following transfer of jurisdiction to the DOI. The language does not address the issue of whether this authority is or is not independent of EPA. Additionally, Army cannot agree to the compromise language ("reservation of authority to change, modify, or terminate the LUC with approval from EPA and consultation from TCEQ and any related transfer or lease provisions") offered in Mr. Tzhone's September 20, 2011 E-mail. Besides limiting Army's statutory authority that is independent of EPA's statutory authority, the subject language will be included in the documents transferring jurisdiction from Army to DOI. USEPA is no part of that transfer and therefore granting USEPA jurisdictional powers interferes with the proper functioning of the federal government. The language used in the ROD is appropriate to address the Army's responsibilities in this particular situation.

Army has no particular objection to striking the text "that the LUC objectives are met to protect," but believes that the word "protectiveness" is more appropriate than the word "integrity" because LUCs, in this instance, are intended to function either as the primary remedy or to protect the integrity of other remedy components. Army is fully aware of its

responsibility to ensure the integrity of the selected remedy, which is the purpose of the retention of Army authority in point (4). Army will revise point (5) to read "…ensuring the protectiveness of the selected remedy."

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"The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change~~ inconsistent with the LUC objectives and industrial use assumptions of the remedy~~."

Army Response: The current language in the ROD is in accordance with 40 CFR 300.435(c)(2), which requires consultation with EPA in the event of a significant change. Clearly, termination of a LUC would be a significant change. Whether the language has been used nationally or not, in this instance the property will continue in federal ownership but under the jurisdiction of an agency other than Army, which is an atypical situation.

The term "support agency" is defined in the NCP at 40 CFR 300.5, and used throughout Subpart E of the NCP, Hazardous Substance Response, to differentiate the lead agency, acting under authority delegated by the President in Executive Order 12580 and related delegations, from the support agency, usually either EPA or a State environmental regulator but possibly other Federal agencies, who provide technical support to the lead agency with regard to the conduct of response actions, including regulatory review and consultation. It is the correct term to refer to EPA's role in the response actions being conducted by the Army at LHAAP.

Comment #11. Notification of state and county. A year is a long time to wait before notification. We understand that the boundaries are not set. However, rather than risk that someone will be allowed to use groundwater that is not protective, it is prudent to notify the state and county within 90 days of ROD signature, with language that the boundaries are subject to change. Please send a preliminary notice and then update it in a year.

Army Response: Army currently has jurisdiction over this federal property and has no intention or need to use groundwater. Army is unaware that DOI has any similar desire or need. Clearly, any third party who would drill a well in this location would be trespassing on federal property, illegally appropriating a federally owned right (the water right), and would have to do so without the federal government's knowledge. As noted in the original response to comment, the notification will be placed in the county land records prior to transfer of jurisdiction. Army has no objection to notifying the Texas Department of Licensing and Regulation within 90-days of signing the ROD since drillers do not in any event have access to the property.

00113165

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT CHIEF OF STAFF FOR INSTALLATION MANAGEMENT
600 ARMY PENTAGON
WASHINGTON, DC 20310-0600

4 November 2011

Mr. Samuel Coleman, P.E.
Director, Superfund Division
US EPA Region 6
Fountain Place
1445 Ross Ave.
Dallas, TX 75202-2750

Dear Mr. Coleman:

This letter notifies U.S. Environmental Protection Agency Region 6 (Region 6) of the U.S. Army's (Army) objection to Region 6's attempt to circumvent the informal dispute resolution process required by the Federal Facilities Agreement (FFA) for the Longhorn Army Ammunition Plant. The Army requests that the Region 6 Regional Project Manager (RPM) meet and discuss the issues in dispute with the Army and State Project Managers (PMs) in a good faith effort to resolve these matters.

Two disputes currently exist between Army and Region 6. On October 27, 2011, Army submitted a letter disputing the Region 6 assessment of stipulated penalties related to the Records of Decision (RODs) for four sites at Longhorn. The Army dispute letter asserts that Army complied with the FFA by submitting the relevant primary documents on time and therefore there is no basis for the assessment of stipulated penalties, and that the stipulated penalties are prematurely assessed contrary to the consultation process of the FFA. On the same day, Region 6 submitted a letter invoking dispute resolution on the draft final RODs for the four sites, LHAAP-16, 17, 001-R-01 MMRP, and 003-R-01 MMRP.

In its October 27 letter, Region 6 attempted to circumvent informal dispute resolution by claiming to elevate the dispute to the formal level based on an October 18 courtesy office call by Mr. Tom Lederle, the supervisor of the Army PM, Dr. Rose Zeiler. Region 6's claim that Mr. Lederle's visit was not only informal dispute resolution, but also was the only informal dispute resolution necessary, disregards both the requirements of the FFA and inter-agency comity. The October 18 meeting did not include the Texas Commission on Environmental Quality (TCEQ), a party to the FFA, nor was Mr. Lederle informed at any time that Region 6 considered the meeting to be part of the dispute resolution process. Additionally, the FFA requires that the parties meet as many times as necessary to attempt in good faith to resolve the dispute. It is my belief that a courtesy call by an unsuspecting Army official without TCEQ participation does not satisfy the informal dispute resolution process.

Army believes that the purpose of dispute resolution is to resolve as many issues as possible and to frame the remaining issues in a manner that facilitates meaningful discussions by the FFA Dispute Resolution Committee (DRC). Army does not believe that the issues are properly framed at this time. Army was in fact unaware that several of the issues raised in the October 27 letter were in dispute. For example, Army was unaware that there is a dispute regarding ARARs or principal threat waste determinations. The Army will be prepared to elevate the dispute to the DRC as provided in the FFA after there has been an opportunity at the informal PM level to thoroughly vet these issues, resolve those that can be resolved, and frame for the DRC those that cannot be resolved.

The FFA provides that the informal dispute resolution involve the Project Managers "and/or" their immediate supervisors. Army is agreeable to the FFA format and agrees that counsel should be included as requested by EPA. Because the parties have not engaged in informal dispute resolution with respect to either dispute, Army proposes that informal dispute resolution meetings begin as soon as possible. As provided in the FFA, all three of the parties should meet as many times as necessary prior to submitting any unresolved issue to the DRC. These meetings should occur over a 30-day period as a minimum and may be held in the Region 6 office, the TCEQ office, or the BRACD office in Arlington, VA, and should include PMs and counsel for all parties. The Army is not prepared to participate on the DRC and have a meaningful discussion on November 7th of 8th because there is no common understanding of the specific issues that may be referred to the DRC.

Army also believes it is in the best interest of all the parties that the October 13, 2011 Region 6 letter assessing stipulated penalties be withdrawn pending the outcome of the dispute resolution process. As discussed in Army's October 27 letter, the assessment of these penalties is not in compliance with the FFA. Withdrawing the penalty assessment would allow the parties to focus attention on the issues requiring resolution. The prompt and cooperative resolution of all issues will allow these RODs to become effective and the remedies to move forward toward completion for the protection of human health and the environment.

The legal Point of Contact for this action is David Minvielle, david.minvielle@us.army.mil, or 703.693.0570, and the Army PM is Dr. Rose Zeiler, rose.zeiler@us.army.mil, or (479) 635-0110.

Sincerely,

CLARENCE D. TURNER
Colonel, General Staff
Chief, Army BRAC Division

CC

Mr. Carlos A. Sanchez
Chief, AR/TX Section
Region 6, Superfund Division (6SF-RA)
Fountain Place
1445 Ross Ave.
Dallas, TX 75202-2750

Stephen L. Tzhone
Superfund Remedial Project Manager
USEPA Region 6 (6SF-RA)
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Ms. Fay Duke
Project Manager, Superfund Cleanup Division
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

00113168

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS TX 75202-2733

NOV 09 2011

CERTIFIED MAIL-RETURN RECEIPT REQUESTED

Colonel Clarence D. Turner
Department of the Army
Assistant Chief of Staff for Installation Management
600 Army Pentagon
Washington, DC 20310-0600

RE: Dispute Resolution Committee (DRC) Meeting
Longhorn Army Ammunition Plant (LHAAP)
Federal Facility Agreement (FFA) Under CERCLA Section 120

Dear Colonel Turner:

The United States Environmental Protection Agency Region 6 (EPA) is providing this letter as a follow-up to the EPA October 27, 2011, letter to the Army, regarding the LHAAP dispute resolution.

According to the dispute resolution provisions provided in the FFA: "Following elevation of a dispute to the DRC, the DRC shall have twenty-one (21) days to resolve unanimously the dispute and issue a written decision signed by all parties. If the DRC is unable to resolve unanimously the dispute within this twenty-one (21) day period, the written statement of dispute shall be forwarded to the Senior Executive Committee (SEC) for resolution, within seven (7) days after the close of the twenty-one (21) day resolution period."

I am available to discuss the disputed issues on November 15, 16, or 17, 2011. Please confirm a time on any of these dates. Should you have any questions, please feel free to call me at 214.665.6701.

Sincerely,

Pamela Phillips, Acting

Samuel Coleman, P.E.
Director
Superfund Division

cc: Reggie Cheatham
EPA Federal Facilities Restoration and Reuse Office

David Kling
EPA Federal Facilities Enforcement Office

Maureen Sullivan
Office of the Secretary of Defense Installations and Environment

John Tesner
Office of the Deputy Assistant Secretary of the Army (Environment, Safety and Occupational Health)

Beth Seaton
TCEQ Remediation Division

From:	Zeiler, Rose Ms CIV USA OSA
To:	Fay Duke; Tzhone.Stephen@epa.gov
Cc:	Lambert, John R SWT; Williams, Aaron K SWT
Subject:	DF LHAAP-16 ROD PDF and doc
Date:	Thursday, November 17, 2011 6:02:43 PM
Attachments:	Draft FINAL LHAAP-16 ROD 17 NOV 2011 (2) clean.doc Draft FINAL LHAAP-16 ROD 17 NOV 2011.pdf

Fay and Steve,

Please see DF ROD for LHAAP-16 in pdf and doc files.

Rose
Rose M. Zeiler, Ph.D.,
Site Manager
Longhorn Army Ammunition Plant
479-635-0110 (0112 – fax)

00113171

From:	Zeiler, Rose Ms CIV USA OSA
To:	Tzhone.Stephen@epa.gov; Fay Duke
Cc:	Lambert, John R SWT; Williams, Aaron K SWT
Subject:	DF LHAAP-17 ROD in PDF and DOC
Date:	Thursday, November 17, 2011 6:29:36 PM
Attachments:	LHAAP-17 ROD draft final clean.doc LHAAP-17 ROD draft final.pdf

Fay and Steve,
Please see attached electronic copies of the DF LHAAP-17 ROD in pdf and doc files.
Thanks,
Rose

Rose M. Zeiler, Ph.D.,
Site Manager
Longhorn Army Ammunition Plant
479-635-0110 (0112 – fax)

00113172

From:	Zeiler, Rose Ms CIV USA OSA
To:	Tzhone.Stephen@epa.gov; Fay Duke
Cc:	Lambert, John R SWT; Williams, Aaron K SWT
Subject:	DF ROD for LHAAP-001-R and LHAAP-003-R Part 1
Date:	Thursday, November 17, 2011 6:21:16 PM
Attachments:	09 2011 Draft FINAL ROD LHAAP-001-R 003-RText.pdf 09 2011 Draft FINAL ROD LHAAP-001-R 003-Rclean.docx

Steve and Fay,
Electronic copies of the MMRP DF ROD is attached in pdf (text only) and docx. The figures in pdf will be sent in a separate email - too large to send as a single pdf.
Rose

Rose M. Zeiler, Ph.D.,
Site Manager
Longhorn Army Ammunition Plant
479-635-0110 (0112 – fax)

00113173

From: Zeiler, Rose Ms CIV USA OSA
To: Tzhone.Stephen@epa.gov; Fay Duke
Cc: Lambert, John R SWT; Williams, Aaron K SWT
Subject: LHAAP-001-R and -003-R DF ROD (figures) Part 2
Date: Thursday, November 17, 2011 6:26:24 PM
Attachments: 09 2011 Draft FINAL ROD LHAAP-001-R 003-R Figures.pdf

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Fay and Steve - Please see attached figures in a pdf file.
Rose

Rose M. Zeiler, Ph.D.,
Site Manager
Longhorn Army Ammunition Plant
479-635-0110 (0112 – fax)

00113174

DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

November 17, 2011

DAIM-ODB-LO

Mr. Stephen Tzhone
US Environmental Protection Agency
Superfund Division (6SF-AT)
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Responses to EPA Comments on Draft Final RODs for LHAAP-16, LHAAP-17, and LHAAP-R-001and -R-003, Longhorn Army Ammunition Plant, Karnack, Texas

Dear Mr. Tzhone,

Enclosed are responses to EPA's October 20, 2011 comments on the September 29, 2011 Draft Final RODs for LHAAP-16 and LHAAP-17 and EPA's October 13, 2011 comments on the September 27, 2011 Draft Final ROD for LHAAP-001-R and LHAAP-003-R. Hard copies of the Draft Finals RODs are being transmitted under separate cover. Also enclosed are responses to EPA's October 27, 2011 Issues in Dispute.

The point of contact for this action is the undersigned. I may be contacted at 479-635-0110, or by email at rose.zeiler@us.army.mil.

Sincerely,

Rose M. Zeiler

Rose M. Zeiler, Ph.D.
Longhorn AAP Site Manager

Copies furnished:
Fay Duke, TCEQ
Four Enclosures

Enclosure 1:

Response to EPA's October 20, 2011 Comments

Draft Final LHAAP-16 ROD

29 September 2011

Longhorn Army Ammunition Plant Response to EPA Comment dated October 20, 2011 LHAAP-16 Draft Final ROD (29 SEP 2011)

1. Overall ROD, Table 2-7, Table 2-10: Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-16 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). Therefore, the appropriate standards to be applied at LHAAP-16 should be the State of Texas Groundwater MSC for Residential Use, which for nickel is at 730 ug/L, perchlorate at 26 ug/L, and manganese at 7,820 ug/L (95% UTL Background), per 40 CFR 300.430(a)(iii)(F), and 300.430(f)(1)(ii)(B) .

   The ROD language needs to reflect this State of Texas groundwater designation and the appropriate residential standards in order to be consistent with the EPA July 2011 OSWER Directive 9283.1-34, EPA June 2009 OSWER Directive 9283.1-33, and the DoD April 2009 Perchlorate Release Management Policy.

   - EPA July 2011 OSWER Directive 9283.1-34, Groundwater Road Map Recommended Process for Restoring Contaminated Groundwater at Superfund Sites: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/gwroadmapfinal.pdf
   - EPA June 2009 OSWER Directive 9283.1-33: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf
   - DoD April 2009 Perchlorate Release Management Policy: http://www.denix.osd.mil/cmrmd/upload/dod_perchlorate_policy_04_20_09.pdf
   - TCEQ March 2006 MSC and risk-based screening levels tables: http://www.tceq.texas.gov/assets/public/remediation/rrr/msc-rbscn_2006.xls

Army Response: **See response to the First Issue in Dispute.**

2. Section 2.9.1, page 2-26. Section 2.12.2, page 2-55. For LTM, Groundwater and Surface Water Monitoring, and Long-Term Operations, monitoring after the next five year review should be on an annual basis unless the five year review recommends otherwise.

   Example, page 2-26: "LTM semiannually for 3 years, annually until the next five-year review, then ~~once every 5 years to remedy performance.~~ annually thereafter until recommended otherwise by the five-year review."

   Example, page 2-55: "Surface water and wells will then be sampled annually until the next five-year review and ~~every 5 years~~ annually thereafter until ~~indicated by the data.~~ recommended otherwise by the five- year review."

Army Response: Concur. Please also see response to TCEQ Comment #1.

3. The Army proposed replacement of Section 2.12.1 with the following language (along with related changes in Section 2.12.2 and Section 2.12.4) is acceptable to EPA: "The MNA was selected as one component of the remedy based on available groundwater evidence as presented in the Addendum to the FS (Shaw, 2010). A tiered approach using three lines of evidence was used to examine the occurrence of natural attenuation. The first line of evidence evaluated reductions in COC concentrations over time and with distance, the second line of evidence evaluated geochemical indicators, while the third line of evidence entailed estimation of natural attenuation rates. Historical decreases in concentrations of chlorinated solvents and perchlorate in individual wells were observed in both shallow and intermediate groundwater, including the detection of daughter by-products that suggest the occurrence of complete reductive dechlorination. These results indicated the shallow and intermediate contaminant plumes are stable in certain areas (at the source area and side-downgradient in the plumes); however, there were increases in other well locations in the shallow groundwater that suggest a portion of the plume is migrating toward Harrison Bayou. The intermediate groundwater zone plume was relatively more stable than the shallow groundwater with less migration. Geochemical conditions were adequate for perchlorate degradation (as evidenced by non-detect nitrate/nitrite levels), but methanogenic conditions (needed for chlorinated ethene degradation) were not detected consistently throughout the site. Thus, natural attenuation was considered feasible for much of the site, but not as a sole remedy for the entire site. Additional evaluation, including the installation of additional monitoring wells, will be implemented as part of the MNA component. MNA, together with the in situ bioremediation and biobarriers, will ultimately restore the groundwater to attain groundwater cleanup standards/levels; this is anticipated to be completed in approximately 280 years. This approximate timeframe to achieve cleanup levels is considered reasonable based on the anticipated future land use of the site as a national wildlife refuge and the fact that there is no current or anticipated future use of groundwater as a drinking water supply. Thus, MNA is an appropriate component of the remedy for those regions outside the influence of the active remedies because it will protect human health and the environment and will document that further reductive dechlorination is occurring within the groundwater plume and that contaminant concentrations are being reduced to attain groundwater standards/levels."

Army Response: Concur. Text will be added as suggested.

4. Section 2.12.2, page 2-51. Under Cap Maintenance, please provide the rationale for 40 CFR 264.310(b)(2) to not be included as an ARAR.

Army Response: 40 CFR 264.310(b)(2) is the requirement to continue to operate the leachate collection and removal system until leachate is no longer detected. The LHAAP-16 landfill does not have a leachate collection and removal system and therefore cannot "continue" to operate it. Therefore the requirement is not appropriate and relevant. Please also see response to Comment #5.

5. Table 2-10, page 2-88. Under Post Closure Care, please clarify if all items under 40 CFR 264.310(b) are ARARs, or only the specific ones identified in Section 2.12.2.

Army Response: Only those identified in Section 2.12.2 (as corrected) are considered appropriate and relevant. The text will be revised to state that the following post-closure requirements provided in 40 CFR 264.310(b) are relevant and appropriate:

(1) Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events;
(4) Maintain and monitor the ground-water monitoring system and comply with all other applicable requirements of subpart F of this part; (5) Prevent run-on and run-off from eroding or otherwise damaging the final cover.

In addition, 40 CFR 264.310(b)(6) is considered appropriate and relevant for a benchmark located near the landfill and will be included in Section 2.12.2. The benchmark was established in 1982 and adjusted in 1995 and was likely used in conjunction with closure/post-closure activities at the landfill - construction of the cap, installation of groundwater monitoring wells.

In addition, only those substantive requirements of 40 CFR 264.117 though 120 related to post-closure of the remedy-in-place are considered appropriate and relevant. It is noted the post closure administrative requirements of 40 CFR 264.117-120 are not considered ARARs, but that CERCLA provides for their equivalents such as, for example, post-closure plans.

40 CFR 264.310(b)(2) and (3) are not considered appropriate and relevant. Leak detection systems and leachate collections systems are not generally installed in an existing landfill. The landfill predates RCRA with its use beginning in 1942 for the disposal of TNT redwater ash generated from the TNT Waste Disposal Plant. The landfill was inactive by the early 1980s. The landfill presumptive remedy of capping was selected for Site 16 and implemented through an IRA in 1997 which was signed by Army and EPA. In the IRA ROD it is stated that removal and treatment or disposal of landfill contents is not feasible and is inconsistent with EPA's presumptive remedy guidance. In addition it is stated that excavating and removing the contaminants would unnecessarily endanger the ecosystems of Harrison Bayou, Central Creek and Caddo Lake. It is noted that the landfill has an extensive groundwater monitoring system.

6. IC Checklist #4 (LUC Objectives): Section 2.9.1. Section 2.12.2. We are appreciative that the Army has agreed to modify the groundwater LUC and add the prohibition on residential land use as we requested. Regarding the LUC to maintain the remedy integrity, we appreciate the offer to prohibit intrusive activities but there are other activities which could damage the wells.

   Please add either one of the following LUC objectives to address this issue:

   "LUC to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells. "

   or:

"LUC to prohibit intrusive or any other activities which could damage the landfill cap and the groundwater monitoring system."

Army Response: Do not concur that maintaining the integrity of the groundwater monitoring system is or should be a LUC objective. Please see response to Issue of Dispute #2.

Provisions for the maintenance and protection of the groundwater monitoring system will be addressed in post-ROD documents. Those provisions will be presented in the RD – and carried through to any post-RD documents such as O&M Plans - and will include periodic inspections of the protective measures such as bollards, pads, protective casing, and locks as well as evaluations of individual well performance.

Provisions for protection of the monitoring system are also included in the transfer documentation. In this particular situation, DOI, the agency with future jurisdiction, will be made aware of protective measures for the groundwater monitoring system via post-ROD documents. Army does not understand how placing a note in the county land records would improve DOI's awareness. In addition, transfer documents, such as the letter of transfer and the ECP which includes the Environmental Protection Provisions, will be provided to USF&WS.

7. IC Checklist #6 (LUC Duration): Because additional LUCs will be added, the Army must either add the general LUC checklist language to memorialize its understanding that LUCs are to remain in place until unlimited use and unrestricted exposure is reached for all of them or the Army needs to develop a specific duration statement for each separate LUC. It appears that the Army would prefer to have a separate statement for each LUC which is fine, but please send us the statements so that we can review.

Army Response: Army believes the comment has already been satisfied. A response to a similar comment was made on 23 September 2011 (see response to EPA Comment #7) which included the LUC objective durations.

Army also responded to this comment on 28 September 2011 as follows: A description of the durations for the relevant LUCs are included in the ROD."

For example, please see pages 1-3, 2-7 and 2-50 of the ROD.

Please also see response to Issue of Dispute #3.

8. IC Checklist #8 (Remedy Integrity): Section 1.4, page 1-4. Section 2.12.2, page 2-52. The Army does not have independent authority to modify a remedy. See CERCLA Section 120 (e)(4). Please make the following edits: "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 ultimately 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 the LUC and any related transfer or lease provisions ;~~ and ~~(5)~~(4) ensuring the protectiveness 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 these sites after they have been transferred."

Army Response: See response to Issue of Dispute #4.

9. Section 1.4, page 1-4. Section 2.9.2, page 2-27. Section 2.12.2, page 2-52. The Army must get EPA concurrence on any modification and/or termination of LUCs. The LUC is part of the remedy which, by law, is both selected by Army and EPA. Thus, the Army shall not unilaterally make decisions on any modifications and/or terminations of LUCs, including whether a proposed modification is 'significant'. Please make the following edits: "The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~."

Army Response: See response to Issue of Dispute #4.

10. Regarding previous Army comments on the term 'support agency', in the event of a dispute, EPA independently selects the remedy as an <u>oversight agency</u>.

Army Response: See response to Issue of Dispute #4.

Enclosure 2:

Response to EPA's October 20, 2011 Comments

Draft Final LHAAP-17 ROD

29 September 2011

Longhorn Army Ammunition Plant Response to EPA Region 6 Comments dated October 20, 2011 LHAAP-17 Draft Final ROD (29 SEP 2011)

1

1. Overall ROD, Table 2-10, Table 2-14: Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-16 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). Therefore, the appropriate standard to be applied at LHAAP-17 should be the State of Texas Groundwater MSC for Residential Use, which for perchlorate is at 26 ug/L, per 40 CFR 300.430(a)(iii)(F), and 300.430(f)(1)(ii)(B) .

   The ROD language needs to reflect this State of Texas groundwater designation and the appropriate residential standard in order to be consistent with the EPA July 2011 OSWER Directive 9283.1-34, EPA June 2009 OSWER Directive 9283.1-33, and the DoD April 2009 Perchlorate Release Management Policy.

   - EPA July 2011 OSWER Directive 9283.1-34, Groundwater Road Map Recommended Process for Restoring Contaminated Groundwater at Superfund Sites: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/gwroadmapfinal.pdf
   - EPA June 2009 OSWER Directive 9283.1-33: http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf
   - DoD April 2009 Perchlorate Release Management Policy: http://www.denix.osd.mil/cmrmd/upload/dod_perchlorate_policy_04_20_09.pdf
   - TCEQ March 2006 MSC and risk-based screening levels tables: http://www.tceq.texas.gov/assets/public/remediation/rrr/msc-rbscn_2006.xls

   -

Army Response: See response to Issue of Dispute #1

2. Section 1.4, page 1-2. Section 2.12.2, page 2-33. For LTM, monitoring after the next five year review should be on an annual basis unless the five year review recommends otherwise.

   Example, page 1-2: "In subsequent years, LTM will be annual until the next five-year review and annually thereafter until recommended otherwise by the five-year review. The monitoring and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue ~~every 5 years~~ until cleanup levels are achieved and annually until recommended otherwise by the five-year review."

   Example, page 2-33: "Continue LTM ~~every 5 years~~ annually thereafter until recommended otherwise by the five-year review to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen."

Army Response: Concur. Please also see response to TCEQ Comment 1.

3. IC Checklist #4 (LUC Objectives): Section 2.9.1. Section 2.12.2. We are appreciative that the Army has agreed to modify the groundwater LUC and add the prohibition on residential land use as we requested. Regarding the LUC to maintain the remedy integrity, we appreciate the offer to prohibit intrusive activities but there are other activities which could damage the wells.

   Please add either one of the following LUC objectives to address this issue:

   "LUC to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells**.** "

   or:

   "LUC to prohibit intrusive or any other activities which could damage the landfill cap and the groundwater monitoring system."

Army Response: Do not concur that maintaining the integrity of the groundwater monitoring system is or should be a LUC objective because damage to a well or a well system, unlike damage or destruction of the cap system, does not present a risk to human health through direct exposure. Please also see response to Issue of Dispute #2.

Provisions for the protection of the groundwater monitoring system will be addressed in post-ROD documents. The requirements for protection and maintenance of the well system will be presented in the RD and will include periodic inspections of the protective measures such as bollards, pads, protective casing, and locks as well as evaluations of individual well performance.

Provisions for protection of the monitoring system are also included in the transfer documentation. In this particular situation, DOI, the agency with future jurisdiction, will be made aware of protective measures for the groundwater monitoring system via post-ROD documents. Army does not understand how placing a note in the county land records would improve DOI's awareness. In addition, transfer documents, such as the letter of transfer and the ECP which includes the Environmental Protection Provisions, will be provided to USF&WS. It is Army's understanding that implementation of these types of controls through the inclusion within site management documents has been acceptable to EPA in the past.

4. IC Checklist #6 (LUC Duration): Because additional LUCs will be added, the Army must either add the general LUC checklist language to memorialize its understanding that LUCs are to remain in place until unlimited use and unrestricted exposure is reached for all of them or the Army needs to develop a specific duration statement for each separate LUC. It appears that the Army would prefer to have a separate statement for each LUC which is fine, but please send us the statements so that we can review.

Army Response: Please see Army's previous responses on 9/12/2011 and 9/28/2011 to similar EPA comments. Specific durations are provided for the LUC objectives. Please also see responses to Issue of Dispute #3.

5. IC Checklist #8 (Remedy Integrity): Section 1.4, page 1-3. Section 2.12.2, page 2-33. The Army does not have independent authority to modify a remedy. See CERCLA Section 120 (e)(4). Please make the following edits: "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 ultimately 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 the LUC and any related transfer or lease provisions ;~~ and ~~(5)~~(4) ensuring the protectiveness 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 these sites after they have been transferred."

Army Response: See response to Issue of Dispute #4.

6. Section 1.4, page 1-4. Section 2.9.2, page 2-20. Section 2.12.2, page 2-34. The Army must get EPA concurrence on any modification and/or termination of LUCs. The LUC is part of the remedy which, by law, is both selected by Army and EPA. Thus, the Army shall not unilaterally make decisions on any modifications and/or terminations of LUCs, including whether a proposed modification is 'significant'. Please make the following edits: "The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~."

Army Response: See response to Issue of Dispute #4.

7. Regarding previous Army comments on the term 'support agency', in the event of a dispute, EPA independently selects the remedy as an oversight agency.

Army Response: See response to Issue of Dispute #4.

Enclosure 3:

Response to EPA's October 13, 2011 Comments

Draft Final LHAAP-001-R and LHAAP-003-R

27 September 2011

Longhorn Army Ammunition Plant Response to EPA Region 6 Comments dated October 13, 2011 LHAAP-001-R and LHAAP-003-R Draft Final ROD (27 SEP 2011)

1. Overall ROD, Table 2-4: Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-001-R and LHAAP-003-R 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). Therefore, the appropriate standard to be applied at LHAAP-001-R and LHAAP-003-R should be the State of Texas Groundwater MSC for Residential Use, which for perchlorate is at 26 µg/L, per 40 CFR 300.430(a)(iii)(F), and 300.430(f)(1)(ii)(B).

Army Response: See response to Issues in Dispute #1.

2. Table of Contents: The 'Section 2.10.2 Compliance with ARARs' is missing and subsequent sections mis-numbered.

Army Response: As discussed during the Managers' informal dispute conference on the 2nd of November, the Table of Contents will be revised to include Section 2.10.2 and the section numbers in the text will be corrected.

3. Section 1.5, Section 2.14.5: Revise to state that: "Although the statutory preference for treatment was not fully satisfied, the MEC removal action removed…"

Army Response: As discussed during the Managers' informal dispute conference on the 2nd of November, it is unclear what is meant by the comment. After some discussion, it was agreed that the revision suggested by EPA would be reviewed by Longhorn in the context of the remaining text in the section.

The section has been reviewed and it remains unclear how destruction of the MEC by detonation would not fully satisfy the preference for treatment. During the 2008 removal action, any items identified as MEC were either blown in place or consolidated at a point within the site and destroyed by detonation. The hazardous waste present as explosive material was consumed during the reaction and the remaining solid waste disposed appropriately.

Moreover, in the second paragraph of Issue 8 of the Statement of Dispute, Enclosure One of the letter dated 27 October 2011, EPA states, "Because MEC has already been treated and removed from the MRS sites…"

In conclusion, Army does not concur with the recommended text change. See also response to Issue of Dispute #8.

4. Section 2.2.2: The last two sentences of this section should either be deleted or explained to reflect that the MMRP sites LHAAP-001-R and LHAAP-003-R are now NPL sites under the FFA and that EPA is the lead regulatory agency for these sites.

Army Response: Concur. As discussed during the Managers' informal dispute conference on the 2nd of November, the two sentences were pointed out by EPA on 29 September 2011. At that time, 29 September, Longhorn noted to EPA that they were in the document by error and that they would be removed. The two sentences were deleted in the Final ROD signed by Army on 29 September 2011.

5. Section 2.5.2.2, first sentence: Please refer to the ROD as the 1998 NFA ROD.

Army Response: The sentence will be revised as suggested.

6. Section 2.12.1: Before the first sentence in this Section add the following sentence, "Notwithstanding any other provision in this ROD, all remedial action selections made at Sites LHAAP-001-R and LHAAP-003-R shall complied with CERCLA Sections 113,117, 120(e), 121, 40 C.F.R.§§300.430(f) and 300.820, and the FFA.

Army Response: Do not concur. The ROD incorporates the statutory determinations recommended by the EPA ROD guidance. See MMRP ROD Sections 1.5 and 2.14. Neither CERCLA nor the NCP require citation to specific CERCLA and NCP sections.

7. IC Checklist #4: The ROD confuses the term "LUC" and "objective" and includes inconsistent and unclear objectives. The LUC objectives appear to be partially listed in section 1.4 p. 1-2, although they are also generally described in 2.12.1 and 2.9.1. Note that the list includes signs and education programs and these are LUCs, not objectives. Please replace the listing on in section 1.4, p. 1-2 as follows: "The LUC objectives are 1) to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells, 2) to prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds, and 3) prohibit intrusive activities such as digging or any other activity which could result in detonation of explosive hazards."

Army Response: Concur. The text has been revised to differentiate between LUC objective and LUC. However, Army does not concur with the addition of the LUC objective to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells. See Response to Issues in Dispute #2. The listing in Section 1.4, page 1-2 has been revised as follows: "The LUC objectives are to: 1) prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds, and 2) prohibit intrusive activities such as digging or any other activity which could result in explosive safety risks".

8. IC Checklist #5: LUCs. The "LUC" means the legal or administrative mechanism by which the LUC objective is implemented. In this case, the property appears to be still under Army control, then the Army should identify the current mechanism (some sort of internal Army procedures) and the future mechanism (ensure the controls are maintained by USFWS in the document transferring property). The signs and education programs mentioned in several places are also part of the LUCs and should be included, as well as the TAC restriction.

Army Response: The 2007 Comprehensive Land Use Control (LUC) Management Plan for Longhorn Army Ammunition Plant is the current internal mechanism used by the Army through which the LUC objective is implemented. The Comprehensive Plan, along with other documents, can serve USFWS, the future transferee, in the same manner. The Comprehensive LUC Management Plan is a tabbed compilation of the LUC RDs by site. It also includes county recordations, site maps, a master LUC table and a master map for the installation. When final, the LUC RD for the two MMRP sites will be inserted into the Plan.

At transfer, USFWS will be officially notified of the restrictions associated with the two MMRP sites by the Letter of Transfer to which the Environmental Protection Provisions of the ECP is attached. Moreover, USFWS is provided, as they are produced, copies of all environmental documents associated with the sites as required by the 2004 Memorandum of Agreement (MOA) between Army and DOI-USFWS. The 2004 MOA presents the framework for the transfer process. The documents provided to USFWS include RI/FS as well as post-ROD documents, including the LUC RD. USFWS will be required to certify annually that is has not allowed any use inconsistent with the use restrictions in place for the sites.

The signs have been surveyed and the education program, are included in the TAC restriction and in the site specific LUC Plan for the MMRP sites, both of which were developed during the 2008 removal action and approved by regulators. Subsequently, the signs were installed and the education program developed and provided to the Refuge. The restriction notification, including the survey was completed to the point of recordation in the county, but remained unrecorded at the request of EPA. EPA recently requested the notification be recorded. Due to continued comment resolution, this action is pending.

The following sentence has been added to Section 2.12.1: "The internal control mechanism for this closed installation is the Comprehensive LUC Management Plan to which the final approved LUC RD will be added".

The text in Section 2.12.2 will be revised as follows: "A recordation of the area with the prohibition of intrusive activity and residential land use will be filed in the Harrison County Courthouse in accordance with TAC § 335.569, Appendix III. The recordation will include the locations of the signs and a description of the educational material available. To transfer this property (LHAAP-001-R-01 & LHAAP-003-R-01), an Environmental Condition of Property (ECP) document would be prepared and the Environmental Protection Provisions from the ECP would be attached to the letter of transfer. The ECP

would include the LUCs as part of the Environmental Protection Provisions. The property would be transferred subject to the LUCs identified in the ECP.

9. IC Checklist #6. Duration language – missing. Please include the following: "Land Use Controls will be maintained until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure."

Army Response: The text will be revised to state that the LUC to prohibit residential land use will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure and it is demonstrated that there are no explosive hazards. The LUC to prohibit intrusive activities will remain in place until it is demonstrated there are no explosive hazards". Please see response to Comment #14.

10. IC Checklist #7. Responsibility language. The language in Section 2.12.2, page.2-25 is ok. But the reference to monitoring in Section 1.4, page 1-2 and in Section 2.12.2, page 2-26 and must be modified as EPA does not consider the 5YR a substitute for LUC monitoring: "~~Monitoring in the form of~~ Five Year Reviews will be conducted to ensure that the LUCs are specified, implemented, monitored, reported on, and enforced in an efficient, cost effective…"

Army Response: Concur. The text will be revised as suggested.

In addition, on page 1-3, first paragraph: "The U.S. Army will remain responsible for implementation, maintenance, periodic inspection, reporting on and enforcement of the LUCs ~~in accordance with the LUC plan in Appendix I of the removal action work plan (EODT, 2008)~~."

Army Response: Concur. The text will be revised as suggested.

11. IC Checklist #8: Remedy integrity. This problematic language appears in Sections 1-4 and 2.12.2 (Page 2-25) and must be changed to: "4) reservation of authority to change, modify, or terminate the LUC with approval from EPA and consultation from TCEQ and any related transfer or lease provisions; and (5) ensureing the integrity of the selected remedy…"

Army Response: See response to Issues of Dispute #4.

12. IC Checklist #9: Commitment to provide RD for implementation actions. In Section 1.4 next to the last paragraph there is a reference to the removal MEC work plan for LUC implementation details. The removal workplan will not suffice as it is not a primary document. Please include language from the Checklist or the language or as follows: "A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 90 days of ROD signature, the Army shall prepare and submit to EPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections."

Army Response: Army prepared a LUC Plan during the 2008 removal action at the two MMRP sites. This plan was included in the removal report which was reviewed by both TCEQ and EPA. EPA's May 21, 2009 review comments on the Draft Final Site Specific Final Report, MEC Removal Action which included the following comment:

"The EPA has completed its review of the Draft Final Site Specific Final Report, MEC Removal Action at the Former Longhorn Army Ammunition Plant, LHAAP-001-R (Site 27) and LHAAP-003-R (Site 54), Karnack Texas (March 2009). Please finalize the report with resolution to the following EPA comments: ……… Page 2-7, Land Use Controls: There should be an annual report produced by the Army verifying that the institutional controls are being complied with. Also, if the property is transferred, the new property owner should be given the education material and the health and safety video's pertaining to UXO for sites 27 and 54."

Army's response to this comment was:

"*As already in the LUC Plan, Army will require annual inspections and certification of land use controls. The educational material and safety video were developed with the purpose of providing the transferee with the safety information.*"

Subsequently, the signs were installed and their locations surveyed, educational material including video and pamphlets were produced, the proposed county recordation (including notification of uses, plat map and survey) were developed and reviewed to the point of recordation. The educational material was transmitted to USFWS. All of these actions were conducted with EPA coordination and approval.

However, in order to complete the formal requirements of the FFA and in response to EPA's comments on this matter, the LUC plan will be revised and finalized as a LUC RD. And although the statement "A LUC RD will be prepared within 90 days of the ROD" was added to the fifth paragraph of Section 1.4 of the Final ROD signed by Army on 29 September, 2011, the timeframe was found to be inconsistent with Section XVI.C of the FFA. Therefore the text will be revised as follows:

"A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 21 days of the issuance of the Record of Decision, the Army will propose deadlines for completion of the LUC Remedial Design. The documents will be prepared and submitted to EPA and TCEQ for Consultation pursuant to the FFA and the LUC Remedial Design that will contain implementation and maintenance actions, including periodic inspections. The LUC RD will be the 2008 LUC Plan revised and finalized as the LUC RD".

13. IC Checklist #14: Modification/termination of LUC. The problematic language appears in Section 1.4, page 1-3 and in section 2.12.2, page 2-26. Please modify as follows: "In the event that ~~TCEQ and/or~~ USEPA and the U.S. Army agree with respect to any ~~significant~~ modification

of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the Federal Facility Agreement (FFA) and 40 CFR.§300.435(c)(2)."

Army Response: See response to Issues of Dispute #4.

14. Pages 1-3 and 2-25 (1st bullets), please make it clear that it is the Army who notifies the county and insert a deadline, for example: "In addition, within 90 days of signature of this ROD, the Army shall: 1)request the Texas Department of Licensing and Regulation ~~will be requested~~ to notify well drillers of groundwater restrictions: and 2) ~~the Army shall~~ notify the ~~a notification of the LUC with the~~ Harrison County Courthouse of the LUC to include ~~would include~~ a map showing the areas of groundwater restriction at the sites in accordance with 30 TAC 335.565."

Army Response: The ROD does not present a groundwater use restriction for either of the MMRP sites. No groundwater use restriction is required because there is no risk or confirmed exceedance of a standard for either of the data gap constituents, white phosphorus and perchlorate, that were addressed in this ROD.

For the data gap constituent perchlorate, a single exceedance of perchlorate above the TCEQ GW-Ind level of 72 µg/L in groundwater was detected by EPA in a single well at LHAAP-001-R. It is noted that EPA's sample result of 76 µg/L was an estimated value whereas Army's split sample result of 50 µg/L was not. An agreement was made among Army, EPA and TCEQ to include limited groundwater monitoring in the ROD to confirm that the levels of perchlorate in groundwater are protective of human health. The concentrations of perchlorate in groundwater at both sites are presented in the following tables.

LHAAP-001-R

Perchlorate	Apr-May 2000	Aug/Sep/Oct 2000	Jan-Feb 2001	Apr-Jun 2001	2009 EPA	2009 Army
Well 131	<1 U	<4 U	<0.71 U	NS	<5.0 G	ND
Well 132	<1 U	<8 U	NS	NS	2.6 B,G	ND
27WW01	52.6	<16 U	<3.6 U	NS	<5.0 G	ND
27WW02	NS	<16 U	NS	NS	3.2 B,B	3.4
27WW03	NS	<16 U	NS	NS	76 Q	50
27WW04	16.4	<16 U	<2.8 U	NS	<5.0 G	ND

LHAAP-001-R

Perchlorate	Apr-May 2000	Aug/Sep/Oct 2000	Jan-Feb 2001	Apr-Jun 2001	2009 EPA	2009 Army
127	26.8	<4 U	<1.7 U	NS	<5.0 G	ND
128	20.4	<8 U	<1.7 U	NS	<5.0 G	ND
18WW16	22.7	<8 U	8	NS	4.6 B,G	5.4
GPSAS54-01	NS	NS	NS	<4 U		
GPSAS54-02	NS	NS	NS	<40 U		

GPSAS54-03	NS	NS	NS	<40 U		
18WW01					<1.0	ND

TCEQ Risk Reduction Standard 2 MSC for GWP-Ind = 72 ppb

Exceeds the TCEQ Risk Reduction Standard 2 MSC for GWP-Ind of 72 µg/L

B= Estimated result. Result is less than Reporting Limit (RL) of 5.0 ug/L

G= Elevated reporting limit. The reporting limit is elevated due to matrix interference

Q= Elevated reporting limit. The reporting limit is elevated due to high analyte levels

GP = Geoprobe sample

15. Section 2.12.1, Section 2.12.2: The language (i.e.: The details and description of the LUC….” On page 2-24 and page 2-26 is confusing in that it seem to state that the LUC implementation actions are already in an approved remedial design. This language need to be clarified to reflect that: “A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 90 days of ROD signature, the Army shall prepare and submit to EPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections.”

Army Response: See response to Comment #12.

Enclosure 4:

Response to EPA’s October 27, 2011

Issues in Dispute

U. S. Army Responses to Written Statement of Dispute

Longhorn Army Ammunition Plant LHAAP

November 17, 2011

First Issue in Dispute

Issue 1: When there is no Federal Maximum Contaminant Level (MCL) for a specific contaminant (e.g., perchlorate), the Texas GWD-Res is the applicable, relevant and appropriate (ARAR) standard to be utilized for groundwaters determined to be a current or potential source of drinking water. Groundwater at the sites in question is designated as potential drinking water sources by the State of Texas in accordance with Texas regulation. As provided in the National Contingency Plan (NCP), it is appropriate to return contaminated groundwaters to their beneficial uses wherever practicable.

EPA Position: As a result of the designated use of these contaminated groundwaters as potential drinking water sources, the MCLs at 40 CFR 141, are ARARs under 40 CFR 300.430(e)(2)(i)(B & C). In the event that there is no Federal MCL for that contaminant, the Texas standard for GWD-Res (i.e., 30 TAC 335.559(b)) establishes a health based MCL that constitutes an ARAR for groundwater restoration for those contaminants. CERCLA Section 121(d) provides that onsite remedial actions must comply with the substantive requirements of environmental laws. The NCP, at 40 CFR 300.430(f)(1)(ii), also provides that on-site remedial actions must comply with ARARs or obtain a waiver. As a result, any failure to incorporate the Texas MCL groundwater standard noted above for contaminants that do not have a Federal MCL into the relevant primary reports is a violation of the FFA at Sections VIII and XIX.

The following EPA and Texas policies guide this issue as well:

EPA July 2011 OSWER Directive 9283.1-34, Groundwater Road Map Recommended Process for Restoring Contaminated Groundwater at Superfund Sites:

http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/gwroadmapfinal.pdf

EPA June 2009 OSWER Directive 9283.1-33:

http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf

TCEQ March 2006 MSC and risk-based screening levels tables:

http://www.tceq.texas.gov/assets/public/remediation/rrr/msc-rbscn_2006.xls

Army Response

A. Army agrees that federal MCLs are ARARs for groundwater at these sites based on potential risk from exposure and because the State of Texas considers these groundwaters to be potential drinking water sources. The Records of Decisions (RODs) reflect that federal MCLs are ARARs. The Army agreed to designate the federal MCLs as ARARs even though the property will be transferred to the Department of the Interior (DOI) based on an interagency agreement that limits its use to wildlife conservation.

B. EPA has taken inconsistent positions with respect to which state regulatory standard is the basis of the purported ARAR. On page 2 of EPA's October 27, 2011 Statement of Dispute, EPA states that "the Texas standard for GWD-Res (i.e., 30 TAC 335.559(b)) establishes a health based MCL that constitutes an ARAR for groundwater restoration for those contaminants." This is Risk Reduction Standard Number 2. However, in separate October 20, 2011 comments on the "Draft Final Record of Decision, LHAAP-16 Landfill, Longhorn Army Ammunition Plant, Karnack, Texas," September 2011 (hereinafter "LHAAP-16 ROD") and the "Draft Final Record of Decision, LHAAP-17, Burning Ground No. 2/Flashing Area, Group 2, Longhorn Army Ammunition Plant, Karnack, Texas," September 2011 (hereinafter "LHAAP-17 ROD"), EPA States that "The State of Texas designates all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 TAC 335.563(h)(1)." This is Risk Reduction Standard Number 3. These EPA comments on ARAR designations are inconsistent and far too late in the process, as well as being contrary to the TCEQ position with regard to a State standard.

C. Army disagrees that 30 TAC §335.559(b) is a "Texas MCL groundwater standard" that "establishes a health based MCL that constitutes an ARAR for groundwater restoration." Section 335.559(b) establishes *surface water* cleanup levels for chemical constituents by using the following numerical sources in preferential order: Texas Surface Water Quality Standards, SDWA MCLs, and Texas MSCs based upon human ingestion of the water. Thus, for the protection of surface water quality, if there is a Texas surface water quality standard for the target chemical, then that standard is used. If no Texas surface water quality standard exists, then the MCL is used. Only if there is neither a surface water standard nor a MCL exists would the MSC be used. Nothing in this paragraph suggests that MSCs are MCLs, nor does this paragraph state that GW-Res is used as the MSC.

D. The correct State ARAR for the *cleanup* of potential groundwater drinking water sources is promulgated at 30 TAC §335.559(d), provided as Attachment 1. Paragraph (d) establishes the state groundwater cleanup standard as the federal MCL for those chemicals having a federal MCL. Otherwise, the state MSC is used as the cleanup standard. There is nothing in the regulation supporting the conclusion that because state cleanup standards are federal MCLs for those chemicals with MCLs, then the state cleanup standards are state MCLs for the remaining chemicals without federal MCLs. TAC §335.559(d) establishes two cleanup standards for groundwater based on the type of use exposure anticipated for the groundwater – one for residential exposure and one for non-residential exposure. The groundwater at LHAAP 16 will be subject to nonresidential exposure because this site is within the larger federal property, is restricted to conservation purposes, and is under United States Government control which will prevent any future residential use.

E. The non-residential exposure standard found at 30 TAC §335.559(d)(2) is the ARAR for cleanup of groundwater at the four sites. For non-MCL contaminants, this standard is calculated at 3.36 times the MSC for carcinogens and 2.8 times the MSC for systemic toxicants to account for lower ingestion rates associated with nonresidential worker exposure. CERCLA Section 121(d) (2)(C)(iii)(I) requires that the state standard must be "of general applicability." Army believes that the state residential cleanup standard is generally applicable to residential use properties, and that the nonresidential cleanup standard is generally applicable to all nonresidential properties.

   The Army property will be subject to the nonresidential exposure standard. While Army notes some departures from the above-cited ratios in the Texas MSC table (also included in Attachment 1), the applicable cleanup standards are determined by the GW-Ind concentrations and not the GW-Res concentrations.

F. TCEQ comments on the RODs do not raise any objection to the use of 30 TAC §335.559(d)(2) as a groundwater ARAR and the Texas GW-Ind MSC as the cleanup standard for non-MCL contaminants. *See*, Attachment 2.

G. CERCLA § 121(d) (2)(A)(ii) establishes the elements to determine whether specific state standards are ARARs for the hazardous substance, pollutant or contaminant that will remain onsite after the completion of a remedial action.

   - The State standard, requirement, criteria, or limitation was promulgated in a State environmental or facility siting law.
   - The State standard, requirement, criteria, or limitation must be more stringent than any Federal ARAR determined under CERCLA §121(d)(2)(A)(i).

- The State standard, requirement, criteria, or limitation must be legally applicable to the hazardous substance or pollutant or contaminant or relevant and appropriate under the circumstances of the release.

In addition, a State standard which meets these criteria may be waived if the State has not consistently applied the standard, requirement, criteria, or limitation in similar circumstances at other remedial actions within the State. CERCLA §121(d)(4)(E). Of primary importance in this case is whether the application of the GW-Res standard to industrial property has been consistently applied in similar circumstances at other remedial actions within Texas. As noted in paragraph F, TCEQ has provided no written comment that the GW-Res is applicable to any of the four sites. TCEQ has also maintained at all prior times in the past that the GW-Ind standard is the proper standard for groundwater cleanup at Longhorn sites. Most importantly, TCEQ has concurred in writing with the Army RODs as submitted on 29 September 2011.

The GW-Res standard is not applicable or relevant and appropriate and, as a result, CERCLA § 121(d)(4)(E) would be applicable in the event that Army is requested to designate the residential standard as an ARAR for these RODs.

H. The NCP provides that lead and support agencies are to identify ARARs in a timely manner during the RI, and review them during the preparation of the FS:

- 40 CFR 300.400(g), (4), (5), and (6), require state standards to be identified in a "timely manner" and refers to 300.515(d) for the meaning of timeliness;
- 40 CFR 300.430(d)(3) requires lead and support agencies to identify ARARs during the RI in a timely manner;
- 40 CFR 300.430(e)(2)(i) provides for the establishment of RAOs based on ARARs during the FS as more information becomes available;
- 40 CFR 300.515(d)(1) requires lead and support agencies to "identify their respective potential ARARs and communicate them to each other in a timely manner, i.e., no later than the early stages of the comparative analysis" during the development of the FS so the lead agency may "consider and incorporate all potential ARARs without inordinate delays and duplication of effort"; and
- 40 CFR 300.515(h)(2) requires the lead and support agencies to discuss potential ARARs during the RI/FS scoping, and again during the comparative analysis phase of the FS with a 30 day period for support agency response, with further updates as appropriate.

In addition, Subparagraph VIII.F.1of the FFA requires the early identification of potential ARARs:

> For those primary reports or secondary documents that consist of or include ARAR determinations, *prior to the issuance of a draft report*, the Project Managers shall meet to identify and propose, to the best of their ability, all potential ARARs pertinent to the report being addressed. *TWC shall identify all potential state ARARs as early in the remedial process as possible consistent with the requirements of CERCLA §I21 and the NCP*. The Army shall consider any written interpretation of ARARs provided by the State. Draft ARAR determinations shall be prepared by the Army in accordance with CERCLA §121(d) (2), 42 U.S.C. s9621 (d) (2) , the NCP, and pertinent guidance issued by EPA and TWC, that is consistent with CERCLA and the NCP.

(Emphasis added.) TCEQ is the support agency for identification of potential State ARARs. The Army conferred with TCEQ regarding the use of the TAC groundwater cleanup level regulation and all agencies agreed during the RI and FS that the nonresidential exposure standard is relevant and appropriate for these Longhorn remedies. This was communicated to the public in the proposed plan in 2010 and no objection was raised to this by TCEQ. Only EPA has untimely objected after the draft ROD was reviewed and accepted by the Region 6 staff and concurred in by the TCEQ. For EPA to now raise this issue is inconsistent with the NCP, as well as being without foundation under the TCEQ regulations or appropriately based on any current or reasonably foreseeable exposure scenario for these Longhorn sites.

I. Army recognizes 30 TAC §335.559(d)(2) as the ARAR establishing the cleanup standard for groundwater, subject to any applicable exceptions and limitations on the use of the GW-Ind cleanup standard. *See*, *e.g.*, LHAAP-16 ROD at page 2-6 and Table 2-10; LHAAP-17 ROD at page 2-5 and Table 2-14; "Draft Final Record of Decision, LHAAP-001-R (South Test Area/Bomb Test Area) and LHAAP-003-R (Ground Signal Test Area), Longhorn Army Ammunition Plant, Karnack, Texas," at page 2-27 and Table 2-4 (hereinafter "MMRP ROD).

J. Because the MSCs are cleanup standards as opposed to drinking water standards and because the RODs properly incorporate GW-Ind as the ARAR for groundwater, the RODs meet the requirements of the FFA and are consistent with CERCLA and the NCP.

Second Issue in Dispute

2. Issue 2: Adequate LUC objectives are missing from the RODs. The RODs should include objectives designed to protect the integrity of the groundwater monitoring system and landfill caps. This is because the groundwater monitoring system and the landfill caps are integral engineering components of the final remedies. The remedial systems must be protected from intrusive or other activities which could damage the engineered portion of the remedy. Additionally, to ensure protectiveness, the relevant RODs should also include a LUC objective to prohibit development and/or other intrusive activities such as digging which could result in detonation of explosive hazards or exposure to other contaminants.

EPA Position: CERCLA Section 121(d)(2)(B) refers to the use of enforceable measures (e.g., ICs) as part of the remedial action selection alternatives at sites. In addition, 40 CFR 300.430(a)(1)(iii) provides that institutional controls may be needed in combination with the use of treatment; and engineering controls in order for the selected remedy to be protective of human health and the environment. The NCP Preamble (at pp. 55 FR 8701 - 8702) makes clear that the nine criteria evaluation under 40 CFR 300.430(e)(9)(iii), encompass the CERCLA 121(b)(1) remedy selection statutory requirements. This particular NCP Preamble discussion specifically addresses the long-term effectiveness factor that must be assessed under CERCLA section 121(b)(1). The trade-offs among alternatives with respect to the long-term effectiveness and permanence they afford, and the reductions in toxicity, mobility, or volume they achieve through treatment, are the most important considerations in the balancing step by which the remedy is selected. Outside of the threshold criteria for remedy selection found at 40 CFR 300.430(f)(1), the long-term effectiveness primary balancing criteria is one of the most important remedy selection factors.

Also note that NCP Preamble (at p. 55 FR 8720) provides that the long-term effectiveness analysis focuses on any residual risk remaining at the site after the completion of the remedial action. This analysis includes consideration of the degree of threat posed by the hazardous substances remaining at the site and the "adequacy and reliability" of any controls (e.g., engineering or institutional controls) used to manage the hazardous substances remaining at the site. The criterion is founded on CERCLA's mandates to select remedies that are protective of human health and the environment that maintain protection over time. In this case, it is imperative that the groundwater monitoring system includes protections and restrictions designed to ensure that the movement (i.e., whether the movement shows a decrease or an increase in size and plume stability) of contaminated groundwater is not presenting unnecessary risk to human health and the environment. Without a groundwater monitoring system that is reliable for 280 years (i.e., the estimated time-frame for the contaminated groundwater to attain drinking water standards for the

LHAAP-16 plume), then the selected remedies may not be protective of human health and the environment.

The NCP Preamble (at pp. 55 FR 8706-8707) demonstrates that although EPA believes institutional controls should be used be used to provide protection to human health and the environment, it also recognized that special precautions must be made to assure that the controls are reliable. An example of a special precaution is included in 40 CFR 300.510(c) to require states to assure institutional controls implemented as part of a remedial action at a fund-lead site are in place, reliable, and will remain in place. Finally, EPA has addressed remedy selection and the LUC issues noted above in relevant policy documents including "A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Documents," pp. 6-6, 6-26-27, 6-48, and "Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups," pp. 3 - 4, 7 - 9.

For example, EPA has drafted language for inclusion in the relevant primary reports at issue. One of two language options noted below, or their equivalent, may be utilized to address this LUC objective issue:

“LUC to maintain the integrity of any current and/or future groundwater monitoring system such as monitoring wells. “

or

“LUC to prohibit intrusive or any other activities which could damage the landfill cap and the groundwater monitoring system.”

In addition, for other examples, please see the October 2011 letters from EPA to the Army which conveyed EPA’s detailed comments on the RODs.

The following EPA policies guide this issue as well:

EPA November 2010 Interim Final OSWER 9355.0-89 EPA-540-R-09-001, Institutional Controls**:** A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites: http://www.epa.gov/superfund/policy/ic/pdfs/PIME-IC-Guidance-Interim.pdf

EPA October 2006, Sample Federal Facility Land Use Control ROD Checklist with Suggested Language: http://www.epa.gov/fedfac/documents/icchecklist.pdf

EPA September 2000, OSWER 9355.0-74fs-p, Institutional Controls: A Site Manager’s Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups: http://www.epa.gov/superfund/policy/ic/guide/guide.pdf

Army Response

A. This Issue statement seeks LUC objectives protecting two components of the remedy: (1) the landfill cover systems, and (2) the groundwater monitoring systems. The Issue statement also seeks, where appropriate (i.e, at sites LHAAP-01 and LHAAP-23) LUC objectives to prevent intrusive activities that could result in detonation of explosives or exposure to contaminants.

B. As statutory support for its position, the EPA Position statement incorrectly cites to CERCLA Section 121(d)(2)(B) as referring “to the use of enforceable measures (e.g., ICs) as part of the remedial action selection alternatives at sites.” CERCLA Section 121(d)(2)(B)(i) discusses only that the circumstances of the release must be considered when determining whether water quality criteria under the Clean Water Act is relevant and appropriate. This clause does not make any reference to ICs.

The sole purpose of CERCLA Section 121(d)(2)(B)(ii) is to exclude the application of Alternate Concentration Limits beyond the facility boundary unless, among other things, the remedy includes enforceable measures that will preclude human exposure to the contaminated groundwater. CERCLA Section 121(d)(2)(B) does not require "enforceable measures" within the facility boundary. Army is not proposing an alternate concentration limit and there is no groundwater contamination beyond the facility boundary. CERCLA Section 121(d)(2)(B) is therefore wholly inapplicable to the issue raised and does not provide that "institutional controls may be needed in combination with the use of treatment; and engineering controls in order for the selected remedy to be protective of human health and the environment."

C. Army views the first through third paragraphs of the EPA Position statement as a discussion of specifically how institutional controls can be considered in evaluating the long-term effectiveness of a remedy during the remedy selection process and how these institutional controls work with other remedy components to provide long-term protectiveness of human health. The EPA Position statement references 40 CFR 300.430(a)(1)(iii), which states that "EPA expects to use institutional controls such as water use and deed restrictions to supplement engineering controls … to prevent or limit exposure to hazardous substances, pollutants, or contaminants." Army agrees that institutional controls may be useful in combination with other remedy components in order to assure protectiveness. 40 CFR 300.430(a)(1)(iii) is clear, however, that the purpose of the institutional controls is to "prevent or limit exposure" and does not include protecting remedy integrity.

D. The draft final RODs employ adequate governmental controls and information devices to protect human health and the environment from the risk of harm, and therefore comply with CERCLA and the NCP.

EPA guidance identifies four classes of institutional controls (ICs): proprietary controls, governmental controls, enforcement and permit tools with IC components, and informational devices. Proprietary controls cannot currently be used at Longhorn because the property will continue in federal ownership.[1] The RODs include both informational devices and governmental controls. For example, the RODs include the informational device of recording in the local land records notices that the property is suitable for non-residential use only, that there will be no intrusive activities, that the use of groundwater is prohibited, and and of notifying well drillers of the groundwater use prohibitions by registering those prohibitions with the Texas Department of Licensing and Regulation. *See*, *e.g.*, LHAAP-16 ROD at pages 1-5 and 2-27; LHAAP-17 ROD at pages 1-3 and 2-20; and MMRP ROD at page 1-2. Each ROD also discusses the preparation of a Remedial Design that "will include the specific LUCs and implementation details." See, *e.g.*, LHAAP-16 ROD at page 1-4, LHAAP-17 ROD at page 1-3, MMRP ROD at page 1-3. The RODs will be modified to reflect that copies of site documents, including the Remedial Designs, will be provided to USF&WS.

The RODs also state that governmental controls will be included in the Letter of Transfer. For example, the following language appears at Page 2-20 of the LHAAP-17 ROD.

> To transfer this property (LHAAP-17), an Environmental Condition of Property (ECP) document would be prepared and the Environmental Protection Provisions from the ECP would be attached to the letter of transfer. The ECP would include the LUCs as part of the Environmental Protection Provisions. The property would be transferred subject to

[1] OSWER 9355.0-74fs-p, Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups, at 4 (September 2000).

> the LUCs identified in the ECP. These restrictions would prohibit or restrict property uses that might result in exposure to the contaminated groundwater (e.g., drilling restrictions).

The LHAAP-16 ROD contains the following language referencing LUCs at Page 2-27.

> To transfer LHAAP-16, an Environmental Condition of Property (ECP) document would be prepared and the Environmental Protection Provision from the ECP would be attached to the letter of transfer. The ECP will include land use and groundwater use restrictions as part of the Environmental Protection Provisions. The property would be transferred subject to the LUCs identified in the ECP. These restrictions would prohibit or restrict property uses that may result in damage to the existing remedy (landfill cap) or exposure to the contaminated groundwater (e.g., drilling restrictions).

Because the LUCs at LHAAP-01 and LHAAP-03 have been implemented under the approved IRP RODs, the discussion in the MMRP ROD at Page2-9 is more definitive.

> LUCs were designed and constructed for the site consistent with recommendations of the EE/CA and AM that included:
>
> - Restriction against intrusive activities. TAC § 335.569, Appendix III requires that the restriction be recorded in the Harrison County Clerk's Office, with the survey, map, and LUC language.
> - Signage at the perimeter of LHAAP-001-R. Signs were installed at the perimeter of the site, serving as the physical demarcation of the controlled areas. The signs have visibility from one sign to the next with a maximum spacing of 100 ft. The signs include warning of the potential presence of MEC and state the restriction against intrusive activities.
> - Education program for future refuge visitors, staff, and volunteers. The program includes informational pamphlets and safety video warning of the potential presence of MEC and presenting examples of MEC that were or may be found at the site.

E. The above and other IC/LUC discussions are presented throughout the three RODs. Army disagrees that there is a failure to include "adequate LUC objectives" and that this is a failure to comply with CERCLA and the NCP given the detailed discussion of LUCs presented in the RODs. Army notes that there are no references to the specific phrase "LUC objectives" in CERCLA or the National Contingency Plan. The above format has been used in numerous RODs and has in the past been acceptable to EPA. The objection appears to be only that the RODs do not use specific EPA-mandated language. That does not affect the protectiveness of the remedy.

   Nonetheless, Army has no objection to use of the word "objectives" and the RODs are revised to reference "LUC objectives" where appropriate.

F. Army does not agree that LUCs are appropriate or necessary to protect the integrity of the groundwater monitoring system because protecting the integrity of a well or even a group of wells does not protect the public from risk of harm. The sole purpose of a groundwater monitoring system is to assist in the collection of valid groundwater samples. Therefore, it is the integrity of the groundwater sample that is at issue. Sample integrity is achieved through physical barriers such as bollards and locking covers, as well as the well inspection and sampling procedures that occur immediately prior to and during well sampling. These procedures include such things as inspecting the well for damage or tampering, sounding the well, and monitoring the purge water for indicator parameters such as pH and temperature. Wells that are damaged or tampered with are replaced, repaired or rehabilitated, thereby preserving the integrity of the sample. All of these features are included in the remedial design and/or groundwater monitoring plans, as opposed to the LUC RD.

This approach is illustrated by examining the meaning of the EPA Position statement's assertion that the groundwater monitoring system must be reliable for 280 years in order for the selected remedies to be protective of human health and the environment.[2] It is important to understand that there is no human experience indicating that any individual component of the groundwater monitoring system (well, concrete pad, locking cover, locks, and bollards) is capable of a 280-year life span. Periodic failure of individual components must therefore be assumed. As discussed in the preceding paragraph, the reliability of the groundwater monitoring system, defined by its ability to produce valid groundwater samples, is maintained through replacement, repair, and rehabilitation. These procedures are components of the various operating plans, as opposed to LUCs. As a result, there is no basis to conclude that component failures, whether caused by deterioration, accident, or intentional act, will affect protectiveness by yielding invalid, low-concentration[3] groundwater samples. It must then be concluded that LUCs to prevent accidental or intentional acts, even if effective, would not reduce the risk of harm by increasing the probability of collecting valid samples.

G. Verbally, Region 6 has expressed concern that the LUCs will have to be maintained in the event that property is transferred out of federal ownership. Where property is being conveyed out of federal ownership, Army frequently places land use restrictions in the property deed, which are real property encumbrances that "run with the land" in perpetuity or until such time as Army, often in conjunction with the regulatory agencies, agrees to remove them once cleanup standards are achieved. Examples may include restrictions on excavation to prevent exposure to contaminated subsurface soil or the use and/or ingestion of contaminated groundwater to prevent exposure to groundwater contaminants.

However slight the possibility, the RODs provide for proprietary controls that will be implemented in the event of a transfer into private ownership.

> To transfer this property (LHAAP-17), an Environmental Condition of Property (ECP) document would be prepared and the Environmental Protection Provisions from the ECP would be attached to the letter of transfer. The ECP would include the LUCs as part of the Environmental Protection Provisions. The property would be transferred subject to the LUCs identified in the ECP. These restrictions would prohibit or restrict property uses that might result in exposure to the contaminated groundwater (e.g., drilling restrictions).

LHAAP-17 ROD at page 2-20. Similar language also appears in the LHAAP-16 ROD at page 2-17. The MMRP ROD is a slightly different case in that a LUC RD already exists. However, the ROD will be modified to make clear that the same process will be followed in the unlikely event that an MMRP site is transferred out of federal control by including language similar to the above passage.

H. Because the RODs adequately incorporate LUC objectives, the RODs meet the requirements of the FFA and are consistent with CERCLA and the NCP.

[2] Army agrees only that a reliable groundwater monitoring system is necessary to verify protectiveness.

[3] It should also be noted that invalid groundwater samples typically yield high-concentration samples (i.e., tampering, failed well seal, etc.). While invalid high-concentration samples affect cost, these do not affect protectiveness.

Third Issue in Dispute

Issue 3: The ROD must ensure that LUCs (individually or together) are to remain in place until unlimited use and unrestricted exposure is reached for each engineering component of the remedy.

EPA Position: By way of example, as noted above, because the groundwater monitoring system is an integral engineering component of the selected remedy, the duration associated with the LUC objective for protecting the integrity of the groundwater monitoring system must be identified in the ROD as to be in place until unlimited use and unrestricted exposure is reached. For similar reasons provided in issue #2 note that NCP Preamble (at p. 55 FR 8720) provides that the long-term effectiveness analysis focuses on any residual risk remaining at the site after the completion of the remedial action. This analysis includes consideration of the degree of threat posed by the hazardous substances remaining at the site and the "adequacy and reliability" of any controls (e.g., engineering or institutional controls) used to manage the hazardous substances remaining at the site. The criterion is founded on CERCLA's mandates to select remedies that are protective of human health and the environment that maintain protection over time. Similarly, for the other objectives described in item 2 above, the RODs must ensure that all components of the remedy are durable over time. Note that the statutory criteria and NCP provisions cited in issue #2 are also relevant to this particular issue.

The following EPA policies guide this issue as well:

EPA November 2010 Interim Final OSWER 9355.0-89 EPA-540-R-09-001, Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites: http://www.epa.gov/superfund/policy/ic/pdfs/PIME-IC-Guidance-Interim.pdf

EPA October 2006, Sample Federal Facility Land Use Control ROD Checklist with Suggested Language: http://www.epa.gov/fedfac/documents/icchecklist.pdf

EPA September 2000, OSWER 9355.0-74fs-p, Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups: http://www.epa.gov/superfund/policy/ic/guide/guide.pdf

Army Response

A. By reviewing the comments submitted by EPA on October 20, 2011 in the context of the Issue statement above, Army concludes that EPA is asking Army to "memorialize its understanding that LUCs are to remain in place until unlimited use and unrestricted exposure is reached for all of them or the Army needs to develop a specific duration statement for each separate LUC." *See, e.g.*, EPA Region 6 Comments dated October 20, 2011, LHAAP-17 Draft Final ROD (29 SEP 2011), Comment #4. The remainder of the EPA Position statement is redundant to aspects of Issue 2 and no additional response from Army is required.

B. In response to a similar comment regarding the duration of LUCs in the LHAAP-16 ROD on 23 September 2011, Army responded with the following proposed text revision:

> The LUCs to protect and maintain the integrity of the landfill cap will remain in place as long as the landfill waste remains at the site. LUCs restricting the use of groundwater to environmental monitoring and testing only will remain in place until the contaminated groundwater attains groundwater cleanup levels in order to prevent human exposure to the contaminated groundwater. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure."

This text was subsequently included on page 2-7 of the Draft Final ROD. Army also responded to this comment on 28 September 2011 as follows. “A description of the durations for the relevant LUCs are included in the ROD. For examples, please see pages 1-3, 2-7 and 2-50 of the Draft Final ROD.”

C. LUC duration statements also appear in the LHAAP-17 ROD. For example, the following text appears on Page 1-3.

- A land use control (LUC) to prevent human exposure to contaminated groundwater by prohibiting the use of groundwater except for environmental monitoring and testing. A preliminary LUC boundary is presented in Section 2.12.2 and a final LUC boundary will be determined during the RD/Remedial Action. When the cleanup level is achieved, the LUC will be terminated.
- A LUC restricting land use to nonresidential use only. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.
- CERCLA five-year reviews until cleanup levels are achieved.

Duration references also appear at Pages 2-6, 2-20, 2-24, 2-25, 2-30, and 2-33 among other locations in the LHAAP-17 ROD. All of these statements ensure that the LUCs will remain in place until unlimited use and unrestricted exposure concentrations are achieved.

D. Because the Draft Final LHAAP-16 and LHAAP-17 RODs already include the statements requested in the Issue statement, there is no basis to assert that these draft final documents fail to meet the requirements of the FFA, or are inconsistent with the NCP or CERCLA.

E. A duration statement has been added to the Draft Final MMRP ROD. The text has been revised to state that the LUC restricting land use to nonresidential will remain in place until it is demonstrated that surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure. The MMRP ROD shall be modified to include a LUC duration to prohibit intrusive activities until it is demonstrated there are no explosive hazards. There is no groundwater use restriction remedy in the ROD.

While the September 27, 2011 submittal will be revised to add the duration statement, that Draft Final ROD is consistent with the draft LUC plan included in the “Draft Final Site Specific Final Report” that EPA commented upon on May 21, 2009. Those comments do not include a request for a LUC duration statement. Because EPA accepted the LUCs proposed in the “Draft Final Site Specific Final Report,” there was no reason for Army to conclude that EPA viewed a duration statement as necessary for this site. Army prepared the draft final ROD with that understanding and with the understanding that, where there is no duration statement, the duration will be indefinite until such time as the remedy is modified to remove the controls. Therefore, there is no basis to assert that the draft final MMRP ROD fails to meet the requirements of the FFA, or is inconsistent with the NCP or CERCLA.

Fourth Issue in Dispute

Issue 4: The Army does not have independent authority to modify a remedy. The LUC is part of the remedy which, under CERCLA, is both selected by Army and EPA. In the event of dispute, the EPA Administrator selects the remedy. Thus, the Army cannot unilaterally make modify or terminate a LUC remedy.

EPA Position: Section XIX, Selection, Design and Implementation of Remedial Actions of the FFA, in relevant part, states "... [f]ollowing consideration of comments by TWC, the ROD will be finalized jointly by the Army and EPA, or if they are unable to reach agreement about the selection of the remedial action, by the EPA Administrator." CERCLA Section 120(e)(4) and 40 CFR 300.430(f)(5)(iii), contain substantially the same language as noted above. Remedy selection authority as provided in CERCLA applies regardless of whether the Army currently owns the property. The FFA conveys the same principle. For example, in Section XXVI, Transfer of Property, the FFA provides that "no change in ownership or conveyance of any property interest in LHAAP shall in any way alter the status of the Parties under this Agreement." The FFA also provides that "Notice ...of any transfer of ownership or property interest shall not relieve the Army of its obligation to perform under this Agreement." As such, any language included in the draft final primary reports that is inconsistent with the above requirements is a violation of the FFA. The transfer or potential transfer of the LHAAP property or sites in question does not change the Army's obligations and responsibilities under the FFA or CERCLA. The FFA requires that the Army follow EPA policy. The relevant guidance or policy for this particular issue includes, "A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Documents," at pp. 6-6, 6-26-27, 6-48. The following examples include language that must be deleted from the draft final RODs, as the language is inconsistent with the FFA, CERCLA Section 120(e)(4) and the NCP at 40 CFR 300.430(f)(5)(iii). In the below examples, EPA modified Army language to make it consistent with CERCLA, the NCP, and the FFA. The Army may propose other language that would ensure that the Army does not independently modify or terminate a LUC without EPA concurrence as that is modifying or terminating a CERCLA remedy. To date, the Army has not proposed an alternative that meets these concerns.

Example (a): “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 ultimately 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 the LUC and any related transfer or lease provisions ;~~ and ~~(5)~~(4) ensuring the protectiveness 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 these sites after they have been transferred.”

Example (b): “The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~.”

The following EPA policies guide this issue as well:

EPA November 2010 Interim Final OSWER 9355.0-89 EPA-540-R-09-001, Institutional Controls**:** A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites: http://www.epa.gov/superfund/policy/ic/pdfs/PIME-IC-Guidance-Interim.pdf.

EPA October 2006, Sample Federal Facility Land Use Control ROD Checklist with Suggested Language: http://www.epa.gov/fedfac/documents/icchecklist.pdf.

EPA September 2000, OSWER 9355.0-74fs-p, Institutional Controls: A Site Manager’s Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups: http://www.epa.gov/superfund/policy/ic/guide/guide.pdf.

Army Response

A. Army concurs with the first paragraph of the Issue statement. Army understands that the following four assertions are made, which are repeated in outline form below:

(1) The Army does not have independent authority to modify a remedy.
(2) The LUC which is part of the remedy, under CERCLA, is selected by both Army and EPA.
(3) In the event of dispute over the alternative to be selected in a remedy selection decision, the EPA Administrator selects the remedy.
(4) The Army cannot unilaterally make, modify, or terminate a LUC remedy which reduces protectiveness of the remedy.

B. Army concurs in the first six sentences of the first paragraph of the EPA Position statement, with the following limitations:

- In the first sentence, Army points out that finalization of the ROD by the EPA Administrator can only occur following FFA Section VIII Consultation and the procedures in Executive Order 12580, Section 10. A ROD prepared by the EPA Administrator is not a product of consultation.
- Army does not concur that 40 CFR 300.430(f)(5)(iii) cited in the second sentence "contain[s] substantially the same language" as the FFA and CERCLA § 120(e)(4) regarding finalization of RODs.

C. Army does not concur that "As such, any language included in the draft final primary reports that is inconsistent with the above requirements [as outlined in Paragraph A above] is a violation of the FFA."

The FFA clearly contemplates that Army and EPA may not resolve all issues during the Section VIII Consultation process. Paragraph H of Section VIII specifically provides for invoking dispute resolution. There is nothing in the FFA that provides any basis for the assertion that the failure of Army to accept all or any EPA language in a draft final document is a violation of the FFA.

The purpose of a draft final ROD is to document a decision on selecting a remedy and not to interpret the law or the FFA. In any event, the draft final RODs do not contain any language that is contrary to CERCLA, the NCP, or a term or condition of the FFA.

D. Army concurs that "the transfer or potential transfer of the LHAAP property or sites in question does not change the Army's obligations and responsibilities under the FFA or CERCLA."

E. Army concurrence in the statement "the FFA requires that the Army follow EPA policy" is limited to when the policy is required to fill gaps in or furthers the implementation of the statutes and regulations, when the policy is consistent with statutes and regulations, and when the policy is properly coordinated and officially issued as final agency policy. It is Army's position that the intent of the FFA is to require adherence to CERCLA, the NCP, and then CERCLA/EPA policy in that order.[4]

[4] *See, e.g.*, the following Notice to "A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Documents:"

This document provides guidance to EPA and State staff. It also provides guidance to the public and to the regulated community on how EPA intends to exercise its discretion in implementing its regulations. The guidance is designed to implement national policy on these issues. The document does not, however, substitute for statutes EPA administers nor their implementing regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the specific circumstances. EPA may change this guidance in the future, as appropriate.

F. The Position statement asserts that “[t]he relevant guidance or policy for this particular issue includes, ‘A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Documents,’ at pp. 6-6, 6-26-27, 6-48.”

- On Page 6-6, “Highlight 6-6: Notes on ROD Authorizing Signatures” addresses coordination between EPA and states, Nations, or Tribes when signing RODs. The text notes that when another federal agency, such as DOD, is the lead agency, that agency should co-sign the ROD.
- Pages 6-26 through 6-27 discuss the formulation of remedial action objectives and description of alternatives.
- Page 6-48 discusses statutory determination, specifically protection of human health and the environment and compliance with ARARs.

Nothing in any of these cited pages reference any of the four assertions outlined in Paragraph A above. While Highlight 6-6 does note that the lead agency “should co-sign the ROD with EPA,” it does not address any of the four issues raised in the Position statement.

G. The remainder of the Position statement purports to give examples of ROD language that is contrary to Pages 6-6, 6-26-27, 6-48 of the above-cited guidance. However, these examples are the exact language objected to, and Army is unaware of any other language to which EPA objects. Therefore, the remainder of Army’s response will be limited to the examples cited in the Position statement.

H. Example (a): “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 ultimately 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 the LUC and any related transfer or lease provisions ;~~ and ~~(5)~~(4) ensuring the protectiveness 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 these sites after they have been transferred.”

The Position statement seeks to delete the phrase “reservation of the authority to change, modify, or terminate the LUC and any related transfer or lease provisions” from the list of continuing Army *obligations* in the event that the responsibility for continued implementation of all or part of remedy is transferred to another federal agency. Despite the context of the language, EPA has chosen to interpret this clause as a limitation on EPA authority when it is in fact silent on EPA authority.

The list of obligations that Army will remain “ultimately responsible” for includes three “affirmative” obligations requiring Army to do something: (1) conduct CERCLA five-year reviews; (2) notify regulators of known LUC deficiencies or violations; and (5) ensure the protectiveness of the selected remedy. In addition, the list includes the obligation to retain two authorities necessary to fulfill the remaining three “affirmative” obligations: (3) access to the property to conduct any necessary response; and (4) authority to change, modify, or terminate the LUC and any related transfer or lease provision.

Here, Army’s obligation to retain its authority to change, modify, or terminate LUCs, or to transfer or lease property under its jurisdiction, has no more impact upon EPA’s CERCLA authorities with respect to remedy modification or termination than the Army’s retention of authority to access the property has on EPA’s CERCLA authority to access the property. Both are simply silent on those issues, but EPA has objected to only one.

By way of example, a very similar retention of authority appears in the second to last paragraph of Highlight 6-6 on Page 6-6 of EPA's "A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Documents." This is the guidance relied upon by EPA to support its position on this issue. That statement is as follows: "It should be noted that EPA retains the authority to sign RODs at NPL sites owned/operated by federal agencies." No one should conclude that this statement is intended to limit the statutory authorities that other federal agencies have under CERCLA.

I. Example (b): "The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or ~~significant~~ modification of a LUC, or in the highly unlikely event of a land use change ~~inconsistent with the LUC objectives and industrial use assumptions of the remedy~~."

The changes sought raise two issues. The first issue is whether the inclusion of the term significant is appropriate in this context. The concept of a "significant" change or difference as a trigger for lead and support agency consultation appears in the NCP at § 300.430(f)(3)(ii)

> After publication of the proposed, plan and prior to adoption of the selected remedy in the record of decision, if new information is made available that *significantly* changes the basic features of the remedy with respect to scope, performance, or cost, such that the *remedy significantly differs* from the original proposal in the proposed plan and the supporting analysis and information, the *lead agency* shall:
>
> (A) Include a discussion in the record of decision of the *significant changes* and reasons for such changes, *if the lead agency determines* such changes could be reasonably anticipated by the public based on the alternatives and other information available in the proposed plan or the supporting analysis and information in the administrative record;

(emphasis added), and again at § 400.435(c)(2)

> After the adoption of the ROD, if the remedial action or enforcement action taken, or the settlement or consent decree entered into, *differs significantly* from the remedy selected in the ROD with respect to scope, performance, or cost, *the lead agency* shall consult with the support agency, as appropriate, and shall either:

(emphasis added). The NCP is clear that it is the lead agency's responsibility to determine "significance" and to initiate the required coordination. Therefore, Army's position is that the inclusion of the word "significant" is correct in this context, and consistent with its authority and responsibility as the lead agency.

J. By so doing, Army does not seek to define significance, recognizing that the cited NCP sections provide significant guidance on that point. Army does agree, however, that *at least* the termination of a LUC is a significant modification (and is therefore specifically distinguished in the text). Army also takes the position that *at least* "a land use change inconsistent with the LUC objectives and industrial use assumptions of the remedy" constitutes new information pursuant to § 300.430(f)(3)(ii) that significantly changes the basic features of the remedy.

K. For the reasons stated above, the draft final RODs do not constitute a failure to comply with a term or condition of the FFA, nor are they inconsistent with CERCLA, the NCP, or EPA policy as cited above.

Fifth Issue in Dispute

Issue 5: The identification of ARARs and rationale for exclusion. The presence of the LHAAP-16 landfill requires attainment of landfill post closure requirements as ARARs.

EPA Position: The Army has not provided the rationale for excluding items under 40 CFR 264.310(b) as ARARs. As provided in the NCP Preamble (at pp. 55 FR 8701 - 8702), it is clear that the nine criteria evaluation under 40 CFR 300.430(e)(9)(iii), encompasses the CERCLA 121(b)(1) remedy selection statutory requirements. CERCLA selected remedies must satisfy the threshold criteria of protecting human health and the environment, and compliance with ARARs under 40 CFR 300.430(f)(1). At issue here is the selected remedy's compliance with ARARs under hazardous waste management regulations. CERCLA Section 121(d) provides that on-site remedial actions must comply with the substantive requirements of environmental laws. Under 40 CFR 300.430(f)(1)(ii), on-site remedial actions must comply with ARARs or obtain a waiver. Any failure to include an ARAR without obtaining an EPA approval of an ARAR waiver request fails to comply with the FFA at Section XIX, CERCLA Sections 120 and 121, 40 CFR 300.430 (f)(1)(ii), and EPA ARARs policy and guidance (i.e., ARARs Q's & A's: General Policy, RCRA, CWA, SDWA, Post-ROD Information and Contingency Waivers - July 1991).

Army Response

A. Army interprets the Issue statement as requesting that Army modify the LHAAP-16 ROD to either identify as ARARS those post-closure requirements identified in 40 CFR § 264.310(b), including the relevant requirements of 4- CFR § 264.117 - .120, that were not included in the LHAAP-16 ROD, or provide a rationale for exclusion of these requirements as ARARs.

B. The LHAAP-16 ROD identified § 264.310 (b)(1), (3), (4) and (5) as ARARs. The requirement under clause (2) was not included as an ARAR because it is applicable only to leachate collection systems. The LHAAP-16 remedy is the capping of an in-place waste fill and therefore there is no leachate collection system. The requirement to collect leachate from a leachate collection system is therefore not relevant, appropriate, or required. Clause (3), requiring the continued operation of the leak detection system, was erroneously included in the LHAAP-16 ROD and because there is no leak detection system it will be removed.

C. The § 264.310 (b)(6) requirement to maintain site benchmarks was not included in the LHAAP-16 ROD, but has been added. There is no on-site benchmark. However, subsequent to submittal, it has been determined that a nearby off-site benchmark can be used for post-closure purposes.

D. In addition, only those substantive requirements of 40 CFR 264.117 though 120 related to post-closure are considered appropriate and relevant. The Army and agency project managers have agreed that the post closure administrative requirements of 40 CFR 264.117-120 are not considered ARARs. CERCLA exempts the remedy from the applicability of such procedural requirements in §121(e), 42 U.S.C. §9621(e)(1).

Sixth Issue in Dispute

Issue 6: The selection of LUCs (“LUC” means the legal or administrative mechanism by which the LUC objective is implemented) in the RODs. The RODs must identify the legal or administrative mechanism by which the LUC objective is implemented. Thus, the RODs must specifically identify and select LUCs as remedial action components.

EPA Position: As provided in previous issues identified herein (i.e., issues ## 2, 3, and 4) CERCLA selected remedies must comply with the nine criteria evaluation under 40 CFR 300.430(e)(9)(iii), which encompass the CERCLA 121(b)(1) remedy selection statutory requirements. The LUC mechanism must be identified in the RODs so that EPA is assured that the remedy can be implemented as required by the NCP. It is especially important to identify the LUCs at complex sites such as Longhorn where the property will be transferred, In this case, because the property is still under Army control, then the Army should identify the current mechanism (some sort of internal Army procedures) and the future mechanism (ensure the controls are maintained by USFWS in the document transferring property). If the transferee is unable or unwilling to implement the LUCs, a different remedy may need to be chosen in order to ensure protectiveness. The requirement that the LUCs be identified as part of the RODs (i.e., the selected remedial action) ensures that the LUCs are part of an enforceable selected remedy that will be protective of human health and the environment over the short-term and long-term life of the selected remedy.

The following EPA policies guide this issue as well:

EPA November 2010 Interim Final OSWER 9355.0-89 EPA-540-R-09-001, Institutional Controls**:** A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites: http://www.epa.gov/superfund/policy/ic/pdfs/PIME-IC-Guidance-Interim.pdf

EPA October 2006, Sample Federal Facility Land Use Control ROD Checklist with Suggested Language: http://www.epa.gov/fedfac/documents/icchecklist.pdf

EPA September 2000, OSWER 9355.0-74fs-p, Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups: http://www.epa.gov/superfund/policy/ic/guide/guide.pdf

Army Response

A. Two issues are raised.

   (1) The RODs must identify the legal or administrative mechanism by which the LUC objective is implemented.

   (2) Thus, the RODs must specifically identify and select LUCs as remedial action components.

B. Army's position is that the details of implementation of the LUCs should be addressed in the LUC RD or RD, as appropriate to each site. The "Principles and Procedures for Specifying, Monitoring and Enforcement of Land Use Controls and Other Post-ROD Actions," October 2, 2003 (Attachment 3) (hereinafter "Navy Principles"), to which DoD and EPA agreed, provides that the record of decision will "refer to the RD or RAWP for LUC *implementation actions*." NAVY PRINCIPLES, at 4 – 5 (emphasis in original). The RODs are consistent with this agreement. For example, the LHAAP-16 and LHAAP-17 RODs contain the following statement: "The remedial design (RD) will include the specific LUCs and implementation details." LHAAP-16 ROD, at 1-4; LHAAP-17, at 1-3. The MMRP ROD at Page 1-3 references implementation details contained in an existing MEC removal work plan and states that a new LUC RD will be prepared.

C. Nonetheless, the RODs contain considerable information on how the LUCs are a component of the remedies and the legal and administrative mechanisms by which the LUCs will be implemented. For example, the "Summary of Rationale for the Selected Remedy" section of the LHAAP-16 ROD includes the following text on Page 2-50:

   > Landfill LUCs will remain in place as long as the landfill waste remains at the site. In addition, the LUC restricting the use of groundwater to environmental monitoring and

testing only, will remain in place until the contaminated groundwater attains groundwater cleanup standards/levels in order to prevent human exposure to the contaminated groundwater. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that surface soil and subsurface soil meet unrestricted use criteria.

In the "Description of the Remedy" section on Pages 2-51 and 2-52, there are three paragraphs and over 600 words describing the LUCs and their implementation in significant detail, including implementation times.

Land Use Control. The LUCs will prohibit access to the contaminated groundwater except for environmental monitoring and testing only, will preserve the integrity of the landfill cap and restrict intrusive activities (e.g., digging) that would degrade or alter the cap, and restrict land use to nonresidential. The landfill LUCs will remain in place as long as the landfill waste remains at the site. The LUCs restricting the use of groundwater to environmental monitoring and testing only will remain in place until the contaminated groundwater attains groundwater cleanup levels in order to prevent human exposure to the contaminated groundwater. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that the contaminated surface soil and subsurface soil meet unrestricted use criteria. LUCs 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 LUCs. The boundary of the LUCs would enclose the site boundaries and the plume boundaries shown on Figure 2-3.

The U.S. Army would be responsible for implementation, maintenance, inspection, reporting on, and enforcement of the LUCs. 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 LUCs 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 the protectiveness of the selected remedy. In the event that TCEQ and/or EPA and the Army agree with respect to any significant modification of the selected remedy, including the LUCs component of the selected remedy, the remedy will be changed consistent with the FFA and 40 C.F.R. §300.435(c)(2) . The U.S. Army shall retain the ultimate responsibility for remedy integrity as provided in the 1991 FFA.

LUCs implementation and maintenance actions would be described in the RD for LHAAP-16. The LUCs would be included in the property transfer documents and a recordation of them would be filed in the Harrison County Courthouse. The LUCs will prevent human exposure to groundwater contaminated with chlorinated solvents, metals, and perchlorate through the prohibition of groundwater use (except for environmental monitoring and testing) and require cap protection and maintenance. The groundwater LUCs shall be maintained until there is no further threat of releases of contaminated groundwater into the surface water and the concentrations of contaminants and byproduct (daughter) contaminants have been reduced to below their respective MCLs under the SDWA to allow unrestricted use and unlimited exposure at LHAAP-16. In addition, within 90 days of signature of this ROD, the U.S. Army shall request the Texas Department of Licensing and Regulation to notify well drillers of groundwater use prohibitions based on a preliminary LUC boundary. Within one year of signature of this ROD, the Army shall: 1) request the Texas Department of Licensing and Regulation to notify well drillers of the final boundary of groundwater use prohibitions; and 2) notify the Harrison County Courthouse of the LUCs to include a map showing the area of

> groundwater use prohibition at the site, in accordance with 30 TAC 335.565. The landfill LUCs will remain in place as long as the landfill waste remains at the site. The LUCs restricting the use of groundwater to environmental monitoring and testing only will remain in place until the contaminated groundwater attains groundwater cleanup levels in order to prevent human exposure to the contaminated groundwater. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that the contaminated surface soil and subsurface soil are at levels that allow for unlimited use and unrestricted exposure.

The LHAAP-17 ROD contains a very similar 600-word description of the LUCs at the same level of detail in the "Summary of Rationale for the Selected Remedy" and "Description of the Selected Remedy" sections on Pages 2-30 through 2-34. That text is not repeated here.

The MMRP ROD presents the administrative and legal actions needed to implement the LUCs, references the LUCs as a component of the remedy, and references the existing LUC plan. The following ROD text makes clear what the LUCs are and that these LUCs are a component of the remedy.

> The major components of the selected remedy include:
>
> - ***Land Use Control.*** LUCs were designed and constructed to promote ongoing protection of human safety against potential explosive hazards that may have remained at the sites. The LUCs' performance objectives are to identify areas that could possibly contain MEC, ensure all personnel within the site boundaries are made aware of possible safety issues concerning MEC and restrict uses and activities that could result in explosive safety risks. The recordation notification for the sites which will be filed with Harrison County will include a description of the LUCs. The boundary of the LUCs encloses the site boundaries shown on Figures 2-7 and 2-8. The locations of the signs are also shown on Figures 2-7 and 2-8. LUCs for the MRS sites include:
> - Restriction against intrusive activities. TAC § 335.569, Appendix III requires that the restriction be recorded in the Harrison County Clerk's Office, with the survey, map, and LUC language.
> - Restriction against uses other than nonresidential.
> - Signage at the perimeter of LHAAP-001-R and LHAAP-003-R. Signs are in place at the perimeter of the sites, serving as the physical demarcation of the controlled areas. The signs have visibility from one sign to the next with a maximum spacing of 100 ft. The signs include warning of the potential presence of MEC, state the restriction against intrusive activities, and provide a contact number.
> - Education program for future refuge visitors, staff, and volunteers. The program includes informational pamphlets and safety video warning of the potential presence of MEC and presenting examples of MEC that were or may be found at the site.

MMRP ROD, at 2-25. The text goes on for two additional paragraphs to describe implementation of the LUCs, to note the these details were presented in the 2008 plan, and to state that a LUC RD will be prepared.

D. There is no basis for EPA's claim that the RODs fail to identify the legal or administrative mechanism by which the LUC objective is implemented, or do not specifically identify and select LUCs as remedial action components. It is Army's position that these RODs exceed all such requirements. These RODs inform the public of the nature of the controls that are part of the remedy, are specific enough to allow a determination of compliance in the future, and comply with CERCLA, the NCP, and EPA policy including the EPA agreement with DoD to use the Navy Principles, cited above.

Seventh Issue in Dispute

Issue 7: Currently, references to the MEC removal work plan for LUC implementation details are not appropriate as the removal work plan is not enforceable under the FFA.

EPA Position: As provided in previous issues identified herein (i.e., issues ## 2, 3, 4, and 6) CERCLA selected remedies must comply with the nine criteria evaluation under 40 CFR 300.430(e)(9)(iii), which encompass the CERCLA 121(b)(1) remedy selection statutory requirements. One of the factors that must be assessed includes the short-term effectiveness. Thus the submission of a Remedial Design by a date certain (EPA suggests 90 days after the ROD) will assist in ensuring that the selected remedy will be protective in the short term. As mentioned earlier, the NCP Preamble specifically addresses the long-term effectiveness factor that must be assessed under CERCLA section 121(b)(1). Institutional controls may be used to provide protection to human health and the environment and special precautions must be made to assure that the controls are reliable. Submission of the LUC Implementation Plan in the RD is required a primary document under the FFA, Section VIII. EPA would also agree to including LUC implementation items in the ROD, if the Army would prefer. However, to date, the Army has preferred to include them in the Remedial Design and/or Remedial Action Work Plan.

As such, the MMRP ROD for LHAAP-001-R and LHAAP-003-R must either include the LUC implementation items in the ROD or provide them as a LUC component of the Remedial Design or Remedial Action Workplan. Because the Army has historically provided these details in an enforceable remedial design, EPA has suggested the following: "A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 90 days of ROD signature, the Army shall prepare and submit to EPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections." EPA's suggested language, or similar language, is in every Federal agency ROD since 2004 (the initial year EPA issued the LUC Checklist) except those for the Air Force which includes LUC implementation components in the ROD.

The following EPA policies guide this issue as well:

EPA November 2010 Interim Final OSWER 9355.0-89 EPA-540-R-09-001, Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites: http://www.epa.gov/superfund/policy/ic/pdfs/PIME-IC-Guidance-Interim.pdf

EPA October 2006, Sample Federal Facility Land Use Control ROD Checklist with Suggested Language: http://www.epa.gov/fedfac/documents/icchecklist.pdf

EPA September 2000, OSWER 9355.0-74fs-p, Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups: http://www.epa.gov/superfund/policy/ic/guide/guide.pdf

Army Response

A. This issue in dispute is specific to the MMRP ROD. Although the Issue statement restricts the issue raised to whether it is appropriate to include a reference to the LUCs detailed in the MEC removal work plan, the first two paragraphs of the EPA Position statement also assert that a LUC RD is required by a date certain (suggested within 90 days of ROD issuance) or that the LUC implementation items be included in the MMRP ROD. The first paragraph of the EPA Position statement also discusses remedy selection criteria to which Army has previously responded.

B. Army's position is that the reference to the LUCs in the MEC removal work plan is appropriate. The work plan is referenced as a descriptive tool because it is where the existing LUCs can be found. It is background information.

C. The Final MMRP ROD submitted on September 29, 2011 specifically commits to the submission of a LUC Remedial Design.

> The details and description of the LUCs implementation and maintenance actions were presented in the LUC design and plan (EODT, 2008) associated with the 2008 removal action. Within 90 days of signing the ROD, the U.S. Army will prepare and submit the LUC RD to USEPA consistent with the schedule of Section XVI of the Federal Facility Agreement (FFA). The LUC RD will be the 2008 LUC design and plan revised to include the nonresidential LUC. The LUCs would be included in the property transfer documents and a recordation of the area of intrusive activity restriction would be filed in the Harrison County Courthouse.

MMRP ROD at 2-26.

D. Following a review of the FFA, and contrary to the suggestion in the Issue statement that the ROD include a date certain for submission of the LUC RD (suggested by EPA as 90-days after ROD signature), Section XVI.C of the FFA requires that within twenty-one days of ROD issuance the Army propose target dates for completion of the draft R/D Workplan, draft Remedial Design, and draft Remedial Action Work Plan. Therefore, the 90-day deadline in ***all*** RODs has been replaced with the following:

> A LUC Remedial Design will be finalized as the land use component of the Remedial Design. Within 21 days of the issuance of the Record of Decision, the Army will propose deadlines for completion of the Remedial Design Work Plan, Remedial Design and Remedial Action Work Plan. The documents will be prepared and submitted to EPA and TCEQ for Consultation pursuant to the FFA and the LUC remedial design that will contain implementation and maintenance actions, including periodic inspections.

E. There is no basis for EPA's claim that the inclusion of the LUC implementation details from the MEC removal work plan or reference to that plan is inappropriate for the MMRP ROD. There is no basis to conclude that the MMRP ROD does not adequately include the LUC implementation items in the ROD or require these as a LUC component of the remedial design or remedial action workplan. (*See* Paragraph C of Army Response to the Sixth Issue in Dispute.) There is no basis to conclude that reference to the MEC removal work plan constitutes a failure to meet the FFA requirements.

Eighth Issue in Dispute

Issue 8: The identification of principal threat wastes at the Site. It should be clear that any munitions and explosives of concern (MEC) found at the MMRP ROD sites in the future will be evaluated to determine if they constitute principal threat wastes.

EPA Position: The NCP, at 40 CFR 300.430(a)(1), establishes that EPA anticipated the use of treatment to address principal threats posed at CERCLA sites. The above NCP provision is consistent CERCLA's statutory preference to include treatment in selected remedial actions under CERCLA Section 121(b). EPA defines source material as material that act as a reservoir for migration of contamination to ground water, to surface water, to air, or acts as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. Because MEC has already been treated and removed from the MRS sites, it is clear that at least some of the MEC would have presented a significant risk to human health or the environment had exposure occurred. The EPA believes that the MEC removal report and investigations support the Agency's determination.

The Agency's determination is not only supported by the above statutory and regulatory authority cited herein, but also the Agency's policy titled "A Guide to Principal Threat and Low Level Threat Wastes" November 1991. CERCLA Section 120(a) and the FFA at Section XIX also require federal facilities to comply with the Agency's statutes, regulations, and policies concerning sites containing hazardous substances, and the selection of remedial actions to address releases of hazardous substances. In addition, the EPA's policy concerning munitions response actions ("EPA Munitions Response Guidelines, Interim Final" July 2010) provides a detailed analysis concerning response measures authorized under CERCLA at munitions sites. The EPA Munitions Response Guidelines also support the Agency determination to clarify the principal threat waste issue, as the characterization of wastes serves as a integral component in addressing CERCLA's statutory preference for utilizing treatment in selected remedial actions.

An example of addressing this issue for the MMRP ROD for LHAAP-001-R and LHAAP-003-R may include: “While all known MEC was removed from these two MRS sites, if any MEC is discovered at the sites in the future the MEC will be evaluated for its potential designation as a principal threat waste;" and removal of the statement, "There are no known principal threat wastes at these two MRS sites."

Army Response

A. This Issue statement pertains only to the MMRP ROD.

B. EPA agrees that the “MEC has already been treated and removed from the MRS sites.” Regardless of whether or not the treated and removed MEC did or did not constitute a principal threat waste, the removal action effectively addressed the threat that was posed by the waste.

C. The statement in the MMRP ROD that “[t]here are no known principal threat wastes at these two MRS sites” is factually correct and will not be removed.

D. The statement “[w]hile all known MEC was removed from these two MRS sites, if any MEC is discovered at the sites in the future the MEC will be evaluated for its potential designation as a principal threat waste” will not be added. Army does not agree that it is either appropriate or necessary that this ROD address hypothetical future discoveries of munitions at these sites. This ROD is a remedy selection decision for the MEC that was present and has been removed, including controls to mitigate or prevent any future exposure. If a future discovery should necessitate further response action by the Army, all necessary response actions will be carried out in compliance with CERCLA, the DERP statute, and the NCP, including addressing this issue as appropriate.

Attachment 1:

Issues of Dispute

C

Texas Administrative Code Currentness
Title 30. Environmental Quality
Part 1. Texas Commission on Environmental Quality
Chapter 335. Industrial Solid Waste and Municipal Hazardous Waste
Subchapter S. Risk Reduction Standards
→→ § 335.559. Medium Specific Requirements and Adjustments for Risk Reduction Standard Number 2

(a) Numeric cleanup levels. The subsections (b)-(h) of this section specify requirements that can define or modify numeric cleanup levels such as MSCs or require non-health based criteria to be addressed.

(b) Surface water. In determining the necessity for remediation at the facility, persons shall utilize Chapter 307 of this title (relating to Texas Surface Water Quality Standards) or, if those values are not available, Maximum Contaminant Levels (MCLs) promulgated under the Safe Drinking Water Act, or if MCLs are not available or appropriate, MSCs based upon human ingestion of the water. Any discharge or release into or adjacent to surface water, including storm water runoff, occurring during or after attainment of Risk Reduction Standard Number 2, shall be compliant with the Texas Surface Water Quality Standards of Chapter 307 of this title and may be subject to the permitting requirements of Chapter 305 of this title (relating to Consolidated Permits) or other authorization from the commission.

(c) Air. In determining the necessity for remediation at the facility, persons shall observe limitations established by the National Ambient Air Quality Standards (NAAQS) and the National Emission Standards for Hazardous Air Pollutants (NESHAPS) as found in the 40 Code of Federal Regulations (CFR) Parts 50 and 61, respectively, and other applicable federal standards and guidelines of the EPA. Also, limitations established by the commission under the Texas Clean Air Act, the state implementation plan or other federal requirements must be observed. Permit requirements, limitations established by standard exemptions, or other requirements of the commission relative to atmospheric emissions and/or air quality may also apply.

(d) Groundwater. The groundwater cleanup levels shall be determined by a consideration of the following.

(1) For residential exposure, the concentration of a contaminant dissolved in groundwater must not exceed the MCL, if promulgated pursuant the Federal Safe Drinking Water Act, § 141, otherwise the water MSC for ingestion determined pursuant to § 335.556 of this title (relating to Determination of Cleanup Levels for Risk Reduction Standard Number 2). Phase-separated non-aqueous liquids released from the unit that is undergoing closure or remediation must be removed or decontaminated.

(2) For nonresidential exposure, the concentration of a contaminant dissolved in groundwater must not exceed the MCL if promulgated pursuant to the Federal Safe Drinking Water Act, § 141. If no MCL has been promulgated, the groundwater concentration shall not exceed the water MSC for ingestion determined pursuant to § 335.556 of this title, which has been multiplied by a factor of 3.36 for carcinogens or 2.8 for systemic toxicants to account for lower ingestion rates associated with nonresidential worker exposure. Persons must be able to demonstrate that the quality of groundwater at the facility property boundary will be protective for residential exposure. Phase-separated non-aqueous liquids released from the unit that is undergoing closure or remediation must be removed or decontaminated to the extent practicable.

(3) For residential and non-residential exposure, if the groundwater at the facility or area has a naturally occurring background total dissolved solids concentration greater than 10,000 milligrams per liter, the cleanup level for a contaminant dissolved in this groundwater determined pursuant to paragraph (1) or (2) of this subsection, as appropriate, may be adjusted by multiplying by 100. The resulting value becomes the maximum concentration for groundwater for residential and non-residential exposure, respectively.

(4) The executive director may require the evaluation of additional exposure pathways or environmental receptors as part of the adjustment of

paragraph (3) of this subsection.

(e) Soil. For all situations, concentrations of contaminants in soils must be protective of surface water, air, and groundwater as specified in subsections (b)-(d) of this section. No soil remaining in place shall exhibit the hazardous waste characteristics of ignitability, corrosivity, or reactivity as defined in 40 CFR Part 261, Subpart C. The sum of concentrations of the volatile organic compounds in vapor phase in soil shall not exceed 1,000 parts per million by weight or volume, as measured by EPA Test Method 8015 or calculated by using soil concentrations and Henry's Law constants.

(f) Residential soil requirements. In addition to the requirements of subsection (e) of this section, the concentration of a contaminant throughout the soil column (i.e., surface and subsurface soils) shall not exceed the lower of the soil MSC, based upon residential human ingestion of soil and inhalation of particulates and volatiles (as defined in the preceeding section), and the residential soil-to-groundwater cross-media protection concentration, a numeric value which is determined as follows:

(1) a value which is 100 times the residential groundwater cleanup level determined by the procedures of subsection (d)(1) of this section. Examples of such values are listed in Appendix II; or

(2) a concentration in soil that does not produce a leachate in excess of MCLs or MSCs for groundwater when subjected to the Synthetic Precipitation Leaching Procedure, Method 1312 of SW 846, Test Methods for Evaluating Solid Waste, United States Environmental Protection Agency. Other test methods that more accurately simulate conditions at the facility may be used in the demonstration in place of this method, subject to prior approval of the executive director.

(g) Nonresidential soil requirements. Nonresidential soils shall conform to the requirements of subsection (e) of this section. The concentration of a contaminant in near-surface soils (i.e., within two feet of the land surface) shall not exceed the lower of the nonresidential soil MSC defined in paragraph (1) of this subsection, based upon worker ingestion of soil and inhalation of particulates and volatiles, and the nonresidential soil-to-groundwater cross-media protection concentration deficned in paragraph (2) of this subsection. In no event shall compliance be achieved with the surface soil criteria by applying two feet of clean soil onto the surface of a facility or area without prior approval from the executive director. The concentration of a contaminant in subsurface soils (i.e., greater than two feet in depth from the land surface) shall not exceed the nonresidential soil-to-groundwater cross-media protection concentration.

(1) Nonresidential soil MSC. The MSC is calculated using the equations and factors listed in subparagraphs (A) and (B) of this paragraph. The chemical-specific factors SF_o, SF_i, RfD_o, RfD_i, and VF are the same as for the soil MSCs of the preceding section. The derivation of all equations is presented in Appendix I.

(A) Carcinogenic effects equation, in units of milligram per kilogram (mg/kg):

$$MSC = \frac{286.16\ (TR)\ mg/kg}{[((5 \times 10^{-5}) \times SF_o) + (Sf_i \times [(20/VF) + (4.3 \times 10^{-9})])]}$$

(B) Systemic toxicant effects equation, in units of milligram per kilogram (mg/kg):

$$MSC = \frac{102.2\ mg/kg}{[(5\times 10^{-5}/RfD_o) + ((1/RfD_i) \times [(20/VF) + (4.3 \times 10^{-9})])]}$$

(2) Non-residential soil-to-ground water cross-media protection concentration. Persons must demonstrate that a contaminant in soil does not pose the potential for a future release of leachate in excess of the groundwater concentration considered to be protective for nonresidential worker exposure. Persons may make this demonstration by showing that a contaminant occurs in soil at less than the concentration described in either subparagraph (A) or (B) of this paragraph:

(A) a concentration which is 100 times the nonresidential groundwater cleanup level determined by the procedures of subsection (d)(2) or (3), as applicable, of this section.

(B) a concentration in soil that does not produce a leachate in excess of the ground-water concentration of this paragraph when subjected to the Synthetic Precipitation Leaching Procedure, Method 1312 of SW 846, Test Methods for Evaluating Solid Waste, U. S. Environmental Protection Agency. Other test methods that more accurately simulate conditions at the facility may be used in the demonstration in place of this method, subject to prior approval by the executive director.

(h) Other criteria. For contaminants that do not exceed standards or criteria protective of human health and environmental receptors as determined by the procedures of this section but otherwise adversely impact environmental quality, or the public welfare and safety, or present objectionable characteristics (e.g., taste, odor, etc.), or make a natural resource unfit for use, other scientifically valid published criteria may be utilized such as but not limited to threshold limit values for air and secondary maximum contaminant levels for water.

Source: The provisions of this § 335.559 adopted to be effective June 28, 1993, 18 TexReg 3814; amended to be effective November 15, 2001, 26 TexReg 9135.

30 TAC § 335.559, 30 TX ADC § 335.559

Current through October 31, 2011

END OF DOCUMENT

No Proposed Regulatory history references were found for your request.

Attachment 2:

Issues of Dispute

00113220

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

October 24, 2011

Ms. Rose Zeiler
Army / BRAC Site Manager
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final ROD
LHAAP-16: Old Landfill
Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas

Dear Ms. Zeiler:

The Texas Commission on Environmental Quality (TCEQ) has completed its review of the *Draft Final ROD for LHAAP-16, Old Landfill* submitted on September 29, 2011. We generally concur with the changes. However, we do not concur with your response to our previous comment regarding the frequency of the long term monitoring.

Long term monitoring requirements pertaining to surface water and groundwater sampling are specified in Section 2.9.1 and Section 2.12.1. In general, sampling will be conducted semi-annually for three years, annually until the next five-year review and every five years thereafter. We believe that the reduced monitoring frequency to every five year is unsupported at this time. The reduced monitoring frequency should be based on data collected and analyzed and changes in monitoring frequency can be recommended and incorporated in the five-year review.

If you have any questions or need additional information, please feel free to contact me at (512) 239-2443.

Sincerely,

Fay Duke, Project Manager
Team 2, Superfund Section
Remediation Division

FD/cw

cc: Mr. Stephen L. Tzhone, U. S. Environmental Protection Agency Region 6, Dallas, TX

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

October 24, 2011

Ms. Rose Zeiler
Army / BRAC Site Manager
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final ROD
LHAAP-17: No. 2 Flashing Area Burning Ground
Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas

Dear Ms. Zeiler:

The Texas Commission on Environmental Quality (TCEQ) has completed its review of the *Draft Final ROD for LHAAP-17: No. 2 Flashing Area Burning Ground* submitted on September 29, 2011. We have the following comment:

Long term monitoring requirements pertaining to groundwater sampling are specified in Section 12.12.1. In general, sampling will be conducted semi-annually for three years, annually until the next five-year review and every five years thereafter. We believe that the reduced monitoring frequency to every five years is unsupported at this time. The reduced monitoring frequency should be based on data collected and analyzed and changes in monitoring frequency can be recommended and incorporated in the five-year review.

If you have any questions or need additional information, please feel free to contact me at (512) 239-2443.

Sincerely,

Fay Duke, Project Manager
Team 2, Superfund Section
Remediation Division

FD/cw

cc: Mr. Stephen L. Tzhone, U. S. Environmental Protection Agency Region 6, Dallas, TX

00113222

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

October 24, 2011

Ms. Rose Zeiler
Army / BRAC Site Manager
Longhorn Army Ammunition Plant
Post Office Box 220
Ratcliff, AR 72951

Re: Comments on Draft Final MMRP Record of Decision (ROD)
LHAAP-001-R South Test Area/Bomb Test Area
LHAAP-003-R Ground Signal Test Area
Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas

Dear Ms. Zeiler:

The Texas Commission on Environmental Quality (TCEQ) has completed its review of the evaluations of the *Draft Final MMRP ROD (LHAAP-001-R South Test Area/Bomb Test Area, LHAAP-003-R Ground Signal Test Area)* submitted on September 27, 2011. We concur with the changes and have no further comments.

If you have any questions or need additional information, please feel free to contact me at (512) 239-2443.

Sincerely,

Fay Duke, Project Manager
Team 2, Superfund Section
Remediation Division

FD/cw

cc: Mr. Stephen L. Tzhone, U. S. Environmental Protection Agency Region 6, Dallas, TX

Attachment 3:

Issues of Dispute

00113224

10/24

C

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 24 2003

THE ADMINISTRATOR

Raymond F. Dubois
Deputy Under Secretary of Defense (Installations and Environment)
3000 Defense Pentagon
Washington, D.C. 20301-3000

Dear Mr. Dubois,

Thank you for your letter of October 2, 2003, in which you stated support for two approaches for Superfund post-Record of Decision (ROD) project management: one based upon Navy Principles, which we support and were developed in collaboration with my Agency, and another based upon the Air Force performance-based Principles. Our Headquarters and Regional offices will work together to ensure that both approaches, when offered to us, receive full consideration.

As you indicated, our two organizations have worked very hard over the previous months to establish a collaborative path forward on Superfund cleanup activities. We look forward to this new opportunity to partner with the Services to implement these approaches.

Sincerely,

Marianne L. Horinko

Marianne Lamont Horinko
Acting Administrator

Printed on Recycled Paper

00113225

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

OCT 2 - 2003

Honorable Marianne Lamont Horinko
Acting Administrator
U.S. Environmental Protection Agency
Ariel Rios Building, Mail Code 5101
Washington, DC 20460

Dear ~~Ms. Horinko~~ Marianne,

The Environmental Protection Agency (EPA) and the Department of Defense have worked hard over the previous months to resolve the issue of our respective agencies roles in Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) response actions. We appreciate your Agency's commitment to this dialogue. As we have discussed, I have determined that my office will support the two Department of Defense approaches enclosed: (a) an approach based on the Navy Principles; and (b) an approach based on the Air Force Principles. My office will fully support our components in either approach, to further accomplishment of the President's Management Agenda by replacing an "emphasis on process" with a "focus on results."

I understand that EPA fully supports the Navy Principles, but that the Agency, at this time, may have reservations over the Air Force approach. As we have discussed, however, I understand that EPA headquarters, though exercising appropriate policy supervision, will neither require nor forbid the Regions from negotiating on the basis of either approach. It is our hope that this dual-track, interim approach can lead to improvements in the administration of both our programs and in the protection of the environment.

Again, let me express my sincere appreciation for your Agency's constructive approach to this complex and important issue.

Sincerely,

Ray

Raymond F. DuBois
Deputy Under Secretary of Defense
(Installations and Environment)

Enclosures

PRINCIPLES AND PROCEDURES FOR SPECIFYING, MONITORING AND ENFORCEMENT OF LAND USE CONTROLS AND OTHER POST-ROD ACTIONS

PREAMBLE

Since the Department of Defense (DoD) /Environmental Protection Agency (EPA) Model Interagency Agreement (IAG)/Federal Facility Agreement (FFA) was developed in 1988, EPA and Navy have gained considerable knowledge and understanding about post-Records of Decisions (ROD) activities, especially Land Use Controls (LUCs). Thinking, policies, regulations and procedures concerning LUCs have evolved considerably since DoD and EPA developed the 1988 FFA model language. New statutes and regulations related to LUCs are being considered in many states. Accordingly, EPA and the Department of the Navy (DON) believe that a set of Principles will assist Navy field commands and EPA Regions to better implement our respective Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) responsibilities. The Principles described below do not replace or substitute for any existing CERCLA statutory or regulatory requirement. Rather they provide a mutually agreeable framework to provide a more efficient process to implement LUCs at National Priority List (NPL) installations.

These Principles will guide the EPA and DON personnel involved in these decisions. They are written in full knowledge that state regulatory and trustee organizations have independent responsibilities and authorities. EPA and the DON recognize the importance of the state role in helping to ensure a cleanup is protective of human health and the environment. Headquarters EPA and DoD will jointly develop a communications plan to ensure we include the states in this important issue.

These Principles support the President's Management Agenda by focusing on improving environmental results. The Principles encourage continued innovation and improvement in CERCLA implementation. EPA and the Components should continue to propose and pilot initiatives at Component installations or at other properties for which they are responsible. This includes proposing variations in, or alternatives such as performance-based practices to, the approach described in this document.

PRINCIPLES

- At sites where remedial action is determined necessary to protect human health and the environment, the actions must be documented in accordance with CERCLA and its implementing regulation, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

- At sites where contaminants are left in place at levels that do not allow for unrestricted use, LUCs are used to ensure that the contaminants do not pose an unacceptable risk to human health or the environment. LUCs consist of engineering controls and/or institutional controls.

- The EPA and DON desire to ensure that LUCs are specified, implemented, monitored, reported on, and enforced in an efficient, cost-effective manner that ensures long-term protectiveness. In addition, in accordance with CERCLA and the NCP, if an equally protective but more cost-effective remedy is identified, DON may propose, and EPA will consider, using the more cost-effective remedy.

- The EPA acknowledges the DON's role and responsibilities as the Federal Lead Agent for response actions. This role includes selecting remedies with EPA at NPL sites and funding response actions.

- The DON acknowledges EPA's role and responsibilities for regulatory oversight and enforcement at NPL sites. This role includes ultimate ability to select the remedy at NPL sites if EPA disagrees with DON's proposed remedy and dispute resolution fails.

- Federal Facilities Agreements (FFAs) are CERCLA 120 agreements used by DON and EPA to describe in detail the roles and relationships among DON, EPA and often the state. They form the foundation for these relationships regarding DON's response actions at NPL sites. FFAs also contain installation specific details and procedures for planning, budgeting, and dispute resolution. DON and EPA desire FFAs to be as standardized as possible and relatively <u>static</u> (i.e., the FFA should not need to be changed for a given installation).

- Primary Documents developed under the FFA are relatively <u>dynamic</u> and document important plans and actions. In that sense, they are action-oriented. For example, a Site Management Plan is revised yearly via collaboration among DON and EPA remedial project managers and is an important tool for planning response actions and demonstrating commitment to the public. Likewise, a LUC Remedial Design (RD) or Remedial Action Work Plan (RAWP) describes those actions that are needed to ensure viability of both long-term engineered and institutional control remedies.

- Records of Decision should document the remedy selection process and remedy decision in accordance with CERCLA and the NCP, as well as applicable and appropriate guidance, regulations, standards, criteria, and policy. With regard to LUCs, the ROD should describe the LUC objectives; explain why and for what purpose the LUCs are necessary, where they will be necessary, and the entities responsible for implementing, monitoring, reporting on and enforcing the LUCs. The ROD will refer to the RD or RAWP for implementation actions.

- Where situations arise (such as new cleanup standards; new or additional contamination is discovered on a site, etc.) that require additional response actions that go beyond the actions and objectives described in a ROD, and any related ROD Amendment or Explanation of Significant Difference (ESD), the additional actions required and their remedial objectives will be further documented in an ESD or ROD Amendment, as appropriate. There may also arise situations after a remedy has been completed that require removal actions to protect human health and the environment, such as the newly discovered contamination posing an imminent risk to human health. In such circumstances, documentation as required in the removal process should be created.

- Given the above, EPA and DON agree that the most efficient framework for specifying, implementing, monitoring, reporting on and enforcing LUCs is:
  - a standard FFA for NPL sites,
  - a clear, concise RoD with LUC objectives, and
  - a RD or RAWP with LUC implementation actions.

Note: These documents are described more fully below.

- EPA and DON will move expeditiously to finalize all outstanding FFAs using a standard FFA template as a guide to minimize the development/writing process.

Note: A "standard FFA" means the Agreement presently being used between EPA and DoD using the DoD-EPA model language, plus site-specific statements of fact, plus the additional primary document shown in Attachment (1).

- EPA and DoD will initiate a task force with appropriate headquarters and field representatives from EPA and the military services. The task force will make recommendations as to how to ensure that the same documentation can be used to memorialize both remedial action completion and deletion, as well as to determine the process whereby DoD and EPA will document the completion of the remedial actions required by the ROD in a single primary document. The task force will examine ways to reduce document size, review time, and revisions. The task force will recommend changes to guidance and policy that will help reduce document size or streamline the process in order to manage costs. The task force may also include other stakeholders.

After reviewing the task force recommendations EPA and DoD will determine how to ensure that the same documentation can be used to memorialize both remedial action completion and deletion, as well as to determine the process whereby DoD and EPA will document the completion of the remedial actions required by the ROD in a single primary document. In addition, EPA and DoD will streamline the remedial process and better manage costs. While the efforts of the Task Force are meant to complement the Principles described above, its work is separate from the Principles and must not impede their implementation. The work of the Task Force also must not impede completion or closeout of individual sites or operable units.

GENERAL PROCEDURES

1. Federal Facility Agreement

- The LUC implementation and operation/maintenance actions will be included in the RD or RAWP which are already primary documents deliverable under standard FFAs. In addition, the same documentation as determined by the task force and approved by the Parties to memorialize both the remedial action completion and deletion will be provided as a primary document for new FFAs. For existing FFAs without such a primary document, this document will be provided as an attachment to the RD or RAWP with the same enforceability as a primary document.

Note: Model FFA language will need to be supplemented to reflect these Principles and Procedures. Attachment (1) contains necessary modifications to FFA language.

2. Record of Decision

- It is EPA's and DON's intent that Records of Decision (RoDs) continue to be consistent with CERCLA and the National Contingency Plan. Relative to land use controls and institutional controls, the ROD shall:
  - Describe the risk(s) necessitating the remedy including LUCs;
  - Document risk exposure assumptions and reasonably anticipated land uses;
  - Generally describe the LUC, the logic for its selection and any related deed restrictions/notifications;
  - State the *LUC performance objectives*. (See attachment (2) for examples of

LUC performance objectives);
- List the parties responsible for implementing, monitoring, reporting on, and enforcement of the LUC;
- Provide a description of the area/property covered by the LUC (should include a map);
- Provide the expected duration of the LUCs; and
- Refer to the RD or RAWP for LUC *implementation actions,* since these details may need to be adjusted periodically based on site conditions and other factors. (See attachment (2) for examples of LUC implementation actions).

- The ROD at transferring properties will need to be crafted based on the responsibilities of the new owner and state-specific laws and regulations regarding LUCs. At transferring properties, compliance with the LUC performance objectives may involve actions by the subsequent owners in accordance with deed restrictions, however, ultimate responsibility for assuring that the objectives are met remains with DON as the party responsible under CERCLA for the remedy. DON and regulators will consult to determine appropriate enforcement actions should there be a failure of a LUC objective at a transferred property.

3. <u>LUC Remedial Design (RD) or Remedial Action Work Plan (RAWP)</u>

- The RD or RAWP will be provided as a primary document in accordance with the FFA.
- The RD or RAWP will describe short and long-term implementation actions and responsibilities for the actions in order to ensure long-term viability of the remedy which may include both LUCs (e.g., institutional controls) and an engineered portion (e.g., landfill caps, treatment systems) of the remedy. The term "implementation actions" includes all actions to implement, operate, maintain, and enforce the remedy. Depending on the LUC and site conditions, these actions can include:
- Conducting CERCLA five-year remedy reviews for the engineered remedies and/or LUCs.
- Conducting periodic monitoring or visual inspections of LUCs; frequency to be determined by site-specific conditions.
- Reporting inspection results.
- Notifying regulators prior to any changes in the risk, remedy or land use including any LUC failures with proposed corrective action.
- Including a map of the site where LUCs are to be implemented.

For active bases,

- Developing internal-DON policies and procedures with respect to LUC monitoring, reporting, and enforcement in order to institutionalize LUC management and to ensure base personnel are aware of restrictions and precautions that should be taken; Consulting with EPA at least 14 days prior to making any changes to these policies and procedures to ensure that any substantive changes maintain a remedy that is protective of human health and the environment.
- Developing a comprehensive list of LUCs with associated boundaries and expected durations.
- Notifying regulators of planned property conveyance, including federal-to-federal transfers. "Property conveyance" includes conveying leaseholds, easements and other partial interests in real property.
- Obtaining regulator concurrence before modifying or terminating land use control objectives or implementation actions.

For closing bases/excess property:

- Notifying regulators of planned property conveyance, including federal-to-federal transfers.
- Consulting with EPA on the appropriate wording for land use restrictions and providing a copy of the wording from the executed deed.
- Defining responsibilities of the DON, the new property owner and state/local government agencies with respect to LUC implementation, monitoring, reporting, and enforcement.
- Providing a comprehensive list of LUCs with associated boundaries and expected durations.
- Obtaining regulator concurrence before modifying or terminating land use control objectives or implementation actions.

Note: The mix of responsibilities among DON, the new property owner, and other government agencies depends on state and federal laws and regulations that are applied in the state. Implementation actions at closing bases may include elements characteristic of both active and closing bases, depending on the timing of transfer.

- Should there be a failure to complete LUC implementation actions at an active base, the EPA Region shall notify the installation and seek immediate action. Should there be a failure to complete LUC actions after such notification to the base, EPA may notify the Deputy Assistant Secretary of the Navy (Environment) who will ensure that LUC actions are taken.

- Should there be a failure to complete implementation actions that are the responsibility of a subsequent owner or third party at a transferred property, EPA and DON will consult on the appropriate enforcement action. Should there be a failure to complete implementation actions that are the remaining responsibility of DON at a transferred property, the EPA Region will notify the cognizant Navy Engineering Field Division. If necessary, EPA may notify the Deputy Assistant Secretary of the Navy (Environment) who will ensure that corrective action is taken.

Note: The RD or RAWP should contain no more or no less implementation actions than needed to ensure the viability of the remedy. There is a delicate balance required. EPA and DON both desire to ensure protectiveness while minimizing process and documents. The parties agree to work diligently to define the appropriate implementation actions for each LUC. EPA and DON believe the key elements can be easily developed between RPMs in a matter of a few hours. Based on detailed discussions and the examples shown in Attachment (2), EPA and DON expect that the LUC portion of the RDs or RAWPs to be in the range of 2-6 pages. If combined with a sampling plan, there may be additional pages needed to list the analyses, sampling locations and frequencies.

4. LUC Data

- The DON will ensure that all LUCs at its installations are included in the Service LUC database.

Attachments:
1. Incorporating Land Use Control (LUC) Objectives and Implementing Actions into Federal Facilities Agreements (FFAs)
2. Examples of LUC objectives and LUC Implementation Actions

Attachment 1

INCORPORATING LAND USE CONTROL (LUC) OBJECTIVES AND IMPLEMENTATION ACTIONS INTO FEDERAL FACILITIES AGREEMENTS (FFAs)

FFA Model Template Additions/Changes

1. Definitions Section:

Add: "Land use controls" shall mean any restriction or administrative action, including engineering and institutional controls, arising from the need to reduce risk to human health and the environment.

2. Primary Documents:

Add: A document memorializing remedial action completion.

Note: EPA and DoD believe it is important that a primary document: (1) document the completion of remedy-in-place and/or site close-out and (2) receive concurrence from EPA. The task force discussed above will make recommendations on the scope and content of the document, and DoD and EPA will determine this document after reviewing the task force recommendations. In the meantime, EPA and DON shall enter into FFAs which include a primary document memorializing remedy completion. The document shall not duplicate information in the Administrative Record or previously provided to EPA. Previously provided information shall be referenced and itemized. New information/data (e.g., sampling data) may be needed to demonstrate that the Remedial Action Objectives have been met. The report shall also include any as-built drawings for remedies if different from the remedial design. EPA and DoD do not envision this to be a lengthy document, but shall contain only the information needed to justify the remedy completion. EPA and DoD believe the document should discuss how the remedial objectives in the ROD have been met. It should not be used to expand the scope of requirements beyond the remedial actions required in the original ROD or any subsequent amendment or explanation of significant difference. Instead, if new requirements are needed for a protective remedy, these will be documented in an Explanation of Significant Difference or ROD Amendment, as appropriate, prior to reaching the milestone. The EPA and DoD will determine the precise nature of this document after reviewing the task force's recommendations.

Change: Eliminate the sub-bullets (subsidiary documents) under remedial action work plan for document streamlining purposes.

Attachment 2

EXAMPLES OF LUC OBJECTIVES AND LUC IMPLEMENTATION ACTIONS

(Note: Actions are to be tailored to site-specific conditions.
This is neither a mandatory nor a complete list)

LUC OBJECTIVES (contained in ROD)

- Ensure no construction on, excavation of, or breaching of the landfill cap.
- Ensure no residential use or residential development of the property.
- Ensure no withdrawal and/or use of groundwater.
- Ensure no excavation of soils without a use permit and special handling procedures.

LUC IMPLEMENTATION ACTIONS (contained in the RD or RAWP)

- Conduct a CERCLA five-year remedy review of the LUC and provide to EPA for review.
- Conduct annual inspections of the LUC and report results (active or BRAC – responsible party to be defined).
- Record the LUC in the base master plan. (active)
- Produce a survey plat of the LUC by a state registered land surveyor. (active or BRAC).
- File the survey plat with the local government/Circuit Court for purposes of public notification (active or BRAC)
- Place a survey plat in CERCLA administrative record, and send copies to EPA and state. (active or BRAC).
- Develop and implement a base procedure that requires excavation to be approved by the Public Works Officer or equivalent official. (active)
- Develop and implement a base procedure that requires changes in land use to be approved by the Public Works Officer or equivalent official. (active)
- Notify the regulatory agencies 45 days in advance of any Base proposals for a major land use change at a site inconsistent with the use restrictions and exposure assumptions described in the RoD, any anticipated action that may disrupt the effectiveness of the land use controls, any action that might alter or negate the need for the land use controls, or any anticipated transfer of the property subject to the land use controls.
- Obtain regulator concurrence before modifying or terminating land use control objectives or implementation actions.
- Maintain a comprehensive list of LUCs with associated boundaries and expected durations.

Note: These examples are consistent with draft EPA guidance: "Describing Institutional Controls in Remedy Decision Documents at Active Federal Facilities".

00113235

PRINCIPLES OF AGREEMENT FOR PERFORMANCE-BASED RECORDS OF DECISION IN ENVIRONMENTAL RESTORATION

1. *The President's Management Agenda* clearly directs federal agencies to reform their activities to prioritize performance and results so that "emphasis on process will be replaced by a focus on results." Thus the focus of the Air Force's (AF) environmental restoration program is to select, implement, maintain, and where necessary review and monitor remedial action results that protect human health and the environment. EPA has joint responsibility with the AF to select the remedy at National Priority List (NPL) facilities, and an interest in confirming that such remedies remain in place and continue to be protective. The actions of both agencies should reflect the President's direction to restore freedom to manage to responsible agencies, eliminating excessive command and control, approval mechanisms and red tape that hinder efficiency.

2. Records of Decision (RODs) are public documents that should direct: (i) remedy implementation based on performance needed to achieve remedial objectives, (ii) notification and dialogue among parties, (iii) reasonable access to sites for performance verification, and (iv) accountability for performance on the part of the AF.

3. The AF has the responsibility and obligation to carry out the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and National Contingency Plan (NCP) requirements as it implements, maintains, and where necessary reviews and monitors protective remedies needed to achieve remedial objectives.

4. Restoration resources in the form of time, money and personnel should be focused on defining remedial objectives (i.e., results) and the essential actions required to achieve those objectives. Such objectives and essential actions are enforceable requirements of the ROD under CERCLA and the NCP.

   a. The ROD should be streamlined to contain remedial objectives, essential implementation and maintenance actions to achieve the objectives, and other content elements required by CERCLA and the NCP. These performance objectives in the ROD, supported by the "essential actions" taken to meet them, are enforceable requirements of the remedy.

   b. The Air Force must still determine the detailed steps to take to carry out actions that achieve remedial objectives. This can include, as appropriate, O&M plans or detailed implementation plans; the details of such documents will be shared with regulators for review and comment, but are not subject to additional EPA approval and enforcement beyond that applied to the ROD, subject to Section 8 below.

   c. The ROD should not require new or further deliverables and documents, or contain repetitive information, and should use cross-references, existing data, templates, and remedy selection assumptions wherever it makes sense and is cost-effective to do so.

5. The Air Force will be held accountable to achieve the remedial objectives and essential actions identified in the ROD. This means being prepared for enforcement action should the Air Force fail to perform its essential responsibilities.

a. The Air Force remains subject to CERCLA enforcement mechanisms by EPA, states, and citizens if it fails to implement and maintain a protective remedy, such as, but not limited to, citizen suits, civil penalties, etc.

b. The Air Force remains subject to stipulated penalty provisions where existing Federal Facilities Agreements (FFAs) identify RODs as "primary documents."

6. The Air Force will agree to provide essential information to EPA, states and the public regarding the status of achieving performance objectives and essential actions identified in the ROD. EPA and states can independently verify such information through reasonable access to documents and facilities. Depending on site-specific risk factors that may warrant a change in reporting frequency, the expectation is that an annual summary report will be appropriate, supplemented by additional prompt reporting of any remedy deficiency or failure that presents or could imminently lead to an actual risk to human health and the environment, and the actions taken or planned to address and correct such deficiency or failure. Such limited monitoring and reporting, as described here, is an exception to the prohibition on post-ROD implementation measures reflected in the 23 Jan 2002 Air Force Policy and Guidance on Remedy Selection Documentation in Records of Decision (RODs).

7. Because "success" and "compliance" will be defined in terms of achieving performance objectives and essential actions, rather than meeting document exchange deadlines, Air Force personnel must foster and maintain dialogues with the regulators, particularly concerning technical implementation issues. Work plans or other technical documents that are not independently enforceable or subject to regulator approval should nonetheless undergo review by all parties to ensure compatibility with ultimate remedial objectives. The failure to do so will increase the likelihood of a legitimate challenge by the regulators and the public as to whether remedial action objectives in fact are being achieved (or have been achieved, if a closeout determination is at issue).

8. Integration of Performance-Based Response Actions with existing FFAs and RODs:

a. The process improvements developed as part of the Air Force performance-based principles do not change obligations under existing FFAs or RODs. However, parties to existing FFAs may amend them or interpret them to incorporate these performance-based actions and improvements.

b. If an existing FFA already addresses implementation, O&M plans, or completion and review provisions (e.g., identifies an O&M plan as a "primary" document"), then such documents should conform to the enforceable objectives and actions contained in the ROD.

c. The Air Force should update the ROD as necessary to protect human health and the environment in conformance with Section 300.435 of the National Contingency Plan (i.e. perform a ROD amendment for fundamental changes, or an Explanation of Significant Difference (ESD) for significant changes, or record non-significant or minor changes in the post-ROD site file). If the Air Force finds that such an update is necessary, it should be done in accordance with the approach defined by these principles. In particular, if hazardous substances are left in place above unlimited use and unrestricted exposure levels, the 5-year review affords the Air Force an opportunity to confirm the conclusions in an existing ROD or to update the ROD if differences significantly or fundamentally alter the basic features of the selected remedy with respect to scope, performance or cost.

d. The Air Force shall incorporate these principles both in negotiating future Interagency Agreements and in modifying existing FFAs.

00113238

DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

November 17, 2011

DAIM-ODB-LO

Ms. Fay Duke (MC-136)
SSDAT/Superfund Section
Remediation Division
Texas Commission on Environmental Quality
12100 Park 35 Circle, Bldg D
Austin, TX 78753

Re: Responses to TCEQ Comments on Draft Final RODs for LHAAP-16, LHAAP-17, Longhorn Army Ammunition Plant, Karnack, Texas

Dear Ms. Duke,

Enclosed are responses to TCEQ's October 24, 2011 comments on the September 29, 2011 Draft Final RODs for LHAAP-16 and LHAAP-17. Hard copies of the Draft Finals RODs are being transmitted under separate cover.

The point of contact for this action is the undersigned. I may be contacted at 479-635-0110, or by email at rose.zeiler@us.army.mil.

Sincerely,

Rose M. Zeiler

Rose M. Zeiler, Ph.D.
Longhorn AAP Site Manager

Copies furnished:
Steve Tzhone, EPA Region 6
Two Enclosures

Longhorn Army Ammunition Plant Response to TCEQ Comment dated October 24, 2011 LHAAP-16 Draft Final ROD (29 SEP 2011)

1. Long term monitoring requirements pertaining to surface water and groundwater sampling are specified in Section 2.9.1 and Section 2.12.1. In general, sampling will be conducted semi-annually for three years, annually until the next five-year review and every five years thereafter. We believe that the reduced monitoring frequency to every five year is unsupported at this time. The reduced monitoring frequency should be based on data collected and analyzed and changes in monitoring frequency can be recommended and incorporated in the five-year review.

   Army Response: Concur. The text will be revised to indicate that sampling will be conducted semi-annually for three years and annually thereafter until recommended otherwise by the five-year review.

Longhorn Army Ammunition Plant Response to TCEQ Comment dated October 24, 2011 LHAAP-17 Draft Final ROD (29 SEP 2011)

1. Long term monitoring requirements pertaining to groundwater sampling are specified in Section 12.12.1. In general, sampling will be conducted semi-annually for three years, annually until the next five-year review and every five years thereafter. We believe that the reduced monitoring frequency to every five years is unsupported at this time. The reduced monitoring frequency should be based on data collected and analyzed and changes in monitoring frequency can be recommended and incorporated in the five-year review.

   Army Response: Concur. The text will be revised to indicate that sampling will be conducted semi-annually for three years and annually thereafter until recommended otherwise by the five-year review.

To:
Cc:
Bcc:
Subject: Fw: Agenda

LONGHORN DISPUTE RESOLUTION COMMITTEE (DRC) AGENDA

November 30, 2011

I. Sign-In and Introduction

II. Issues in Dispute/Discussion

#1 (Perchlorate ground water standard);
#2 (LUC objective);
#3 (LUC duration);
#4 (remedy selection authority and modification authority);
#5 (LHAAP - 16 - landfill post-closure ARAR leachate collection system and leak detection system);
#6 (LUCs administrative mechanism);
#7 (MRS Sites LUC Remedial Design); and
#8 (MEC and principal threat waste).

III. Proposed Resolutions

IV. Next Steps and the Federal Facility Agreement

V. Conclusion

00113242

To:
Cc:
Bcc:
Subject: Longhorn sign-in sheet
From: George Malone/R6/USEPA/US - Wednesday 11/30/2011 10:04 AM

LONGHORN DISPUTE RESOLUTION COMMITTEE (DRC) MEETING SIGN-IN SHEET

November 30, 2011

NAME	ORGANIZATION AND CONTACT INFO
1. Samuel Coleman	6SF Coleman.sam@epa.gov 214.665.6701
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7. Tom LEDERLE	Army BRAC thomas.lederle@us.army.mil 703 5452488
8. Rose M. Zeiler	Longhorn AAP Site Mgr-rose.zeiler@us.army.mil 479 635 [illegible]
9. Don Williams	6SF williams.donald@epa.gov (214)665-2197
10. Fay Duke	TCEQ fay.duke@tceq.texas.gov 512-239-2444
11. Cullen McMorrow, TCEQ,	cullen.mcmorrow@tceq.texas.gov 512-239-0607
12.	
13.	

see back

14.

15.

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17.

18.

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20.

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 335	INDUSTRIAL SOLID WASTE AND MUNICIPAL HAZARDOUS WASTE
SUBCHAPTER S	RISK REDUCTION STANDARDS
RULE §335.565	**Post-Closure Care Required for Risk Reduction Standard Number 3**

In cases under Risk Reduction Standard Number 3 where the executive director determines that either engineering or institutional control measures are required to protect human health and the environment, the person shall comply with the requirements of paragraphs (1) and (2) of this section, as applicable, and deed record the facility in accordance with §335.566 of this title (relating to Deed Recordation for Risk Reduction Standard Number 3):

(1) carry out the post-closure requirements as evaluated and approved by the remedy evaluation process described in §335.562 of this title (relating to Remedy Evaluation Factors);

(2) for hazardous waste storage, processing, or disposal facilities, the person must also satisfy the applicable requirements of Subchapter E and F of this chapter (relating to Interim Standards for Hazardous Waste Storage, Processing, or Disposal Facilities; and Permitting Standards for Owners and Operators of Hazardous Waste Storage, Processing, or Disposal Facilities, respectively).

Source Note: The provisions of this §335.565 adopted to be effective June 28, 1993, 18 TexReg 3814.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 26 2009

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

**OSWER Directive
9283.1-33**

MEMORANDUM

SUBJECT: Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration

FROM: James E. Woolford, Director
Office of Superfund Remediation and Technology Innovation

John E. Reeder, Director
Federal Facilities Restoration and Reuse Office

TO: Superfund National Policy Managers, Regions 1 - 10

Purpose

The mission of the Superfund program is to protect human health and the environment, consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA),[1] as implemented by the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), in part by restoring contaminated groundwaters to beneficial use. The purpose of this memorandum is to provide a compilation of some key existing EPA groundwater policies to assist EPA Regions in making groundwater restoration decisions pursuant to CERCLA and the NCP. In addition, by providing this information in a single document, it may serve to enhance the transparency and understanding, by the public, state regulators and others, of EPA's clean up decisions related to groundwater.[2]

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[1] This document provides guidance to Regional staff regarding how the Agency intends to interpret and implement the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) which provides the blueprint for CERCLA implementation. However, this document does not substitute for those provisions or regulations, nor is it a regulation itself. Thus it cannot impose legally binding requirements on EPA, states, or the regulated community, and may not apply to a particular situation based upon the circumstances. Any decisions regarding a particular situation will be made based on the statute and the regulations, and EPA decision-makers retain the discretion to adopt approaches on a case-by-case basis that differ from the guidance where appropriate.
[2] *See* 74 FR 4685-4686 (January 26, 2009) Memoranda from President Obama to the Heads of Executive Departments and Agencies "Transparency and Open Government" (signed January 21, 2009). For example: *Government should be transparent. Transparency promotes accountability and provides information for citizens*

This memorandum brings together and highlights some of the basic principles related to groundwater restoration that are articulated in multiple existing Agency guidance documents, including those related more generally to cleanup actions. It does not create any new guidance to the EPA regions; rather this memorandum addresses some of the key overall principles for groundwater remedial actions, as well as important concepts related to the following:

- Whether CERCLA remedial action is warranted
- Appropriate role of institutional controls (ICs)
- Groundwater classification and beneficial use policy
- Remedial action cleanup levels
- Groundwater point of compliance

In working with other Federal agencies to make groundwater clean up decisions at sites where the other Federal agency is lead for cleanup, EPA Regions should use the principles highlighted in this document to the same extent as at non-federal facility sites.[3] Section 120(a)(2) of CERCLA provides that all guidelines, rules, regulations, and criteria for preliminary assessments, site investigations, National Priorities List (NPL)[4] listing, and remedial actions are applicable to Federal facilities to the same extent as they are applicable to other facilities. It states the following: "No department, agency, or instrumentality of the United States may adopt or utilize any such guidelines, rules, regulations, or criteria which are inconsistent with the guidelines, rules, regulations, and criteria established by the Administrator under this Act."

Background

Groundwater response actions under CERCLA are governed in part by the following mandate established by Congress in CERCLA 121(d)(2)(A):

> …Such remedial action shall require a level or standard of control which at least attains Maximum Contaminant Level Goals established under the Safe Drinking Water Act and water quality criteria established under section 304 or 303 of the Clean Water Act, where such goals or criteria are relevant and appropriate under the circumstances of the release or potential release.

This requirement is reflected in the NCP as follows: "Maximum contaminant level goals (MCLGs), established under the Safe Drinking Water Act, that are set at levels above zero, …" or "maximum contaminant level (MCL) shall be attained where relevant and appropriate to the circumstances of the release…"[5]

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about what their Government is doing. Information maintained by the Federal Government is a national asset. My Administration will take appropriate action, consistent with law and policy, to disclose information rapidly in forms that the public can readily find and use. See also memorandum from EPA Administrator Lisa Jackson to EPA Employees (April 23, 2009).

[3] CERCLA Section 120(e)(4))A) provides a role for EPA in the selection of remedies at Federal facilities on the National Priorities List.

[4] *See* 55 FR 8666-8865 (March 8, 1990).

[5] 40 CFR §300.430(3)(B) and (C).

Consistent with CERCLA and the NCP, Superfund response actions protect human health and the environment in a number of ways, such as by remediating contaminated soils, restoring contaminated groundwaters to their beneficial uses, preventing migration of contaminant plumes, and protecting groundwater and other environmental resources. To ensure protective remedies, CERCLA response actions that clean up contaminated groundwater generally address all pathways of exposures that pose an actual or potential risk to human health and the environment. For example, groundwater response actions should generally address the actual or potential direct contact risk posed by contaminated groundwater (e.g., human consumption, dermal contact, or inhalation), and also should consider the potential for the contaminated groundwater to serve as a source of contamination into other media (e.g., for vapor intrusion into buildings; sediment; surface water; or wetlands).

The NCP establishes general expectations for purposes of groundwater restoration as follows:

> EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site. When restoration of ground water to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction.[6]

Recognizing that groundwaters of the United States are valued natural resources, the Agency carries out CERCLA response actions in a manner that ensures Superfund remedies are protective by, among other things, restoring contaminated groundwater to beneficial uses. Generally, these response actions attain MCLs (and non-zero MCLGs, where appropriate) for current or potential drinking water aquifers.

Principles for Groundwater Remediation

As discussed in the NCP and in various associated guidance, there are in general, five key principles that stem from the overarching expectations for groundwater restoration. These are as follows:

1) If groundwater that is a current or potential source of drinking water is contaminated above protective levels (e.g., for drinking water aquifers, contamination exceeds Federal or State MCLs or non-zero MCLGs), a remedial action under CERCLA should seek to restore that aquifer to beneficial use (e.g., drinking water standards) wherever practicable.
2) Groundwater contamination should not be allowed to migrate and further contaminate the aquifer or other media (e.g., vapor intrusion into buildings; sediment; surface water; or wetland).
3) Technical impracticability waivers and other waivers may be considered, and under appropriate circumstances granted if the statutory criteria are met, when groundwater clean up is impracticable; the waiver decision should be scientifically supported and clearly documented.

[6] 40 CFR §300.430(a)(1)(iii)(F).

4) Early actions[7] (such as source removal, plume containment, or provision of an alternative water supply[8]) should be considered as soon as possible. ICs related to groundwater use or even surface use, may be useful to protect the public in the short-term, as well as in the long-term.
5) ICs should not be relied upon as the only response to contaminated groundwater or as a justification for not taking action under CERCLA.[9] To ensure protective remedies, CERCLA response action cleanup levels for contaminated groundwater should generally address all pathways of exposure that pose an actual or potential risk to human health and the environment.

In addition, the state or tribe with jurisdiction over the groundwater often can have an important role in framing EPA's approach to groundwater characterization and remediation under Superfund. For example, states and tribes may have antidegradation or similar regulations or requirements that may be potential applicable, or relevant and appropriate requirements (ARARs). How state and tribal groundwater policies potentially impact remediation decisions is discussed later in this guidance.

Whether CERCLA Remedial Action is Warranted

The NCP preamble states, "The results of the baseline risk assessment are used to determine whether remediation is necessary, to help provide justification for performing remedial action, and to assist in determining what exposure pathways need to be remediated."[10] In the "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions" (OSWER Directive 9355.0-30, April 22, 1991) (see http://www.epa.gov/oswer/riskassessment/pdf/baseline.pdf), the Agency further clarified this policy:

> Chemical-specific standards that define acceptable risk levels (e.g., non-zero MCLGs, MCLs) also may be used to determine whether an exposure is associated with an unacceptable risk to human health or the environment and whether remedial action under Section 104 or 106 is warranted. For ground water action, MCLs and non-zero MCLGs will generally be used to gauge whether remedial action is warranted.

In addition, the NCP preamble notes that regulations that help define protectiveness (e.g., MCLs) also may help ascertain whether a remedial action taken at a site remains protective for CERCLA purposes.[11]

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[7] See "Considerations in Ground-Water Remediation at Superfund Sites and RCRA Facilities –Update" (Directive Number 9283.1-06, May 27, 1992) for a more complete discussion of early actions. (See pages 6-8.)
[8] *See* 55 FR 8865 (March 8, 1990) for a list of potential ways of providing an alternative water supply (Appendix D).
[9] *See* 40 CFR § 300.430(a)(iii)(D) ("The use of institutional controls shall not substitute for active response measures (e.g., treatment and/or containment of source material, restoration of ground waters to their beneficial uses) as the sole remedy unless such active measures are determined not to be practicable, based on the balancing of trade-offs among alternatives that is conducted during the selection of remedy.") Also see 40 CFR § 300.430(a)(iii) (A) related to the expectation for treatment.
[10] *See* 55 FR 8709 (March 8, 1990).
[11] In the context of post-ROD changes, the NCP preamble notes: "… a remedy must be modified if necessary to protect human health and the environment; newly promulgated or modified requirements contribute to that

A CERCLA remedial action generally is appropriate[12] in various circumstances, including: a regulatory standard that helps define protectiveness (e.g., a federal or state MCL or nonzero MCLG for current or potential drinking water aquifers) is exceeded; when the estimated risk calculated in a risk assessment exceeds a noncarcinogenic level for an adverse health effect or the upper end of the NCP risk range for "cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use[13]"; the non-carcinogenic hazard index is greater than one (using reasonable maximum exposure assumptions for either the current or reasonably anticipated future land use); or the site contaminants cause adverse environmental impacts.[14] It is important to note that all conditions do not need to be present for action and the conditions may be independent of each other.

Under existing Agency policy, groundwaters that are current or potential sources of drinking water that exceed risk-based standards (e.g., MCLs) or pose an unacceptable risk generally warrant a remedial action under CERCLA. Other routes of exposure, such as vapor intrusion, or current or potential threat to sediment quality, surface water quality, wetlands or critical habitats for protected species, also may be the basis for remedial action under CERCLA.

Appropriate Role of ICs

While ICs related to groundwater or surface use may be used as part of a response action, the NCP preamble indicates that ICs generally are not to be included when evaluating whether a CERCLA remedial action is appropriate in the first place.[15] In addition, the NCP preamble[16] states that "[t]he baseline assessment is essentially an evaluation of the no-action alternative. Institutional controls, while not actively cleaning up the contamination at the site, can control exposure and, therefore, are considered to be limited action alternatives."[17] Therefore, the baseline assessment should not include the impact of potential or existing ICs.

Furthermore, an IC by itself generally should not substitute for active remediation[18] of groundwater. The NCP preamble states: "Institutional controls will usually be used as supplementary protective measures during implementation of ground-water remedies."[19]

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evaluation of protectiveness." *See* 55 FR 8758 (March 8, 1990).

[12] *See* "Rules of Thumb for Superfund Remedy Selection" OSWER Directive 9355.0-69 (August 1997)

[13] *See* "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions" OSWER Directive 9355.0-03 (April 22, 1991).

[14] *See* "Rules of Thumb for Superfund Remedy Selection" OSWER Directive 9355.0-69 (August 1997)

[15] *See* 55 FR 8710- 8711, (March 8, 1990).

[16] *See* 55 FR 8711 (March 8, 1990).

[17] Some Regions have incorrectly identified remedies requiring only institutional controls as "no action" remedies. For further information and guidance regarding ICs, see http://www.epa.gov/superfund/policy/ic/guide/index.htm

[18] *See* 40 CFR § 300.430(a)(iii)(D) ("The use of institutional controls shall not substitute for active response measures (e.g., treatment and/or containment of source material, restoration of ground waters to their beneficial uses) as the sole remedy unless such active measures are determined not to be practicable, based on the balancing of trade-offs among alternatives that is conducted during the selection of remedy.")

[19] *See* 55 FR 8732 (March 8, 1990).

While there may be limited circumstances where an IC-only final remedy[20] is appropriate, generally an IC-only ROD would follow selection of other remedial action elements in previous decision documents. For example, previous decision documents may have selected active remediation that included removal of sources contributing to groundwater contamination, may have addressed groundwaters to the extent practicable, and may have invoked a TI waiver of ARARs for specific contaminants in one part of an aquifer. Where the cleanup under previous decision documents has not ensured protection of human health for that part of the groundwater that will not achieve MCLs, a separate decision document would generally be issued to select one or more ICs to prevent current or future exposure to contaminated groundwater.

Where a Region is considering an IC-only ROD that is also an IC-only remedy for all or a portion of a site for groundwater, the Region should consult early with the appropriate Regional Coordinator from Office of Superfund Remediation and Technology Innovation (OSRTI) or Federal Facilities Restoration and Reuse Office (FFRRO). This consultation is intended to ensure that the decision making process appropriately evaluates and properly documents key aspects that may be associated with the remedy selection process leading to an IC-only remedy. This evaluation may include consideration of source removal, active remediation, granting a Technical Impracticability (TI) waiver [21] for applicable and relevant and appropriate requirements (ARARs), or adopting monitored natural attenuation[22] (MNA)).

Groundwater Classification and Beneficial Use Policy

The NCP states that "EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site."[23] This policy often hinges on the determination of the current or potential use of the groundwater aquifer. The NCP preamble states:

> …to the degree that the state or local governments have classified their ground water, EPA will consider these classifications and their applicability to the selection of an appropriate remedy… If a state classification would lead to a less stringent solution than the EPA classification scheme, then the remediation goals will generally be based on EPA classification. Superfund remedies must be protective. If the use of state classification would result in the selection of a nonprotective remedy, EPA would not follow the state scheme.[24]

[20] An IC-only ROD is a decision document that is only selecting an institutional control to achieve protectiveness for the current or reasonably anticipated land, ground water or surface water use. It normally does not mean a decision document that selects ICs together with other actions, such as monitored natural attenuation or ground water pump and treat.

[21] *See* "Consistent Implementation of the FY 1993 Guidance on Technical Impracticability of Ground-Water Restoration at Superfund Site" (Directive Number 9200.4-14, Jan. 19, 1995) and "Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration" (Directive Number 9234.2-25, Sept. 1993). For further information see http://www.epa.gov/superfund/health/conmedia/gwdocs/arars.htm

[22] "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites" (OSWER Directive 9200.4-17P, April 21, 1999) clarifies EPA policy regarding the use of MNA for soils and groundwater. For further information see http://www.epa.gov/superfund/health/conmedia/gwdocs/monit.htm

[23] 40 CFR § 300.430(a)(1)(iii)(F).

[24] *See* 55 FR 8733 (March 8, 1990).

The NCP preamble also states that if such groundwater classification, as discussed above, is not available, then "[a] determination is made as to whether the contaminated ground water falls within Class I, II, or III. Guidance for making this determination is available in "EPA Guidelines for Ground-Water Classification" (1986 Federal Guidelines) (Final Draft, December, 1986).[25]

The NCP preamble guides almost all EPA groundwater classification and beneficial use decisions for CERCLA response actions. In States that have an EPA-endorsed Comprehensive State Ground Water Protection Program (CSGWPP), however, EPA's guidance entitled: "The Role of CSGWPP in EPA Remediation Programs" (April 4, 1997, OSWER Directive 9283.1-09) builds on the NCP preamble with respect to the State role. The guidance[26] states:

> Superfund and other EPA remediation programs should generally defer to a State's determination of current and future groundwater uses, when based on criteria or methodology that 1) are specified in an EPA-endorsed Core CSGWPP, and 2) can be applied at specific sites or facilities.

It further clarifies:

> For States that do not have an EPA-endorsed CSGWPP, or for CSGWPPs that do not have provisions for making site-specific determinations of ground water use (or resource value, priority or vulnerability), the Superfund program will continue to follow guidance provided in the NCP Preamble.

Land use is not identified as a consideration in making groundwater classifications. The CSGWPP Guidance and the 1986 Federal Guidance, as well as other EPA guidance related to groundwater cleanups under CERCLA authority, are available on the "Key OSWER Ground Water Guidances and Reports" on EPA's web page http://www.epa.gov/superfund/health/conmedia/gwdocs/.

In summary, groundwaters should be restored to their beneficial use. While a State's designation of groundwater use will be considered for establishing remediation goals, EPA's classification scheme (*EPA Guidelines for Ground-Water Classification* (Final Draft, December 1986)) will generally be used if a state's classification would lead to a less stringent solution. In 1997, EPA initiated a policy of deferring to a State's determination of current and future groundwater uses, when based on criteria or methodology that are specified in an EPA endorsed CSGWPP, and can be applied at specific sites or facilities.

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[25] *See* 55 FR 8732 (March 8, 1990). Class I and II are considered to be current and potential drinking water aquifers.
[26] "The Role of CSGWPPS in EPA Remediation Programs," (OSWER Directive 9283.1-09) April 4, 1997..

Remedial Action Cleanup Levels

Pursuant to CERCLA section 121, all Superfund remedial actions must be protective of human health and the environment and must comply with ARARs.[27] As noted previously, CERCLA 121(d) specifically identifies Safe Drinking Water Act MCLs and nonzero MCLGs, as well as Clean Water Act Water Quality Criteria as potentially relevant and appropriate standards to be attained by the remedial action. In addition, the NCP states:

> Maximum contaminant level goals (MCLGs), established under the Safe Drinking Water Act, that are set at levels above zero, shall be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water, where the MCLGs are relevant and appropriate under the circumstances of the release based on the factors in 300.400(g)(2). If an MCLG is determined not to be relevant and appropriate, the corresponding maximum contaminant level (MCL) shall be attained where relevant and appropriate to the circumstances of the release.[28]

The NCP preamble further clarifies that:

> EPA's policy is that MCLs or MCLGs above zero should generally be the relevant and appropriate requirement for ground water that is or may be used for drinking, and that a waiver is generally needed in situations where a relevant and appropriate MCL or non-zero MCLG cannot be attained."[29]

Where groundwaters may impact surface water quality, "water quality criteria established under section 304 or 303 of the Clean Water Act," may be relevant and appropriate standards consistent with CERCLA §121(d)(2)(A)(ii).

Cleanup levels for remedial actions under CERCLA generally are developed based on site-specific risk assessments, ARARs[30], and/or to-be-considered materials (TBCs).[31] Where

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[27] Under CERCLA section 121(d)(4), an ARAR may be waived under certain circumstances. See 40 CFR 300.430(f)(1)(i)(A) and See 40 CFR 300.430(f)(1)(1)(ii)(B). The NCP further states "On-site remedial action selected in a ROD must attain those ARARs that are identified at the time of the ROD signature or provide grounds for a waiver.."

[28] *See* 40 CFR 300.430(e)(2)(i)(B).

[29] *See* 55 FR 8754 (March 8, 1990).

[30] In situations where two or more regulations are found to constitute ARARs for the CERCLA response, the cleanup level should be established as the more stringent of the levels. For example, the "Use of Uranium Drinking Water Standards under 40 CFR 141 and 40 CFR 192 as Remediation Goals for Groundwater at CERCLA Sites" (Directive No. 9283.1-14, Nov. 6, 2001, page 6), states: "...the CERCLA approach for complying with the MCL throughout the plume is more stringent than the UMTRCA approach of complying with the groundwater standard only in the uppermost aquifer. Thus if an MCL is attained through the plume, the groundwater standard will also be attained in the uppermost aquifer." The same is true for any state ARAR that is more stringent than the Federal ARARs and the remedy would need to meet the more stringent cleanup levels.

[31] "To-be-considered material (TBCs) typically are non-promulgated advisories or guidance issued by Federal or State governments that are not legally binding and do not have the status of potential ARARs. However, TBCs will be considered along with ARARs as part of the site risk assessment and may be used in determining the necessary level of cleanup for protection of health and the environment" "Establishment of Cleanup Levels for CERCLA sites with Radioactive Contamination" (OSWER Directive No. 9200.4-18, Aug. 22, 1997, page 2), See also 40 CFR §

ARARs are not available or are not sufficiently protective, EPA generally sets site-specific remediation levels for: 1) carcinogens at a level that represents an excess upper bound lifetime cancer risk to an individual of between 10^{-4} to 10^{-6}; and for 2) non-carcinogens such that the cumulative risks from exposure will not result in adverse effects to human populations (including sensitive sub-populations) that may be exposed during a lifetime or part of a lifetime, incorporating an adequate margin of safety.[32] As noted in that guidance, Regions should consult with Headquarters before making a site-specific determination that a specific ARAR is not protective of human health and the environment.

CERCLA cleanup levels are designed to address all reasonably anticipated routes of exposure that may pose an actual or potential risk to human health or the environment. For example, Regions should ensure that cleanup levels established to restore groundwater to beneficial use, consistent with the NCP (e.g., restoration to MCLs for current or potential drinking water aquifers), also adequately address other routes of exposure associated with the groundwater, including groundwaters as a source of contamination to other media (e.g., for vapor intrusion into buildings; sediment; surface water; wetlands).

As discussed above, groundwater cleanup levels are established based on promulgated standards (e.g., Federal or State MCLs or non-zero MCLGs, or other standards found to be ARARs), or risk-based levels (e.g., for contaminants when there are no standards that define protectiveness).

Groundwater Area of Attainment or Point of Compliance

The NCP preamble[33] uses both "area of attainment" and "point of compliance"[34] in discussing where groundwater cleanup levels are to be achieved. The area of attainment/point of compliance is important in the overall framework of developing and implementing cleanup of a contaminated aquifer. The NCP preamble sets forth the Agency's policy that for groundwater,

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300.400(g)(3) and CERCLA Compliance with Other Laws Manual: Interim Final (EPA/540/6-89/006, Aug. 1988), at 1-76.

[32]*See* 40 CFR §300.430(e)(2)(i)(A)(1) and (2). Also see "Clarification of the Role of Applicable, or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals under CERCLA" (OSWER 9200.4-23, Aug. 22, 1997).). "It remains EPA's policy that ARARs will generally be considered protective absent multiple contaminants or pathways of concern….in rare situations, EPA Regional offices should establish PRGs [preliminary remediation goals] at levels more protective than required by a given ARAR, even absent multiple pathways or contaminants, where application of the ARAR would not be protective of human health or the environment. This judgment should be made based on a review of the level of risk associated with application of the ARAR; the soundness of the technical basis for the ARAR; and other factors relating to the ARAR or to its application at an individual site."

[33]."See "Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites" (OSWER Directive 9283.1-2, December 1988, p. xv) where the area of attainment is defined as "[t]he area of the plume outside the boundary of any waste to be managed in place as part of the final remedy and inside the boundaries of the contaminant plume."

[34]See 55 FR 8753-8754, March 8, 1990. These terms complement one another and generally mean that everything down gradient from the point of compliance or area of attainment should achieve the cleanup level. If the point of compliance is throughout the plume, the area of attainment is the entire plume. If the point of compliance is the unit boundary, then the area of attainment is throughout the plume down gradient of the unit.

"remediation levels generally should be attained throughout the contaminated plume, or at and beyond the edge of the waste management area[35] when waste is left in place."[36]

The NCP preamble also indicates that in certain situations it may be appropriate to address the contamination as one waste management area for purposes of the groundwater point of compliance; for example, this may be protective of public health and the environment at certain sites where there are multiple sources from closely spaced waste management areas.[37]

The preamble states:

> In such cases, the most feasible and effective ground-water cleanup strategy may be to address the problem as a whole, rather than source-by-source, and to draw the point of compliance to encompass the sources of release. In determining where to draw the point of compliance in such situations, the lead agency will consider factors such as the proximity of the sources, the technical practicability of ground-water remediation at that specific site, the vulnerability of the ground water and its possible uses, exposure and likelihood of exposure and similar considerations.[38]

In summary, the area of attainment/point of compliance for achieving groundwater cleanup levels is generally expected to be throughout the plume or, where there is a waste management area, at the edge of the waste management area. Regions are strongly encouraged to contact OSRTI groundwater experts listed at the end of the memorandum concerning questions regarding the area of attainment/point of compliance.

Implementation

When addressing groundwater contamination at CERCLA sites, Regions should carefully consider the five principles discussed herein, as well as the NCP and other Superfund guidance documents, in evaluating CERCLA remedial actions. Regions are requested to consult with OSRTI or, when a Federal facility is involved, FFRRO, in cases of IC-only groundwater decision documents or if there are questions related to area of attainment/point of compliance.

This memorandum compiles some key aspects of important groundwater policies regarding CERCLA remedy selection. For further information on the basis for actions and ARARs, please contact Robin M. Anderson at Anderson.RobinM@epa.gov (703) 603-8747. For information related to groundwater response policies, please contact Matt Charsky at Charsky.Matthew@epa.gov (703-603-8777) or David Bartenfelder at Bartenfelder.David@epa.gov (703-603-9047). For questions related to Federal facilities please

[35] "DNAPLs are typically not located in a waste management area, as envisioned in the NCP." "Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites" (Directive 9283.1-12, October 1996 at page 18.

[36] *See* 55 FR 8753 (March 8, 1990). Similarly, the preamble to the proposed-NCP states: "For ground water, remediation levels should generally be attained throughout the contaminated plume, or at and beyond the edge of the waste management area when waste is left in place. For surface waters, the selected levels should be attained at the point or points where the release enters the surface waters." *See* 53 FR 51246, December 21, 1988.

[37] *Id.*

[38] See 55 FR 8754, March 8, 1990.

contact Tim Mott at Mott.Timothy@epa.gov (703-603-8807). Consultations should be coordinated through the appropriate Regional Coordinator from OSRTI or, if Federal facilities are involved, FFRRO.

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United States Environmental Protection Agency

Solid Waste and Emergency Response

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Superfund

A GUIDE TO PREPARING SUPERFUND PROPOSED PLANS, RECORDS OF DECISION, AND OTHER REMEDY SELECTION DECISION DOCUMENTS

NOTICE

This document provides guidance to EPA and State staff. It also provides guidance to the public and to the regulated community on how EPA intends to exercise its discretion in implementing its regulations. The guidance is designed to implement national policy on these issues. The document does not, however, substitute for statutes EPA administers nor their implementing regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the specific circumstances. EPA may change this guidance in the future, as appropriate.

Highlight 6-5: Standard Language for ROD Data Certification Checklist

The following information is included in the Decision Summary section of this Record of Decision. Additional information can be found in the Administrative Record file for this site.

- Chemicals of concern and their respective concentrations.
- Baseline risk represented by the chemicals of concern.
- Cleanup levels established for chemicals of concern and the basis for these levels.
- How source materials constituting principal threats are addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of ground water used in the baseline risk assessment and ROD.
- Potential land and ground-water use that will be available at the site as a result of the Selected Remedy.
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- Key factor(s) that led to selecting the remedy (i.e., describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision).

[Note: Add references to page numbers, if appropriate.]

Highlight 6-6: Notes on ROD Authorizing Signatures

When a State regulatory agency is the lead agency for developing and preparing the ROD for a Fund-financed or CERCLA enforcement-lead site, the director of the State regulatory agency or Chairman of the Indian Tribe or Nation should co-sign the ROD with EPA. In these cases, EPA must concur and adopt the ROD before a State can proceed with a Fund-financed remedial action (NCP Section 300.515(e)(2)(ii)) or use CERCLA authority to achieve a PRP-lead remedial action. When the State is the support agency, the State's signature on the ROD is optional (i.e., the SMOA may or may not provide for such a signature). At a minimum, a letter from the State specifying concurrence or nonconcurrence should always be included in the Administrative Record file.

Where a Federal agency other than EPA (e.g., DOE or DOD) is the lead agency at an NPL site, that agency should co-sign the ROD with EPA as well.

Although the goal of the interactions between the lead and support agencies is to reach mutual agreement on the ROD, there may be limited instances in which this is not achieved. In such an event, the procedures for selecting and implementing the remedy depend on who has the lead responsibility for the ROD. If EPA has the lead, and the State does not concur with the Selected Remedy, then EPA has the discretionary authority to sign the ROD and continue with the remedy using Fund monies or enforcement authority through the remedial design stage. EPA cannot proceed with a remedial action without the State's cost-share for Fund-financed remedial actions. However, where PRPs are conducting the RA, the RA can proceed.

If the State is the lead for an action using Fund monies or based on CERCLA enforcement authorities and EPA does not concur with the Selected Remedy, EPA can assume the lead for the ROD and proceed with an EPA-Selected Remedy (through the RD stage for Fund-financed remedial actions). In either case, all non-privileged information pertaining to the disagreement should be included in the Administrative Record file. Where the State has been designated as the lead agency for a non-Fund-financed State-lead enforcement response action (i.e., actions taken under State law) at an NPL site, the State may select a remedy without EPA's concurrence.

It should be noted that EPA retains the authority to sign RODs at NPL sites owned/operated by Federal agencies.

(See Chapter 5 for a more complete discussion of lead/support agency interactions in developing the ROD.)

6.3.8 Remedial Action Objectives

A discussion of the *remedial action objectives (RAOs)* for the specific response action described in the ROD should be presented prior to the discussion of cleanup alternatives and remedy selection rationale.[14] RAOs provide a general description of what the cleanup will accomplish (*e.g.*, restoration of ground water to drinking water levels). These goals typically serve as the design basis for many of the remedial alternatives which will be presented in the next section. Presenting RAOs prior to the discussion of remedial alternatives provides the reader of the ROD with a basis for evaluating the cleanup options for the site and an understanding of how the risks identified in the previous section will be addressed by the response action. A clear statement of the RAOs also facilitates the five-year review determination of protectiveness of human health and the environment.

This section should include a discussion of the following:

- Clear statement of the specific RAOs for the operable unit or site (*e.g.*, treatment of contaminated soils above health-based action levels, restoration of ground-water plume to drinking water levels, and containment of DNAPL source areas). See Chapter 9 for additional information on documenting RAOs for OUs that address contaminated ground water.
- Basis and rationale for RAOs (*e.g.*, current and reasonably anticipated future land use and potential beneficial ground-water use).
- How the RAOs address risks identified in the risk assessment (*e.g.*, how will the risks driving the need for action be addressed by the response action?)

[14] If specific RAOs vary across alternatives, these differences should be described in general terms in this section and in more specific terms in the *Description of Alternatives section.*

6.3.9 Description of Alternatives

The objective of this section is to provide a brief explanation of the remedial alternatives developed for the site.

The description of each alternative in this section should contain enough information so that the comparative analysis of alternatives (the next section of the ROD) can focus on the differences or similarities among alternatives with respect to the nine evaluation criteria.

This discussion should be organized in three sections:

Description of Remedy Components

Provide a bulleted list of the major components of each alternative as they logically occur in the remediation process. This list should include the following:

- Treatment technologies and materials they will address (*e.g.*, source materials constituting principal threats).[15]
- Containment components of remedy (*e.g.*, engineering controls, cap, hydraulic barriers) and materials they will address (*e.g.*, low concentration source materials, treatment residuals).[16]

[15] Describe technologies in general terms that permit a number of "technological approaches" to be applied within a "technology category" (*e.g.,* use terms such as "ex-situ bioremediation" rather than "composting" or "soil slurry reactors"). This provides more flexibility to the design engineer and minimizes unnecessary ESDs and ROD Amendments. However, if the public's perception of the remedy is affected by the technology description, it may be appropriate to clarify which specific technology is being proposed (*e.g.,* use terms such as "incineration" and "thermal desorption" rather than "thermal treatment").

[16] "Engineering controls" are physical barriers to exposure and do not include "institutional controls," which are non-engineering methods intended to affect human activities in such a way as to prevent or reduce exposure to hazardous substances (*e.g.*, deed restrictions such as easements and covenants, deed notices, land use restrictions such as zoning and local permitting, ground-water use restrictions, and public health advisories).

- Institutional controls (and the entity responsible for implementing and maintaining them).[17]

- Operations and Maintenance (O&M) activities required to maintain integrity of remedy (*e.g.*, cap maintenance).

- Monitoring requirements.

Highlight 6-22 provides examples of the details that should be described for each alternative.

Common Elements and Distinguishing Features of Each Alternative

Describe common elements and distinguishing features unique to each response option. Examples of these elements include:

- Key ARARs (or ARAR waivers) associated with each alternative (*e.g.*, action- and/or location-specific ARARs, including the control of air, emissions from ground-water treatment units, manifesting of hazardous waste, and regulating solid waste landfills).[18]

- Long-term reliability of remedy (potential for remedy failure/replacement costs).

- Quantity of untreated waste and treatment residuals to be disposed off-site or managed on-site in a containment system and degree of hazard (*e.g.*, concentrations) remaining in such material.[19]

- Estimated time for design and construction (*i.e.*, implementation time frame).

- Estimated time to reach remediation goals (*i.e.*, time of operation, period of performance).

- Estimated capital, annual O&M, and total present worth costs; discount rate (current OSWER policy is 7%): and the number of years over which the remedy cost estimate is projected.

- Uses of presumptive remedies and/or innovative technologies.

Expected Outcomes of Each Alternative

- Available uses of land upon achieving cleanup levels. Note time frame to achieve available use (*e.g.*, commercial or light industrial use available in 3 years when cleanup levels are achieved).

- Available uses of ground water upon achieving cleanup levels. Note time frame to achieve available use (*e.g.*, restricted use for industrial purposes in TI waiver zone, drinking water use in non-TI zone upon achieving cleanup levels in 100 years).

- Other impacts or benefits associated with each alternative.

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[17] The term "deed restrictions" commonly appears in RODs, consent decrees, and other EPA materials (including the NCP). However, it is not a traditional real property term and does not have a precise legal meaning. The term "deed restrictions" should be understood as simply a catchall term for proprietary controls (such as easements and covenants) that are legally enforceable against subsequent property owners. Therefore, it is important to make sure that all those involved in evaluating remedies using proprietary controls understand that to establish legally enforceable restrictions, rather than merely informational notices (such as a deed notice), a conveyance or contract of some kind will likely be required. Where clarity of intent is important (such as in a ROD), a more precise term , such as easement or covenant, should generally be used (*Institutional Controls: A Reference Manual* (March 1998 draft)).

[18] Key ARARs that drive the remedial action objectives and response options should also be discussed. Key ARARs are generally considered to be those ARARs that provide a basis for developing an alternative (*e.g.*, cleanup levels such as state non-degradation standards for ground-water resources) or ARARs that help distinguish between alternatives. One approach to covering key ARARs in this section is to provide a table which cites the ARAR, identifies the alternative to which it applies, and clarifies how it will be applied at the site. The ROD must describe all ARARs for the selected remedy (NCP Section 300.430(f)(5)(ii)(B) and (C)). Therefore, a more extensive table of ARARs that apply to the Selected Remedy should be presented in the Statutory Determinations (see section 6.3.13 and Highlight 6-34).

[19] Off-site transfers of CERCLA wastes, residuals from CERCLA wastes treated on site, or wastewater containing CERCLA waste, should be compliant with the Off-Site Rule at 58 FR 49200, September 22, 1993, and 40 CFR Part 300.440. Regarding the off-site disposal of wastes, note that CERCLA §121(b)(1) states: "The offsite transport and disposal of hazardous substances or contaminated materials without such treatment should be the least favored alternative remedial action where practicable treatment technologies are available." NCP §300.430(f)(1)(ii)(E) also states: "The balancing shall also consider the preference for treatment as a principal element and the bias against off-site land disposal of untreated waste."

is readily available and sufficiently documented (*e.g.*, increased property values, reduced water supply costs, jobs created, increased tax revenues due to redevelopment, environmental justice concerns addressed, enhanced human uses of ecological resources); and

- Anticipated environmental and ecological benefits, where such information is readily available and sufficiently documented (*e.g.*, restoration of sensitive ecosystems, protection of endangered species, protection of wildlife populations, wetlands restoration).

6.3.13 Statutory Determinations

The purpose of this section is to provide a brief, site-specific description of how the Selected Remedy satisfies the statutory requirements of CERCLA §121 (as required by NCP §300.430(f)(5)(ii)) and explain the five-year review requirements for the Selected Remedy. Highlight 6-33 illustrates the relationship between the nine evaluation criteria and the statutory requirements.

1) Protection of Human Health and the Environment

This discussion must describe how the Selected Remedy will adequately protect human health and the environment through treatment, engineering controls, and/or institutional controls (NCP §300.430(f)(5)(ii)). Specifically, the remedy should be described in terms of how the existing or potential risks posed by the site or operable unit through each pathway will be eliminated, reduced, or controlled by the response action. This discussion should also indicate that exposure levels will be reduced to protective ARAR levels or to within EPA's generally acceptable risk range of 10^{-4} to 10^{-6} for carcinogenic risk and below the HI of 1 for non-carcinogens. Finally, this discussion should reflect that the implementation of the Selected Remedy will not pose unacceptable short-term risks or cross-media impacts. If the site presents ecological risks, then there should be a brief discussion of how the remedy provides adequate protection of the environment. See also *Risk Assessment Guidance for Superfund. Volume 1. Human Health Evaluation Manual (Part C, Risk Evaluation of Remedial Alternatives), Interim Final* (EPA 540-R-92-004, December 1991).

2) Compliance with Applicable or Relevant and Appropriate Requirements[24]

NCP §§300.430(f)(5)(ii)(B) and (C) require that a ROD:

- Describe the Federal and State ARARs that the remedy will attain; and
- Describe the Federal and State ARARs that the remedy will not meet, the waiver invoked, and the justification for invoking the waiver.

The ARARs that the Selected Remedy will attain should be listed and briefly described. Provide the regulatory citation in an appropriate level of detail. Some remedies may require a more lengthy discussion of a statute or regulation. A tabular summary should be used if appropriate. See Highlight 6-34 for an example.

This section should also describe other available information that does not constitute an ARAR (*e.g.*, advisories, criteria, and guidance) that should be considered in the analysis if it helps to ensure protectiveness or is otherwise appropriate for use in a specific alternative. Such information is commonly referred to as TBCs (To Be Considered). Use of a TBC should be justified for the record.[25]

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[24] Applicable or Relevant and Appropriate Requirements (ARARs) include substantive provisions of any promulgated Federal or more stringent State environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate requirements for a CERCLA site or action. These requirements may include regulations promulgated under the Resource Conservation and Recovery Act (RCRA), the Toxic Substances Control Act (TSCA), the Safe Drinking Water Act (SDWA), the Clean Water Act (CWA), and other Federal or State environmental laws. *Applicable requirements* are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. *Relevant and appropriate requirements* are requirements that, while not legally "applicable" to circumstances at a particular CERCLA site, address problems or situations sufficiently similar to those encountered at the site that their use is well-suited. (See the NCP at 40 CFR 300.5 for definitions.) Additional guidance on ARARs is provided in *CERCLA Compliance with Other Laws Manual: Parts I and II* (EPA 540-G-89-006, August 1988 and 540-G-89-009, August 1989), and the NCP preamble at 55 FR 8741-8766.

[25] Include policies or support documents for the TBC in the Administrative Record file, or incorporate by reference. If the validity of TBCs is challenged, justify the use in the Responsiveness Summary (see Section 6.4).

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United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

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Institutional Controls:

A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites

1. PURPOSE

The purpose of this guidance is to provide site managers of contaminated sites, site attorneys,[1] and other interested parties with information and recommendations that should be useful for planning, implementing, maintaining,[2] and enforcing institutional controls (ICs) for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund); Brownfields; federal facility; underground storage tank (UST); and Resource Conservation and Recovery Act (RCRA) site cleanups. It addresses some of the common issues that may be encountered and provides an overview of EPA's policy regarding the roles and responsibilities of the parties involved in various aspects of planning, implementing, maintaining, and enforcing ICs. A thorough understanding of the concepts and sources in this and related documents referenced here should help ensure that ICs are properly implemented and operate effectively during their lifespan.

This is the second in a series of guidance documents on the use of ICs. The first document, *Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups*, September 2000 (OSWER 9355.0-74FS-P, EPA 540-F-00-005) (*A Site Manager's Guide to ICs*), provides guidance for identifying, evaluating, and selecting ICs.

Table of Contents

This document addresses crosscutting multi-program IC issues, while recognizing that there are some differences among the cleanup programs.[3] It defines ICs as used in this document, describes their role in contaminated site cleanups, and discusses four general life cycle stages — planning, implementing, maintaining, and enforcing ICs. References to additional guidance documents including those mentioned in the text of this document are included in Appendix A. This

[1] The terms "site manager" and "site attorney," as used in this document, refer to personnel from the lead agency involved in a CERCLA (remedial and removal), Brownfields, federal facility, UST, or RCRA cleanup project. Where the lead agency is a Federal agency other than the EPA, EPA and the Federal agency may share some site manager/site attorney responsibilities or EPA may retain them independently depending on the responsibility under any of the five cleanup programs. The term "site" is used generically in this guidance to also represent areas of contamination managed under all five of these cleanup programs. The terms "CERCLA," and "Superfund," generally include both remedial and removal sites. In addition, the term "responsible party" as used in this document is intended to mean a person or entity with cleanup or IC responsibilities under the various cleanup programs listed above. Similarly, because CERCLA removal actions are generally discrete, short-term actions, EPA generally relies on state agencies to plan, implement, maintain, and enforce ICs following a removal action.

[2] The term "maintenance" refers to those activities, such as monitoring and reporting, that ensures ICs are implemented properly and functioning as intended.

[3] This document provides guidance to the Regions on how EPA generally intends to plan, implement, maintain, and enforce institutional controls as part of a cleanup project. The guidance is designed to help promote consistent national policy on these issues. It does not, however, substitute for CERCLA, RCRA, or EPA's regulations, nor is it a regulation itself. Thus, it does not impose legally binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA, State, tribal, and local decision-makers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate. Any decisions regarding a particular facility will be made based on the applicable statutes and regulations.

document is designed to provide general guidance and does not include an exhaustive list of considerations.

Regions and authorized states are encouraged to coordinate among different tribal and government agencies and consult with the local community. Legal requirements for maintaining ICs and community acceptance of the need for ICs to provide for protection from residual waste and the land use limitations that can go along with ICs, are often important to the long-term effectiveness of ICs.

Assistance with ICs is available from EPA Headquarters staff in the Office of Superfund Remediation and Technology Innovation (OSRTI), the Office of Emergency Management (OEM), the Office of Brownfields and Land Revitalization (OBLR), the Office of Site Remediation Enforcement (OSRE), the Office of Resource Conservation and Recovery (ORCR), the Office of Underground Storage Tanks (OUST), the Federal Facilities Restoration and Reuse Office (FFRRO), the Federal Facilities Enforcement Office (FFEO), the Office of General Counsel (OGC), and IC Coordinators in the EPA Regional offices.

Typical Key Activities in the IC Life Cycle

- ***Planning*** may include activities leading up to the establishment of an IC. It can include an evaluation of the type of IC contemplated, potential instruments that might be used to implement the selected IC, potential parties who will be responsible for the various activities, criteria for termination of the ICs, issues that might impact the effectiveness of the ICs, and estimated costs and funding sources.
- ***Implementing*** may include activities undertaken to put the ICs in place including drafting and signing the specific documents necessary to establish the IC, and arranging for any technical and legal support that may be needed for monitoring and reporting. ICs may be implemented at any stage in the cleanup process.
- ***Maintaining*** includes both monitoring and reporting which are generally conducted to routinely and critically evaluate ICs to determine whether the IC instrument remains in place and whether it meets the stated objectives and performance goals.
- ***Enforcing*** can include actions taken to address ICs that have been breached or improperly implemented, monitored, or reported. IC enforcement can involve a range of activities, including informal communications to seek voluntary compliance to more formal steps, when appropriate.

2. DEFINITION AND ROLE OF INSTITUTIONAL CONTROLS

For purposes of this document, EPA defines ICs as non-engineered instruments, such as administrative and legal controls, that help to minimize the potential for human exposure to contamination and/or protect the integrity of a response action.[4] ICs are typically designed to work by limiting land or resource use or by providing information that helps modify or guide human behavior at a site. Some common examples of ICs include zoning restrictions, building or excavation permits, well drilling prohibitions, easements, and covenants. ICs are a subset of Land Use Controls (LUCs). LUCs include engineering and physical barriers, such as fences and security guards, as well as ICs. The federal facility program may use either term in its decision documents.

As response components, ICs are designed to achieve the precise substantive restrictions articulated in the decision documents that are needed at a site to achieve cleanup objectives.[5] The evaluation of whether an IC is needed at a site is a site-specific determination. Regions and authorized states should consider whether the site meets unlimited use and unrestricted exposure (UU/UE) as one of the factors in deciding when an IC is appropriate at a site. UU/UE is generally the level of cleanup at which all exposure pathways present an acceptable level of risk for all land uses.

Regions or authorized states should provide adequate opportunities for public participation (including potentially affected landowners and communities) when considering appropriate use of ICs. Those opportunities should include providing appropriate notice, and opportunities for comment, particularly in the Proposed Plan and other steps in the CERCLA cleanup process. Regions or authorized states should consider the impacts of the IC on current and reasonably anticipated future land uses, and should maintain a solid administrative record. ICs should be carefully evaluated, selected, and narrowly tailored to meet the cleanup objectives. As an example, a response selecting a capped landfill may require an IC. To ensure protection of both the engineering component and human health and the environment, it may be necessary to prohibit activities that compromise the response

[4] The words "response action" or "response" are used to include remedial and removal actions under CERCLA and similar actions under other programs. The NCP provisions for CERCLA removal actions address ICs through a particular process (i.e., post-removal site controls, such as ICs, are typically implemented following removal actions, not as part of removal actions). Generally, this guidance attempts to distinguish removals from other response actions, including CERCLA remedial actions or responses under other programs covered by this guidance, through use of the term "remedy" or "remedial action."

[5] In cases where EPA or authorized state determines that "no action" is needed under CERCLA, the decision document should document the assumptions upon which the remedy is based. If conditions at the site change, then EPA can assert its authority to later require a response, including ICs.

action and/or result in exposure to humans. Thus it may be appropriate to prohibit heavy machinery usage on or near the capped area, while allowing light recreational uses (e.g., soccer fields). The relevant decision document should clearly articulate the substantive restrictions (e.g., groundwater shall not be used for human consumption) needed to address the exposure pathways and the risks necessitating ICs.

Definition and Role of Institutional Controls

- Role of ICs (Section 2.1)
- Types of ICs (Section 2.2)
- Program-specific Role of ICs in Cleanups (Section 2.3)

2.1 Role of ICs

ICs may be necessary to ensure protectiveness and/or to protect a remedy. If any cleanup options being evaluated leave waste in place, ICs should be considered to ensure that unacceptable risk from residual contamination does not occur. Cleanup actions such as capping waste in place, construction of containment facilities, monitored natural attenuation, and long-term pumping and treating of groundwater, may leave residual contamination on site where restrictions provided by ICs to supplement the engineering controls can help ensure protection of human health and the environment. ICs, where appropriate, can be used in the context of either short-term temporary site solutions (e.g., restoration responses that will not leave waste in place above unacceptable levels upon completion) or long-term permanent solutions (e.g., containment responses that will leave waste in place in perpetuity).

As a site moves through the response selection process, site managers and site attorneys should collect information and develop assumptions about the reasonably anticipated future land use (for CERCLA-specific guidance, see *Land Use in the CERCLA Remedy Selection Process*, OSWER 9355.7-04, May 1995). Site managers and site attorneys should consider the reasonably anticipated future land use during response selection and take it into account when selecting ICs and drafting IC language in decision documents. Furthermore, site managers and site attorneys should clearly and explicitly document reasonably anticipated future land use assumptions upon which the response action rests.

The site manager and site attorney should discuss reasonably anticipated future uses of the site with local land use planning authorities, local and state officials, the public, tribes and other federal agencies as appropriate, as early as possible during the scoping phase of the Remedial Investigation/ Feasibility Study (RI/FS) for CERCLA or RCRA Facility Investigation/ Corrective Measures Study (RFI/CMS) for RCRA. At sites where any media will not be cleaned up to a level that supports UU/UE, the site manager and site attorney should discuss any IC instruments (in addition to active response measures) that may be appropriate, taking into account legal implementation issues, jurisdictional questions, the impact of layering ICs, and reliability and enforcement concerns. It is also important for the site manager to recognize that, in addition to restricting certain land uses, ICs can also be used to restrict or modify specific activities at sites (e.g., fishing prohibitions).

2.2 Types of ICs

For purposes of this guidance, ICs are divided into four categories: proprietary controls, governmental controls, enforcement and permit tools with IC components, and informational devices. Within each category, there are a number of instruments that may be employed. The following paragraphs summarize each category of ICs and each are discussed in Sections 3 through 9 as they relate to four stages of the IC life cycle (planning, implementing, maintaining, and enforcing ICs).

Proprietary controls are generally created pursuant to state and tribal law to prohibit activities that may compromise the effectiveness of the response action or restrict activities or future resource use that may result in unacceptable risk to human health or the environment. The most common examples of proprietary controls are easements and covenants. Many states have enacted statutes addressing the implementation and long-term effectiveness of proprietary controls. One model that has been developed is the Uniform Environmental Covenants Act (UECA)[6], which can be adopted as is or in modified form by states to provide advantages over traditional common law proprietary controls.

Governmental controls impose restrictions on land use or resource use, using the authority of a government entity. Typical examples of governmental controls include zoning; building codes; state, tribal, or local ground water use regulations; and commercial fishing bans and sports/recreational fishing limits posed by federal, state and/or local resources and/or public health agencies. In many cases, federal landholding agencies, such as the Department of Defense, possess the authority to enforce ICs on their property. At active federal facilities, land use restrictions may be addressed in Base Master Plans, facility construction review processes, facility digging permit systems, and/or the facility well permitting systems.

Enforcement and permit tools with IC components are legal tools, such as administrative orders, permits, Federal Facility Agreements (FFAs) and Consent Decrees (CDs), that limit certain site activities or require the performance of specific activities (e.g., to monitor and report on an IC's effectiveness). They may be issued unilaterally or negotiated.

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[6] UECA was developed by the National Conference of Commissioners on Uniform State Laws. http://www.environmentalcovenants.org/ueca

Informational devices provide information or notification to local communities that residual or contained contamination remains on site. As such, the site manager and site attorney should make sure to provide language that clearly conveys the purpose of the informational device. Typical informational devices include state registries of contaminated sites, notices in deeds, tracking systems, and fish advisories.

The four categories of ICs described above are typically available for CERCLA, RCRA, Brownfields, federal facilities, and UST cleanups. However, some of the individual instruments may not be available for all site types. For example, county zoning is typically not available at an active federal facility, and base master plans are typically no longer relevant at transferring federal facilities. In addition, more than one category of IC can be used to ensure a given objective is fully addressed (see Section 3.3).

2.3 Program-specific Role of ICs in Cleanups

Most cleanup programs use ICs, and the challenges of planning, implementing, maintaining and enforcing ICs may be similar across the programs, with some differences at active federal facilities. Generally, under each program, site managers and attorneys should fully evaluate ICs during the development of cleanup alternatives and plan for the implementation, maintenance and enforcement challenges early in the cleanup process. However, it may be important to recognize the program-specific differences in the processes, authorities and responsibilities for planning, implementing, maintaining, and enforcing ICs.

This guidance illustrates some of the program-specific factors that should be considered. It is not intended to be an exhaustive list of the requirements and practices in each cleanup program. It highlights key crosscutting principles rather than enumerating the program-specific variations. Although the cleanup programs do have important differences, the cleanup objectives are similar in that they use ICs in implementing cleanup decisions that are protective of human health and the environment.

CERCLA. Under the National Contingency Plan (NCP), the remedy selection process under CERCLA is guided by several expectations. These include: 1) treatment should be used wherever practicable to address principal threat wastes[7]; 2) ground water should be returned to its beneficial use wherever practicable in a reasonable time frame[8]; and 3) ICs should supplement engineering controls to prevent or limit exposure, but ICs normally "shall not substitute for active response measures."[9] Thus, ICs are expected to play an important role by minimizing the potential for human exposure and protecting engineered remedies,[10] but they are not intended to be a way "around" treatment or ground water restoration. Under the NCP, ICs are not to be used as the sole remedy unless active response measures are determined to be impracticable.[11] An IC-only remedy is considered a "limited action" and as such is not the same as a "no action" remedy decision. In cases where EPA determines that "no action" is needed under CERCLA, the decision document should state that the "no action" decision does not preclude EPA from reasserting its authority to later require a response, including ICs.

The use of ICs following Fund-financed removal actions is discussed in previous EPA guidance that addresses post-removal site controls (PRSCs) (*Policy on Management of Post-Removal Site Control*, OSWER 9360.2-02, December 1990). Generally, Regions should treat ICs like PRSCs.[12] The NCP states that *to the extent practicable* (emphasis added) provision for PRSCs following a Fund-financed removal action at both NPL (National Priorities List) and non-NPL sites is encouraged to be made prior to the initiation of the removal action. Such control includes actions necessary to ensure the effectiveness and integrity of the removal action after the completion of the on-site removal action (40 CFR § 300.415(l)). Such controls may be conducted by state, tribal, or local governments; potentially responsible parties (PRPs); or EPA's remedial program for some federal-lead Fund-financed responses at NPL sites upon completion of the removal action.[13] EPA encourages the Regions to coordinate with the state, local governments, and/or community groups prior to the initiation of the removal action, to seek commitments for conducting PRSC, and to notify the state of any recommendation or decision regarding the need for ICs.

Further information to assist states and EPA with the transition of responsibilities from the EPA removal program to the state following an EPA removal action is provided in *Coordination*

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[7] Principal threat wastes generally are source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. For more information, please see *A Guide to Principal Threat and Low Level Threat Wastes*, November 1991. Office of Emergency and Remedial Response (OERR) 9380.3-06FS.

[8] For more information on remedy selection see *Rules of Thumb for Superfund Remedy Selection*, August 1997. EPA 540-R-97-013 OSWER 9355.0-69

[9] These expectations appear in 40 CFR § 300.430(a)(1)(iii).

[10] Regulations that define protectiveness may include requirements for restricting land use in certain situations. These may be determined on a site-specific basis to be an applicable, or relevant and appropriate requirement under CERCLA.

[11] See 40 CFR § 300.430(a)(1)(iii)(A), (B), (C), and (D).

[12] Unlike ICs, PRSC can include a broader array of items such as site maintenance activities, repairs, O&M, and environmental monitoring.

[13] It is important to note that EPA does not use the Fund to pay for IC monitoring or enforcement at removal sites. CERCLA § 104(c)(3) requires states to pay for or ensure the payment of all future routine O&M following Fund-financed remedial actions.

of Federal Removal Actions and State Remedial Activities, Association of State and Territorial Solid Waste Management Officials (ASTSWMO), 2007.

RCRA. The use of ICs for RCRA cleanups is discussed in a 1996 Advance Notice of Proposed Rulemaking (ANPR) for corrective action for releases from solid waste management units (EPA 1996), pages 19,448-19,464; *Final Guidance on Completion of Corrective Action Activities at RCRA Facilities ("Corrective Action Completion Guidance")*, 68 FR 8,457-8,764 (February 25, 2003) and an EPA memorandum titled *Ensuring Effective and Reliable Institutional Controls at RCRA Facilities*, June 2007.

Generally, under RCRA, ICs are included as components of the corrective action and/or post-closure care requirements at a facility, and as such may be incorporated into a permit or an order. The Corrective Action Completion Guidance discusses issues associated with completing corrective actions at RCRA facilities, and provides for two types of completion determinations: (1) Complete with Controls; and (2) Complete without Controls. The Corrective Action Complete with Controls determination may be appropriate at facilities where, among other requirements, all that remains is performance of required Operations and Maintenance (O&M) and monitoring actions, and/or compliance with and maintenance of any ICs. Facilities, or portions of facilities, that are not conducting cleanup as part of corrective action may still have cleanup and IC requirements as part of their facility post-closure care permit requirements. RCRA permits and orders can be used to restrict the use of a property by the current facility owner/operator and/or require that the owner operator implement, maintain and enforce proprietary controls, as needed. For example, EPA-issued orders under RCRA § 3008(h) or § 7003 may require, or prohibit, certain activities at the facility by the current facility owner/operator, and also require as part of corrective action that proprietary and/or governmental controls are used to ensure long-term protectiveness. States may be authorized to implement either or both of the corrective action or base regulatory programs under RCRA and as such may develop their own approaches for cleanup and ICs. For more information on remedial action selection under RCRA see the ANPR, page 19432.

Federal Facilities. EPA's FFRRO and FFEO have issued guidance on describing and documenting ICs in federal facility response actions in Records of Decision (RODs), remedial designs (RD), and remedial action work plans (RAWP) in the *Sample Federal Facility Land Use Control ROD Checklist with Suggested Language (2006)*, which provides language for creating enforceable LUC requirements. The LUC Checklist includes sample language for ICs to include in a ROD, RD, RAWP, or other post-ROD document.

Because some federal agencies may have somewhat different procedures, it is important when dealing with federal facility issues to coordinate with FFRRO and FFEO and the specific federal agency in question.

Brownfields and UST Sites. State and local governments often define the cleanup levels at Brownfields and UST sites. The site manager and site attorney are encouraged to work together to make sure that the types of ICs used are consistent with the level of cleanup, and the proposed re-use of the sites.

3. PLANNING FOR INSTITUTIONAL CONTROLS

Full life-cycle planning (i.e., planning, implementing, maintaining, enforcing, modifying if necessary, and terminating) is recommended to ensure the long-term durability, reliability, and effectiveness of ICs. Many problems experienced by practitioners using ICs can be avoided by critically evaluating and thoroughly planning for the entire IC lifespan early in the response selection and design process. [14]

Site managers and site attorneys should seek input from state, tribal, and local governments, responsible parties, affected communities, and other stakeholders during the response selection process in order to ensure that the most appropriate response, including IC(s), is selected. Early cooperation and coordination among these parties with IC planning activities can be critical to the long-term stewardship at a site. Long-term protectiveness at the site often depends on compliance with the ICs to assure the remedy continues to function as intended.

It may be beneficial for state, tribal, and local governments to work with, and reach a common understanding[15] with, the responsible parties and other stakeholders about various IC roles and responsibilities. This common understanding will likely vary depending upon whether federal, state, and/or local authority is used. Whenever possible, Regions should document in writing any arrangements made between parties with responsibilities for IC implementation, maintenance, and enforcement. Existing state and local programs may provide a good framework or foundation for ICs. The following are additional considerations that may be important in evaluating and planning for the IC life cycle.

[14] In addition to the remedy selection process, ICs may also be chosen as part of a non-time critical removal action and should be evaluated as part of the Engineering Evaluation/Cost Analysis Study (EE/CA) under CERCLA.

[15] Parties may be able to reach a common understanding regarding their respective IC roles and responsibilities through various mechanisms that may be available under State law (e.g., a Memorandum of Understanding, Administrative Order on Consent, contract, or enforceable agreement).

> ***Planning for Institutional Controls***
>
> - Selection of ICs (Section 3.1)
> - Determining Which Legal Tools to Apply (Section 3.2)
> - Layering (Section 3.3)
> - IC Implementation and Assurance Plans (Section 3.4)
> - Cost Estimation (Section 3.5)
> - Funding (Section 3.6)
> - Community Involvement (Section 3.7)
> - Capacity for Implementing and Managing ICs (Section 3.8)

3.1 Selection of ICs

As part of a remedial action, evaluation and selection of ICs should generally follow a process similar to other remedy components. This typically includes an evaluation of the substantive restrictions on the use of property that may be needed to protect engineering controls and human health and the environment. Site managers and site attorneys should also evaluate the capability and capacity of the local governmental (or other) entities that will be responsible for implementing, maintaining, and enforcing the potential ICs (see Section 3.8). In parallel, they should engage with communities to ensure the community is fully aware of ICs under consideration and seek community input (see Section 3.7).

A preliminary IC evaluation should typically be included as part of site investigation efforts. These may include, for example, a RI/FS developed during CERCLA remedial actions; an Engineering Evaluation/Cost Analysis study (EE/CA) in CERCLA non-time critical removal actions; and in similar Brownfields and UST investigations and decision documents.

Under CERCLA, the proposed restriction should normally be identified in the Proposed Plan, for notice and opportunity to comment by potentially affected landowners and the public. ICs are typically then selected and memorialized in the ROD; generally they are implemented through various types of legal instruments (e.g., an easement). When evaluating different types of IC instrument(s), Regions should normally consider: (1) what are the basic use restrictions needed to ensure that the response actions remain protective and effective, and what types of IC instrument(s) could achieve those restrictions (i.e., what are the potential routes of exposures and how would the IC instrument(s) help minimize those risks)? (2) what tools and strategies are potentially available and what are their legal and practical limits (e.g., are IC lifecycle costs prohibitive)? and, (3) who will ultimately be responsible for activities through each phase of the lifespan of the IC?

For emergency and time-critical removals, EPA, states, or responsible parties should conduct a preliminary IC evaluation as early in the response process as possible. Before commencing a CERCLA removal action, EPA should discuss with the State and/or PRPs the need for ICs following a removal action, and seek a written commitment that the State and/or PRP will assume responsibility for ICs at the site (*Policy on Management of Post-Removal Site Control*, OSWER 9360.2-02, December 1990). EPA may consider requiring an IC in the removal decision document (i.e., action memorandum) when the removal action does not result in UU/UE, especially when EPA will not likely initiate a remedial action upon the completion of the removal action.

In RCRA Corrective Action cleanups, ICs should be evaluated as early as possible, such as when contamination is first discovered at the facility or during the RFI. ICs should be more fully evaluated as part of the CMS or equivalent, or during the design of any interim measures for the facility. In cases where EPA or the State uses performance standards or a similar approach, or in less complex sites, the submission or approval of a formal CMS might not be required. However, ICs should still be evaluated as early as possible under these alternative approaches. Typically, at Corrective Action facilities, the facility owner/operator recommends a response action based on the CMS or equivalent, the lead agency evaluates the response action recommendation and decides what response to propose for public comment and, with owner/operator and public input, makes the final response selection, typically through a permit or order. Each step in this remedy evaluation and selection process provides an opportunity to evaluate and plan for the full life cycle of any ICs.

3.2 Determining Which Legal Tools to Apply

The site attorney should carefully examine state and local laws relevant to the ICs being considered.[16] To help ensure a thorough evaluation, this examination should normally be done as a standard practice during the identification and analysis of the response action. The examination typically occurs during the Superfund FS for remedial actions, the EE/CA process for Superfund non-time critical removal actions, the RFI/CMS process during the RCRA corrective action and permitting processes or the equivalent closure process under Brownfields and UST. Some of the key considerations for this examination are:

- Based on an early evaluation of land title records, are proprietary controls durable?
- Who has the legal authority for implementing and enforcing proprietary controls?
- Who can hold a property interest (i.e., be the grantee) for a proprietary control?

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[16] Some State and local laws and regulations relating to land use may not be enforceable on federal facilities.

- Which state, tribal, or other agency has the legal authority and willingness to accept the transfer of an interest in real property?
- Can real property law in the jurisdiction be used to implement the selected IC in a way that will make it binding on future land owners (i.e., "run with the land") and function in perpetuity, if necessary?
- Are there any restrictions on the use of appurtenant easements (i.e., an easement, or interest, created to benefit an adjoining property) versus in gross easements (interest created was not for the benefit of a particular adjoining property)?
- Are there state laws that authorize ICs (e.g., whether the state has adopted UECA, and what role is allowed under that statute for EPA)?
- What are the limits of the local government zoning and permitting authority?
- Which state and/or local agencies have the legal authorities to control the potential exposure points (e.g., commercial fishing, market place, restaurant, sport/recreational/subsistence fishing)?
- Do these regulatory agencies actively enforce existing regulations?

The specific provisions of ICs usually depend on the specific site conditions as well as the type of legal instruments available.

3.3 Layering

Often ICs are more effective if they are layered or implemented in series. Layering can involve using different types of ICs at the same time to enhance the protectiveness of the response action. For example, layering governmental controls and informational devices is a common approach used at sediment sites to control human health exposure through eating contaminated fish and/or shell fish. [17] Although layering can have its advantages as an IC strategy, site managers and site attorneys should evaluate whether layering may lead to misunderstandings over accountability or to an unnecessarily restrictive response (e.g., preventing reuse) if ICs are not narrowly tailored to meet the response objectives. The layering of ICs and extent of ICs should be commensurate with the amount, concentrations, toxicity and other characteristics of the residual waste. Site managers and site attorneys should also consider informing the entity responsible for maintaining a particular IC that layering does not diminish the importance of its responsibilities. For an additional explanation of layering, see *A Site Manager's Guide to ICs.*

3.4 IC Implementation and Assurance Plans

To ensure effective implementation of ICs, we recommend using an IC Implementation and Assurance Plan (ICIAP).[18] Regions generally should include an ICIAP, or a reference to it, in the final action decision document and site O&M plan.[19] An ICIAP is designed to systematically (a) establish and document the activities necessary to implement and ensure the long-term stewardship of ICs, and (b) specify the persons and/or organizations that will be responsible for conducting these activities. EPA recommends that the Regions prepare a detailed ICIAP which can help ensure ICs are properly implemented and operate effectively during their entire lifespan, and that can function as a single-source of concise site-specific IC information. At PRP-lead Superfund sites, the revised model Remedial Design/ Remedial Action (RD/RA) Consent Decree (CD) incorporates the concept of ICIAPs and provides some optional model language regarding their use. *See Model RD/RA Consent Decree*, Office of Site Remediation Enforcement, Office of Enforcement and Compliance Assistance. October 2009, sections IV & IX).

The ICIAP should identify the existing or anticipated enforcement documents and approaches that may be used to enforce the ICs, where applicable. It should also describe how the combination of ICs for the site relate to the reasonably anticipated future land use assumption used in the response selection process, especially for special siting circumstances (e.g., schools), as well as resource use restrictions called for in the decision document and how they will be effective and durable over their lifetime. Finally, the ICIAP should address effective steps for information disclosure to affected communities, and full cost accounting of ICs throughout the life of the cleanup project.

The ICIAP may be developed at different times during the cleanup process, depending upon the size and complexity of the cleanup and the cleanup authority or program under which it is being developed. Although information related to the development of the ICIAP may be generated throughout the cleanup process (site investigation, response selection, response implementation, and long-term stewardship), it is generally recommended to initiate the ICIAP prior to, or at the same time as, the design (i.e. RD phase under CERCLA) of the physical response action and finalize it with the completion of the response action. This approach should allow

[17] For guidance on institutional controls at contaminated sediment sites, please see *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*, December 2005. EPA-540-R-05-012, OSWER 9355.0-85 or *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites,* February 2002. OSWER Directive 9285.6-08

[18] An ICIAP may not be appropriate for emergency removals and time-critical removals since information needed for IC planning and implementation may not be available prior to a removal action.

[19] ICIAPs do not replace the need to consider ICs in the Feasibility Study analysis or including ICs in decision documents.

time for the site managers, site attorneys, and other interested parties to complete detailed post-response discussions with potential IC implementers, inspectors and other stakeholders. If the ICIAP is not developed in time for inclusion in decision documents, those documents may note the usefulness and potential scope for an ICIAP. The criteria and responsible authority for terminating each selected IC should be identified as part of the full life-cycle planning process in the ICIAP.

As an example, the need for early development of an ICIAP may occur at contaminated sediment sites where CERCLA remedial investigations are in progress and human health exposures from eating contaminated fish are well documented. In such circumstances, developing and implementing an ICIAP in collaboration with appropriate federal, state and/or local jurisdictions, in advance of and/or in conjunction with the engineered response should help ensure protectiveness for populations at risk; by receiving timely outreach and education, those populations can modify their fishing and fish eating behaviors.

EPA is developing a separate guidance on preparing IC implementation and assurance plans.

3.5 Cost Estimation

There are several reasons why a complete and realistic estimate of the full life-cycle cost of ICs is often an important part of the IC planning process. For example, an accurate estimate of the full costs to all parties (e.g., EPA, the State, local government, property owners, federal agencies, and responsible parties) can help evaluate the cost-effectiveness of alternative remedies during response selection, where ICs are an important component of total remediation and/or removal costs. Early in the cleanup process, such as during the RI/FS, EE/CA, or CMS, cost information would typically be compiled to assist in response decision-making, using the best information available at the time. During the response action design phase, more precise information usually is developed and can be used for designing and planning the ICs and for preparing the ICIAP.

In addition, IC maintenance, and enforcement costs may extend beyond the 30-year period traditionally used in many response cost calculations.[20] These continuing costs should be acknowledged when developing response cost estimates and can be important in evaluating long-term effectiveness.

Finally, accurate response cost estimates are typically important so that agencies, governments, responsible parties, and other organizations with the long-term responsibility for the ICs can know their financial obligations prior to entering into settlements. Their involvement can help ensure that adequate resources will be available in the long-term for maintaining and enforcing ICs outside of an agency's direct control, and can significantly increase the reliability of the ICs and overall protectiveness of the response. For more information on cost estimation, please see a *Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, July 2000, EPA 540-R-00-002 OSWER 9355.0-75.

3.6 Funding

Reliable cost estimates can also be important to parties, such as states and PRPs, who will be responsible for site cleanups and ICs. Parties responsible for the cleanups are often required to provide assurances to regulatory authorities that they will complete the O&M, including ICs.[21] Regions should ensure that whatever entity will be responsible for maintaining the IC, including local governments, has the capacity to do so. Cost estimates may also help the planning process for removal actions when appropriate. Under RCRA, the owner/operator of a facility is responsible for conducting corrective action which includes ICs.

An important part of this assurance can be the availability of State or PRP funds throughout the life of the O&M. Further information regarding assurance requirements and costs is provided in Sections 4.4, 6.5, and 8.7 herein.

3.7 Community Involvement

Another important aspect of IC planning normally is community involvement. Site managers and site attorneys should work with the community early in the process to understand the future land uses being considered at a site, and understand how ICs may impact future land uses. Land use planning decisions are generally intended to serve the interests of the community, and communities typically play a central role in shaping policies at the local government level regarding land use planning. As mentioned in the *Land Use in the CERCLA Remedy Selection Process* directive (OSWER 9355.7-04, May 25, 1995), where there are concerns that "the local residents near the Superfund site may feel disenfranchised from the local land use planning and development process…EPA should make an extra effort to reach out to the local community to establish appropriate future land use assumptions…"[22] Thus, community input is

[20] "Past USEPA guidance recommended the general use of a 30-year period of analysis for estimating present value costs of remedial alternatives during the FS (USEPA 1988). While this may be appropriate in some circumstances, and is a commonly made simplifying assumption, the blanket use of a 30-year period of analysis is not recommended. Site-specific justification should be provided for the period of analysis selected, especially when the project duration (i.e., time required for design, construction, O&M, and closeout) exceeds the selected period of analysis." (*Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, July 2000, EPA 540-R-00-002 OSWER 9355.0-75)

[21] See, for example, 40 CFR § 264.101 for financial assurance requirements for corrective action at RCRA-permitted facilities.

[22] *Land Use in the CERCLA Remedy Selection Process* (OSWER Directive 9355.7-04; May 1995) available at http://www.epa.gov/swerosps/bf/html-doc/landuse.htm.

often critical in helping site managers and site attorneys develop assumptions regarding the reasonably anticipated future land use for a site, and in selecting ICs.

Site managers and site attorneys are encouraged to work with the Community Involvement Coordinators (CICs) to develop strategies to ensure that the community understands why ICs are needed (e.g., why it may not be feasible to clean up the site to levels that allow for unrestricted use), how the ICs will work as part of the cleanup to protect human health and the environment, and any potential implementation issues associated with an IC. Community understanding and support can significantly improve the likelihood that ICs will be appropriately selected, implemented and maintained effectively.

Regions should ensure communities have meaningful opportunity to review proposals for site remedies and provide adequate information to allow informed public comment regarding the choices between cleanup alternatives that either achieves levels that allow for unrestricted use, or leave levels that lead to restricted uses and rely on ICs. When waste is left in place and ICs are needed, Regions should provide the affected community an opportunity to review the analysis (e.g., a proposed plan) that supports the choice of leaving waste in place as opposed to a more aggressive cleanup.

Once cleanup actions have been completed, the local community may be impacted by ICs and associated land use limitations if there is residual waste on site that requires continued management. As such, one of the critical roles a community can play is to identify potential issues regarding state or local government capacity or ability to manage and oversee the ICs effectively. In the event that there is a question about the ability to manage and oversee ICs effectively, Regions should consider whether it may be appropriate to consider removal of additional waste to eliminate the need for ICs, or rely on other ICs that can be effective in ensuring that reuse would not pose a threat to human health or the environment.

Finally, it should be recognized that public input can help identify combinations of ICs that can more effectively facilitate the return of environmentally distressed properties to beneficial use. For example, CERCLA Fund-financed response actions may require certain state assurances for implementing, maintaining, and enforcing ICs at remedial action sites following completion of the remedial action, and for implementing post-removal site controls at removal sites. Involving community members in the evaluation of the options may provide valuable information and foster the understanding, acceptance, and support for ICs that can be critical to support the long-term reliability of the cleanup.

3.8 Capacity for Implementing and Managing ICs

When ICs are to be employed as a component of a site response, Regions should carry out an analysis to determine if the state and local agencies responsible for oversight and management of the controls have the ability and capacity to implement, maintain and enforce the controls. ICs can only be a reliable component of site cleanup if the responsible agencies have the ability, willingness and capability to oversee and manage these controls. The Regions should consider a number of factors when evaluating ability, willingness and capability for the management of ICs, including:

- Can the ICs be accurately mapped?
- Is it possible to use the States' one-call system(s) to prevent breaches?
- Is it possible to establish a mandatory monitoring and reporting program to routinely review ICs to ensure their continued effectiveness?
- What enforcement authorities are available to ensure ICs are maintained?
- Is it possible to establish informational ICs that effectively disseminate information on the location of controls, compliance status, and monitoring reports to interested stakeholders, state and local environmental officials?
- Is there a source of funding, or is it possible to establish a mechanism to provide funds, for the operation and maintenance of ICs?
- How are IC expenditures to be tracked? Is there a history of expenditures that can be used to refine future planning estimates for the long-term costs of maintaining ICs?

4. GENERAL IMPLEMENTATION ISSUES

A number of factors should be considered to evaluate whether ICs can be effectively implemented as part of a response action. These factors, and the roles of the various interested parties, may differ depending on the type of IC instrument, the specific circumstances at each site, and which authorities are being applied. At many sites, responsible parties may have the primary responsibility for implementing and ensuring the long-term effectiveness of ICs. This section addresses some general issues and concepts typically encountered in implementing ICs.

4.1 Documentation of Use Restrictions and IC Instruments in Decision Documents

For most cleanup programs, use restrictions and IC instruments relied upon to help achieve protectiveness should be incorporated in site decision documents; often such an IC can be based upon a preexisting state or local law or program. The decision document(s) should describe the rationale for using the ICs in helping to achieve protectiveness (e.g., their role in maintaining the effectiveness of the response action) and should include as much detail about the ICs as possible. Specifically, the decision documents should describe how the recommended ICs accomplish the specific land and resource use restrictions that are the objectives of the IC.

General Implementation Issues

- Documentation of Use Restrictions and IC Instruments in Decision Documents (Section 4.1)
- Drafting IC Language in the Selected Instruments (Section 4.2)
- Role of Local Governments and Communities (Section 4.3)
- State Assurance for Stewardship at CERCLA Fund-lead Sites (Section 4.4)
- ICs and Landowners (Section 4.5)

Different cleanup programs utilize different authorities, processes, and documentation of response actions. The main remedy decision documents used for Superfund remedial actions generally are RODs, Explanation of Significant Differences (ESDs), and ROD Amendments. For CERCLA removal actions, the Action Memorandum is the decision document to select and authorize removal actions (*Superfund Removal Guidance for Preparing Action Memoranda*, September 2009 which updates and replaces *Superfund Removal Procedures: Action Memoranda Guidance*, OSWER 9360.3-01). Because ICs are generally not selected as part of the removal action, the Action Memorandum should generally indicate that the State will be the lead agency for planning, implementing, maintaining and enforcing ICs in those cases where ICs would be appropriate after the removal action and where the site is non-federal. Examples of RCRA documents that may contain IC language include permits and orders, corrective action decision documents known as Statements of Basis, Final Decision/Response to Comments, and equivalent documents issued by authorized states. Brownfields, UST, and federal facility sites often have equivalent decision documents, cooperative agreements, or work plans.

In addition to decision documents, other documents that may include information related to the remedy and/or ICs for the site are Superfund orders, CDs, and related documents. The RD, ICIAP, IC requirements in an O&M plan, five-year review (FYR) or other periodic remedy reviews, or equivalent documents also may provide IC details. For federal facilities under CERCLA, LUC implementation details are generally placed in a post-ROD enforceable document usually called a LUC Remedial Design or Remedial Action Work Plan or a LUC Implementation Plan.

Specificity of Language in Decision Documents - Selecting Restrictions and ICs. Because many ICs involve complex legal analysis and issues, site attorneys should play a leading role in developing the appropriate language. Developing the appropriate language may require a combination of expertise in the federal and state environmental laws, regulations, and programs involved, as well as local and state real estate law and practice. One of the challenges that site attorneys and site managers may face is translating the substantive land and resource use restrictions selected in the decision document into IC instruments. Vague or missing language about the restrictions in the decision document may have unintended consequences including either under or overly-prescriptive IC instruments. As a general principle, site managers and site attorneys are encouraged to present information in decision documents that, for any ICs selected in the decision document:

- Clearly describes the objectives to be attained in terms of specific land and resource use restrictions;
- Includes a map and describes the geographic location of the restricted areas;
- Identifies the entities responsible for implementing, maintaining, and enforcing the ICs;
- Discusses plans for maintaining and, as appropriate, the enforceability of the anticipated IC instrument(s);
- Evaluates the likelihood that the ICs can be effectively implemented, and
- Identifies the necessary lifespan of the IC (e.g., either as interim or permanent measures).

An analysis of this type of information will generally help the site manager and site attorney appropriately select the IC instrument(s) that can meet the response action objectives. Providing this information to the public should also aid the public's understanding of the need for the specific ICs and their relationship to the overall response. This analysis should be appropriately documented in the decision document(s).

It is recognized that at the time of decision document signature there may be some uncertainty as to the specific IC instrument to be implemented at the site. Every effort should be made to provide as much specificity at the time of the decision including, where appropriate, the types of uses of the site that should be protective based on the proposed response actions, the ICs that can help ensure protectiveness, and which entity will assume responsibility for implementing, maintaining and enforcing the restriction, where possible.

For additional information on federal facilities, see EPA's *Sample Federal Facility Land Use Control ROD Checklist with Suggested Language*, October 2006.

Modifying Existing Response Action Decision Documents. In some circumstances, it may be appropriate for site managers and site attorneys to work together to clarify or specify IC requirements in existing decision documents (e.g., where IC language is vague or incomplete). At Superfund sites, if the change to a Superfund remedial action is deemed minor or not significant, it may be appropriate to clarify the ROD through a memo to be added to the site file. If the change is determined to be significant, but not fundamental, an ESD may be appropriate. In some instances, a site manager and site attorney may determine that an opportunity for public comment is appropriate for sites with significant stakeholder interest. In some cases, a fundamental change to a Superfund remedy may be necessary; in such cases, a ROD amendment should be prepared. This may occur in situations where, for example, an implemented remedy that relies in part on an IC fails to attain the remedial action objectives (RAOs). In addition, if an appropriate IC cannot be developed to attain the RAOs described in the ROD; a revision to the overall remedy may be warranted.

Regions should continue to review and strengthen ICs with periodic reviews that take changes in land use into account. For a site-wide ready for anticipated use (SWRAU) determination, [23] the Regions consider whether all ICs called for in the decision documents are in place and continue to be effective. IC instruments, such as notices, can be effective controls and should be considered when evaluating a SWRAU determination. In some cases, it may be appropriate to strengthen, layer, or include supplemental ICs at the site to ensure protectiveness of human health. In the event that a review (e.g., a CERCLA FYR) identifies the need to modify the existing IC(s), it may be appropriate to modify the original decision document (e.g., the ROD). If a decision document is amended to require additional ICs, then the Region may want to wait to evaluate whether the site achieves SWRAU.

If the RAOs can be met using new or additional ICs, Regions should evaluate what type of modifications, if any, to existing remedy decision documents and associated enforcement documents (if any) may be appropriate. Where the Region makes changes to the engineering component of the remedy, the site manager and site attorney also should ensure that any existing ICs are consistent with the revised remedy. For information on changing Superfund remedies, see *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents*," EPA 540-R-98-031, OSWER 9200.1-23, July 1999. When documenting significant changes made to a remedy in the Superfund program, the lead agency must comply with the public participation requirements of CERCLA § 117(c); the NCP also has provisions that address public participation (see e.g., 40 CFR §§ 300.435(c)(2)(i) and 300.825(a)(2)).

To document IC changes to the removal action, the Region should either supplement or amend the action memorandum as appropriate depending upon the nature of the IC and the change.

Under RCRA, a permit modification or change to a corrective action order may be necessary if the previously understood conditions, selected remedies, or overall operations change. The requirements for modifying an existing permit may vary from state to state. If the selected response, including any ICs, differs from the proposed response as discussed in the Statement of Basis, the final permit modification should reflect such changes.

As stated previously, Brownfields and UST cleanup requirements vary by state authority, so the state site manager and site attorney should research the existing administrative procedures for modifying response decisions.

4.2 Drafting IC Language in the Selected Instruments

This section provides recommendations for identifying and addressing several potential issues regarding IC language in a variety of contexts. Vague or inappropriate IC language can lead to confusion and conflict in establishing effective ICs and, in some cases, may result in the creation of unintended rights and/or obligations. Regions generally should ensure that the IC language in the instrument clearly states the IC objectives (e.g., restrict well drilling) and their relationship to the response action (e.g., prevent human consumption of contaminated ground water).

Using Subject-Matter Experts and Stakeholder Input

It may be useful to consult subject-matter experts and stakeholders in developing appropriate IC provisions. For example, special expertise may be needed to develop language for proprietary controls, governmental controls, or informational devices.

When developing the specific IC language, the site attorney may consider consulting, where appropriate, with officials from national professional organizations; the state attorney general's office; state environmental protection agency; local government planning agencies; several EPA offices including OSRTI, Office of Enforcement and Compliance Assurance (OECA), FFRRO, FFEO and OGC; responsible parties; site owner (if different from the responsible party); other federal agencies; and community stakeholders. Such consultations can help to ensure that IC instruments that are identified and implemented (such as covenants, easements and notices) are recorded in local land records, and comply with the real property law and recording statutes of the appropriate jurisdictions. Such consultations can be especially useful because state laws can vary significantly.

For enforcement-lead sites, attorneys may consider drafting enforcement documents that would require the responsible parties to provide supporting information (e.g., a certification from a real estate attorney) demonstrating that the covenant, easement, or notice meets the appropriate requirements for the jurisdiction. In the case of local governmental controls such as zoning, the site attorney and site manager should work closely with local government staff to ensure that the IC can be implemented, maintained, and enforced.

[23] As further discussed in Section 9, this determination is made for purposes of the Government Performance and Results Act.

Through active interagency and intergovernmental coordination, the site attorney and site manager usually can better ensure that the language used leads to effective ICs that meet the IC objectives stated in the decision document and that can be appropriately implemented, maintained, and enforced within the jurisdiction. Community involvement in the development process to promote the acceptance and understanding of ICs can help in developing ICs that are reliable, durable, and effective over time.

Useful IC Provisions. The following provisions should be considered for inclusion in the IC documents:

- *Notification to lessees.* Enforcement documents such as Administrative Orders on Consent (AOCs) and CDs may reference existing lease agreements and require lessors to notify existing lessees and sub-lessees of the residual contamination and the restrictions on the use of the property. Also, a notice of the residual contamination and use restrictions should be included in any future leases or subleases of the property and such leases and subleases should be made subject to any proprietary controls.
- *Notification to EPA, states, tribes, and local governments*. The site attorney and site manager should determine whether proprietary controls and enforceable documents should require the signator or owner of a proprietary interest to give prior notice to EPA (or other lead agency), as well as the state, tribal, and local governments, of any changes in land use, property transfers, or any other activity that may affect the protectiveness of the IC and/or the engineered response action. In addition, the IC should have clear provisions for notification in the event of a breach of the IC. Such notifications should indicate, or provide enough information to determine, if the IC process and environmental performance objectives are being met.
- *Site description.* IC documents should include a comprehensive site description to help focus the ICs needed on specific areas of the site or on specific environmental issues. Regions should avoid applying ICs to the entire site rather than the specific area requiring the restriction, where this would result in the needless restriction of areas that should not have been subject to ICs. Thus, it is important to accurately describe the parcel boundaries and the location of any residual contaminants as well as provide a map to reflect these boundaries and locations. Appropriate mapping can show both the location of site-related contamination and where ICs have been implemented. It is also helpful to note the location of any structures (including temporary structures associated with response activities), zoning, ownership, and other information deemed relevant for the intended use of the site. It should be noted that the location and dimensions of the residual contamination may change over time (e.g., due to contaminant migration or attenuation). A number of descriptors can be used to characterize the location and other factors about the site. Information describing suggested location variables can be found in Section 3 of the *Institutional Control Data Standard, Standard No.: EX000015.1*, January 6, 2006, Environmental Data Standards Council (EDSC). At some sites it may be appropriate to develop dual descriptions, where the EDSC standards are different from the legal description.
- *Termination*. The site manager and site attorney should determine the criteria for terminating a particular IC and who will have the authority to make and implement that determination.

4.3 Role of Local Governments and Communities

While EPA, the state, or tribe may take the lead on many response actions, local governments and community members typically plan and regulate land use at the site. Local governments and community members can offer valuable information on the land use controls available in their area, and may help develop creative solutions that can help ensure protection of human health and the environment while also considering the interests of other local stakeholders. Local governments are often the only entities that have legal authority to implement certain types of ICs (e.g., zoning restrictions). Therefore, local governments and community members generally are important partners for implementing, maintaining, and enforcing certain ICs.

> **Some Potential Key Roles for Local Governments and Community Members**
>
> - Provide input on the reasonably anticipated future use at the site.
> - Provide information and input on the available land use controls within the jurisdiction of the local government.
> - Implement, maintain, and enforce zoning and permitting regulations.
> - Evaluate building permit requests, site plans, and zoning applications.
> - Provide notice to EPA and the state regarding land use changes at the site.
> - Provide information relevant to the planning, design, and execution of periodic reviews, such as the CERCLA Five-Year Review (FYR) process.

Site managers and site attorneys are encouraged to involve both community members and local governments early in the response process, and to discuss reasonably anticipated future land use, public health protection goals, and the IC instruments being considered to achieve these goals. In addition, it can be important to clearly discern the regulatory jurisdictions of different state and local resource agencies and public health agencies regarding their authorities and programs. This process often encourages multiple face-to-face meetings with local officials and community members by both site managers and CICs. The involvement of local governments and community members in IC planning and implementation can lead to more effective and appropriate ICs, and avoid delays in developing them or completing the cleanup.

4.4 State Assurance for Stewardship at CERCLA Fund-lead Sites

In general, CERCLA § 104(c)(3)(A) requires the State to provide assurance that it will assume responsibility for O&M of a Fund-financed remedial action. The NCP (40 CFR § 300.510(c)(1)) provides that "the State must assure that any institutional controls implemented as part of the remedial action at a site are in place, reliable, and will remain in place after the initiation of O&M. The State and EPA shall consult on a plan for operation and maintenance prior to the initiation of a remedial action." These assurances are normally documented in a cooperative agreement for State-lead sites, or in a Superfund State Contract (SSC) for Fund-lead sites.

Detailed cooperative agreements and contracts with State agencies may contain much more detailed information about IC implementation than an ICIAP. These cooperative agreements, contracts, or commitment letters can be used to clarify the State's role in implementing ICs that are part of the remedy selected in the ROD. For example, they may include detailed activities, deliverables, schedules, and tracking mechanisms. However, they cannot be used to provide Federal funds to the state or local agencies for maintaining and enforcing ICs that fall under the umbrella of O&M at Fund-lead sites. See Section 8.7 for further details on the limits of the use of Fund money.

An agreement to fund the initial implementation of ICs and formalize O&M responsibilities may enable the State to provide the necessary assurance. However, if the State is unwilling or unable to provide this assurance, the site manager and site attorney may need to consider other ICs or, if necessary, choose an alternate remedy that does not need ICs to ensure protectiveness. Therefore, it is important that a site manager and site attorney fully understand the capability and willingness of the State to provide assurances for ICs before Superfund remedy decisions are made.

Prior to initiating a time-critical or non-time-critical removal action, Regions are encouraged to seek a written commitment from the State, local government, or PRP that they will assume responsibility for ICs. Where the State will be responsible for the ICs following a non-time critical removal action, the request for commitment could be included in the applicable or relevant and appropriate requirements (ARARs) request letter (which may already be happening prior to signature of the decision document). For PRSCs, the Region is encouraged to obtain the commitment prior to initiating the removal action. For an emergency removal, the Region may seek a written commitment after initiating the removal action**.** See *Superfund Removal Procedures – Removal Enforcement Guidance for On-Scene Coordinators*, OSWER 9360.3-06, April 1992.

4.5 ICs and Landowners

Generally, owners of contaminated property are responsible for addressing the contamination on their property, including implementing and/or maintaining ICs. Under CERCLA, for instance, landowners specifically may be liable for costs associated with or performance of the cleanup.

There may be instances under any of the cleanup programs where a restriction needs to be placed on the property of a landowner who did not cause or contribute to the contamination. Under CERCLA, EPA has authority to obtain property access under § 104(e), to order parties to perform site cleanup under § 106, and to acquire real property interests under § 104(j). Similar authorities may not be available to states or EPA under other cleanup programs (e.g., different liability provisions apply to UST and RCRA cleanups). EPA strives to ensure that the parties responsible for the contamination implement and maintain ICs, including those restrictions on properties not owned by them.[24] In such cases, a responsible party may need to negotiate with landowners in order to obtain cooperation or agreements to maintain an IC on their property. If responsible parties are unable to negotiate an IC with landowners, the Region may need to reassess the response action or pursue other strategies to implement the selected IC. Where responsible parties are unwilling to work with landowners to implement ICs, the Region should ensure that IC commitments or requirements made in enforcement documents (e.g. commitments in settlements, requirements in administrative orders) are met. Where landowners of contaminated property are unwilling to have an IC implemented on their property, the Region may require them to take an appropriate action through enforcement tools such as a Unilateral Administrative Order (UAO). These scenarios are addressed in more detail in Section 9.4 herein.

Where a response action involves ICs that are to be implemented on properties owned by parties who did not cause or contribute to the contamination, the community (including all property owners involved) and local government should be involved early during the response process. Moreover, any affected landowners should be given adequate notice of the proposed response action and the opportunity to comment. This can occur, for example, in the Proposed Plan

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[24] "*Enforcement First" to Ensure Effective Institutional Controls at Superfund Site, OSWER Directive 9208.2, March 17, 2006*.

and comment period process used for CERCLA remedial actions.

The sections below discuss some specific considerations when contemplating a remedy that calls for landowners who either qualify for conditional limitations on, or exclusions from, liability or who are otherwise not liable to take steps to implement or maintain ICs.

Conditional Limitations on or Exclusions from, Liability for Landowners of Contaminated Property. Some selected response actions may call for ICs to be implemented on properties owned by parties who did not cause or contribute to the contamination but nonetheless may have responsibilities for implementing and maintaining ICs on their properties. For example, the Small Business Liability Relief and Brownfields Revitalization Act, Pub. Law 107-118 (the Brownfields Amendments), enacted in January 2002, amended CERCLA to provide and clarify certain qualified liability limitations for landowners, including: (1) bona fide prospective purchasers; (2) contiguous property owners; and (3) innocent landowners. These qualified liability limitations are conditioned on meeting certain threshold criteria and continuing obligations. Particularly relevant to ICs is the continuing obligation to comply with any land use restrictions and to not impede the effectiveness or integrity of any ICs established, relied on, or connected with a response action. For more information on these statutory liability protections available to landowners, see *Interim Guidance Regarding Criteria Landowners Must Meet in Order to Qualify for Bona Fide Prospective Purchaser, Contiguous Property Owner, or Innocent Landowner Limitations on CERCLA Liability ("Common Elements" Guidance),* March 6, 2003.

Some responses may also call for ICs on properties owned by parties subject to a liability protection (e.g., landowners of uncontaminated properties that have liability protection and the properties are otherwise integral to a response action). For example, an IC can be used to protect the integrity of a ground water sampling well that is in place to monitor the migration of a contaminated ground water plume. It may be challenging to implement ICs in these scenarios because the landowners have a liability protection that shields them from liability for the response action. Early and meaningful outreach to these landowners, including describing the purpose and objectives of the response and the need for the IC, is particularly important in these cases.

For landowners that may not qualify for the qualified liability limitations contained in the 2002 Brownfields amendments, EPA has enforcement tools that may alleviate some concerns about their CERCLA liability as owners of contaminated property. EPA issued its *Policy Towards Owners of Residential Properties at Superfund Sites, OSWER Directive 9834.6*, July 3, 1991, an enforcement discretion policy, the goal of which was to relieve residential owners of the fear that they may be subject to an enforcement action even though they had not caused the contamination on the property. Similarly, EPA has issued an *Interim Enforcement Discretion Guidance Regarding Contiguous Property Owners*, January 13, 2004, and a *Final Policy Toward Owners of Property Containing Contaminated Aquifers*, November 1995, which discuss EPA's enforcement position with respect to contiguous property owners and owners of property that contains an aquifer that has become contaminated as a result of subsurface migration.

Additional Considerations. The challenges presented by implementing ICs on properties owned by landowners who did not cause or contribute to the contamination are heightened when the desired IC is a proprietary control. These challenges are significant but so are the benefits of proprietary controls, such as their enforceability and long-term effectiveness. These considerations should be balanced when determining when to pursue other types of ICs.

5. IMPLEMENTING PROPRIETARY CONTROLS

Proprietary controls generally use real property and contract law to place restrictions on, or otherwise affect the use of property or related resources. Common examples of proprietary controls include covenants and easements, which give their holders "property interests," or the right to restrict use of the land, but generally not possession of the land.

Implementing Proprietary Controls

- Principles of Proprietary Controls (Section 5.1)
- Proprietary Control Strategies (Section 5.2)
- Documenting the Proprietary Control (Section 5.3)
- Selecting the Grantee (Section 5.4)
- Implementing Proprietary Controls at CERCLA Fund-lead Sites (Section 5.5)
- State Assurance Requirements for Acquiring Real Estate Interests under CERCLA (Section 5.6)
- Establishing ICs through RCRA Orders and Permits (Section 5.7)

5.1 Principles of Proprietary Controls

For a proprietary control to be put in place, a transaction typically occurs in which a property interest is conveyed from the owner of the land, known as the "grantor," to some other party who will be the "holder," also known as the "grantee." The term "grantee" refers to the party holding the reserved uses (e.g., property interests). This transfer of interest generally is memorialized in a written agreement, which is then recorded in the local land records.

For example, a property owner (grantor) may agree to restrict the drilling of ground water wells on his/her property and grant the right to prohibit the drilling of wells to another party.

Through the recording of a proprietary control, the restricted uses normally are considered to be "running with land" so that all future owners or interest holders would be bound by them. Selecting an appropriate grantee can be one of the most critical issues in the effective implementation of a proprietary control, and is discussed in Section 5.4 herein.

The implementation of a proprietary control may or may not be part of a larger transaction involving the sale or transfer of the underlying property. Some states do not consider certain proprietary controls (e.g., covenants) to constitute interests in real estate. However, the process for implementing such a control will typically be similar to that needed when the control does constitute an interest in real estate.

Since proprietary controls rely heavily on state law and practice, it is important to be aware of all relevant state legislation and regulations. States can address some of the legal impediments to the long-term durability of proprietary controls through legislation (e.g., statutorily allowing the environmental covenant to "run with the land"). Several states have adopted some or all of UECA, model legislation that may reduce the legal and management complications associated with using environmental covenants as ICs. The site manager and site attorney should determine whether there are any such state statutes, and whether they can help ensure the protectiveness of the remedy before the response action is chosen and thereafter as part of any periodic review, maintenance and/or optimization of the remedy.

5.2 Proprietary Control Strategies

At many sites, the responsibility for implementing proprietary controls typically rests with the responsible party or landowner. At many CERCLA Fund-lead cleanups, EPA or the State (depending on which is the lead agency) will typically have implementation responsibility as part of the response action. Required activities are usually documented in a CD or an administrative cleanup order (either unilateral or on consent). At a minimum, the document should state the objective of the IC, the location of the property and specific areas to be covered by the IC, the specific type of proprietary control anticipated, the party who will be the grantee, and a requirement that the responsible party provide notice to EPA and/or the state if the control is violated.

Generally, when the responsible party owns the land that is being restricted, the proprietary control should be memorialized in an enforceable easement or restrictive covenant. If the response action includes the use of a restriction on the use of land not owned by the responsible party, that responsible party should use its "best efforts"[25] to obtain a proprietary interest. This can include responsible party compensation to the affected landowners for the proprietary control. To secure an agreement with the owner of the affected property as to the valuation of the property interests, one or more independent appraisals may be necessary.

If the responsible party cannot obtain the necessary interests despite its best efforts, EPA and/or the state may acquire the interests, and the responsible party may be required to reimburse EPA and/or the state for all costs incurred in acquiring the interests. EPA has authority to acquire property interests for purposes of conducting remedial action at CERCLA sites provided that the State agrees to accept transfer of the real estate interest when O&M is initiated.[26] For additional information on other enforcement strategies that may be appropriate, see Section 9.4.

For purposes of allowing EPA to directly enforce certain proprietary controls, EPA may pursue the role of a "third party beneficiary." That is, another party such as a responsible party or a state would serve as the grantee of the easement or covenant that specifically provides third-party rights of enforcement to EPA. Other viable parties with legitimate interests in ensuring ICs remain in place, such as neighbors, local governments, and environmental and civic organizations, may also act as third-party beneficiaries. This approach can strengthen the effectiveness of the IC by providing an additional means of ensuring compliance. Site managers and site attorneys should consider the third-party beneficiary approach whenever a proprietary control is used. For further information on third-party beneficiary rights, see *Institutional Controls: Third-Party Beneficiary Rights in Proprietary Controls*, Office of Enforcement and Compliance Assistance memorandum, April 19, 2004.

5.3 Documenting the Proprietary Control

As previously discussed, the form of a proprietary control needs to comply with the laws of the jurisdiction in which the property is located, and should be implementable, legally effective, and enforceable. The language of each document should be tailored to the site characteristics, IC objectives (land and/or resource use restrictions), and performance standards (if any) designated in the decision document.[27]

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[25] "Best Efforts" is defined for the purposes of the EPA CERCLA Model RD/RA Consent Decree to include the payment of reasonable sums of money in consideration of access, access easements, land/water use restrictions, restrictive easements, and/or an agreement to release or subordinate a prior lien or encumbrance (*Model RD/RA Consent Decree*, Office of Site Remediation Enforcement, Office of Enforcement and Compliance Assistance. October 2009, paragraph 28).

[26] Although EPA may acquire property interests at remedial sites, and receive reimbursement for costs incurred in acquiring the interests, there is no explicit equivalent authority for CERCLA removal, RCRA, Brownfield, or UST cleanups. See discussion in Section 5.6, State Assurance Requirements for Acquiring Real Estate Interests Under CERCLA.

[27] Where appropriate, use of sample language or model proprietary control documents may be useful. For example, some states have developed templates for proprietary controls consistent with their legislation, partly to ensure that the controls are enforceable and run with the land. Using some

Responsibilities and Approvals. A draft proprietary control is typically developed by the responsible party, EPA, and/or a state (depending on site lead). The site attorney and site manager typically would review and approve the controls. The responsible party may find it necessary to obtain the services of an experienced real estate attorney in the design and implementation of proprietary controls. This can be important because the exact requirements often vary by the type of proprietary control, the jurisdiction, and cleanup authority or program (e.g., RCRA, CERCLA).

Depending upon the complexity of the control or jurisdiction, the proprietary control also may need to be reviewed and approved by EPA's OGC and/or the state attorney general. If it is determined that the United States is to be the grantee of a property interest at a private site, the U.S. Department of Justice (DOJ) will review and approve the title to the property interest to be acquired unless the assistance of another federal agency with delegated approval authority is obtained. Once the document has been approved by the regulatory agency, the responsible party should ensure that it is executed and recorded in the land records. The site manager should place a copy of the recorded instrument in the site file.

Contents of a Proprietary Control Document. Proprietary controls, such as easements, should generally contain language of conveyance to effectuate a transfer of an interest in real property. As a general rule, such language is drafted in terms of a grantor conveying a property interest to a grantee.[28] It is often important for the language to clearly show the relationship of the specific IC instruments to the land and resource use restrictions called for in the decision document. Typically, the document should contain all substantive parts of the actual restriction, and at a minimum, normally should provide:

- A detailed legal description of the site;
- A list of uses that will be restricted;
- A clear description of who will execute the document;
- A clear description of the area to be restricted, particularly where less than an entire parcel is affected;
- A complete description of the types and location of residual contaminants and response action components;
- The precise names of the parties involved (including the grantee and grantor as they appear on title documents, and any third party beneficiaries);
- Provisions for third-party or other enforcement, as necessary;
- The parties' rights, including resource and use restrictions;
- Language to clearly express whether the IC is binding on subsequent purchasers (i.e., that the proprietary control "runs with the land");
- Specific notice and approval requirements for modifying or terminating the IC;
- A requirement for notification to EPA and/or the state prior to transfer or lease, or if there is an IC violation;
- Information regarding indemnification of the state or other grantee;
- Provision for notification to lessees of the IC, and
- Discussion of any common law impediments, where appropriate.

When developing the legal instrument, it may be important to have the site surveyed, have permanent monuments erected to properly document the location of the affected area, and conduct a review of title to the property to identify all parties who have a lien on or interest in the property. Clearly defining property and IC boundaries may prevent unnecessary confusion and may facilitate beneficial reuse. Accurate maps should be prepared (in both paper and GIS versions) to depict the physical areas subject to restrictions. These maps should be made available to the public, which can help provide notice and important information about the ICs.

Finally, the site manager and site attorney should attempt to resolve any "subordination" issues early in the IC evaluation and selection process before implementing a proprietary control. As a general rule, in most states, real property interests are generally prioritized according to the order in which they are recorded in the land records. A property may be subject to several recorded interests, such as mortgages, tax liens, utility easements, and judgments. In addition, a property may have surface land rights that may be separate from mineral or water rights and the separate rights may need to be considered in drafting effective proprietary controls. To avoid a situation where a proprietary control is subordinate to a prior or "senior" interest, a subordination agreement may be used to switch the priority around. A subordination agreement is a legally binding agreement by which a party holding an otherwise senior lien or other property interest consents to a change in the order of priority relative to another party holding an interest in the same real property. Obtaining a subordination agreement can help ensure that the IC is enforceable against all parties with an interest in the property and not extinguished if a senior lien holder forecloses on the property.

In order to understand whether a subordination agreement is necessary, it normally is important to conduct a thorough title search to identify all parties holding prior interests in the

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sample language can reduce the amount of time spent drafting and negotiating with state agencies, responsible parties, and other entities with a role in the proprietary control.

[28] Depending upon state law, a covenant may not represent an interest in real property. For example, state law may specify that an environmental covenant does not constitute an interest in real property if a state agency is the grantee nor has "agency" status under UECA.

property. Unrecorded interests, such as leases, may also need to be subordinated to ensure that lessees abide by the easement/covenant. If subordination of senior interests is not possible, the lead agency should frequently notify the holder(s) of the senior interest(s), and identify the risk of harm that could occur, and the potential liability that may arise, if the recorded environmental restrictions are not respected.

5.4 Selecting the Grantee

Another critical issue in the effective implementation of a proprietary control can be the selection of the holder of the property interest or covenant (i.e., the "grantee"). Generally, the grantee, sometimes referred to the "holder," holds the covenant or title to the real property interest and has the primary responsibility for maintaining and enforcing the proprietary control. Examples of possible grantees of a property interest or covenant include states, responsible parties, local governments, civic or other associations (if authorized under federal, state, or local law to hold title to real property and take legal action to maintain an IC), conservation organizations, trusts, and other appropriate third parties. EPA may be the grantee at remedial action sites under CERCLA. Finally, if proprietary controls are implemented under state legislation that is tailored to the requirements of ICs (e.g., a state's adoption of UECA), it may be possible for a grantor of a property interest or covenant to also be the grantee.

Because of the important role a grantee plays in establishing and maintaining a proprietary control, a thorough evaluation of the viability of potential grantees and covenant holders should be performed prior to, or during, the response selection process. In evaluating potential grantees, consideration should be given to: (1) whether the potential grantee is likely to exist for the duration of the control; (2) whether the grantee is willing and able to maintain the IC (e.g., by expending necessary funds to maintain the control or taking legal action against any party that violates the proprietary control); and (3) whether it is appropriate to assign this responsibility to an entity that is not accountable through a CD, order, permit, or other enforceable instrument (unless EPA or the State is a third-party beneficiary). If a suitable grantee cannot be identified, then alternative ICs or a change in the engineered response may be necessary.

Selecting a Grantee Under CERCLA. EPA may choose to be the grantee of a proprietary control at remedial action sites under CERCLA to ensure that site use is consistent with the remedy. EPA also may perform this role where the land subject to restrictions belongs to a responsible party under CERCLA but the owner of the property cannot create a proprietary control through a conveyance to himself/herself under the laws of the state. However, CERCLA requires that the state must agree to accept transfer of certain real estate interests following completion of the remedial action.

If it is ultimately determined that the United States will be acquiring a real estate interest, 40 USC § 3111 requires, as a precondition of acquisition, that the Attorney General review and approve the sufficiency of the title. This means that title evidence must be obtained, the land must be physically inspected, and the conveyance instrument must be prepared. Authority to review and approve the title rests with the Land Acquisition Section, Environment and Natural Resources Division of DOJ and with certain other federal agencies with delegated authority, such as the U.S. Army Corps of Engineers. More detailed procedural guidance is available in DOJ's *A Procedural Guide for the Acquisition of Real Property by Government Agencies* (1972). Although this guide may be out of date with regard to appraisal matters, it is still current with regard to direct acquisition (negotiated purchase) and condemnation procedures. Also, DOJ's *Title Standards 2001* contains detailed information on acceptable forms of title evidence and requirements for the form of conveyance to the United States.

Selecting a Grantee Under RCRA. In contrast to CERCLA, RCRA does not expressly grant EPA authority to acquire property interests in order to conduct cleanups. Therefore, if a proprietary control creates an interest in real property, EPA may not be the grantee in a RCRA cleanup. However, where the cleanup is being done under an authorized state hazardous waste program, the state may have the authority to serve as the grantee.

If the state cannot be the grantee, the owner/operator or third party should be designated as the holder of the property interest. If the property in question is being sold, the owner/operator can retain a limited interest while conveying the title to the buyer. If part of the response relies on the seller or other third party to retain a limited interest, consideration should be given as to whether the seller will be able and willing to enforce the control for the duration of the IC. If the site is cleaned up under an order, the order can require the selling owner/operator to effectively enforce the control. If it is being done under a permit, steps should be taken to ensure that long-term enforcement is not lost through expiration of the permit. Otherwise, consideration should be given to requiring the owner/operator to transfer the retained interest to a third party (e.g., a land trust or local government), or identifying a third-party beneficiary that is willing to assume enforcement responsibilities.

Other Considerations in Selecting Grantees. A responsible party may become the grantee by acquiring a real property interest from other landowners as part of its obligation to ensure that the response action is properly implemented. By taking title to an easement or similar property interest, the party or facility owner/operator typically ensures that it will be in a position to maintain the IC. Furthermore, it will often have an incentive to maintain the IC because a failure could make further response actions necessary. If enabled under state law, the lead agency should be designated as a third-party beneficiary. Third-party beneficiary status should allow the lead agency (the beneficiary) to enforce the restrictions of the covenant or easement. If the lead agency cannot enforce the

IC as a third party, the lead agency may be able to compel the responsible party (e.g., the facility owner/operator) to carry out its obligations under a CD, order, or permit. If the responsible party is unresponsive or bankrupt, this approach may be ineffective and, at a minimum, the enforcement of the control may be substantially delayed.

If a responsible party owns the property that is subject to an IC, it may also reserve the property interest or covenant when selling the property. A potential disadvantage of this approach can be that the proprietary control may not be implemented until the sale. In this situation, the enforcement document normally should provide assurances (e.g., specify that the owner will reserve the property interest or covenant upon sale of the property, will comply immediately with the ICs, and will place a notice of the ICs with the appropriate recorder of deeds shortly after the effective date of the enforcement document). Regardless of who holds the property interest or covenant, it is usually appropriate to state in the covenant or easement that EPA is a third-party beneficiary. To facilitate enforcement of the IC, the enforcement document and/or permit should also require notice to EPA and/or the state, as appropriate, upon any breach of the IC.

5.5 Implementing Proprietary Controls at CERCLA Fund-lead Sites

If the cleanup is a CERCLA Fund-lead action, EPA or the State (depending upon which is the lead agency) will typically be responsible for ensuring that the control is implemented and that appropriate property interests are conveyed. For removal actions, EPA encourages the Regions to coordinate with the State, local governments and/or community groups prior to the initiation of the removal action, to seek commitments for conducting any prescribed PRSCs and ICs, and to notify the state of any recommendation or decision regarding the need for ICs. Most PRSCs and ICs following removal actions are conducted by the state or PRP. If a commitment to implement an IC cannot be obtained prior to the removal action, then EPA should continue searching for PRPs to implement the IC and negotiating with the State to do the same.

Administratively, the process is similar to that taken by a responsible party at an enforcement-lead site. Because these controls are largely legal in nature, site attorneys typically are responsible for drafting IC language. However, the site manager and site attorney will typically work together to complete the necessary steps for actual implementation. One of the key responsibilities for the site manager is to provide the site attorney(s) with a clear scope of the land/resource area to be restricted. Another key activity is conducting a title analysis that includes an accurate legal description and identifies encumbrances and prior recorded interests. State attorneys general offices and local attorneys can be excellent resources for identifying the specific jurisdictional requirements for the control to be implemented.

In the process of implementing a proprietary control and ensuring that appropriate property interests are conveyed, site managers and site attorneys may face issues associated with just compensation and the power of condemnation through the exercise of eminent domain.

Property Acquisition. EPA may seek donations of property interests (e.g., ground water extraction rights) from landowners in accordance with 49 CFR § 24.108.[29] If a donation cannot be obtained, EPA may choose to acquire interests in real property through negotiated purchase for fair market value. The costs of acquiring property interests typically would be recoverable, a factor to consider when a property owner is a responsible party. If valuation issues arise, the site manager should work with the appropriate state and EPA Regional and Headquarters attorneys to resolve the issue. Prior to initiating negotiations to acquire real property or interests in real property, EPA should establish an amount that it believes reflects fair market value. As a practical matter, the fair market value of real property interests to be acquired for use as proprietary controls may be nominal due to offsetting benefits of the cleanup project. See section B-12 of the *Uniform Appraisal Standards for Federal Land Acquisitions* (DOJ 2000), prepared by the Interagency Land Acquisition Conference, for a discussion of offsetting benefit.

Obtaining a voluntary conveyance through donation or negotiation is preferred over initiating a condemnation action. Federal real property acquisition regulations require agencies to make every reasonable effort to acquire real property expeditiously by negotiation (see 49 CFR § 24.102(a)). However, if a property owner is unwilling to sell, is willing to sell but agreement cannot be reached on price, or if the owner is unable to correct title defects, the lead agency may, under certain circumstances, initiate condemnation proceedings under federal or state law.[30] If condemnation is being considered under CERCLA § 104(j), the site manager and site attorney should contact OGC for assistance and should ensure that EPA has obtained the requisite assurance from the state to accept the transfer of the interest once O&M has begun for that portion of the remedial action. If condemnation is sought under other authorities, coordination with experts under those authorities should be initiated early in the process.

5.6 State Assurance Requirements for Acquiring Real Estate Interests under CERCLA

EPA can acquire real property or any interest in real property at Fund-lead and enforcement-lead sites under CERCLA § 104(j) to conduct a remedial action provided that the state

[29] This regulation, promulgated under the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 as amended, addresses requirements for donations of real property for federal and federally-assisted projects.

[30] Some state agencies may not have powers of eminent domain.

agrees to accept transfer of the real estate interests when O&M is initiated. In accepting the transfer of real property interests from EPA, the state's CERCLA liability as an owner is limited by CERCLA § 104(j)(3). There is no authority equivalent to that of CERCLA § 104(j) for Superfund removal, RCRA, Brownfield, or UST cleanups. For this reason, if EPA provides oversight or is otherwise involved in a cleanup other than a Superfund remedial action, EPA is not expressly authorized by statute to acquire real property. However, the state may have such authority as a matter of state law. In most UECA states, as long as EPA is not the holder, EPA's enforcement status as "agency" is not considered a real property interest and therefore not subject to § 104(j) assurance requirements (for more discussion, see Section 9.3).

Whether a specific proprietary control constitutes a real estate interest under CERCLA § 104(j), thereby requiring state assurance, is a complicated issue that requires site-specific determinations. If there is a question regarding whether specific proprietary controls would require state assurances under § 104(j)(2), the site attorney should consult with OGC to determine whether a specific proprietary control would require state assurances under § 104(j)(2).
The procedures for acquiring interests in real property are subject to the provisions of EPA's CERCLA Delegation 14-30, "Acquisition of Real Property." Among other things, this delegation describes the approvals needed for the acquisition of real property. Acquisition by EPA of interests in real property should be coordinated with OSRTI, OSRE, and OGC.[31]

In the event that it is necessary for EPA to acquire a real property interest, and the state assurance requirement under § 104(j) applies, the state must provide written assurance prior to such transfer that it will accept the transfer of the interest following completion of the remedial action. This assurance should then be documented through a SSC, cooperative agreement, or other authorized signed document. There are a few challenges common to transfers of real estate interests from EPA to a state. For example, some state agencies lack the authority to accept a real estate interest transfer. In other states, real property transfers can be accepted, but they are managed by a property management agency and not by an environmental agency, potentially leading to unreliable maintenance and enforcement of the IC. A few state agencies have authority to transfer real estate interests to third parties such as conservation trusts. This situation may present challenges for some states because the state is still required to provide assurances under § 104(j)(2). Therefore, it is important that the site manager and site attorney understand the state-specific requirements prior to the selection of ICs that require a property acquisition.

[31] For more information, see CERCLA Delegation 14-30

A number of options can be considered if a state is unable to provide assurance that it will accept transfer of real estate interests. One option is to use other types of ICs, e.g., governmental controls. Another option is to have the real property interest conveyed to a party other than the state. For example, if a third party acquires a real estate interest and holds it in its own name, the exercise of CERCLA § 104(j) authority may not apply because EPA has not acquired a real property interest. To minimize disruptions to the implementation of the remedy, the best practice is to raise the issue of real property acquisition early, such as during the RI/FS or development of the proposed plan, and certainly before the State concurs on the ROD.

As a general matter, EPA in practice transfers or releases all real property interests before a Superfund site enters the O&M phase[32], regardless of who will ultimately accept the real estate interest (e.g., the state or some other entity). Prior to selection of the remedy, the site manager and site attorney should thoroughly evaluate the transferee's willingness and capability to fulfill its IC responsibilities for the expected life of the IC.

5.7 Establishing ICs through RCRA Orders and Permits

Many of the considerations in establishing ICs at CERCLA sites also apply to Brownfields, UST, and RCRA corrective action sites. However, the requirements under these cleanup programs are often imposed through legal instruments that differ from one program to another. In the RCRA program, states play a key role by imposing ICs under their own authorities as part of their cleanup activities.

For RCRA cleanups and post-closure care, enforceable requirements will generally be established through a permit (e.g., the corrective action portion of an operating permit, or a post-closure permit), or by EPA through an order under RCRA § 3008(h) or § 7003. RCRA § 7003 allows EPA to require cleanup where there is potential imminent and substantial endangerment related to either solid or hazardous waste. In addition, RCRA § 7003 does not distinguish between on-site and off-site contamination. If there is solid waste as defined by RCRA § 1004(27), and the other elements have been met, there is no need to show the existence of a hazardous waste to require cleanup.

Permits and orders alone can impose enforceable restrictions on the use of property by the facility owner/operator. Orders and permits can be crafted to require that the owner/operator refrain from selling the land unless the purchaser agrees to (1) abide by the restrictions contained in the order or permit; and (2) require any future purchasers to do the same. RCRA permits for treatment, storage, and disposal have a statutory duration of ten years and should be renewed as needed to

[32] "Completion of the remedial action" is the point at which O&M measures would be initiated pursuant to 40 CFR § 300.435(f)

ensure maintenance of corrective measures and ICs. Although orders don't expire, care should be taken when drafting orders to ensure that enforceable IC provisions continue to remain in effect.

In cases where it is necessary for the restrictions to extend beyond the period of performance of a permit or order, proprietary controls should be crafted that run with the land and bind future landowners, as well as the current owner/operator, where feasible given state law requirements. For example, a permit or order may direct the owner/operator to convey such an interest to someone who will then maintain the IC (i.e., a proprietary control). RCRA facility owners may also be required to reserve a property interest when they sell the property and to make the lead agency a third-party beneficiary. Model permit and order language does not yet exist under RCRA for this purpose, although several states are developing such models. If subordination of senior interests is not possible, the lead agency should frequently notify the holder(s) of the senior interest(s), and identify the risk of harm that could occur if the recorded environmental restrictions are not respected.

6. IMPLEMENTING GOVERNMENTAL CONTROLS

State, tribal, and local governments generally have a broad range of regulatory authority to implement a variety of ICs. The authority of government to exercise controls to protect the public's health, safety, and general welfare is referred to as "police power." This authority may include the ability to impose certain land-use controls and ground water restrictions, require informational devices (e.g., notices), and establish building codes and state registries of contaminated sites, among other things. These regulatory and informational devices may serve as highly effective ICs if they are appropriately implemented, maintained, and enforced. In some cases, existing state or local government regulations may serve as ICs. In other cases, new state or local laws or regulations may be most appropriate. Site attorneys should review state or local laws and regulations as they pertain to ICs at a specific site if the site manager is considering relying on or utilizing a state or local land use law or other type of local law to put ICs in place at a site.

State and local governments may impose land use and other government controls at their discretion. EPA has no authority to compel state or local governments to amend or adopt new regulations to impose an IC, or to keep regulations that impose an IC. Any controls established in this way generally operate independently of RCRA and CERCLA, and are enforced through local governmental processes or state law, where applicable. Because each state and local government has different laws and regulations on land use, the site attorney should review those laws and regulations as they pertain to the ICs at a specific site. Where appropriate, the site manager or site attorney may consider providing information on the role of ICs in EPA cleanup programs to local governments.

In addition, when a local government is responsible for, or participates in, planning, implementing, maintaining, or enforcing governmental controls, site managers and site attorneys are encouraged to reach a common understanding with the state, tribal and local governments before the ICs are implemented to document and clarify the roles, responsibilities, and legal authorities. Details of such arrangements should be included in the ICIAP or equivalent plan.

Implementing Governmental Controls

- Ground Water Use Restrictions (Section 6.1)
- Zoning Ordinances (Section 6.2)
- Fishing Bans and Waterway Use Restrictions (Section 6.3)
- Other Uses of State And Local Police Power (Section 6.4)
- Cooperative Agreements to Support Initial Implementation of ICs at CERCLA Fund-lead Sites (Section 6.5)

6.1 Ground Water Use Restrictions

Ground water use restrictions are frequently used to limit or prohibit certain uses of ground water. Implementation of such restrictions normally depends upon state laws governing ground water ownership and use. Numerous states have adopted laws that could be used to restrict ground water use at contaminated sites. Ground water laws commonly involve water-use restrictions and well construction and abandonment requirements. This is a broad category and such restrictions can take a variety of forms, including: the establishment of ground water management zones or protection areas; prohibitions or limitations on certain uses of ground water in particular areas; capping or closing of wells; and limitations on the drilling of new wells. The State of Florida, for example, has five water management districts which protect, maintain and improve water quality including ground water. A consumptive use program and a program to close old, and/or abandoned wells and the proper construction of new wells, are among the regulatory programs each water management district may implement.

State and tribal agencies with the authority to establish ground water use restrictions typically have a well-defined administrative process. For example, the California's State Water Resources Control Board, which has joint authority over water allocation and water quality protection, guides nine Regional Water Quality Control Boards located in the major watersheds of the state. The regional boards serve as the frontline for state and federal water pollution control efforts.

In many cases, the implementation of state or local ground water use restrictions takes a significant amount of time. For this reason, the site manager is encouraged to ensure coordination can begin early and to actively monitor the progress in implementing this type of IC.

Well construction permit processes can also be used to implement restrictions on ground water use. A number of state and local governments have adopted statutes controlling new well installations and requiring permits for existing wells. These permitting programs may include requirements for well installation, licensing of well drillers, prohibitions or restrictions on the drilling of new wells in areas of contamination, and requirements and controls on the operation of wells (withdrawal rates/pumping rates). These types of governmental controls also often have specific administrative processes. The site manager should ensure that early coordination occurs with the appropriate permitting agency and should proactively monitor and verify that the permit restrictions continue for as long as they are needed.

6.2 Zoning Ordinances

Generally, zoning is also an exercise of state and local government "police power." Zoning ordinances typically consist of a map indicating the various land-use zones in the community, and text that sets forth the regulations for the development of land. An ordinance may regulate land use, building height, area of structures, density of population, and the overall intensity of use. Zoning can serve as an effective mechanism when a large number of parcels are affected by a response action. For example, an overlay zone could be used to restrict development along a contaminated stream.

The authority to regulate land use, with the exception of federal lands, generally falls within the domain of state and tribal governments. However, states generally delegate much of this regulatory authority to municipal and county governments. Therefore, the site manager and site attorney will often work with municipal and county officials regarding zoning ICs.

Implementing Zoning Controls. To evaluate the effectiveness of zoning controls, the site manager and site attorney should first determine which local government, if any, has zoning jurisdiction over a site. The site manager and site attorney should then meet with the planning staff of the jurisdiction to discuss the objectives of the cleanup, the potential role of ICs in that cleanup, and specific land-use regulations that may be considered to meet those objectives. Administrative controls vary by jurisdiction within each state. However, there are conventional practices that are common among most jurisdictions.

Unless a re-zoning (i.e., a zoning ordinance amendment to change the zoning designation of one or more parcels) is done as part of a jurisdiction-wide comprehensive plan and zoning ordinance amendment, it will typically require a formal application by the owner of the parcel to be re-zoned.[33] In most cases, a series of public hearings before a planning commission and/or governing body (e.g., city council, county board of supervisors) will then follow. It may be important for the site manager, site attorney, and/or other agency representatives to participate in these hearings to explain the cleanup process, the potential need for a proposed IC and to answer questions posed by members of the public, planning commissioners, and members of the jurisdiction's governing body.

Final approval or denial of the zoning application will generally come from the governing body of the jurisdiction. If the application is denied, the applicant may explore options for modifying the application and/or appealing the decision either within the jurisdiction (e.g., with a zoning board of appeals), or in a state or federal court, depending upon the nature of the challenge.

Limitations of Zoning Controls. Although zoning ordinances can be useful tools, they can have significant limitations. For example, the zoning designation in a particular area may be of limited duration. An area can be re-zoned and/or zoning variances may be granted. Therefore, it may be important to regularly evaluate whether the local zoning ordinance is still in place and is operating in a way that continues to ensure the effectiveness and integrity of the cleanup and its objectives. Thus, zoning may not be a fully effective mechanism unless it is routinely maintained and enforced over the long-term.

Local governments may not have the resources necessary for such oversight. The site manager and site attorney may consider using CERCLA §104(d) cooperative agreements at Fund-lead sites to fund the initial (but not O&M) implementation of ICs. Funding agreements between responsible parties and local governments also may provide resources to the local government for activities that are not considered normal functions of government, including costs for implementing, maintaining, and/or providing notice of any changes in zoning or site use.

Site managers and site attorneys should also be aware that some zoning ordinances can use cumulative zoning, meaning that less intensive uses, such as single family homes, may be permitted in zones designated for intensive, industrial uses. Therefore, even where the site is located in an industrial zone, an amendment may be needed to prohibit less intensive land uses, such as new residential buildings. Finally, some jurisdictions explicitly state the activities allowed in each district while others identify only activities that are prohibited. It is important that the site manager and site attorney understand whether the restrictions will be adequately addressed using the jurisdictional definitions.

[33] The site manager and site attorney may negotiate a consent decree, an administrative order and/or permit language that requires the property owner to apply for a zoning change, if necessary.

6.3 Fishing Bans and Waterway Use Restrictions

Commercial fishing bans are sometimes used as a governmental control to ban commercial fishing for specific species or sizes of fish or shellfish. Usually, state public health agencies and/or resource agencies establish these bans. Another governmental control that may be used is a waterway use restriction where subsurface contamination remains in place. The restriction typically is placed to ensure the integrity of the remedy (e.g., capping). State and local agencies may be responsible for enforcing this type of restriction.

6.4 Other Uses of State and Local Police Power

In addition to land-use controls such as zoning and subdivision ordinances, local governments may exercise their police power to protect the public in other ways. For example, they may adopt ordinances that regulate certain activities on contaminated sites that could threaten human health or the environment; an ordinance, for example, might include a ban on swimming or other potentially inappropriate activities in specified areas. State or local governments also could require that anyone seeking a building permit for construction activities in a particular area be notified of contamination and informed of any relevant management standards. Such measures could be used to control or prohibit certain types of construction that would result in unacceptable exposures (e.g., excavation in areas where subsurface contamination has not been fully removed). Excavation issues may also be addressed, to some extent, through an already existing state or local government requirement to contact a designated office (e.g., an existing "One-Call" excavation notification system[34]) before excavating.

6.5 Cooperative Agreements to Support Initial Implementation of ICs at CERCLA Fund-lead Sites

The site manager and site attorney may consider using CERCLA § 104(d) cooperative agreements, as appropriate, to support the initial (but not O&M) implementation of ICs by state and local governments at Superfund Fund-lead sites. CERCLA authorizes EPA to enter into cooperative agreements with state and local governments to help conduct response actions at remedial action sites and non-time-critical removal sites. A Superfund cooperative agreement is the assistance vehicle that transfers EPA funds for a response to state, tribal, or local governments and documents both EPA and recipient responsibilities for a site. EPA will generally enter into cooperative agreements with the state-lead agency (usually the state's pollution control agency) as designated by the state's governor and, less commonly, with local governments. To involve other essential state agencies, the state-lead agency typically enters into an intergovernmental agreement with these other agencies. States may also enter into intergovernmental agreements with local governments as an alternative to a direct cooperative agreement between EPA and the local government.

Cooperative agreements should not be used to support activities that are considered normal functions of state or local government. If the implementation of a specific IC would require the state or local government to perform activities that are not within its normal governmental functions, those activities may be funded. Such activities, including costs for implementing, maintaining, and/or providing notice of any changes in zoning or site use, may also be funded through funding agreements between responsible parties and local government.

It is important to note that EPA does not generally use the Fund to pay directly for IC monitoring or enforcement at removal sites. The Fund may, however, pay for IC monitoring where the removal program is handing over responsibility for the site to the remedial program and before the remedy has been constructed and has reached O & M.

At remedial sites, CERCLA prohibits the use of Fund monies for O&M activities, including the processing of permit applications for projects at sites where there is an IC in place (see Section 8.7).

7. IMPLEMENTING INFORMATIONAL DEVICES

Informational devices are designed to provide information or notification that residual or contained contamination remains on site. Typical information devices include state registries, notices filed in local land records, tracking systems, and advisories.

Implementing Informational Devices

- Recorded Notices (Section 7.1)
- State Registries of Contaminated Sites (Section 7.2)
- Advisories (Section 7.3)
- Community Involvement (Section 7.4)

7.1 Recorded Notices

Unlike proprietary controls, notices contained in deeds or other instruments to be filed in the local land records are not intended to convey an interest in real property. Consequently, such notices do not serve as enforceable restrictions on the future use of the property. As a matter of practice, such notices are contained in deeds conveying real property or an interest therein or some other written instrument that would be examined during a title search on a particular parcel or parcels. These documents are intended to provide notice to anyone

[34] For more information about state one-call systems, please see http://www.epa.gov/oswer/docs/iwg/OneCall.pdf

reviewing the chain of title (e.g., lenders, prospective purchasers) regarding contamination on the property and to identify whether there are resulting restrictions. As a result, where exposure should be limited, a notice in a deed or other instrument alone generally will not be sufficient to assure protectiveness. Nevertheless, often there are benefits from the use of such notices. For example, notices may effectively discourage developers from purchasing the property for inappropriate land uses and lenders from funding development for such uses.

Notices to be filed in the local land records have been commonly used for general notification of site conditions in remedies under RCRA, Brownfields, UST, and CERCLA programs. This includes, for example, the requirements of § 120(h)(3) of CERCLA pertaining to federal facilities or the model RD/ RA CD requirement that any settling defendant owner record a notice to successors-in-title informing future owners of the NPL listing, the ROD, and the CD. See *Model RD/RA Consent Decree*, Office of Site Remediation Enforcement, Office of Enforcement and Compliance Assistance. October 2009, section v, paragraph 9).

Additionally, there are explicit notice requirements for certain situations under RCRA. Specifically, 40 CFR § 264.119(b)(1) states that for post-closure notices, owners/operators of RCRA hazardous waste disposal units are responsible for submitting a survey plat and ensuring that a permanent notation is made on the deed stating that: (1) hazardous waste management occurred on the property; (2) its use is restricted under RCRA 40 CFR § 264 Subpart G; and (3) the survey plat and other applicable information is available at the local zoning authority or other authority with jurisdiction over local land use and with the EPA Regional Administrator. According to 40 CFR § 264.119(b), these actions must be completed within 60 days of closure certification. Because individual state requirements for Brownfields and UST sites vary, the site manager and site attorney should research the specific requirements within the appropriate jurisdiction.

Notices can be somewhat easier to develop and implement than proprietary controls. Notices typically consist of a legal description of the property and a description of the type, location, and concentration of residual contamination and any associated use restrictions. The drafter(s) of the notice should take care to avoid unintentionally suggesting that the notice creates rights and/or obligations. For example, the recording requirements of some jurisdictions may actually require the conveyance of a property interest as a condition of filing an instrument in the deed records.

The site attorney may work with an attorney familiar with the recording statutes of the jurisdiction where the site is located to determine the requirements and limitations for recording notices. This should be done well in advance of selecting a notice as part of the response action. For example, a statute may indicate what documents are recordable, the contents of a recordable document, and the procedures for their recordation. Also, jurisdictions vary on whether the landowner's approval is needed to record a notice. In some jurisdictions, third parties can record notices, whereas in other jurisdictions only the landowner can record a notice. In jurisdictions that allow the removal of the notice by the owner at any time, the enforcement device and/or permit should be clear that the notice must remain in the land records. Also, a small number of jurisdictions remove notices after a specific period of time. In these jurisdictions the enforceable agreement and/or permit should have a re-filing requirement for the notice.

7.2 State Registries of Contaminated Sites

Some states maintain registries of contaminated sites, which can act as an informational IC. The registries often include a list of contaminated sites in the state; annual reports to the legislature summarizing the status of each site on the registry; requirements for inclusion of a notice in deeds that the site is contaminated; and requirements that any person conveying title to property on the registry disclose to all potential purchasers that the property is on the registry. Some laws provide that the use of property on the registry cannot be substantially changed without the state's approval. The site manager and site attorney should determine whether such registries exist early in the response action evaluation process.

A potential limitation of the use of state registries as ICs is that the procedure for listing and removing ICs from registries vary by state and are often discretionary, potentially making the available site information inconsistent or out of date. In addition, information contained in a registry may not be consistently accessed by prospective developers or local government officials in the development application review process. Nevertheless, registries can be useful in combination with other measures as part of an overall response for a site by providing information to the public and regulators.

7.3 Advisories

Advisories are typically publicly issued warnings that provide notice to potential users of a land, surface water, ground water, or other resource of some existing or potential risk associated with that use. For example, an advisory may be issued to owners of private wells in areas where contamination has been detected in ground water at levels that pose a threat to human health; or a state may issue fish consumption advisories[35] to protect people from the risks of eating contaminated fish caught in local waters. Advisories are generally issued by public health agencies, either at the federal, state, or local level (e.g., health advisories issued by the U.S. Agency for Toxic Substances and Disease Registry under CERCLA § 104(i)). The site manager and site attorney should work closely with Agency for Toxic Substances and Disease

[35] Unlike fishing bans, fish consumption advisories are not enforced by a State or local agencies but rather provide notice to the public of risks posed by contamination.

Registry (ATSDR), state or local government officials to discuss the appropriateness of such advisory services, and to explore options for supporting advisories. Depending on the situation, certain advisories have a specific threshold that must be met for issuance. Therefore, the site manager and site attorney should coordinate early with the appropriate agencies if an advisory will be a component of the response.

7.4 Community Involvement

Due to the nature of informational devices, particularly advisories, community involvement and outreach are often an important part of the process. Consideration should be given to using multiple tools to inform the community such as web sites, mailings, outreach to community associations, and possibly public meetings. Informed community members can be in a position to provide valuable information on possible IC breaches that might otherwise go unnoticed. In developing informational devices, it is helpful to provide information about the ICs and contact information for reporting a breach.

8. MAINTAINING INSTITUTIONAL CONTROLS

Often the most useful post-implementation approach to ensuring the long-term effectiveness of ICs and maintaining the integrity of the cleanup is rigorous periodic monitoring and reporting. The site manager and site attorney should examine available mechanisms designed to ensure IC compliance at all stages throughout the enforcement process. Generally, the responsible parties, including federal facilities, have the primary obligation to monitor and report on the effectiveness of the ICs. This section discusses some of the tools that may be available to the site manager for ensuring appropriate monitoring and reporting of ICs.

Maintaining Institutional Controls:

- General Considerations (Section 8.1)
- Operations and Maintenance (Section 8.2)
- Periodic Reviews (Section 8.3)
- State, Tribal, and Local Government Oversight (Section 8.4)
- Out-Sourced Monitoring (Section 8.5)
- Community Monitoring (Section 8.6)
- Funding for IC Monitoring and Reporting (Section 8.7)

8.1 General Considerations

Because land use and ownership changes can occur over a relatively short time, developers and other parties may not be fully aware of the ICs that have been put in place as part of a cleanup. It generally should be more effective and protective of human health to proactively address potential weaknesses in ICs revealed by changes in land use before the land use changes actually do occur. The site manager[36] should ensure that there is a process in place to facilitate the routine and critical evaluation of the ICs to determine: (1) whether the instrument remains in place; and (2) whether the ICs are meeting the stated objectives and performance goals and are providing the protection required by the response.

Comprehensive monitoring is generally more effective when there is early planning and coordination, a clear delineation of roles and responsibilities, and detailed reporting requirements. In most situations, it is recommended that monitoring and reporting requirements be layered to increase the likelihood that any breaches will be detected early (e.g., by assigning the monitoring responsibility for an IC to more than one party). At the same time, it is important to ensure that each party with monitoring and reporting responsibility is held accountable and does not make shared responsibility a reason for less vigilant monitoring. Where monitoring and reporting is assigned to more than one entity, a mechanism, such as the designation of an entity with the lead monitoring and reporting responsibility may be useful in ensuring a successful monitoring and reporting effort. In addition, the site manager may want to include frequent reminders of the restrictions via such means as correspondence, notification in access letters for quarterly monitoring, and affixing warning labels to well casings that reiterate applicable restrictions. In many cases, a good way to help ensure effective and comprehensive monitoring is to develop and use an ICIAP or equivalent document early in the site management process.

8.2 Operations and Maintenance

Effective IC monitoring typically begins with a thorough understanding of the IC objectives and the desired audience for each IC, and recognition of the potential weaknesses of each IC. A primary tool for site managers can be a detailed O&M plan, an ICIAP, or other plan related to the long-term stewardship of ICs which should describe at a minimum: (1) monitoring activities and schedules; (2) responsibilities for performing each task; (3) reporting requirements; and (4) a process for addressing any potential IC issues that may arise during implementation or the reporting period.

Provisions describing IC monitoring, reporting, and enforcement mechanisms can be included in an appropriate decision document, ICIAP, and/or enforcement document. Such provisions can include a requirement in a CD to develop a detailed monitoring and reporting plan, or a description of the requirements themselves. At RCRA sites with a permit or order in place, the IC monitoring and reporting requirements may be specified in a separate document (and referenced in the permit or order) or in the permit and/or order itself. Most

[36] Even the site manager may change over time. For instance, the site manager who initiates the IC may be at EPA but ultimately the relevant site manager may become a representative from the State.

Brownfields and UST sites have similar decision documents, cooperative agreements, or work plans, and IC monitoring and reporting should be included in those documents as well. If the site manager anticipates that monitoring or reporting requirements may be changed at some point, language should be added to the appropriate enforceable document to explain the process for approval of the change.

The requirements and frequency of IC monitoring normally will vary depending upon site-specific circumstances, such as the types of IC instruments and monitoring tools used and how the IC is used to help ensure protectiveness. In many cases, inspections and reporting can be incorporated into other site activities, such as routine ground water monitoring and annual reports. If, after a sufficient period, the reliability of the ICs is better understood, the site manager may revisit the monitoring practices on a site-specific basis.

Long-term stewardship procedures should be in place to ensure proper maintenance and monitoring of effective ICs. The procedures can be included in the site O&M plan. The plan should address procedures to ensure regular inspection of ICs at the site; in appropriate circumstances, an annual certification to EPA that the required ICs are in place and effective may be useful. The entities responsible for implementing the plan may also send annual or semi-annual reminder letters to property owners to remind them of the existence of an IC and its provisions. Additionally, such entities should explore whether additional actions can help ensure compliance with the ICs. These actions could include the development of a communications plan and exploring the use of the state's one-call system as part of long-term stewardship.

8.3 Periodic Reviews

As discussed above, monitoring should be sufficiently frequent to ensure that ICs remain effective. In the absence of information to support a different review period, annual reviews are recommended. Reviews may include documentation to show that ICs remain in place and are effective. When changes to site conditions are likely to take place in less than a year (e.g., the site is an area being redeveloped or there has been a change in the zoning designation), more frequent monitoring should take place. If it is highly unlikely that site conditions will change, a monitoring period longer than a year may be appropriate. Some laws or regulations may specify a minimum review period for certain situations, such as the FYR required for certain Superfund remedial actions. Section 121 of CERCLA requires FYRs when remedial actions result in hazardous substances, pollutants, or contaminants being left in place. The NCP further clarifies that FYRs are to be conducted when remedial actions do not allow for UU/UE. The periodic review provides an important opportunity for a site manager to conduct an objective review of the status and performance of ICs.

During the periodic review, the site manager, facility owner/operator, or other review/enforcement authority normally should inspect the site and critically evaluate the effectiveness of the ICs in protecting human health and the environment and/or ensuring the integrity of any engineered response action (e.g., conduct site visits, and review aerial photos or other physical documentation to determine if there is any land or resource use inconsistent with the response). In addition, the site attorney should generally review updated title work to the property to determine whether proprietary controls have been modified or terminated, and should review the local government's zoning regulations for the site to determine if there have been any changes. Also, the enforcement team should follow up on the review provision in any settlement document and, if appropriate, request that the settling parties investigate the performance of the ICs.

If the ICs are not in place by the time of the periodic review, a schedule should be prepared that indicates when the ICs are to be implemented and the person or entity responsible for that activity should be identified. If EPA determines that additional ICs are necessary to protect human health and the environment, the enforcement team should review the enforceable document to determine if the settling party may be required to implement additional ICs or take additional actions (e.g., enforcement tools that may allow for modifications or pursuit of additional work under certain circumstances). An ESD or ROD amendment may also be necessary at Superfund remedial sites if additional ICs or other actions are necessary (or if ICs are being discontinued). In the case of RCRA, when the IC is being implemented by a facility-specific mechanism like a RCRA corrective action permit or order, that document may need to be amended to reflect the current status of the facility.

8.4 State, Tribal, and Local Government Oversight

State, tribal, and local governments are generally important partners in the long-term monitoring and reporting of ICs. Depending on the IC instrument and which agency is the lead agency, the state, tribal, or local government may have direct authority for long-term monitoring of ICs. At sites that rely upon state, tribal or local governments to implement, monitor and enforce ICs, the parties responsible for the cleanup at that site should cooperate with those governmental authorities to ensure the ICs remain effective. The site manager and responsible party are encouraged to coordinate with these governments when developing an approach to inspecting, monitoring, and reporting on ICs. Further, the site manager and site attorney should actively encourage the state, tribal, and/or local governments to undertake monitoring of ICs in order to avoid the need to change the response action. Such monitoring activities may include:

- Inspecting and reporting on sites following the issuance of building/excavation permits to ensure compliance with their terms;

- Inspecting and reporting on sites for compliance with proprietary controls when the state or local government is the holder of a property interest, such as an easement;
- Inspecting and reporting on compliance with zoning restrictions; and
- Reporting proposed zoning amendments that may significantly alter land use at the site or in the vicinity of the site.

State, tribal, and local government laws also may influence the implementation of proprietary controls. In states that have adopted legislation enabling environmental covenants, state law may specify certain criteria as to who qualifies as a grantee, and also may reserve enforcement authority for the state in the event that the state is not the grantee. Since the grantee may assume responsibility for monitoring and reporting on its status, a potential grantee should understand its responsibilities before accepting the conveyance of a proprietary control. Thus it generally is important for the site manager and site attorney to evaluate thoroughly the capability and willingness of a state, tribal, or local government to report on and pursue problems with the IC(s) for as long as it remains in place.

In some cases, the grantee may share monitoring responsibilities with contractors (see discussion on third-party monitoring below), community stakeholders, local governments, or others who have agreed to participate in the monitoring and reporting. Where possible, the arrangements among these parties should be documented in writing to describe commonly understood roles and responsibilities for proper and effective monitoring, reporting, and follow-up. In situations where EPA is the grantee, the site manager and site attorney should ensure that procedures are in place to appropriately monitor, report on, and follow-up on whether the parties are fulfilling their responsibilities at the site and to transition or terminate those responsibilities once the response action is complete.

8.5 Out-Sourced Monitoring

In some instances, monitoring and reporting services may be contracted out, or otherwise arranged by the entity obligated to do monitoring. However, this arrangement does not alter any legal obligations of responsible parties, grantees, and others for maintaining the response action and ensuring its protectiveness. When monitoring and reporting activities are conducted under a contract, the site manager and site attorney should ensure that the scope of monitoring activities is clear; an adequate funding source is available for the duration of this method of monitoring; and the reporting obligations are clearly defined (i.e. to whom the contractor reports and the frequency and content of reports).

8.6 Community Monitoring

Local residents, community associations, and interested organizations can be valuable resources for day-to-day monitoring of ICs. Because community members who live or work near the site will often have a vested interest in ensuring compliance with the ICs, they are generally the first to recognize changes at the site. Although local residents should not be relied upon as the primary or sole means of monitoring, the site manager should encourage local stakeholders to become involved in monitoring ICs. Community monitoring can be fostered through public outreach activities to inform nearby residents of the purpose of the ICs and what types of activities may adversely affect the integrity of the response action. In addition to public meetings and notices, mailings to nearby homeowner associations and property owners may be used to provide community stakeholders with information about the ICs and contact information for reporting a breach.

8.7 Funding for IC Monitoring and Reporting

The availability of resources should be considered when monitoring and reporting plans are developed. State agencies, local governments, and other organizations may require additional funding to meet IC monitoring and reporting requirements. This process should begin with developing a cost estimate for monitoring and reporting activities over the full life-cycle of the IC. The site manager and site attorney may provide state, tribal and local government officials with information they may want to consider concerning possible approaches and strategies to ensure that adequate funding will be available to provide adequate IC monitoring, reporting, and enforcement, including:

- Using trust funds, surety bonds, letters of credit, insurance or other means of financial assurance, as appropriate;
- Billing the responsible party;
- Requiring the responsible party to set up escrow accounts; and
- Using settlement proceeds to fund site-specific accounts for ICs.

In some instances, it may be possible for state, tribal or local authorities to use CERCLA section 107 liability provisions to secure PRP financing for these purposes. It may also be possible to ensure that all potential future IC costs are covered by the financial assurance requirements section of an enforcement document, where appropriate (e.g., three-party consent decree between U.S., state, and PRP). Additionally, financial assurance mechanisms should be reviewed periodically to ensure that they remain adequate.

Under the Brownfields Program, EPA provides grants to state and local governments to carry out site assessment and cleanup activities and to nonprofit organizations to carry out cleanup. Pursuant to EPA's grant guidelines[37] and section 104(k)(4)(C) of CERCLA, a local government that is a Brownfields grant recipient can use up to ten percent of the grant to monitor and enforce ICs designed to prevent human exposure to any hazardous substance from a Brownfields site. States can use grant funds to establish or enhance their response program for addressing Brownfields sites, including O&M or long-term monitoring activities.

For Fund-financed remedial actions, CERCLA § 104(c) requires states to pay for, or ensure payment of, all future O&M for remedial actions. EPA may not use the Fund for O&M activities except for oversight of O&M activities. Generally, it may be appropriate to consider initial implementation of ICs as part of a remedial action; generally, IC monitoring, reporting, and enforcement are considered as O&M-type activities.

Guidance on when a remedy may be considered to be in the O&M phase is provided in *Operation and Maintenance in the Superfund Program*, OSWER 9200.1-37S, EPA 540-F-01-004, May 2001.

Regarding CERCLA Fund-financed emergency and time-critical removal actions, EPA generally does not provide financial assistance to states for ICs. For non-time-critical removal actions, EPA does not generally use the Fund to pay directly for IC monitoring or enforcement, (although the Agency may provide financial assistance for initial implementation through cooperative agreements).

9. ENFORCING INSTITUTIONAL CONTROLS

This section provides an overview of the types of enforcement tools that may be available for dealing with potential problems involving improper or incomplete implementation, maintenance, and breaches of ICs. The site manager and site attorney should examine IC compliance at all stages throughout the enforcement process.[38] This section illustrates some of the more common enforcement actions that site managers and site attorneys may encounter, and is not intended to provide a comprehensive discussion of all enforcement actions available at a given site.

9.1 General Considerations

Often, the preferred and fastest approach for dealing with IC enforcement is to seek voluntary compliance through early problem identification and informal communication. Many issues can be effectively addressed at the site manager and site attorney level with a phone call and appropriate follow-up. Such follow-up may include site visits and letters to ensure complete communication and to create a record. However, there may be occasions when more formal steps are necessary. Enforcement can occur in several ways depending upon the type of IC instrument, the authority being used, the party attempting to compel an activity, and the party responsible for taking an action.

Enforcing Institutional Controls

- General Considerations (Section 9.1)
- Enforcement of Governmental Controls (Section 9.2)
- Enforcement of Proprietary Controls (Section 9.3)
- Enforcement and Permit Tools with IC Components (Section 9.4)
- Informational Devices (Section 9.5)
- Commencement of New Actions (Section 9.6)
- Other Enforcement Concerns (Section 9.7)
- State, Tribal, and Local Government Enforcement Roles and Assurances (Section 9.8)

For Superfund remedies that include ICs, EPA strives to ensure that the potentially responsible parties implement, maintain, and enforce ICs, as appropriate. See *"Enforcement First" to Ensure Effective Institutional Controls at Superfund Sites*, OSWER 9208.2, May 17, 2006. EPA uses a variety of negotiation and enforcement tools to obtain potentially responsible party participation in carrying out Superfund site cleanups, including any IC obligations. See *Negotiation and Enforcement Strategies to Achieve Timely Settlement and Implementation of Remedial Design and Remedial Action at Superfund Sites*, Office of Enforcement and Compliance Assurance memorandum, June 17, 1999. Ensuring that ICs are properly implemented and remain protective is important to both EPA and potentially responsible parties. Therefore case teams should first pursue a cooperative approach when working with potentially responsible parties to enforce ICs.

9.2 Enforcement of Governmental Controls

Governmental controls are typically implemented and maintained by a governmental entity other than the one performing or overseeing the site cleanup. This does not relieve responsible parties from monitoring and reporting on the effectiveness of the ICs (e.g., notifying regulators of any

[37] For more information on EPA's guidelines for Brownfields Assessment Grants, please see: http://www.epa.gov/oswer/docs/grants/epa-oswer-orcr-09-04.pdf

[38] The EPA has recently elevated the importance of ensuring ICs, required as part of the remedy, are being enforced. A new Government Performance and Results Act (GPRA) performance measure, the Site-wide Ready for Anticipated Use (SWRAU), and another new measure, the Cross Program Revitalization Measure (CPRM) contain specific IC requirements. For more information on how ICs relate to the land revitalization performance measures, see *Guidance for Documenting and Reporting Performance in Achieving Land Revitalization* (EPA 2007).

change to or breach of a relied upon governmental control). Some of the most common governmental controls used in CERCLA, Brownfields, UST, and RCRA remedies are zoning ordinances, excavation/building codes, well construction/abandonment requirements, ground water regulations, ground water management zones, fishing bans/restrictions; waterways use restrictions, and restrictions on, in, and/or near water/shoreline access and/or development.[39]

Several difficulties can arise when using ICs in the form of governmental controls including: (1) the IC instrument may have not been implemented or, if implemented, may not address the specific environmental problem because of vagueness or some other deficiency in the drafting of the IC; (2) the IC may not have been appropriately monitored or reported (e.g., failure to notify environmental regulators that a zoning ordinance expires); (3) a governmental entity may not actively respond to an identified problem or breach of an IC; and (4) a governmental entity may inadvertently undermine the IC through its own actions, undertaken for unrelated purposes (e.g., amending zoning to allow uses that would not have been allowed under the prior classification). The challenge for site managers and site attorneys in the use of these types of ICs is that implementing, maintaining, and enforcing ICs generally fall within the authority and discretion of the originating governmental entity. These challenges are compounded by the fact that communication between the environmental regulators and the relevant governmental decision-maker (e.g., the well permitting office) may not be part of the established administrative process of that entity.

Typically, governmental control activities are governed by a defined administrative process. Site attorneys should familiarize themselves with this process, including written petitions and/or administrative hearings, in the event an action to enforce a governmental control is necessary.

In addition, site managers and site attorneys should evaluate the capability and willingness of a governmental entity to implement and enforce any proposed IC in the form of a governmental control, and involve that entity early in the response process when discussing the types of ICs being considered. In certain cases under Superfund, cooperative agreements may be developed to assist the local government in the initial (but not O&M) implementation of the necessary ICs at Fund-lead sites. Local governments may also arrange for direct compensation from other parties for the implementation, maintenance, and enforcement of ICs. It may be beneficial for the state, tribal and local governments to work with and reach a common understanding with the responsible parties and other stakeholders about various IC implementation issues including the roles and responsibilities of the local government in enforcing these controls. This common understanding will likely vary depending upon whether federal, state, and/or local authority is used. Where appropriate, the site manager or site attorney may consider providing IC training to local government.

9.3 Enforcement of Proprietary Controls

The most common examples of proprietary controls used in CERCLA, Brownfields, UST, and RCRA cleanups are easements and covenants. The requirements for enforcing proprietary controls may vary considerably among states, and site attorneys are encouraged to coordinate with attorneys familiar with the laws of the particular jurisdiction.

If proprietary controls are implemented under state legislation that are tailored to the requirements of ICs (e.g., a State's adoption of UECA), there likely will be clear enforcement procedures for the state, a grantee, a third-party beneficiary or others. Generally, under state-adopted laws modeled after UECA, many parties may have the authority to enforce an environmental covenant, including: (1) any parties to the covenant or any party given the right to enforce under the covenant; (2) the state environmental agency; (3) a person whose interest in the real property or liability may be affected by the violation of the covenant (this can include responsible parties); and (4) a unit of local government. If no specific state law addressing environmental covenants exists, these controls will be based more generally on the state's contract and real property law.

Under either state statute or case law, certain enforcement challenges may arise. The grantee will generally have the primary responsibility for enforcing a proprietary control. EPA will typically rely on another party to act as the grantee, due to the limitations on EPA's authority to hold proprietary interests. The grantee may be able to enforce proprietary control restrictions and obligations against the owner(s) of the property pursuant to state law in state court. To help ensure that a grantee other than EPA takes appropriate action in the event of an IC violation, it can be useful for that grantee and other parties to enter into agreements that clearly define the roles and responsibilities of the grantee.

In those cases where EPA is the grantee or has authority to enforce a proprietary control as a third-party beneficiary, the Region should refer the case to DOJ for appropriate action in state or federal court where an enforcement action can remedy the violation. For a more detailed discussion of the third-party beneficiary status, consult *Institutional Controls: Third-Party Beneficiary Rights in Proprietary Controls*, Office of Enforcement and Compliance Assistance memorandum, April 19, 2004. Furthermore, in states that have adopted legislation tailored to the requirements of environmental covenants, (such as those recommended in UECA), the Region may be able to

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[39] Note: these tools may not be available at certain federal facilities. The federal facility is generally responsible for monitoring, reporting, and enforcing any violations of the ICs and other land use controls at CERCLA cleanups, even for surplus property that has been transferred to private use. EPA and often state agencies may enforce the ROD and other post-ROD enforceable document if a federal facility fails to enforce or rectify any IC breach.

refer an enforcement action to DOJ for appropriate action in state or federal court where EPA qualifies as an "agency" that signed the covenant. Regions should note that state law may specify that the agency's enforcement right in the covenant is not based on an interest in real property, and is thus not an acquisition of real property by EPA.

In the RCRA, Brownfields, and UST context, EPA has no authority to be the grantee, so enforcement by EPA is not available unless it is a third-party beneficiary or it has agency rights under a state's UECA or other statute. If a proprietary control is used and another party is the grantee, the regulatory agency may be able to rely on the grantee to act as the enforcer.

9.4 Enforcement and Permit Tools with IC Components

Enforcement and permit tools that may be used to require implementation and maintenance of an IC, or seek a remedy for an IC breach, include CDs, FFAs, UAOs, and permits. Through these instruments, EPA or another regulatory agency may be able to specify the restrictions and requirements for implementing, maintaining, and/or fixing a breach to the IC in the enforceable document. If the responsible parties fail to carry out their obligations under a CD, order, or permit, EPA or another regulatory agency may be able to enforce those obligations under the appropriate CERCLA, Brownfields, UST, or RCRA authority.[40] The remedies available may include requiring the defendant to implement the IC or, in some circumstances, pay certain costs or penalties. Such

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[40] A consent decree can also be enforced as an order of the court.

Figure 1. Examples of IC Categories and Enforcement Processes

IC Categories	IC Authorities and Examples	Typical Enforcement Processes
Governmental Controls	*Police Power* • Zoning ordinances • Ground water use restrictions • Building codes / permit requirements	Local government jurisdiction; enforcement may be possible through administrative process or legal action. State agency; enforcement may be possible through administrative process or legal action.
Proprietary Controls	*State statutory and common law* • Easements and covenants	The grantee of a proprietary control may be able to seek legal action against the property owner for activities prohibited by its proprietary control. EPA, the state, or another party may be able to enforce the proprietary control under state property law if they are a third-party beneficiary of the easement or covenant. Even if they are not the grantee, EPA or any other state or federal agency that signed the covenant may be able to enforce the proprietary control in states that have adopted legislation similar to UECA as the "agency" that approves of the covenant. EPA may be able to order a responsible party to implement a proprietary control
Informational Devices	*Police Power* • Health advisories • Fish advisories • Deed notices • State registries of waste sites • Tracking systems	While informational devices typically are not themselves enforceable, site-specific circumstances may warrant action by EPA. Regions should consult with OECA to discuss possible action such as issue an order to a responsible party if an imminent and substantial endangerment exists at a site due to lack of a recorded notice. Public health agencies; issuance through administrative process.
Enforcement and Permit Tools with IC Components	*Federal and state statutory law* • Superfund CDs, UAOs, AOCs, and Federal Facility Agreements (FFAs) • RCRA orders and permits • Orders issued under state authority	EPA may be able to use a variety of legal instruments to require responsible parties or the signatories of the agreement to control the use of land or resources. If a responsible party is the grantor or grantee of the proprietary control, EPA may be able to employ these tools to enforce the requirements of the IC as the "agency" that approves of the covenant.

payments may be required to reimburse an agency that has incurred the cost of implementing or maintaining the control, cover the costs incurred when addressing IC breaches, and/or pay penalties (stipulated and/or statutory).

An action pursuant to the CD, order, FFA, or permit generally will be effective only against the parties specified in these documents. For example, a provision in a CD or AOC may require a facility operator to secure a proprietary control to prevent a particular type of land use. However, the land owner may not be a party to the CD or AOC and, therefore, would not be obligated to convey the interest. Furthermore, the requirements of the CD may not be enforceable against any successor-in-title if the successor was not a party to the CD.

If proprietary controls are needed on property that is not owned by a responsible party, enforcement documents generally require that the responsible party use "best efforts" to obtain access and to implement the controls. In cases where the responsible party does not use its best efforts to implement the proprietary controls, EPA can seek to enforce the relevant provisions of the CD, order, FFA or permit in place. If the responsible party is unable to acquire proprietary controls on the property of concern despite exercising best efforts (e.g., the property owner is unwilling to sell or agree on a price for an easement or other property interest), there are several approaches to consider, depending on the situation. For Superfund remedial actions, the site attorney may consider acquiring or condemning the necessary real property interests subject to the requirements of CERCLA §104(j).[41] Under CERCLA, many state statutes, and typically under consent agreements such as CDs, the responsible party may be required to reimburse EPA and/or the state for the cost of acquiring the control either through negotiated purchase or condemnation. Alternatively, this may be resolved by selecting and implementing different types of ICs. If other ICs are not viable and the long-term protectiveness of the response is threatened, it may be necessary to reconsider the response action that was selected.

9.5 Informational Devices

The most common informational devices used in UST, Brownfields, federal facility, RCRA, and CERCLA cleanups are notices filed in local land records, state registries, and advisories. Notices are useful devices, but are not typically enforceable. However, some states recently have established laws that allow the state to enforce placement of notices in the local land records under state environmental laws. Similarly, many states are developing laws that require sites with ICs to be placed in a registry. However, these laws typically only apply to the listing of sites in registries, and do not affirmatively limit land or resource use at a site.

9.6 Commencement of New Actions

Where ICs are not properly implemented or maintained, it may be necessary to commence an enforcement action against the responsible party. For example, it may be possible to issue a UAO to require the responsible party to use best efforts to acquire real property interests limiting future land use where zoning restrictions are repealed.

In the event of an IC violation, the site attorney may consider issuing an administrative order under CERCLA § 106(a) and/or RCRA § 7003(a) requiring that the IC be maintained if there is a resulting actual or threatened imminent and substantial endangerment to human health and the environment. If the administrative order is not complied with, EPA may seek judicial enforcement of the order. If the party responsible for enforcing an IC fails to do so in a timely manner, EPA may also use these authorities to seek a court order imposing the IC.

9.7 Other Enforcement Concerns

One significant enforcement concern may be the premature close-out of CDs, orders, FFAs or permits despite a long-term requirement for ICs. Often, a responsible party is anxious to close out its CD, order, or permit and end its relationship with regulatory agencies through those documents once the construction work is complete and routine site maintenance has commenced. It is important that the site manager and site attorney retain the appropriate enforcement authority for implementing, maintaining, and enforcing the ICs over the duration of the period in which ICs may be needed. In some cases, ICs, and, therefore, enforcement instruments, need to be retained for a long period of time. In other cases, such as RCRA permits that have a specific period of performance and long-term requirements for ICs, retaining an adequate instrument mechanism may be needed to ensure the long-term durability, reliability, and effectiveness of the control. An additional area of concern is the change of ownership of facilities subject to orders without proper notification to the site manager. A RCRA order, or other enforceable device, may include a requirement for notification of change of ownership.

9.8 State, Tribal, and Local Government Enforcement Roles and Assurances

Many governmental controls are established under state, tribal, or local jurisdiction. To keep remedies protective, Regions should encourage states, tribes, and local agencies to be proactive in ensuring that ICs subject to their authorities are properly maintained. The site manager and site attorney may choose to request some form of written commitment from the appropriate state, tribal, or local government regarding its capability and willingness to maintain, oversee, and enforce the ICs.

In considering the capabilities and willingness to maintain, oversee, and enforce the ICs, the source of funding for these activities can be a particularly important factor, since a lack of funding may lead to IC breaches and an un-protective response action. The format for these commitments will likely vary depending upon the available state, tribal and/or local authority. A written ICIAP or equivalent document can be a valuable tool in helping define goals, planned activities, and roles, and in establishing relationships.

10. SUMMARY

ICs are often a vital component of remedies in most cleanup programs, including the five programs addressed in this guidance. However, over time, Regions should continue to review their effectiveness in light of any changes to land use, communities, laws, the condition and location of subsurface materials, and responsible entities. This guidance document provides an overview of some key issues the Regions may encounter when evaluating whether ICs are properly selected, implemented, maintained, and enforced.

[41] Under the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (URA) (Pub. L. No. 91-646), negotiations that include offering compensation are required to be completed first.

- When planning and selecting ICs, the site manager and site attorney should familiarize themselves with appropriate state statutes and identify the governmental bodies that have jurisdiction over the site. It may be useful to collaborate with attorneys and remedial and/or removal practitioners familiar with the laws, regulations, and practices in the jurisdiction where the site is located.

- Meeting with community members and local government representatives is often important throughout the IC life cycle to ensure that the need for ICs is understood and accepted as necessary for ensuring protection of human health and the environment.

- An appropriate tool, such as a CD, order, or permit (e.g., under CERCLA, RCRA, and/or state law) should be used in order to implement the cleanup, including any ICs that are part of the cleanup action.

- If a proprietary control is being implemented, selection of an appropriate grantee and careful drafting of the language of the conveyance is often important.

- If an IC in the form of a governmental control is used, the site manager and site attorney should work closely with the state or local government that has jurisdiction to ensure that it has the capability and willingness to implement and enforce the control.

- A good way to ensure effective implementation of ICs is to develop an ICIAP that documents responsibilities over the full life-cycle of each IC, and include this plan, or a reference to it, in the final decision documents. EPA is developing guidance on recommended contents for such a plan.

- A strategy for monitoring and reporting on ICs should be included in the O&M plan for Superfund sites, included in an ICIAP, or developed as part of the permit or order that implements a response decision under RCRA. In addition, the site manager and site attorney should discuss appropriate monitoring roles with the local government and appropriate state agencies.

- If an IC is not being properly maintained or is violated, appropriate enforcement actions should be taken.

APPENDIX A. REFERENCES

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APPENDIX B: GLOSSARY OF TERMS

For purposes of this guidance, the following terms are defined as:

Administrative Order on Consent (AOC) - a legally enforceable document signed by EPA and an individual, business, or other entity through which the party agrees to pay for the correction of violations, take the necessary corrective or cleanup actions, or refrain from an activity. An AOC, which may be subject to a comment period, describes the actions to be taken, is civil rather than criminal in nature, and can be enforced in court.

Advisories - Warnings, usually issued by public health agencies, either at the federal, state, or local level, that provide notice to potential users of land, surface water, or ground water that there is some existing or impending risk associated with the use of these resources.

Appurtenant - A legal term meaning "belonging to" or "incidental to." An easement that is deemed to be appurtenant benefits an adjacent parcel of land and is usually held by the owner of the adjacent land. For example, an easement allowing the owner of a parcel of land the right to cross an adjoining parcel would be deemed appurtenant to the easement holder's parcel of land.

Brownfields Site - Real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. See CERCLA 101(39) for additional information on what sites may qualify as Brownfields under CERCLA.

Chain of Title - A history of conveyances, judgments, and encumbrances affecting title to real estate from the time that the original patent was granted, or as far back as records are available.

Common Law - The body of English law developed primarily from judicial decisions based on custom and precedent, unwritten in statute or code, and constituting the basis of the legal system in all of the U.S. except Louisiana.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) - Legislation enacted in 1980 to identify, investigate, and clean up the nation's most contaminated hazardous waste sites and respond to emergency situations involving hazardous substances, pollutants or contaminants.

Condemnation - The process by which a government agency, exercising the power of eminent domain, acquires an interest in property.

Consent Decree (CD) - A legal document, approved by a judge, that formalizes a settlement reached between EPA and responsible parties through which responsible parties will conduct all or part of a cleanup action at a Superfund site, cease or correct actions or processes that are polluting the environment, or otherwise comply with an EPA-initiated enforcement action. The consent decree describes the actions responsible parties will take and is subject to a public comment period.

Conveyance - The transfer of title to property or an interest in property (e.g., an easement) from one person to another.

Cooperative Agreement - An agreement, including CERCLA §104(d) agreements, that transfers money for the accomplishment of authorized activities or tasks.

Corrective Action - EPA can require RCRA treatment, storage, and disposal facilities (TSDFs) handling hazardous waste to undertake corrective actions to clean up contamination resulting from failure to follow hazardous-waste management procedures or other mistakes.

Covenant - A promise by one landowner to another generally made in connection with a conveyance of property (e.g., warranty of title) that may or may not run with the land. Covenants may also include a promise by the holder of a possessory interest in property to use or refrain from using the property in a certain manner. Covenants are similar to easements but have been traditionally subject to somewhat different formal requirements.

Deed - A written instrument that transfers legal title to real property or an interest therein from one party to another. Generally, it contains the names of the grantor and grantee, a description of the property, and the estate being conveyed. It is signed by the grantor, usually acknowledged before a notary public, and should be recorded.

Deed Notice - Commonly refers to a non-enforceable, purely informational provision in a deed that alerts anyone performing a title search to important information about a particular property but may also be used, somewhat confusingly, to refer to other purely informational documents that are recorded in local land records.

Deed Restriction - Not a traditional real property law term, but rather is used in the NCP as a shorthand way to refer to various types of proprietary controls.

Easement - A right that allows the holder to use the property of another or restrict its use according to the terms of the easement. An "affirmative" easement allows the holder to enter upon or use another's property for a particular purpose (e.g., ingress/egress). A "negative" easement imposes limits on how the owner of the servient estate can use the property.

Emergency Removal Action - A CERCLA emergency removal action generally occurs when a release or threatened release requires the lead agency to initiate on-site cleanup activities within hours of determining that a removal is required.

Enforcement Tools - Tools, such as administrative orders or consent decrees, available to EPA under CERCLA and RCRA that can be used to restrict the use of land. Enforcement authority can be used to either (1) prohibit a party from using land in certain ways or from carrying out certain activities at a specified property, or (2) require a settling party to put in place some other form of control, such as a proprietary control.

Explanation of Significant Differences (ESD) – A CERCLA decision document prepared when there has been a significant change in cost, performance, or cost of a remedy selected in a Record of Decision (ROD). The significant change to the remedy may be as a result of new information.

Environmental Data Standards Council (EDSC) - This organization was established in 1999 to oversee a consensus-based process for developing and promoting environmental data standards. In 2005, the responsibility for overseeing the consensus-based process was transferred to the Exchange Network Leadership Council. http://www.exchangenetwork.net/standards

Five-Year Review (FYR) - An evaluation that may be required by §121(c) of CERCLA. Consistent with the NCP (40 CFR §300.430(f)(4)(ii)), Regions should conduct a review at Superfund sites where the remedy does not allow for unlimited use and unrestricted exposure. FYRs are designed to determine whether the remedy at a site remains protective of human health and the environment. Where remedial actions are still under construction, FYRs can help confirm that immediate threats have been addressed and that the remedy is expected to be protective when all remedial actions are completed.

Governmental Controls - Controls using the regulatory authority of a government entity to impose restrictions on citizens or sites under its jurisdiction. Generally, EPA turns to state, local, or tribal governments to enforce existing controls of this type and to establish new controls. Typical examples of governmental controls include zoning, the issuance of building permits, and state and local ground water use restrictions.

Grantee/Grantor - The entity to/from which ownership of a property interest (e.g., an easement) is transferred.

Informational Devices - IC instruments that provide information or notification that residual or capped contamination could remain on site. Common examples include state registries of contaminated properties, notices in deeds, and advisories.

In Gross - A property law term used to describe easements that provide a benefit not related to any property owned by the holder of the easement. Easements used under CERCLA and RCRA generally will be "in gross" because the restrictions generally are not for the benefit of any particular neighboring parcel owned by the holder of the easement.

Institutional Controls - Non-engineered instruments, such as administrative and legal controls, that help to minimize the potential for human exposure to contamination and/or protect the integrity of a response action. They are typically used in conjunction with, or as a supplement to, other measures, such as waste treatment or containment. There are generally four categories of ICs: governmental controls; proprietary controls; enforcement and permit tools with IC components; and information devices.

Land Use Control (LUC) - Any restriction or control, including institutional controls and engineering controls, arising from the need to protect human health and the environment, such as the restriction of access or limitation of activities at a site that has residual contamination.

Layering - The use of different types of institutional controls at the same time to enhance the protectiveness of the remedy.

Memorandum of Understanding (MOU) - A non-enforceable document that outlines the intentions of its signatories.

Non-Time-Critical Removal Action - A CERCLA non-time-critical removal action occurs when at least six months are available after determining that a removal is appropriate and before on-site cleanup activities must begin.

Overlay Zone - A set of zoning regulations that supplement (i.e., overlay) those of the underlying district. Developments within the overlay zone normally conform to the requirements of both zones, or the more restrictive of the two. Overlay zones may be used to address issues such as historical areas, flood plains, and environmental contamination.

Post-Removal Site Controls (PRSCs) - Actions necessary to ensure the effectiveness and integrity of the removal action after the completion of the on-site removal action

Proprietary Controls - Use of real property law to prohibit certain activities that may interfere with the engineering remedy applied at a site, or to restrict activities or future uses of a resource that may result in unacceptable risk to human health or the environment. The most common examples of proprietary controls are easements and covenants.

Prospective Purchaser Agreement - An agreement between EPA or a state and the prospective purchaser of a property known to be contaminated. Under the agreement, EPA or the state typically provides the purchaser with a covenant not to sue for the contamination existing at the site as of the date of the agreement. In return, the purchaser usually provides EPA with a benefit, which may include carrying out actual cleanup work and/or funding for cleanup at the site. EPA generally would enter into such an agreement at sites where an EPA action has been, is currently being, or will be taken. Parties seeking to operate on or lease contaminated property also may be eligible for such an agreement.

Record of Decision (ROD) - A document that selects the remedial action at a CERCLA site. It is a legal document that is an important part of the remedy selection process carried out in accordance with CERCLA. It includes, but it not limited to the following: a basis for the action, the selected remedy, a discussion of the supporting rationale, and response to stakeholder comments.

Resource Conservation and Recovery Act (RCRA) - The public law that creates the framework for the proper treatment, storage, and disposal of hazardous and nonhazardous solid waste. RCRA focuses on active and future facilities and does not address abandoned or historical sites which are managed under CERCLA, commonly known as Superfund.

Responsible Party - The term "responsible party" as used in this document is intended to mean a person or entity with cleanup or IC responsibilities under the various cleanup programs addressed in this guidance.

"Run with the Land" - A term indicating that a proprietary control will bind subsequent owners of the affected parcel as opposed to one that is personal and binds only the original parties.

Subdivision Ordinance - A local ordinance that regulates the conversion of land into building lots for development. The regulations establish requirements for streets, utilities, site design, and procedures for dedicating land for open space or other public purposes to the local government (or fees in lieu of dedication). In short, subdivision ordinances regulate land conversion, whereas zoning ordinances regulate land use.

Superfund State Contract (SSC) - An agreement between EPA and a state generally before remedial action begins at Superfund sites. Typically, the SSC documents the state's assurances under CERCLA and outlines the roles and responsibilities of both parties.

Time-Critical Removal Action - A time-critical removal action occurs when less than six months are available after determining that a removal is appropriate and before on-site cleanup activities must begin.

Uniform Environmental Covenants Act (UECA) - A model state legislation that addresses the use of proprietary controls as ICs (e.g., environmental covenants) and can be used to reduce the legal and management complications and common law impediments associated with ICs. UECA was developed by the National Conference of Commissioners on Uniform State Laws. http://www.environmentalcovenants.org/ueca

Unilateral Administrative Order (UAO) - A legal document signed by EPA directing any person to take corrective action or refrain from an activity. It describes the violations and actions to be taken, and can be enforced in court.

Unlimited Use/Unrestricted Exposure (UU/UE) – As discussed in EPA guidance documents, UU/UE generally refers to a situation when there are no exposure limitations required for the remedy at a site to be protective.

Zoning - A widely used type of land use control that is based upon the police power. Zoning ordinances typically consist of a map indicating the various land use zones (or districts) in the jurisdiction, and text that sets forth regulations for the development of land by zone.

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 335	INDUSTRIAL SOLID WASTE AND MUNICIPAL HAZARDOUS WASTE
SUBCHAPTER S	RISK REDUCTION STANDARDS
RULE §335.569	**Appendix III**

For the purposes of this subchapter, the following is the model deed certification language.

Attached Graphic

Source Note: The provisions of this §335.569 adopted to be effective June 28, 1993, 18 TexReg 3814; amended to be effective November 15, 2001, 26 TexReg 9135

Figure: 30 TAC §335.569

MODEL DEED CERTIFICATION LANGUAGE

STATE OF TEXAS
( ) COUNTY

INDUSTRIAL SOLID WASTE
CERTIFICATION OF REMEDIATION

KNOW ALL MEN BY THESE PRESENTS THAT:

Pursuant to the Rules of the Texas Natural Resource Conservation Commission pertaining to Industrial Solid Waste Management, this document is hereby filed in the Deed Records of County, Texas in compliance with the recordation requirements of said rules:

I

(Company Name) has performed a remediation of the land described herein. A copy of the Notice of Registration (No.), including a description of the facility, is attached hereto and is made part of this filing. A list of the known waste constituents, including known concentrations (i.e., soil and ground water, if applicable), which have been left in place is attached hereto and is made part of this filing. Further information concerning this matter may be found by an examination of company records or in the Notice of Registration (No.) files, which are available for inspection upon request at the central office of the Texas Natural Resource Conservation Commission in Austin, Texas.

The Texas Natural Resource Conservation Commission derives its authority to review the remediation of this tract of land from Texas Health and Safety Code, §361.002, which enables the Texas Natural Resource Conservation Commission to promulgate closure and remediation standards to safeguard the health, welfare and physical property of the people of the State and to protect the environment by controlling the management of solid waste. In addition, pursuant to the Texas Water Code, §5.012 and §5.013, Texas Water Code, Annotated, Chapter 5, the Texas Natural Resource Conservation Commission is given primary responsibility for implementing the laws of the State of Texas relating to water and shall adopt any rules necessary to carry out its powers and duties under the Texas Water Code. In accordance with this authority, the Texas Natural Resource Conservation Commission requires certain persons to provide certification and/or recordation in the real property records to notify the public of the conditions of the land and/or the occurrance of remediation. This deed certification is not a representation or warranty by the Texas Natural Resource Conservation Commission of the suitability of this land for any purpose, nor does it constitute any guarantee by the Texas Natural Resource Conservation Commission that the remediation standards specified in this certification have been met by (Company name).

II

Being a acre tract, more or less, out of the (Company Name)'s acre tract in the (Name) League (No.), Abstract (No.), recorded in Volume (No.), Page (No.) of the Deed of Records County, Texas, said acre tract being more particularly described as follows:

(Insert metes and bounds description here)

For Standard 2 cleanups: (Contaminants/contaminants and waste) deposited hereon have been remediated (to meet residential soil criteria/ to meet non-residential (i.e., industrial/commercial) soil criteria)), in accordance with a plan designed to meet the Texas Natural Resource Conservation Commission's requirements in 30 Texas Administrative Code, §335.555), which mandates that the remedy be designed to eliminate substantial present and future risk such that no post-closure care or engineering or institutional control measures are required to protect human health and the environment. Future land use is considered suitable for (residential, non-residential (i.e.,industrial/ commercial)) purposes in accordance with risk reduction standards applicable at the time of this filing. Future land use is intended to be (residential, non-residential).

For Standard 3 cleanups: (Contaminants/contaminants and waste) deposited hereon have been remediated (to meet residential soil criteria/to meet non-residential (i.e., industrial/commercial) soil criteria) in accordance with a plan designed to meet the requirements of 30 Texas Administrative Code, §335.561 (Risk Reduction Standard Number 3), which mandates that the remedy be designed to eliminate or reduce to the maximum extent practicable, substantial present or future risk. The remediation plan (does/ does not) require continued post-closure care or engineering or institutional control measures. Future use of the property is considered appropriate for (describe) in accordance with risk reduction standards applicable at the time of this filing. Institutional or legal controls placed on the property to ensure appropriate future use include (describe).

For both Standard 2 and 3 cleanups where the remedy is based upon non-residential soil criteria: The current or future owner must undertake actions as necessary to protect human health or the environment in accordance with the rules of the Texas Natural Resource Conservation Commission.

III

The owner of the site is (Company Name), a Texas corporation, and its address is (P.O. Box or Street), (City), Texas (Zip Code), where more specific information may be obtained from the (plant manager, owner).

EXECUTED this the day of , 20 .

(Company Name)
a Texas corporation

(Name)

00113302

Plant Manager

STATE OF TEXAS
( ) COUNTY

BEFORE ME, on this the day of , personally appeared (Name), (Plant Manager, Owner) of (Company Name), a Texas corporation, known to me to be the person and agent of said corporation whose name is subscribed to the foregoing instrument, and he acknowledged to me that he executed the same for the purposes and in the capacity therein expressed.

GIVEN UNDER MY HAND AND SEAL OF OFFICE, this the day of , 20 .

Notary Public in and
for the State of Texas,
County of

October 2006

SAMPLE FEDERAL FACILITY LAND USE CONTROL ROD CHECKLIST WITH SUGGESTED LANGUAGE[1]

Directions: This checklist applies to all federal facility RODs. At Air Force facilities, numbers 1-8 and 10-19 should be included in the ROD as applicable (generally numbers 18 and 19 apply at closing facilities, but they may have application elsewhere). For all other federal facility RODs (DOE, Navy, Army and others), the LUC implementation details are generally placed in a post-ROD enforceable document. Therefore, numbers 1-9 below would usually appear in the ROD, while numbers 10-19 would be placed in a post-ROD enforceable document such as the LUC Remedial Design or Remedial Action Workplan. In some Regions, the term LUC Implementation Plan is used rather than LUC Remedial Design or Remedial Action Workplan. The specific post-ROD document where the LUC implementation details are designated may vary by site (for instance, it may be called a LUC Implementation Plan or LUCIP), as long as the specific document is identified in the ROD and is enforceable.

Air Force RODs should address numbers1-8 and 10-19, below. All other federal facility RODs should address numbers 1-9, below and numbers 10-19 in the RD/RAWP.

Where appropriate, Regions should consider including concepts and provisions in RODs, etc., similar to the samples provided below in order to ensure protective remedies:

_____1. Map/Figure showing boundaries of the land use controls

_____2. Document risk exposure assumptions and reasonably anticipated land uses, as well as any known prohibited uses which might not be obvious based on the reasonably anticipated land uses. (For example, where "unrestricted industrial" use is anticipated, list prohibited uses such as on-site company day-care centers, recreation areas, etc.)

______3. Describe the risks necessitating the LUCs.

_______4. State the LUC performance objectives. We have had comments on these because several of the objectives have not been clear. The following are some examples of what we have been looking for:

1. Prevent access or use of the groundwater until cleanup levels are met.
2. Maintain the integrity of any current or future remedial or monitoring system such as monitoring wells, impermeable reactive barriers.

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[1]While the checklist applies to land use controls, ROD reviews indicated a slight problem with the Declaration language which often states who selected the remedy. Where that language is included, please ensure that the federal agency and EPA select the remedy.

3. Maintain the 12 inch vegetative soil layer to limit ecological contact.
4. Prohibit the development and use of property for residential housing, elementary and secondary schools, child care facilities and playgrounds.

______5. Generally describe the LUC, the logic for its selection and any related deed restrictions/notifications. (See also #16, below)

_______6. Duration language: "Land Use Controls will be maintained until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure."

________7. Include language that the [federal agency] is responsible for implementing, maintaining, reporting on, and enforcing the land use controls. This may be modified to include another party should the site-specific circumstances warrant it.

________8. Where someone else will or the federal agency plans that someone else will ultimately be implementing, maintaining, reporting on, and enforcing land use controls, the following language should be included:

"Although the [federal agency] may later transfer [has transferred] these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the [federal agency] shall retain ultimate responsibility for remedy integrity."

_________9. [**ONLY INCLUDE IN NON-AF RODS**] Refer to the remedial design (RD) or remedial action work plan (RAWP) for the implementation actions. Because this is a new idea (i.e., including the LUC implementation actions in either or both of these two primary documents), to ensure that the requirement is clear and enforceable, we developed the following language where it makes sense:

> "A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 90 days of ROD signature, the [federal agency] shall prepare and submit to EPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections." Another option is to refer to the enforceable schedule in the IAG for the RD or RAWP."

__________10. Commitment by federal agency to address any situation that may interfere with the effectiveness of LUC:

"Any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs will be addressed by the [federal agency] as soon as practicable, but in no case will the process be initiated later than___ days [10 days suggested] after the [federal agency] becomes aware of the breach."

__________11. Commitment by federal agency to notify EPA of and address any situation that may interfere with the effectiveness of LUC:

"The [federal agency] will notify EPA and [the state] as soon a practicable but no longer than ten days after discovery of any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs The [federal agency] will notify EPA and [the state] regarding how the [federal agency] has addressed or will address the breach within 10 days of sending EPA and [the state] notification of the breach."

________12. Notification to EPA and the state regarding land use changes:

[For closing base]:[We are seeing in federal agency RODs language requiring the property transferee to notify EPA and the state prior to notifying the federal agency about possible land use changes. We have switched that around so that the federal agency reviews the proposal first. This should save EPA some resources.]

"Prior to seeking approval from the EPA and [the state] the recipient of the property must notify and obtain approval from the [federal agency] of any proposals for a land use change at a site inconsistent with the use restrictions and assumptions described in this ROD."

[For active base]:

"The [federal agency] shall notify EPA and state ____ days [45 days suggested] in advance of any proposed land use changes that are inconsistent with land use control objectives or the selected remedy."

________13. Notification regarding transfers and federal-to-federal transfers:

"The [federal agency] will provide notice to EPA and [the state] at least six (6) months prior to any transfer or sale of [OUs at issue] so that EPA and [the state] can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for the facility to notify EPA and [the state] at least six months prior to any transfer or sale, then the facility will notify EPA and [the state] as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions above, the [federal agency] further agrees to provide EPA and [the state] with similar notice, within the same time frames, as to federal-to-federal transfer of property. The [federal agency] shall provide a copy of executed deed or transfer assembly to EPA and [the state]."

_________14. Concurrence language: "The [federal agency] shall not modify or terminate Land Use Controls, implementation actions, or modify land use without approval by EPA and the [state]. The [federal agency] shall seek prior concurrence before any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs."

__________15. Monitoring and reporting language. Note that Regions may alter the monitoring frequency based on site-specific needs.

"Monitoring of the environmental use restrictions and controls will be conducted annually by the [federal agency]. The monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to the USEPA and the [the state]. The annual monitoring reports will be used in preparation of the Five Year Review to evaluate the effectiveness of the remedy.

The annual monitoring report, submitted to the regulatory agencies by the [federal agency], will evaluate the status of the ICs and how any IC deficiencies or inconsistent uses have been addressed. The annual evaluation will address whether the use restrictions and controls referenced above were communicated in the deed(s), whether the owners and state and local agencies were notified of the use restrictions and controls affecting the property, and whether use of the property has conformed with such restrictions and controls."

___________16. A comprehensive list of LUCs. The LUC should not be confused with the LUC objectives. The term LUC refers to the actual LUC instrument which is used to accomplish the objectives. The LUCs are likely to be a legal mechanism or administrative measure used to impose use restrictions (e.g. permits, orders, restrictive covenants, zoning), but they may also include measures such as fences and guards. If the description of the LUCs in #5 above is comprehensive, it could substitute for #16's listing of LUCs.

_________17. For active facilities, a description of the internal procedures for implementing the LUCs (e.g., orders, instructions, Base Master Plan) and a commitment by the [federal agency] to notify EPA in advance of any changes to the internal procedures that would affect the LUCs.

Generally, #s 18 and 19 apply at a BRAC installation, but they may have application elsewhere.

_________18. Other property transfer language:

a. "<u>Deed Restrictions</u>: "Each transfer of fee title from the United States will include a CERCLA 120(h)(3) covenant which will have a description of the residual contamination on the property and the environmental use restrictions, expressly prohibiting activities inconsistent with the performance measure goals and objectives.

The environmental restrictions are included in a section of the CERCLA 120(h)(3) covenant that the United States is required to include in the deed for any property that has had hazardous substances stored for one year or more, known to have been released or disposed of on the property. Each deed will also contain a reservation of access to the property for the [federal agency], USEPA, and [the State], and their respective officials, agents, employees, contractors, and subcontractors for purposes consistent with the [federal agency] Installation Restoration

Program ("IRP") or the Federal Facility Agreement ("FFA"). The deed will contain appropriate provisions to ensure that the restrictions continue to run with the land and are enforceable by the [federal agency]."

b. "Lease Restrictions: " During the time between the adoption of this ROD and deeding of the property, equivalent restrictions are being implemented by lease terms, which are no less restrictive than the use restrictions and controls described above, in this ROD. These lease terms shall remain in place until the property is transferred by deed, at which time they will be superceded by the institutional controls described in this ROD."

c. "Notice: "Concurrent with the transfer of fee title from the [federal agency] to transferee, information regarding the environmental use restrictions and controls will be communicated in writing to the property owners and to appropriate state and local agencies to ensure such agencies can factor such conditions into their oversight and decision-making activities regarding the property."

______ 19. Ensure that the document adequately describes pre-transfer LUCs, not just post-transfer LUCs.

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION
TECHNOLOGY
AND LOGISTICS

APR 2 2 2009

MEMORANDUM FOR DEPUTY ASSISTANT SECRETARY OF THE ARMY (ENVIRONMENT, SAFETY & OCCUPATIONAL HEALTH)
DEPUTY ASSISTANT SECRETARY OF THE NAVY (ENVIRONMENT)
DEPUTY ASSISTANT SECRETARY OF THE AIR FORCE (ENERGY, ENVIRONMENT, SAFETY & OCCUPATIONAL HEALTH)
DIRECTOR, DLA ENTERPRISE SUPPORT

SUBJECT: Perchlorate Release Management Policy

This memorandum updates policy on management of perchlorate releases at DoD installations, including operational ranges and Government Owned-Contractor Operated (GOCO) facilities, Base Realignment and Closure (BRAC) sites, and Formerly Used Defense Sites (FUDS) in the United States. This policy supersedes the previous perchlorate policies issued by this office listed in Attachment A.

Under the Defense Environmental Restoration Program (DERP) and the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), DoD has authority to undertake actions where deemed necessary to protect public health or the environment consistent with the National Oil and Hazardous Substances Spill Contingency Plan (NCP) at facilities under DoD jurisdiction or where the source of a release is from a DoD facility. These actions can span the spectrum from Preliminary Assessments/Site Inspections through Remedial Actions. As required by the NCP, DoD will comply with federal and state standards related to perchlorate that qualify as Applicable or Relevant and Appropriate Requirements (ARARs). It should be noted that promulgation of a Maximum Contaminant Level (MCL) or similar regulatory standard is not a precondition for sampling, assessing the risk from a release of a contaminant, or taking other actions.

On January 10, 2005, the National Research Council (NRC) of the National Academy of Sciences completed its toxicological review of perchlorate. Based on the results of the NRC review, the U.S. Environmental Protection Agency (EPA) adopted an oral reference dose (RfD) of 0.0007 mg/kg/day for perchlorate. On January 26, 2006, EPA issued guidance that recommended a preliminary remediation goal (PRG) for perchlorate of 24.5 ppb in water. The PRG was defined as a Drinking Water Equivalent Level (DWEL) based on the RfD. On January 8, 2009, EPA withdrew its January 26, 2006, perchlorate assessment guidance and issued an Interim Drinking Water Health Advisory for exposure to perchlorate of 15 μg/L (or ppb) in drinking water. The interim health advisory level of 15 μg /L is different from the earlier DWEL of 24.5 ppb in that it incorporates exposure from food. The full Advisory is available at http://www.epa.gov/safewater/contaminants/unregulated/perchlorate.html.

Attachment B provides EPA's revised policy which recommends 15 μg/L (or 15 ppb) as the PRG for perchlorate when making site-specific CERCLA cleanup decisions where there is an actual or potential drinking water exposure pathway and where no ARARs exist under federal or state laws. However, where State regulations qualify as ARARs for perchlorate, the preliminary remediation goals established shall be developed considering the State regulations that qualify as ARARs, as well as other factors cited in the NCP (see 40 CFR 300.430(e)(2)(i)(A)).

The DUSD(I&E) memorandum of January 26, 2006 provided policy with respect to perchlorate sampling and established a "level of concern" of 24 ug/L (ppb). The stated level of concern was similar to a PRG in that it was used for site screening and to help identify the need for a site-specific human health risk assessment. To avoid any confusion, DoD will also use the term PRG for this policy and a PRG of 15 ppb for perchlorate as further described herein. Generally, while it is not anticipated that the PRG change will affect sampling requirements, there may be limited circumstances where additional sampling may be required.

DoD Components shall program resources and address perchlorate releases as follows:

<u>Environmental Restoration</u>

Perchlorate releases shall be addressed in the same manner as other contaminants of concern. For other than operational ranges, DoD Components shall conduct site-specific risk assessments and any necessary response actions in accordance with CERCLA, DERP, other applicable laws, and the NCP and consistent with the DoD relative ranking system for DERP sites. For operational ranges, DoD Components will assess for actual or potential off-range migration of perchlorate in their respective Operational Range Assessment programs consistent with DoDI 4715.14, "Operational Range Assessments."

Based on the EPA's Interim Drinking Water Health Advisory for perchlorate, the recommended PRG is 15 ppb where there is an actual or potential drinking water exposure pathway and where no ARARs exist under federal or state laws. The PRG may be used for initial screening of remedial alternatives and project scoping as described in the NCP, the NCP preamble, and Risk Assessment Guidance for Superfund Volume I, Part B (EPA/540/R-92/003, Pub. 9285.7-01B, Dec. 1991). Unless modified by EPA in the Integrated Risk Information System (IRIS) database, the RfD of 0.0007 mg/kg/day is still appropriate for use in determining risk in site-specific human health risk assessments developed in accordance with the NCP.

DoD-owned Drinking Water Systems

DoD-owned drinking water systems that are required to sample for inorganic analytes pursuant to regulatory requirements shall add perchlorate to their current analyte list for at least two sampling events if they have not done so already. Installations with confirmed results that indicate the presence of perchlorate in finished drinking water shall notify their Major Command and consult with them on appropriate actions, which may include development of an action plan to reduce exposure to perchlorate as appropriate for the protection of public health. At a minimum, these installations shall continue sampling quarterly until they and their Major Command are satisfied that perchlorate concentrations are likely to remain below 15 ppb, an applicable state MCL, or a federal MCL, whichever is lowest.

Managers of DoD-owned drinking water systems that use sodium hypochlorite should be aware of studies reported by the American Water Works Association that surveyed sodium hypochlorite products used to treat drinking water. Perchlorate was found in more than 90% of production facilities sampled across North America that used these sodium hypochlorite products. Results also indicated a trend of increasing perchlorate concentration as the hypochlorite aged. The duration and conditions of storage can affect the levels of the perchlorate in a utility's hypochlorite supplies and ultimately its drinking water.

DoD Wastewater Effluent Discharges

At permitted point sources where use of perchlorate is associated with the manufacture, maintenance, processing, recycling, or demilitarization of military munitions, DoD Components shall sample for perchlorate for at least two semi-annual sampling events if they have not done so already. Sampling will be conducted in conjunction with effluent sampling conducted under the permit applicable to that point source. Installations with confirmed results that indicate perchlorate above 15 ppb in wastewater effluent discharges shall notify their Major Command and consult with them on appropriate actions. Depending on applicable water quality standards and other factors (e.g., mixing zones), permit modifications and follow-on actions may be required. Irrespective of current state permit requirements, risk management actions may be warranted to reduce perchlorate discharges to receiving water bodies. This policy does not require re-sampling where previous results were below 15 ppb. Nothing in this policy is intended to diminish any requirements established by wastewater discharge permits issued by EPA or state regulatory authorities for DoD installations or operations.

Environmental Auditing

Components shall ensure that environmental auditing procedures for active installations, including GOCOs, include provisions for checking compliance with this policy and that all appropriate actions have been initiated, programmed, or determined to be not required under applicable laws and regulations.

Perchlorate Database

As a result of Congressional and regulatory agency concerns related to perchlorate, DoD developed a database for perchlorate sampling with a separate module managed by each Component. DoD Components shall ensure that all perchlorate sampling data, in all media, are entered into the database in accordance with applicable security requirements. Perchlorate sampling in all media shall be conducted in accordance with the DoD Perchlorate Handbook prepared by the DoD Environmental Data Quality Workgroup. Summary reports of sampling will be developed by DUSD(I&E) at the close of each fiscal year. In addition, draft state summaries and narratives will be developed by DUSD(I&E) based on annual data. DoD Components shall review and approve the state summaries before the summaries are posted on the DENIX web site

Funding

Environmental restoration actions related to perchlorate shall be funded under the DERP in accordance with DERP management guidance. For drinking water systems and wastewater effluent discharges, perchlorate sampling and follow-on actions taken pursuant to this policy will be considered an Environmental Quality Status Class I requirement under DoDI 4715.6, "Environmental Compliance."

At installations outside the United States, perchlorate issues will be addressed in accordance with DoDI 4715.5, *Management of Environmental Compliance at Overseas Installations*, DoDD 4715.12, *Environmental and Explosives Safety Management on Operational Ranges Outside the United States,* DoDI 4715.8, *Environmental Remediation for DoD Activities Overseas*, and DoD 4715.5-G, *Overseas Environmental Baseline Guidance Document.*. Any resulting required sampling or follow-on actions will be considered an Environmental Quality Status Class I requirement.

My point of contact for any questions regarding this policy is Mr. Paul Yaroschak at (703) 604-0641, Paul.Yaroschak@osd.mil.

Wayne Arny
Deputy Under Secretary of Defense
(Installations and Environment)

Attachments:
As stated

Attachment A

Superseded DUSD(&E) Perchlorate Policies

- ADUSD(E) memorandum of November 13, 2002, "Perchlorate Assessment Policy"
- DUSD(I&E) memorandum of September 29, 2003, "Interim Policy on Perchlorate Sampling"
- DUSD(I&E) memorandum of January 26, 2006, "Policy on DoD Required Actions Related to Perchlorate"
- ADUSD(ESOH) memorandum of September 21, 2007, "Actions in Response to Perchlorate Releases"

Attachment B

00113314

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN - 8 2009

MEMORANDUM

OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE

SUBJECT: Revised Assessment Guidance for Perchlorate

FROM: Susan Parker Bodine Susan Parker Bodine
Assistant Administrator

TO: Regional Administrators

On January 26, 2006, guidance was issued regarding perchlorate and the cleanup of sites under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Contingency Plan (National Contingency Plan (NCP)), 40 CFR Part 300; the January 2006 guidance recommended that Regions use a preliminary remediation goal (PRG) for perchlorate of 24.5 parts per billion (ppb or micrograms per liter [μg/L]) in water when making site-specific cleanup decisions.[1] The PRG was defined as a Drinking Water Equivalent Level based on EPA's reference dose (RfD) of 0.7 micrograms per kilogram body weight per day (μg/kg-day); the RfD remains an appropriate "to be considered" (TBC) value in accordance with the NCP. However, since the NCP provides that "preliminary remediation goals should be modified, as necessary, as more information becomes available during the RI/FS (remedial investigation/feasibility study)," the January 2006 guidance also made clear that the PRG at any site should be evaluated on a case-by-case basis, and modified accordingly, based on site-specific information, including actual and potential exposure routes, including contributions from non-water sources.

The Agency has now issued an Interim Drinking Water Health Advisory (Interim Health Advisory) for exposure to perchlorate of 15 μg/L in water, a copy of which can be obtained at http://www.epa.gov/safewater/contaminants/unregulated/perchlorate.html. (A health advisory provides technical guidance to federal, state, and other public health officials on health effects, analytical methods and treatment technologies associated with drinking water contamination.) The Interim Health Advisory for perchlorate was developed using EPA's RfD and representative body weight, as well as 90th percentile drinking water and national food exposure data for pregnant women in order to protect the most sensitive population identified by the National Research Council (NRC) (i.e., the fetuses of pregnant women who might have hypothyroidism or iodide deficiency). See "Health Implications of Perchlorate Ingestion."[2] The interim health advisory level of

[1] PRGs are specific statements of desired endpoint concentrations of risk levels (55 FR 8713, March 8, 1990) that are conservative, default endpoint concentrations used in screening and initial development of remedial alternatives before consideration of information from site-specific risk assessments.
[2] NRC 2005. Health Implications of Perchlorate Ingestion, National Research Council of the National Academy of Sciences, National Academies Press, Washington D.C.

15 ug/L is thus different from the earlier DWEL of 24.5 ug/L in that it incorporates exposure from food. Infants and developing children were also identified as sensitive sub-populations by the NRC. Therefore, the Agency also evaluated these other sub-populations and concluded that the Interim Health Advisory of 15 µg/L derived for pregnant women is also an appropriate interim Health Advisory for these other sub-populations.

The NCP (40 CFR 300.430(e)(2)(A)(1)) provides that when establishing acceptable exposure levels for use as remediation goals, consideration must be given to concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effects over a lifetime or part of a lifetime, incorporating an adequate margin of safety. As a result of the publication of the Interim Health Advisory for perchlorate, I am formally withdrawing the January 26, 2006 guidance recommending a PRG of 24.5 ppb for perchlorate. In its place, this memorandum now recommends that where no federal or state applicable or relevant and appropriate (ARAR) requirements exist under federal or state laws, 15 µg/L (or 15 ppb) is recommended as the PRG for perchlorate when making CERCLA site-specific cleanup decisions where there is an actual or potential drinking water exposure pathway. However, where State regulations qualify as ARARs for perchlorate, the remediation goals established shall be developed considering the State regulations that qualify as ARARs, as well as other factors cited in the NCP (see 40 CFR 300.430(e)(2)(i)(ff)).

Final remediation goals and remedy decisions are made in accordance with 40 CFR300.430 (e) and (f) and associated provisions.

If you have further questions regarding the applicability of this memorandum please contact Jayne Michaud at (703) 603-8847.

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United States
Environmental Protection
Agency

2011 Edition of the Drinking Water Standards and Health Advisories

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The *Drinking Water Standards and Health Advisories* Tables are revised periodically by EPA's Office of Water in order to update RfD and Cancer values so that they are consistent with the most current Agency assessments of chemical contaminants that may occur in drinking water and to introduce new Health Advisories. The following information should be kept in mind when using the 2011 Edition of the Tables:

> Reference dose (RfD) values are updated to reflect the values in the Integrated Risk Information System (IRIS) and the Office of Pesticide Programs (OPP) Reregistration Eligibility Decisions (RED) Documents. The Drinking Water Equivalent Level (DWEL) has been adjusted accordingly. Thus, both the RfD and DWEL in the Tables differ from the values in the Health Advisory document when the IRIS or OPP RfD is more recent than the Health Advisory document value. RfD values from IRIS that differ from the values in the Health Advisory documents are presented in **BOLD** type. Values derived from the REDs are given in ***BOLD*** italics. For unregulated chemicals with a recent IRIS or OPP RfD, the lifetime Health Advisory is calculated from the DWEL using the relative source contribution value published in the Health Advisory document. For regulated chemicals, no lifetime value is provided in the Tables when the revised lifetime value would differ from the Maximum Contaminant Level Goal (MCLG).
>
> The cancer group designation or cancer classification and 10^{-4} cancer risk values reflect those presently in IRIS or in the OPP RED. New IRIS cancer designations and 10^{-4} cancer risk values are presented in **BOLD** type and those derived from the REDs are in ***BOLD*** italics.
>
> The IRIS Toxicological Reviews can be accessed at: http://www.epa.gov/IRIS. The OPP REDs can be accessed at: http://www.epa.gov/pesticides/reregistration/status.htm.
>
> In some cases there is a Health Advisory value for a contaminant but there is no reference to a Health Advisory document. These Health Advisory values can be found in the Drinking Water Criteria Document for the contaminant.
>
> With a few exceptions, the RfDs, Health Advisory, and cancer risk values have been rounded to one significant figure following the convention adopted by IRIS.

The *Drinking Water Standards and Health Advisories* Tables may be reached from the Water Science home page at: http://www.epa.gov/waterscience/. The Tables are accessed under the Drinking Water icon.

Copies the Tables may be ordered free of charge from

SAFE DRINKING WATER HOTLINE
1-800-426-4791
Monday thru Friday, 9:00 AM to 5:30 PM EST

DEFINITIONS

The following definitions for terms used in the Tables are not all-encompassing, and should not be construed to be "official" definitions. They are intended to assist the user in understanding terms found on the following pages.

Action Level: The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow. It is the level of lead or copper which, if exceeded in over 10% of the homes tested, triggers treatment for corrosion control.

Cancer Classification: A descriptive weight-of-evidence judgment as to the likelihood that an agent is a human carcinogen and the conditions under which the carcinogenic effects may be expressed. Under the 2005 EPA *Guidelines for Carcinogen Risk Assessment*, descriptive terms for carcinogenicity replace the earlier alpha numeric Cancer Group designations (US EPA 1986 guidelines). The suggested descriptive terms are as follows:

- Carcinogenic to humans (**H**)
- Likely to be carcinogenic to humans (**L**)
- Likely to be carcinogenic above a specified dose but not likely to be carcinogenic below that dose because a key event in tumor formation does not occur below that dose (**L/N**)
- Suggestive evidence of carcinogenic potential (**S**)
- Inadequate information to assess carcinogenic potential (**I**)
- Not likely to be carcinogenic to humans (**N**)

The letter abbreviations provided parenthetically above are now used in the Tables in place of the prior alpha numeric identifiers for chemicals that have been evaluated under the new guidelines (the 2005 guidelines or the 1996 and 1999 draft guidelines).

Cancer Group: A qualitative weight-of-evidence judgment as to the likelihood that a chemical may be a carcinogen for humans. Each chemical was placed into one of the following five categories (US EPA 1986 guidelines). The Cancer Group designations are given in the Tables for chemicals that have not yet been evaluated under the new guidelines.

Group	Category
A	Human carcinogen
B	Probable human carcinogen: **B1** indicates limited human evidence **B2** indicates sufficient evidence in animals and inadequate or no evidence in humans
C	Possible human carcinogen
D	Not classifiable as to human carcinogenicity
E	Evidence of noncarcinogenicity for humans

10^{-4} Cancer Risk: The concentration of a chemical in drinking water corresponding to an excess estimated lifetime cancer risk of 1 in 10,000.

Drinking Water Advisory: A nonregulatory concentration of a contaminant in water that is likely to be without adverse effects on health and aesthetics.

DWEL: Drinking Water Equivalent Level. A lifetime exposure concentration protective of adverse, non-cancer health effects, which assumes that all of the exposure to a contaminant is from drinking water.

HA: Health Advisory. An estimate of acceptable drinking water levels for a chemical substance based on health effects information; a Health Advisory is not a legally enforceable Federal standard, but serves as technical guidance to assist Federal, State, and local officials.

> **One-Day HA:** The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to one day of exposure. The One-Day HA is normally designed to protect a 10-kg child consuming 1 liter of water per day.
>
> **Ten-Day HA:** The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to ten days of exposure. The Ten-Day HA is also normally designed to protect a 10-kg child consuming 1 liter of water per day.
>
> **Lifetime HA:** The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure. The Lifetime HA is based on exposure of a 70-kg adult consuming 2 liters of water per day. The Lifetime HA for Group C carcinogens includes an adjustment for possible carcinogenicity.

MCLG: Maximum Contaminant Level Goal. A non-enforceable health goal which is set at a level at which no known or anticipated adverse effect on the health of persons occurs and which allows an adequate margin of safety.

MCL: Maximum Contaminant Level. The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLG as feasible using the best available analytical and treatment technologies and taking cost into consideration. MCLs are enforceable standards.

RfD: Reference Dose. An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

SDWR: Secondary Drinking Water Regulations. Non-enforceable Federal guidelines regarding cosmetic effects (such as tooth or skin discoloration) or aesthetic effects (such as taste, odor, or color) of drinking water.

TT: Treatment Technique. A required process intended to reduce the level of a contaminant in drinking water.

ABBREVIATIONS

D	Draft
F	Final
I	Interim
NA	Not Applicable
NOAEL	No-Observed-Adverse-Effect Level
OPP	Office of Pesticide Programs
P	Proposed
Pv	Provisional
Reg	Regulation
TT	Treatment Technique

Drinking Water Standards and Health Advisories

Chemicals	CASRN Number	Standards: Status Reg.	Standards: MCLG (mg/L)	Standards: MCL (mg/L)	Status HA Document	Health Advisories: 10-kg Child: One-day (mg/L)	Health Advisories: 10-kg Child: Ten-day (mg/L)	Health Advisories: RfD (mg/kg/day)	Health Advisories: DWEL (mg/L)	Health Advisories: Life-time (mg/L)	Health Advisories: mg/L at 10^{-4} Cancer Risk	Cancer Descriptor[1]
ORGANICS												
Acenaphthene	83-32-9	-	-	-	-	-	-	0.06	2	-	-	-
Acifluorfen (sodium)	62476-59-9		-	-	F '88	2	2	0.01	0.4	-	0.1	***L/N***
Acrylamide	79-06-1	F	zero	TT[2]	F '87	1.5	0.3	**0.002**	0.07	-	-	**L**
Acrylonitrile	107-13-1		-	-	-	-	-	-	-	-	0.006	B1
Alachlor	15972-60-8	F	zero	0.002	F '88	0.1	0.1	0.01	0.4	-	***0.04***	***B2***
Aldicarb[3]	116-06-3	F[4]	0.001	0.003	F '95	0.01	0.01	0.001	0.035	0.007	-	D
Aldicarb sulfone[3]	1646-88-4	F[4]	0.001	0.002	F '95	0.01	0.01	0.001	0.035	0.007	-	D
Aldicarb sulfoxide[3]	1646-87-3	F[4]	0.001	0.004	F '95	0.01	0.01	0.001	0.035	0.007	-	D
Aldrin	309-00-2	-	-	-	F '92	0.0003	0.0003	0.00003	0.001	-	0.0002	B2
Ametryn	834-12-8	-	-	-	F '88	9	9	0.009	0.3	0.06	-	D
Ammonium sulfamate	7773-06-0	-	-	-	F '88	20	20	0.2	8	2	-	D
Anthracene (PAH)[5]	120-12-7	-	-	-	-	-	-	0.3	10	-	-	D
Atrazine	1912-24-9	F	0.003	0.003	F '88	-	-	***0.02***	0.7	-	-	***N***
Baygon	114-26-1	-	-	-	F '88	0.04	0.04	0.004	0.1	0.003	-	C
Bentazon	25057-89-0	-	-	-	F '99	0.3	0.3	0.03	1	0.2	-	E
Benz[a]anthracene (PAH)	56-55-3	-	-	-	-	-	-	-	-	-	-	B2
Benzene	71-43-2	F	zero	0.005	F '87	0.2	0.2	**0.004**	0.1	-	0.1	**H**
Benzo[a]pyrene (PAH)	50-32-8	F	zero	0.0002	-	-	-	-	-	-	**0.0005**	B2
Benzo[b]fluoranthene (PAH)	205-99-2	-	-	-	-	-	-	-	-	-	-	B2
Benzo[g,h,i]perylene (PAH)	191-24-2	-	-	-	-	-	-	-	-	-	-	D
Benzo[k]fluoranthene (PAH)	207-08-9	-	-	-	-	-	-	-	-	-	-	B2
Bis(2-chloro-1-methylethyl) ether	108-60-1	-	-	-	F '89	4	4	**0.04**	1	0.3	-	D
Bromacil	314-40-9	-	-	-	F '88	5	5	***0.1***	3.5	0.07	-	C
Bromobenzene	108-86-1	-	-	-	D '86	4	4	**0.008**	0.3	0.07	-	**I**

1 Chemicals evaluated under the 2005 Cancer Guidelines or the 1996 or 1999 drafts are demoted by an abbreviation for their weight-of-the-evidence descriptor (see page iii). If the agency has not completed a new assessment for the chemical, the 1986 Guidelines Group designation (see page iii) is given in the Cancer Descriptor column.
2 When Acrylamide is used in drinking water systems, the combination (or product) of dose and monomer level shall not exceed that equivalent to a polyacrylamide polymer containing 0.05% monomer dosed at 1 mg/L.
3 The MCL value for any combination of two or more of these three chemicals should not exceed 0.007 mg/L because of a similar mode of action.
4 Administrative stay of the effective date.
5 PAH = Polycyclic aromatic hydrocarbon.

Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		10-kg Child						
						One-day (mg/L)	Ten-day (mg/L)	RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10^{-4} Cancer Risk	
Bromochloromethane	74-97-5	-	-	-	F ‘89	50	1	0.01	0.5	0.09	-	D
Bromodichloromethane (THM)	75-27-4	F	zero	0.08[1]	-	1	0.6	0.003	0.1	-	0.1	L
Bromoform (THM)	75-25-2	F	zero	0.08[1]	-	5	0.2	0.03	1	-	0.8	L
Bromomethane	74-83-9	-	-	-	D ‘89	0.1	0.1	0.001	0.05	0.01	-	D
Butyl benzyl phthalate	85-68-7	-	-	-	-	-	-	0.2	7	-	-	C
Butylate	2008-41-5	-	-	-	F ‘89	2	2	0.05	2	0.4	-	D
Carbaryl	63-25-2	-	-	-	F ‘88	1	1	***0.01***	0.4	-	4	***L***
Carbofuran	1563-66-2	F	0.04	0.04	F ‘87	-	-	***0.00006***	-	-	-	***N***
Carbon tetrachloride	56-23-5	F	zero	0.005	F ‘87	4	0.2	**0.004**	0.1	-	**0.05**	**L**
Carboxin	5234-68-4	-	-	-	F ‘88	1	1	0.1	3.5	0.7	-	D
Chloramben	133-90-4	-	-	-	F ‘88	3	3	0.015	0.5	0.1	-	D
Chlordane	57-74-9	F	zero	0.002	F ‘87	0.06	0.06	**0.0005**	0.02	-	**0.01**	B2
Chloroform (THM)	67-66-3	F	0.07	0.08[1]	-	4	4	**0.01**	0.35	0.07	-	**L/N**
Chloromethane	74-87-3	-	-	-	F ‘89	9	0.4	-	-	-	-	**I**
Chlorophenol (2-)	95-57-8	-	-	-	D ‘94	0.5	0.5	0.005	0.2	0.04	-	D
Chlorothalonil	1897-45-6	-	-	-	F ‘88	0.2	0.2	0.015	0.5	-	0.15	B2
Chlorotoluene o-	95-49-8	-	-	-	F ‘89	2	2	0.02	0.7	0.1	-	D
Chlorotoluene p-	106-43-4	-	-	-	F ‘89	2	2	0.02	0.7	0.1	-	D
Chlorpyrifos	2921-88-2	-	-	-	F ‘92	0.03	0.03	***0.0003***	0.01	0.002	-	***D***
Chrysene (PAH)	218-01-9	-	-	-	-	-	-	-	-	-	-	B2
Cyanazine	21725-46-2	-	-	-	D ‘96	0.1	0.1	0.002	0.07	0.001	-	

[1] 1998 Final Rule for Disinfectants and Disinfection By-products: The total for trihalomethanes (THM) is 0.08 mg/L.

Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
						10-kg Child						
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		One-day (mg/L)	Ten-day (mg/L)	RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10^{-4} Cancer Risk	
Cyanogen chloride[1]	506-77-4	-	-	-	-	0.05	0.05	0.05	2	-	-	D
2,4-D (2,4-dichlorophenoxyacetic acid)	94-75-7	F	0.07	0.07	F '87	1	0.3	***0.005***	0.2	-	-	***D***
DCPA (Dacthal)	1861-32-1	-	-	-	F '08	2	2	***0.01***	0.35	0.07	-	***C***
Dalapon (sodium salt)	75-99-0	F	0.2	0.2	F '89	3	3	0.03	0.9	0.2	-	D
Di(2-ethylhexyl)adipate	103-23-1	F	0.4	0.4	-	20	20	0.6	20	0.4	3	C
Di(2-ethylhexyl)phthalate	117-81-7	F	zero	0.006	-	-	-	0.02	0.7	-	0.3	B2
Diazinon	333-41-5	-	-	-	F '88	0.02	0.02	***0.0002***	0.007	0.001	-	***E***
Dibromochloromethane (THM)	124-48-1	F	0.06	0.08[2]	-	0.6	0.6	0.02	0.7	0.06	0.08	S
Dibromochloropropane (DBCP)	96-12-8	F	zero	0.0002	F '87	0.2	0.05	-	-	-	**0.003**	B2
Dibutyl phthalate	84-74-2	-	-	-	-	-	-	**0.1**	4	-	-	D
Dicamba	1918-00-9	-	-	-	F '88	-	-	***0.5***	18	4	-	*N*
Dichloroacetic acid	76-43-6	F	zero	0.06[3]	-	5	5	**0.004**	0.1	-	**0.07**	**L**
Dichlorobenzene o-	95-50-1	F	0.6	0.6	F '87	9	9	0.09	3	0.6	-	D
Dichlorobenzene —[4]	541-73-1	-	-	-	F '87	9	9	0.09	3	0.6	-	D
Dichlorobenzene p-	106-46-7	F	0.075	0.075	F '87	11	11	0.1	4	0.075	-	C
Dichlorodifluoromethane	75-71-8	-	-	-	F '89	40	40	0.2	5	1	-	D
Dichloroethane (1,2-)	107-06-2	F	zero	0.005	F '87	0.7	0.7	-	-	-	0.04	B2
Dichloroethylene (1,1-)	75-35-4	F	0.007	0.007	F '87	2	1	**0.05**	2	-	**0.006**	**S**
Dichloroethylene (cis-1,2-)	156-59-2	F	0.07	0.07	F '90	4	1	**0.002**	0.07	-	-	**I**
Dichloroethylene (trans-1,2-)	156-60-5	F	0.1	0.1	F '87	20	1	**0.02**	0.7	0.1	-	**I**
Dichloromethane	75-09-2	F	zero	0.005	D '93	10	2	0.06	2	-	0.5	B2
Dichlorophenol (2,4-)	120-83-2	-	-	-	D '94	0.03	0.03	0.003	0.1	0.02	-	E
Dichloropropane (1,2-)	78-87-5	F	zero	0.005	F '87	-	0.09	-	-	-	0.06	B2
Dichloropropene (1,3-)	542-75-6	-	-	-	F '88	0.03	0.03	**0.03**	1	-	**0.04**	**L**
Dieldrin	60-57-1	-	-	-	F '88	0.0005	0.0005	0.00005	0.002	-	0.0002	B2
Diethyl phthalate	84-66-2	-	-	-	-	-	-	0.8	30	-	-	D

[1] Under review.
[2] 1998 Final Rule for Disinfectants and Disinfection By-products: The total for trihalomethanes is 0.08 mg/L.
[3] 1998 Final Rule for Disinfectants and Disinfection By-products: The total for five haloacetic acids is 0.06 mg/L.
[4] The values for m-dichlorobenzene are based on data for o-dichlorobenzene.

Drinking Water Standards and Health Advisories

Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
						10-kg Child						
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		One-day (mg/L)	Ten-day (mg/L)	RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10^{-4} Cancer Risk	
Diisopropyl methylphosphonate	1445-75-6	-	-	-	F '89	8	8	0.08	3	0.6	-	D
Dimethrin	70-38-2	-	-	-	F '88	10	10	0.3	10	2	-	D
Dimethyl methylphosphonate	756-79-6	-	-	-	F '92	2	2	0.2	7	0.1	0.7	C
Dimethyl phthalate	131-11-3	-	-	-	-	-	-	-	-	-	-	D
Dinitrobenzene (1,3-)	99-65-0	-	-	-	F '91	0.04	0.04	0.0001	0.005	0.001	-	D
Dinitrotoluene (2,4-)	121-14-2	-	-	-	F '08	1	1	0.002	0.1	-	0.005	L
Dinitrotoluene (2,6-)	606-20-2	-	-	-	F '08	0.4	0.04	0.001	0.04	-	0.005	L
Dinitrotoluene (2,6 & 2,4) [1]		-	-	-	F '92	-	-	-	-	-	0.005	B2
Dinoseb	88-85-7	F	0.007	0.007	F '88	0.3	0.3	0.001	0.035	0.007	-	D
Dioxane p-	123-91-1	-	-	-	F '87	4	0.4	**0.03**	1	0.2	**.035**	**L**
Diphenamid	957-51-7	-	-	-	F '88	0.3	0.3	0.03	1	0.2	-	D
Diquat	85-00-7	F	0.02	0.02	-	-	-	***0.005***	0.02	-	-	***E***
Disulfoton	298-04-4	-	-	-	F '88	0.01	0.01	***0.0001***	0.0035	0.0007	-	***E***
Dithiane (1,4-)	505-29-3	-	-	-	F '92	0.4	0.4	0.01	0.4	0.08	-	D
Diuron	330-54-1	-	-	-	F '88	1	1	***0.003***	0.1	-	***0.2***	***L***
Endothall	145-73-3	F	0.1	0.1	F '88	0.8	0.8	***0.007***	0.25	0.05	-	***N***
Endrin	72-20-8	F	0.002	0.002	F '87	0.02	0.005	**0.0003**	0.01	0.002	-	D
Epichlorohydrin	106-89-8	F	zero	TT[2]	F '87	0.1	0.1	0.002	0.07	-	**0.3**	B2
Ethylbenzene	100-41-4	F	0.7	0.7	F '87	30	3	0.1	3	0.7	-	D
Ethylene dibromide (EDB)[3]	106-93-4	F	zero	0.00005	F '87	0.008	0.008	**0.009**	0.3	-	**0.002**	**L**
Ethylene glycol	107-21-1	-	-	-	F '87	20	6	**2**	70	14	-	D
Ethylene Thiourea (ETU)	96-45-7	-	-	-	F '88	0.3	0.3	***0.0002***	0.007	-	***0.06***	B2
Fenamiphos	22224-92-6	-	-	-	F '88	0.009	0.009	***0.0001***	0.0035	0.0007	-	***E***

1 Technical grade.
2 When epichlorohydrin is used in drinking water systems, the combination (or product) of dose and monomer level shall not exceed that equivalent to an epichlorohydrin-based polymer containing 0.01% monomer dosed at 20 mg/L.
3 1,2-dibromoethane.

Chemicals	CAS Number	Standards			Status HA Standards	Health Advisories						Cancer Descriptor
						10-kg Child						
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		One-day (mg/L)	Ten-day (mg/L)	RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10^{-4} Cancer Risk	
Fluometuron	2164-17-2	-	-	-	F ‘88	2	2	0.01	0.5	0.09		D
Fluorene (PAH)	86-73-7	-	-	-	-	-	-	0.04	1	-	-	D
Fonofos	944-22-9	-	-	-	F ‘88	0.02	0.02	0.002	0.07	0.01	-	D
Formaldehyde	50-00-0	-	-	-	D ‘93	10	5	**0.2**	7	1	-	B1[1]
Glyphosate	1071-83-6	F	0.7	0.7	F ‘88	20	20	***2***	70	-	-	D
Heptachlor	76-44-8	F	zero	0.0004	F ‘87	0.01	0.01	0.0005	0.02	-	0.0008	B2
Heptachlor epoxide	1024-57-3	F	zero	0.0002	F ‘87	0.01	-	0.00001	0.0004	-	0.0004	B2
Hexachlorobenzene	118-74-1	F	zero	0.001	F ‘87	0.05	0.05	0.0008	0.03	-	0.002	B2
Hexachlorobutadiene[2]	87-68-3	-	-	-	-	0.3	0.3	0.0003	0.01	-	0.09	L
Hexachlorocyclopentadiene	77-47-4	F	0.05	0.05	-	-	-	**0.006**	0.2	-	-	**N**
Hexachloroethane	67-72-1	-	-	-	F ‘91	5	5	0.001	0.04	0.001	**0.3**	C
Hexane (n-)	110-54-3	-	-	-	F ‘87	10	4	-	-	-	-	**I**
Hexazinone	51235-04-2	-	-	-	F ‘96	3	2	***0.05***	2	0.4	-	D
HMX[3]	2691-41-0	-	-	-	F ‘88	5	5	0.05	2	0.4	-	D
Indeno[1,2,3,-c,d]pyrene (PAH)	193-39-5	-	-	-	-	-	-	-	-	-	-	B2
Isophorone	78-59-1	-	-	-	F ‘92	15	15	0.2	7	0.1	4	C
Isopropyl methylphosphonate	1832-54-8	-	-	-	F ‘92	30	30	0.1	3.5	0.7	-	D
Isopropylbenzene (cumene)	98-82-8	-	-	-	D ‘87	11	11	0.1	4	-	-	D
Lindane [4]	58-89-9	F	0.0002	0.0002	F ‘87	1	1	***0.005***	0.2	-	-	***S***
Malathion	121-75-5	-	-	-	F ‘92	0.2	0.2	***0.07***	2	0.5	-	***S***
Maleic hydrazide	123-33-1	-	-	-	F ‘88	10	10	0.5	20	4	-	D
MCPA [5]	94-74-6	-	-	-	F ‘88	0.1	0.1	***0.004***	0.14	0.03	-	***N***
Methomyl	16752-77-5	-	-	-	F ‘88	0.3	0.3	0.025	0.9	0.2	-	E
Methoxychlor	72-43-5	F	0.04	0.04	F ‘87	0.05	0.05	**0.005**	0.2	0.04	-	D
Methyl ethyl ketone	78-93-3	-	-	-	F ‘87	75	7.5	**0.6**	20	4	-	D
Methyl parathion	298-00-0	-	-	-	F ‘88	0.3	0.3	***0.0002***	0.007	0.001	-	***N***

1 Carcinogenicity based on inhalation exposure.
2 Regulatory Determination Health Effects Support Document for Hexachlorobutadiene (http://www.epa.gov/safewater/ccl/pdfs/reg_determine1/support_cc1_hexachlorobutadiene_healtheffects.pdf).
3 HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
4 Lindane = γ – hexachlorocyclohexane.
5 MCPA = 4 (chloro-2-methoxyphenoxy) acetic acid.

Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
						10-kg Child						
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		One-day (mg/L)	Ten-day (mg/L)	RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10^{-4} Cancer Risk	
Metolachlor	51218-45-2	-	-	-	F '88	2	2	***0.1***	3.5	0.7	-	***C***
Metribuzin	21087-64-9	-	-	-	F '88	5	5	***0.01***	0.35	0.07	-	***D***
Monochloroacetic acid	79-11-8	F	0.03	0.06[1]	-	0.2	0.2	0.01	0.35	0.07	-	I
Monochlorobenzene	108-90-7	F	0.1	0.1	F '87	4	4	**0.02**	0.7	0.1	-	D
Naphthalene	91-20-3	-	-	-	F '90	0.5	0.5	**0.02**	0.7	0.1	-	**I**
Nitrocellulose[2]	9004-70-0	-	-	-	F '88	-	-	-	-	-	-	-
Nitroguanidine	556-88-7	-	-	-	F '90	10	10	0.1	3.5	0.7	-	D
Nitrophenol p-	100-02-7	-	-	-	F '92	0.8	0.8	0.008	0.3	0.06	-	D
N-nitrosodimethylamine		-	-	-	-	-	-	-	-	-	**0.00007**	$\mathbf{B_2}$
Oxamyl (Vydate)	23135-22-0	F	0.2	0.2	F '05	0.01	0.01	0.001	0.035		-	N
Paraquat	1910-42-5	-	-	-	F '88	0.1	0.1	***0.0045***	0.2	0.03	-	***E***
Pentachlorophenol	87-86-5	F	zero	0.001	F '87	1	0.3	**0.005**	0.2	0.04	**0.009**	**L**
PFOA[3]	335-67-1	-	-	-	Pv '09	-	-	-	-	-	-	-
PFOS[4]	1763-23-1	-	-	-	Pv '09	-	-	-	-	-	-	-
Phenanthrene (PAH)	85-01-8	-	-	-	-	-	-	-	-	-	-	D
Phenol	108-95-2	-	-	-	D '92	6	6	**0.3**	11	2	-	D
Picloram	1918-02-1	F	0.5	0.5	F '88	20	20	***0.02***	0.7	-	-	D
Polychlorinated biphenyls (PCBs)	1336-36-3	F	zero	0.0005	D '93	-	-	-	-	-	0.01	B2
Prometon	1610-18-0	-	-	-	F '88	0.2	0.2	***0.05***	2	0.4	-	***N***
Pronamide	23950-58-5	-	-	-	F '88	0.8	0.8	***0.08***	3	-	***0.1***	***B2***
Propachlor	1918-16-7	-	-	-	F '88	0.5	0.5	***0.05***	2	-	0.1	***L***
Propazine	139-40-2	-	-	-	F '88	-	-	***0.02***	0.7	0.01	-	***N***
Propham	122-42-9	-	-	-	F '88	5	5	0.02	0.6	0.1	-	D
Pyrene (PAH)	129-00-0	-	-	-	-	-	-	0.03	-	-	-	D
RDX[5]	121-82-4	-	-	-	F '88	0.1	0.1	0.003	0.1	0.002	0.03	C
Simazine	122-34-9	F	0.004	0.004	F '88	-	-	***0.02***	0.7	-	-	***N***
Styrene	100-42-5	F	0.1	0.1	F '87	20	2	0.2	7	0.1	-	C
2,4,5-T (Trichlorophenoxy-acetic acid)	93-76-5	-	-	-	F '88	0.8	0.8	0.01	0.35	0.07	-	D

1 1998 Final Rule for Disinfectants and Disinfection By-products: the total for five haloacetic acids is 0.06 mg/L.
2 The Health Advisory Document for nitrocellulose does not include HA values and describes this compound as relatively nontoxic.
3 Perfluorooctanoic Acid. Provisional short-term value 0.0004 mg/L.
4 Perfluorooctane Sulfonate. Provisional short-term value 0.0002 mg/L.
5 RDX = hexahydro -1,3,5-trinitro-1,3,5-triazine.

Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
						10-kg Child						
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		One-day (mg/L)	Ten-day (mg/L)	RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10^{-4} Cancer Risk	
2,3,7,8-TCDD (Dioxin)	1746-01-6	F	zero	3E-08	F '87	1E-06	1E-07	1E-09	4E-08	-	2E-08	B2
Tebuthiuron	34014-18-1	-	-	-	F '88	3	3	0.07	2	0.5	-	D
Terbacil	5902-51-2	-	-	-	F '88	0.3	0.3	0.01	0.4	0.09	-	E
Terbufos	13071-79-9	-	-	-	F '88	0.005	0.005	***0.00005***	0.002	0.0004	-	D
Tetrachloroethane (1,1,1,2-)	630-20-6	-	-	-	F '89	2	2	0.03	1	0.07	0.1	C
Tetrachloroethane (1,1,2,2-)	79-34-5	-	-	-	F '08	3	3	0.01	0.4	-	0.04	L
Tetrachloroethylene[1]	127-18-4	F	zero	0.005	F '87	2	2	0.01	0.5	0.01	-	-
Tetrachloroterephthalic acid	236-79-0	-	-	-	F '08	100	100	-	-	-	-	I
Trichlorofluoromethane	75-69-4	-	-	-	F '89	7	7	0.3	10	2	-	D
Toluene	108-88-3	F	1	1	D '93	20	2	**0.08**	3	-	-	**I**
Toxaphene	8001-35-2	F	zero	0.003	F '96	0.004	0.004	0.0004	0.01	-	0.003	B2
2,4,5-TP (Silvex)	93-72-1	F	0.05	0.05	F '88	0.2	0.2	0.008	0.3	0.05	-	D
Trichloroacetic acid	76-03-9	F	0.02	0.06[2]	-	3	3	0.03	1	0.02	-	S
Trichlorobenzene (1,2,4-)	120-82-1	F	0.07	0.07	F '89	0.1	0.1	**0.01**	0.35	0.07	-	D
Trichlorobenzene (1,3,5-)	108-70-3	-	-	-	F '89	0.6	0.6	0.006	0.2	0.04	-	D
Trichloroethane (1,1,1-)	71-55-6	F	0.2	0.2	F '87	100	40	**2**	70	-	-	**I**
Trichloroethane (1,1,2-)	79-00-5	F	0.003	0.005	F '89	0.6	0.4	0.004	0.1	0.003	0.06	C
Trichloroethylene [1]	79-01-6	F	zero	0.005	F '87	-	-	0.007	0.2	-	0.3	B2
Trichlorophenol (2,4,6-)	88-06-2	-	-	-	D '94	0.03	0.03	0.0003	0.01	-	0.3	B2
Trichloropropane (1,2,3-)	96-18-4	-	-	-	F '89	0.6	0.6	**0.004**	0.1	-	-	**L**
Trifluralin	1582-09-8	-	-	-	F '90	0.08	0.08	***0.02***	0.7	0.01	0.4	***C***
Trimethylbenzene (1,2,4-)	95-63-6	-	-	-	D '87	-	-	-	-	-	-	D
Trimethylbenzene (1,3,5-)	108-67-8	-	-	-	D '87	10	-	-	-	-	-	D
Trinitroglycerol	55-63-0	-	-	-	F '87	0.005	0.005	-	-	0.005	0.2	-
Trinitrotoluene (2,4,6-)	118-96-7	-	-	-	F '89	0.02	0.02	0.0005	0.02	0.002	0.1	C
Vinyl chloride	75-01-4	F	zero	0.002	F '87	3	3	**0.003**	0.1	-	**0.002**	**H**
Xylenes	1330-20-7	F	10	10	D '93	40	40	**0.2**	7	-	-	**I**

[1] Under review.
[2] 1998 Final Rule for Disinfectants and Disinfection By-products: The total for five haloacetic acids is 0.06 mg/L.

Drinking Water Standards and Health Advisories

Chemicals	CASRN Number	Standards			Status HA Document	Health Advisories						Cancer Descriptor
						10-kg Child						
		Status Reg.	MCLG (mg/L)	MCL (mg/L)		One-day (mg/L)	Ten-day (mg/L)	RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10^{-4} Cancer Risk	
INORGANICS												
Ammonia	7664-41-7	-	-	-	D ‘92	-	-	-	-	30	-	D
Antimony	7440-36-0	F	0.006	0.006	F ‘92	0.01	0.01	0.0004	0.01	0.006	-	D
Arsenic	7440-38-2	F	zero	0.01	-	-	-	**0.0003**	0.01	-	**0.002**	A
Asbestos (fibers/l >10μm length)	1332-21-4	F	7 MFL[1]	7 MFL	-	-	-	-	-	-	700-MFL	A[2]
Barium	7440-39-3	F	2	2	D ‘93	0.7	0.7	**0.2**	7	-	-	**N**
Beryllium	7440-41-7	F	0.004	0.004	F ‘92	30	30	**0.002**	0.07	-	-	-
Boron	7440-42-8	-	-	-	F ‘08	3	3	**0.2**	7	6	-	**I**
Bromate	7789-38-0	F	zero	0.01	D ‘98	0.2	-	**0.004**	0.14	-	0.005	B2
Cadmium	7440-43-9	F	0.005	0.005	F ’87	0.04	0.04	0.0005	0.02	0.005	-	D
Chloramine[3]	10599-90-3	F	4[4]	4[4]	D ‘95	-	-	0.1	3.5	3.0	-	-
Chlorine	7782-50-5	F	4[4]	4[4]	D ‘95	3	3	0.1	5	4	-	D
Chlorine dioxide	10049-04-4	F	0.8[4]	0.8[4]	D ‘98	0.8	0.8	0.03	1	0.8	-	D
Chlorite	7758-19-2	F	0.8	1	D ‘98	0.8	0.8	0.03	1	0.8	-	D
Chromium (total)	7440-47-3	F	0.1	0.1	F ‘87	1	1	**0.003**[5]	0.1	-	-	D
Copper (at tap)	7440-50-8	F	1.3	TT[6]	D ‘98	-	-	-	-	-	-	D
Cyanide	143-33-9	F	0.2	0.2	F ‘87	0.2	0.2	**0.0006**[7]	-	-	-	**I**
Fluoride	7681-49-4	F	4	4	-	-[8]	-	**0.06**[9]	-	-	-	-
Lead (at tap)	7439-92-1	F	zero	TT[6]	-	-	-	-	-	-	-	B2
Manganese	7439-96-5	-	-	-	F”04	1	1	0.14[10]	1.6	0.3	-	D
Mercury (inorganic)	7487-94-7	F	0.002	0.002	F ‘87	0.002	0.002	**0.0003**	0.01	0.002	-	D
Molybdenum	7439-98-7	-	-	-	D ‘93	0.08	0.08	0.005	0.2	0.04	-	D
Nickel	7440-02-0	F	-	-	F ‘95	1	1	0.02	0.7	0.1	-	-

1 MFL = million fibers per liter.
2 Carcinogenicity based on inhalation exposure.
3 Monochloramine; measured as free chlorine.
4 1998 Final Rule for Disinfectants and Disinfection By-products: MRDLG=Maximum Residual Disinfection Level Goal; and MRDL=Maximum Residual Disinfection Level.
5 IRIS value for chromium VI.
6 Copper action level 1.3 mg/L; lead action level 0.015 mg/L.
7 This RfD is for hydrogen cyanide.
8 In case of overfeed of the fluoridation chemical see CDC Guidelines in Engineering and Administrative Recommendations on Water Fluoridation www.cdc.gov/mmwr/preview/mmwrhtml/00039178.htm. Elevated F levels ≥ 10mg/L require action by the water system operator.
9 Based on dental fluorosis in children, a cosmetic effect. MCLG based on skeletal fluorosis.
10 Dietary manganese. The lifetime health advisory includes a 3 fold modifying factor to account for increased bioavailability from drinking water.

Drinking Water Standards and Health Advisories

		Standards				Health Advisories						
						10-kg Child						
Chemicals	CASRN Number	Status Reg.	MCLG (mg/L)	MCL (mg/L)	Status HA Document	One-day (mg/L)	Ten-day (mg/L)	RfD (mg/kg/day)	DWEL (mg/L)	Life-time (mg/L)	mg/L at 10^{-4} Cancer Risk	Cancer Descriptor
Nitrate (as N)	14797-55-8	F	10	10	D ‘93	10[1]	10[1]	1.6	-	-	-	-
Nitrite (as N)	14797-65-0	F	1	1	D ‘93	1[1]	1[1]	0.16	-	-	-	-
Nitrate + Nitrite (both as N)		F	10	10	D ‘93	-	-	-	-	-	-	-
Perchlorate[2]	14797-73-0	-	-	-	I ‘08	-	-	0.007	0.025	0.015	-	L/N
Selenium	7782-49-2	F	0.05	0.05	-	-	-	0.005	0.2	0.05	-	D
Silver	7440-22-4	-	-	-	F ‘92	0.2	0.2	0.005[3]	0.2	0.1[3]	-	D
Strontium	7440-24-6	-	-	-	D ‘93	25	25	**0.6**	20	4	-	D
Thallium	7440-28-0	F	0.0005	0.002	F ‘92	0.007	0.007	-	-	-	-	**I**
White phosphorous	7723-14-0	-	-	-	F ‘90	-	-	0.00002	0.0005	0.0001		D
Zinc	7440-66-6	-	-	-	D ‘93	6	6	0.3	10	2	-	**I**
RADIONUCLIDES												
Beta particle and photon activity (formerly man-made radionuclides)		F	zero	4 mrem/ yr	-	-	-	-	-	-	4 mrem/yr	A
Gross alpha particle activity		F	zero	15 pCi/L	-	-	-	-	-	-	15 pCi/L	A
Combined Radium 226 & 228	7440-14-4	F	zero	5 pCi/L	-	-	-	-	-	-	-	A
Radon	10043-92-2	P	zero	300 pCi/L AMCL[4] 4000 pCi/L	-	-	-	-	-	-	150 pCi/L	A
Uranium	7440-61-1	F	zero	0.03	-	-	-	0.0006[5]	0.02	-	-	A

1 These values are calculated for a 4-kg infant and are protective for all age groups.
2 Subchronic value for pregnant women.
3 Based on a cosmetic effect.
4 AMCL = Alternative Maximum Contaminant Level.
5 Soluble uranium salts. Radionuclide Rule.

Secondary Drinking Water Regulations

Chemicals	CAS Number	Status	SDWR
Aluminum	7429-90-5	F	0.05 to 0.2 mg/L
Chloride	7647-14-5	F	250 mg/L
Color	NA	F	15 color units
Copper	7440-50-8	F	1.0 mg/L
Corrosivity	NA	F	non-corrosive
Fluoride	7681-49-4	F	2.0 mg/L
Foaming agents	NA	F	0.5 mg/L
Iron	7439-89-6	F	0.3 mg/L
Manganese	7439-96-5	F	0.05 mg/L
Odor	NA	F	3 threshold odor numbers
pH	NA	F	6.5 – 8.5
Silver	7440-22-4	F	0.1 mg/L
Sulfate	7757-82-6	F	250 mg/L
Total dissolved solids (TDS)	NA	F	500 mg/L
Zinc	7440-66-6	F	5 mg/L

Microbiology

	Status Reg.	Status HA Document	MCLG	MCL	Treatment Technique
Cryptosporidium	F	F 01	-	TT	Systems that filter must remove 99% of *Cryptosporidium*
Giardia lamblia	F	F 98	-	TT	99.9% killed/inactivated
Legionella	F[1]	F 01	zero	TT	No limit; EPA believes that if *Giardia* and viruses are inactivated, *Legionella* will also be controlled
Heterotrophic Plate Count (HPC)	F[1]	-	NA	TT	No more than 500 bacterial colonies per milliliter.
Mycobacteria	-	F 99	-	-	-
Total Coliforms	F	-	zero	5%	No more than 5.0% samples total coliform-positive in a month. Every sample that has total coliforms must be analyzed for fecal coliforms; no fecal coliforms are allowed.
Turbidity	F	-	NA	TT	At no time can turbidity go above 5 NTU (nephelometric turbidity units)
Viruses	F[1]	-	zero	TT	99.99% killed/inactivated

[1] Regulated under the surface water treatment rule.

Drinking Water Advisory Table

Chemicals	Status	Health-based Value	Taste Threshold	Odor Threshold
Ammonia	**D ‘92**	**Not Available**	**30 mg/L**	
Methyl tertiary butyl ether (MtBE)	**F ‘98**	**Not Available**	**40 μg/L**	**20 μg/L**
Sodium	**F ‘03**	**20 mg/L (for individuals on a 500 mg/day restricted sodium diet).**	**30-60 mg/L**	
Sulfate	**F ‘03**	**500 mg/L**	**250 mg/L**	

Taste Threshold: Concentration at which the majority of consumers do not notice an adverse taste in drinking water; it is recognized that some sensitive individuals may detect a chemical at levels below this threshold.

Odor Threshold: Concentration at which the majority of consumers do not notice an adverse odor in drinking water; it is recognized that some sensitive individuals may detect a chemical at levels below this threshold.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

September 29, 2000

MEMORANDUM

SUBJECT: Transmittal of Final Fact Sheet Entitled "Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups"

FROM: Timothy Fields, Jr., Assistant Administrator ***s/ Timothy Fields, Jr.***
Office of Solid Waste and Emergency Response

TO: Regional Waste Policy Managers
RCRA Senior Policy Advisors
Regions 1 - 10

PURPOSE

The purpose of this memorandum is to transmit the final fact sheet entitled "Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups" EPA 540-F-00-005, OSWER 9355.0-74FS-P, dated September 2000. This fact sheet is intended to provide Superfund and RCRA site managers and other decision makers with an overview of the types of institutional controls (ICs) that are commonly available, including their relative strengths and weaknesses, and to provide a discussion of the key factors to consider when evaluating and selecting ICs in Superfund and RCRA Corrective Action cleanups.

OBJECTIVE AND IMPLEMENTATION

This fact sheet was written for EPA site managers at Superfund and RCRA sites. However, many of the concepts are directly applicable to States (especially when they implement the RCRA programs), Federal Facilities, Tribes, local agencies and private individuals that contemplate the use of ICs. For this reason we are also making the fact sheet publicly available by posting it on the EPA internet. I encourage you to pass on the information to other interested parties.

Some of the key messages from this fact sheet are: 1) if the cleanup does not result in unrestricted use and unlimited exposure at a site, an IC is likely appropriate, 2) understand the life-cycle strengths, weaknesses and costs for implementation, monitoring and enforcement before choosing an IC, 3) coordinate early with all state and local governments that may have responsibilities for the ICs, 4) evaluate ICs as rigorously as you would any other remedial alternative, 5) layer and/or place ICs in series to increase their reliability, 6) when writing decision documents, make sure that the objective(s) of the IC are clear, 7) get assurances (in writing if possible) from entities that will be responsible for implementing, monitoring, and enforcing ICs, and 8) remember that since all ICs have weaknesses, the role of the decision maker is to select the best ICs to protect human health and the environment.

This fact sheet is the first of several cross program activities that place increased emphasis and priority on the appropriate identification, evaluation and use of institutional controls at RCRA and Superfund sites. As a follow-up to this fact sheet, work has begun on a second fact sheet that focuses on issues involving the implementation, monitoring and enforcement of ICs. This fact sheet is tentatively planned for fall 2001.

In closing, thanks to all the Regions, States, Tribes and others for your comments on the fact sheet, as these comments have significantly improved the document. If you have questions regarding this memo or the attached fact sheet, please feel free to contact Michael Bellot at (703) 603-8905 for Superfund or Carlos M. Lago for RCRA at 703-308-8642.

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Institutional Controls:

A Site Manager's[1] Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups

Office of Solid Waste and Emergency Response

Purpose

This fact sheet provides Superfund and RCRA Corrective Action site managers and decision-makers with an overview of the types of Institutional Controls (ICs) that are commonly used or implemented, and outlines the factors that should generally be considered when evaluating and selecting ICs as part of the remedy. For more detailed information on the different types of instruments available, site managers and attorneys should consult the document, "Institutional Controls: A Reference Manual (Workgroup Draft - March 1998)." EPA site managers should also work closely with Regional attorneys and Headquarters staff in the Office of Emergency and Remedial Response (OERR), the Office of Site Remediation Enforcement (OSRE), the Federal Facilities Restoration and Reuse Office (FFRRO), the Federal Facilities Enforcement Office (FFEO) and/or the Office of Solid Waste (OSW) on any site-specific issues that may arise while evaluating, implementing, enforcing, or monitoring ICs.[2]

Table of Contents

Definition and Importance of ICs

Generally, EPA begins the remedy evaluation process with the expectation that treatment or engineering controls will be used to address principal threat wastes and that groundwater will be returned to its beneficial use. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) emphasizes that ICs, such as water use restrictions, are meant to supplement engineering controls during all phases of cleanup and may be a necessary component of the completed remedy. The NCP also cautions against the use of ICs as the sole remedy unless active response measures are determined to be impracticable. At the same time, ICs play an important role in site remedies. Often, ICs are a critical component of the cleanup process and are used by the site manager to ensure both the short- and long-term protection of human health and the environment. For this reason it is important to understand what constitutes an IC. Specifically for EPA, ICs:

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[1]Site Manager, as used in this fact sheet, refers to both CERCLA sites and RCRA facilities. In RCRA, project managers are the equivalent to site managers in CERCLA.

[2]This document provides guidance to EPA Regions and states involved in Superfund and RCRA corrective action cleanups. It also provides guidance to the public and the regulated community on how EPA intends to evaluate and implement institutional controls as part of a cleanup decision. The guidance is designed to implement national policy on these issues. The document does not, however, substitute for CERCLA, RCRA or EPA's regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA and State decision makers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate. Any decisions regarding a particular facility will be made based on the applicable statutes and regulations. Therefore, interested parties are free to raise questions and objections about the appropriateness of the application of this guidance to a particular situation, and EPA will consider whether or not the recommendations or interpretations in the guidance are appropriate in that situation. EPA may change this guidance in the future.

- are non-engineered instruments such as administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting land or resource use;
- are generally to be used in conjunction with, rather than in lieu of, engineering measures such as waste treatment or containment;
- can be used during all stages of the cleanup process to accomplish various cleanup-related objectives; and,
- should be "layered" (i.e., use multiple ICs) or implemented in a series to provide overlapping assurances of protection from contamination. These concepts are discussed in the text box below.

Some examples of ICs include easements, covenants, well drilling prohibitions, zoning restrictions, and special building permit requirements. Deed restriction is a phrase often used in remedy decision documents to describe easements or other forms of ICs; however, this is not a traditional property law term and should be avoided. Fences that restrict access to sites are often termed ICs; however, because fences are physical barriers instead of administrative or legal measures, EPA does not consider them to be ICs. ICs are among the tools allowable under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [as amended by the Superfund Amendments and Reauthorization Act (SARA)], the NCP, and the Resource Conservation and Recovery Act (RCRA). To read more about the regulatory framework for ICs, refer to the box on page 3 entitled, "A Look at ICs in CERCLA, the NCP and RCRA." Finally, where protectiveness depends on reducing exposure, ICs are a response action under CERCLA or a corrective action under RCRA. Accordingly, even in the unusual case where a CERCLA Record of Decision (ROD) only requires the implementation of ICs, it is considered to be a "limited action," not a "no action" ROD. Likewise, when a corrective action under RCRA includes an IC, whether it is part of an interim measure or occurs at the end of the cleanup as part of the final corrective measure, the IC is considered a part of the remedy.

Common Misnomers

"Deed restriction" is not a traditional property law term, but rather is a generic term used in the NCP and elsewhere as a shorthand way to refer to types of ICs. To avoid confusion, site managers should avoid the term and instead be specific about the types of ICs under consideration and their objectives. In addition, EPA does not consider physical barriers as ICs. Fences that restrict access to sites are often termed as ICs. However, fences are not considered by EPA to be ICs .

ICs are vital elements of response alternatives because they simultaneously influence and supplement the physical component of the remedy to be implemented. On the one hand, the right mix of ICs can help ensure the protectiveness of the remedy; on the other, limitations in ICs may lead to reevaluation and adjustment of the remedy components, including the proposed ICs. At some sites, remedy contingencies may protect against uncertainties in the ability of the ICs to provide the required long-term protectiveness. These points illustrate how important it is for site managers to evaluate ICs as thoroughly as the other remedy components in the Feasibility Study (FS) or Corrective Measures Study (CMS), when looking for the best ICs for addressing site-specific circumstances. Adding ICs on as an afterthought without carefully thinking about their objectives, how the ICs fit into the overall remedy, and whether the ICs can be realistically implemented in a reliable and enforceable manner, could jeopardize the effectiveness of the entire remedy.

Often ICs are more effective if they are layered or implemented in series. Layering means using different types of ICs at the same time to enhance the protectiveness of the remedy. For example, to restrict land use, the site manager may issue an enforcement tool [e.g., Unilateral Administrative Order (UAO)]; obtain an easement; initiate discussions with local governments about a potential zoning change; and enhance future awareness of the restrictions by recording them in a deed notice and in a state registry of contaminated sites. Also, the effectiveness of a remedy may be enhanced when ICs are used in conjunction with physical barriers, such as fences, to limit access to contaminated areas.

ICs may also be applied in series to ensure both the short- and long-term effectiveness of the remedy. For example, the site manager may use an enforcement tool to require the land owner to obtain an easement from an adjacent property owner in order to conduct ground water sampling or implement a portion of the active remedy. This easement may not be needed for the long-term effectiveness of the remedy and is terminated when the construction is complete. At another site, the site manager may use an Administrative Order on Consent (AOC) or permit condition to prohibit the land owner from developing the site during the investigation. Later, the site manager may add a provision to the Consent Decree (CD) or the permit requiring the land owner to notify EPA if the property is to be sold and to work with the local government to implement zoning restrictions on the property.

Layering and Implementing ICs in Series

ICs are more effective-if they are layered or implemented in series.

Layering ICs means using different types of ICs at the same time to enhance the protectiveness of the remedy.

Using ICs in series is the use of ICs at different points in the investigation and remediation process to ensure the short- and long-term protection of human health and the environment.

Types of ICs

implementing ICs during the cleanup process and a matrix summarizing examples of ICs are included at the end of the fact sheet.

A Look at ICs in CERCLA, the NCP, and RCRA

CERCLA as amended by SARA, the NCP and RCRA support the use of ICs in remediation of a site:

CERCLA—Section 121(d)(2)(B)(ii)(III) refers to the use of enforceable measures (e.g., ICs) as part of the remedial alternative at sites. EPA can enforce the implementation of ICs, but not necessarily their long term maintenance. For example, the local government with zoning jurisdiction may agree to change the zoning of the site to prohibit residential land uses as part of the remedy, but the local government retains the authority to change the zoning designation in the future. EPA is authorized, under CERCLA section 104(j), to acquire (by purchase, lease or otherwise) real property interests, such as easements, needed to conduct a remedial action provided that the state in which the interest is to be acquired is willing to accept transfer of the interest following the remedial action. Transfers of contaminated Federal property are subject to special deed requirements under CERCLA sections 120(h)(3)(A)(iii) and 120(h)(3)(C)(ii)(I) and (II).

NCP—the NCP provides EPA's expectations for developing appropriate remedial alternatives, including ICs under CERCLA. In particular, it states that EPA expects to use treatment to address the principal threats posed by sites; engineering controls for wastes that pose relatively low risk or where treatment is impracticable; and a combination of the two to protect human health and the environment [40 CFR 300.430(a)(1)(iii)(A), (B), and (C)]. In appropriate situations, a combination of treatment, containment, and ICs may be necessary. The NCP also emphasizes the use of ICs to supplement engineering controls during all phases of cleanup and as a component of the completed remedy, but cautions against their use as the sole remedy unless active response measures are determined to be impracticable [40 CFR 300.430(a)(1)(iii)(D)]. In the case where ICs are the entire remedy, the response to comments section of the preamble to the NCP states that special precautions must be made to ensure the controls are reliable (55 Federal Register, March 8, 1990, page 8706). Recognizing that EPA may not have the authority to implement such controls, the NCP requires that (for fund financed sites) the state assure that the ICs implemented as part of the remedial action are in place, reliable, and will remain in place after the initiation of operation and maintenance [40 CFR 300.510(c)(1)]. Lastly, for Superfund financed and private sites, the NCP also requires the state to hold any interest in property that is acquired (once the site goes into O&M) to ensure the reliability of ICs [40 CFR 300.510(f)].

RCRA—RCRA requirements are imposed through legal mechanisms different from those used under CERCLA. In RCRA, authorized states are the primary decision makers, this results in a wide variety of state-specific mechanisms being available. This fact sheet does not attempt to list all of the state and local IC mechanisms, but to identify key principles for the use of ICs. If the IC is being imposed through a RCRA permit, steps should be taken to ensure that long-term enforcement is not lost through property transfer or permit expiration. Cleanups under RCRA are conducted in connection with the closure of regulated units and facility-wide corrective action either under a permit [RCRA sections 3004(u) and (v)], interim status order [RCRA section 3008(h)] or imminent hazard order [RCRA section 7003] or other authorities. It should also be noted that landfill closure requirements under 40 CFR 264.119 require deed notices that the land has been used to manage hazardous waste, although the notice itself does not restrict future use. EPA expects to use a combination of methods (e.g., treatment, engineering, and institutional controls) under RCRA, as appropriate, to achieve protection of human health and the environment. EPA also expects to use ICs, such as water and land use restrictions, primarily to supplement engineering controls, as appropriate, for short- and long-term management to prevent or limit exposure to hazardous wastes and constituents. ICs are not generally expected to be the sole remedial action.

General Categories

There are four categories of institutional controls: governmental controls; proprietary controls; enforcement and permit tools with IC components; and informational devices. Each of these categories is described below. In addition, a checklist that highlights steps in

Governmental Controls—Governmental controls are usually implemented and enforced by a state or local government and can include zoning restrictions, ordinances, statutes, building permits, or other provisions that restrict land or resource use at a site. Local governments have a variety of land use control measures available from simple use restrictions to more sophisticated measures such as planned unit development zoning districts and overlay zones.

Development zoning districts allow for more flexible site planning and overlay zones impose additional requirements to those of the underlying zoning district. Regardless of which measures are relied on, the land use control should be carefully evaluated to make certain that there are no exceptions which could allow for improper use of the site (e.g., allowing a day care center use within an industrial district). Once implemented, local and state entities often use traditional police powers to regulate and enforce the controls. Since this category of ICs is put in place under local jurisdiction, they may be changed or terminated with little notice to EPA, and EPA generally has no authority to enforce such controls.

For active military bases, the local authority for regulating and enforcing ICs is the Commanding Officer. Therefore, EPA and the state should work with the installation personnel to incorporate restrictions into the base master plans, instructions, and orders used by the Commanding Officer to govern conduct, actions and activities on the base (in some cases these restrictions may be imposed as permit conditions if the base is subject to RCRA permit requirements).

Proprietary Controls—These controls, such as easements and covenants, have their basis in real property law and are unique in that they generally create legal property interests. In other words, proprietary controls involve legal instruments placed in the chain of title of the site or property. The instrument may include the conveyance of a property interest from the owner (grantor) to a second party (grantee) for the purpose of restricting land or resource use. An example of this type of control is an easement that provides access rights to a property so the Potentially Responsible Party (PRP), facility owner/operator, or regulatory agency may inspect and monitor a groundwater pump-and-treat system or cover system. The benefit of these types of controls is that they can be binding on subsequent purchasers of the property (successors in title) and transferable, which may make them more reliable in the long-term than other types of ICs.

However, proprietary controls also have their drawbacks. Property law can be complicated because a property owner has many individual rights with respect to his or her property. To illustrate this point, property rights can be thought of as a bundle of sticks, with each stick representing a single right (e.g., the right to collect rents). The terminology, enforceability, and effect of each of these rights is largely dependent upon real property common law and the state where the site is located. A property owner can convey certain rights to other entities (either voluntarily or involuntarily through condemnation) and keep other rights. For example, if it is determined that a long-term easement is required to ensure remedy protectiveness, this “right” would need to be transferred by the property owner to another entity. For the easement to bind subsequent purchasers, some states require that the entity be an adjacent property owner. This may complicate long-term monitoring and enforcement since the party receiving the right (the grantee) is often not an adjacent property owner. To eliminate this problem, a proprietary control may be established “in gross.” This means that the holder of the control (the grantee) does not need to be the owner of the adjacent property. However, it should be noted that easements in gross may not be enforceable under the laws of some states. State property laws governing easements should therefore be researched before this type of IC is selected in order to determine its enforceability in that jurisdiction.

A distinction at Federal sites being transferred to the private sector is that CERCLA sections 120(h)(3)(A)(iii) and 120(h)(3)(c)(ii) and (iii) require that property interests be retained by the Federal government. At active Federal sites, proprietary controls may not be an option because a deed does not exist or the landholding Federal agency lacks the authority to encumber the property. However, the landholding Agency may be willing to enter a Memorandum of Understanding (MOU) with EPA and/or state regulators providing for specific IC implementation plans, periodic inspections and other activities which it will undertake (in lieu of deed restrictions) to assure that ICs for the active site will remain effective.

Enforcement and Permit Tools with IC Components—Under sections 104 and 106(a) of CERCLA, UAOs and AOCs can be issued or negotiated to compel the land owner (usually a PRP) to limit certain site activities at both Federal and private sites; CDS can also be negotiated at private sites under 122(d). Similarly, EPA can enforce permits, conditions and/or issue orders under RCRA sections 3004(a), 3004(u) and (v), 3008(h), or 7003. These tools are frequently used by site managers, but may also have significant shortcomings that should be thoroughly evaluated. For example, most enforcement agreements are only binding on the signatories, and the property restrictions are not transferred through a property transaction. For example, if a PRP under CERCLA signs a CD or receives a UAO and then sells his or her property, many types of ICs would not be enforceable against the next owner. This could jeopardize the protectiveness of the remedy. One possible solution to this problem is to ensure that the enforcement tool contains provisions requiring EPA or state notification and/or approval prior to a property transfer. In this instance, EPA could negotiate an agreement with the new owner. Another solution is to require signatories of an enforcement document to implement additional long-term institutional controls such as information devices or proprietary controls (*i.e.*, layering).

Informational Devices—Informational tools provide information or notification that residual or capped contamination may remain on site. Common examples include state registries of contaminated properties, deed notices, and advisories. Due to the nature of some informational devices (*e.g.*, deed or hazard notices) and their potential non-enforceability, it is important to carefully consider the objective of this category of ICs. Informational devices are most likely to be used as a secondary “layer” to help ensure the overall reliability of other ICs.

ICs at Federal Facilities

Because of Federal ownership, there are significant differences in the way ICs are applied at Federal facilities. Some proprietary or governmental controls cannot be applied on active Federal facilities. However, for properties being transferred as part of a base closure, the Department of Defense does have the authority to restrict property by retaining a property interest (i.e., an easement intended to assure the protectiveness of the remedy). For active bases, ICs are commonly addressed through remedy selection documents, base master plans, and separate MOUs. More detailed information on ICs and Federal facilities is contained in “Institutional Controls: A

Reference Manual (Workgroup Draft - March 1998)" and in the FFRRO IC guidance ("Institutional Controls and Transfer of Real Property under CERCLA Section 120(h)(3)(A), (B), or (C)," January, 2000).

Legal Mechanisms for Imposing ICs Under CERCLA and RCRA

CERCLA and RCRA employ the same types of ICs to reduce exposure to residual contamination. However, as explained below, EPA's legal authority to establish, monitor and enforce ICs varies significantly between the two programs. As a result, officials involved in cleanups need to appreciate the range of options available under each program before determining whether, and to what extent, ICs should be incorporated into a remedial decision.

At CERCLA sites, EPA often imposes ICs via enforcement tools (e.g., UAOs, AOCs, and CDs). Since these enforcement tools only bind the parties named in the enforcement document, it may be necessary to require the parties to implement ICs that "run with the land" (i.e., applied to the property itself) in order to bind subsequent land owners. For Fund-lead CERCLA sites, the lead agency has the responsibility for ensuring ICs are implemented. Legal mechanisms such as UAOs, AOCs and CDS should also require reporting to EPA and/or the state of any sale of the property.

Under RCRA, ICs are typically imposed through permit conditions or by orders issued under section 3008(h). In certain circumstances cleanup may also be required under the imminent hazard order authority of section 7003. In the case where an IC is meant to continue beyond the expiration of a permit, an order may be required to ensure the IC remains in effect for the long term RCRA permit writers should incorporate ICs as specific permit conditions, where appropriate. By doing so, such conditions would be enforceable through the permit. At the same time, permit writers should consider whether additional ICs are available (e.g., governmental and/or proprietary controls) to ensure that subsequent property owners will be aware of, and bound by, the same types of restrictions. Similar factors should be considered when preparing RCRA corrective action orders to ensure that both the current facility owner/operator and any subsequent property owners are subject to effective and enforceable ICs that will minimize exposure to any residual contamination.

One significant difference between RCRA and CERCLA is that RCRA generally does not authorize EPA to acquire any interests in property. Therefore, many proprietary controls (such as easements) will require the involvement of third parties (e.g., states or local governments) under RCRA.

ICs and Future Land Use

Land use and ICs are usually linked. As a site moves through the Superfund Remedial Investigation/Feasibility Study (RI/FS) or RCRA Facility Investigation/Corrective Measures Study (RFI/CMS), site managers should develop assumptions about reasonably anticipated future land uses and consider whether ICs will be needed to maintain these uses over time. EPA's land use guidance (Land Use in CERCLA Remedy Selection Process, OSWER Directive No. 9355.7-04, May 25, 1995) states that the site manager should discuss reasonably anticipated future uses of the site with local land use planning authorities, local officials, and the public, as appropriate, as early as possible during the scoping phase of the RI/FS or RFI/CMS. Where there is a possibility that the land will not be cleaned up to a level that supports unlimited use and unrestricted exposure, the site manager should also discuss potential ICs that may be appropriate, including legal implementation issues, jurisdictional questions, the impact of layering ICs and reliability and enforceability concerns. It is also important for the site manager to recognize that, in addition to land uses, ICs can be used to affect specific activities at sites (e.g., fishing prohibitions).

Screening ICs

The need for ICs can be driven by both the need to guard against potential exposure and to protect a remedy. If any remedial options being evaluated in the FS or CMS leave waste in place that would not result in unrestricted use and unlimited exposure, ICs should be considered to ensure that unacceptable exposure from residual contamination does not occur. However, ICs may not be necessary if the waste that is left at the site allows for unrestricted use and unlimited exposure. Remedy options that typically leave residual wastes on site and necessitate ICs include capping waste in place, construction of containment facilities, natural attenuation and long-term pumping-and-treatment of groundwater.

ICs should be evaluated in the same level of detail as other remedy components. ICs are considered response actions under CERCLA and RCRA. ICs must meet all statutory requirements, and are subject to the nine evaluation criteria outlined in the NCP (40 CFR 300.430 (e)(9)(i)) for CERCLA cleanups. The balancing criteria recommended for corrective actions should generally be used in evaluating ICs under RCRA. However, before applying these criteria, the site manager should first make several determinations:

- Objective—Clearly state what will be accomplished through the use of ICs.

  Example: Restrict the use of groundwater as a drinking water source until the Maximum Contaminant Levels are met.

- Mechanism—Determine the specific types of ICs that can be used to meet the various remedial objectives.

  Example: Work with the local jurisdiction to develop ordinances to restrict well drilling or prohibit groundwater access until cleanup goals are met; record the groundwater contamination in the land record to provide notice of the issue to the public; and record contaminated aquifers on state registry to maintain institutional tracking.

- Timing—Investigate when the IC needs to be implemented and/or secured and how long it must be in place. Since ICs are often implemented by parties other than EPA, the time required to secure an IC should be taken into consideration.

Example: A deed notice may be required in the short-term, and a formal petition for a zoning change may be necessary in the long-term, both of which need to be in place prior to site deletion from the NPL.

- Responsibility—Research, discuss, and document any agreement with the proper entities on exactly who will be responsible for securing, maintaining and enforcing the control. It might be useful to secure a written statement of the appropriate entities' willingness to implement, monitor, and enforce the IC prior to the signature of the remedy decision document.

Example: Work with the State to determine whether it is willing and able to hold an enforceable easement to ensure appropriate land use; in addition, determine whether the local government is willing and able to change and enforce the applicable zoning requirements. If assurances cannot be obtained, then ICs may not be a viable component of the remedy.

Typically, the site manager is faced with balancing the relative strengths of ICs in terms of enforceability, permanence, etc., with achieving remedial objectives. As discussed previously, one option is to "layer" different controls to ensure long-term reliability. For example, layered ICs may involve concurrent use of enforceable agreements, deed notices, and adoption of land use controls by a local government. ICs may also be used in series. For example, an enforcement order may prohibit the land owner from disturbing the cap on his/her property (i.e., a short-term control), until the local government goes through the process of restricting the future use of the land (i.e., the long-term control).

Determining the State Role

Where EPA is implementing a remedy, states often play a major role in implementing and enforcing ICs. As stated previously, some governmental controls may be established under state jurisdiction: the state may use its enforcement tools to compel the PRP or facility land owner to limit site activities; the state may provide the notification or information on the contamination that remains on-site; or the state may assume ownership of a property in order to implement, maintain, and enforce proprietary controls. Under RCRA, the state will typically be imposing and overseeing the remedial action.

When to Begin Coordinating with the State

No matter what role the state assumes with ICs, the EPA site manager should begin coordinating with the state early in the RI/FS (for CERCLA) or RFI/CMS (for RCRA) process or after sampling has been completed and the extent of the risk is known. Even if ICs are not required for the long-term maintenance of the selected remedy, they may be necessary during the response activities.

Factors to Consider in State Coordination

In evaluating the need for and the type of ICs that may be implemented at a site, the site manager should consult with their Regional attorney to determine who has the proper legal authority to implement and enforce the proposed controls. Certain states have enacted statutes that provide the state with the legal authority to restrict land use at contaminated properties. In addition, several states have adopted statutes providing for conservation easements. These easements override common law barriers to the enforcement of easements by parties who do not own adjacent property. For example, at many sites, the state, in cooperation with the PRPs or facility owner/operator, may use its own enforcement tools to restrict the use of the land and ensure that the selected remedy, including ICs, is implemented and maintained. At other sites, a property interest may be conveyed (either directly or, if necessary, through EPA at Superfund sites) from the owner of the land to the state which becomes the holder and enforcer of a proprietary control. Finally, the state is often responsible for issuing advisories or warnings of potential risks (e.g., fishing or swimming prohibitions), and providing registries of hazardous waste sites (i.e., informational controls).

If it appears that the state will be relied upon to establish the ICs, the site manager should immediately talk to state agency personnel to gauge their willingness to establish, maintain and enforce the control, if necessary. This discussion is encouraged regardless of the type of IC(s) that will be implemented. The site manager should work with his or her state counterpart to identify and contact the appropriate state agency and personnel for each proposed IC. In addition, if a property interest is conveyed by the land owner to EPA to perform a remedial action (e.g., to ensure the reliability of the ICs restricting the use of the land), CERCLA requires the state to accept transfer of the title from EPA following completion of the CERCLA remedial action. If the state does not agree to accept title to the property, the site manager must find another party to assume ownership (e.g., a local government, community group or trust) or another type of IC (e.g., local government control)[3] must be selected. State assurances for O&M or for transfer of property interest are formalized in a Superfund State Contract (SSC), cooperative agreement, or MOU that is negotiated between the state and EPA.

State Role at Fund-Financed CERCLA Cleanups

The state assumes other responsibilities for ICs if the remedial action, including the ICs, will be Fund-financed under CERCLA. CERCLA specifically requires that the state provide assurance that it will assume responsibility for operation and maintenance (O&M) of the selected remedy before a Fund-financed remedial action is implemented. The NCP requires the state to ensure that any ICs implemented as part of the remedial action at the site are in place, reliable, and will remain in place after the initiation of O&M. These assurances are also documented in a cooperative agreement, SSC or MOU.

State Role at RCRA Sites

[3]Likewise, either the state or a third party must be willing to accept property interests at PRP-led sites.

Under RCRA, states will typically be the implementing and overseeing agency. Therefore the state, when authorized and overseeing corrective action, will be responsible for identifying appropriate institutional controls. Where EPA is overseeing the remedy there are no state assurance requirements in RCRA Corrective Action. However, because there is no Federal mechanism in RCRA allowing EPA to acquire interest in property, EPA may be forced to rely on third parties (typically state or local government) to establish, maintain and enforce most types of ICs.

State Role at Federal Facilities
At Federal facilities, the landholding agency is ultimately responsible for all response activities. The state is not required to provide assurance that it will assume responsibility for O&M. However, states may enter into an agreement with the landholding Federal agency to monitor and enforce ICs at Federal sites.

Determining the Role of Local Governments

CERCLA, RCRA, and the NCP do not specify a role for local governments in implementing the selected remedy. However, a local government is often the only entity that has the legal authority to implement, monitor and enforce certain types of ICs (e.g., zoning changes). While EPA and the states take the lead on CERCLA and RCRA response activities, local governments have an important role to play in at least three areas: (1) determining future land use; (2) helping engage the public and assisting in public involvement activities; and (3) implementation and long-term monitoring and enforcement of ICs. Therefore, it is critical that the site manager and his or her state counterpart involve the appropriate local government agency in discussions on the types of controls that are being considered. The capability and willingness of the local government to implement and ensure the short- or long-term effectiveness of the proposed ICs should be considered during the RI/FS or RFI/CMS. In certain cases, cooperative agreements may be considered to assist local governments in the implementation, monitoring and enforcement of required ICs.

Evaluating ICs

Once the site manager has considered the objectives, mechanism, timing, and entity responsible for implementing, monitoring and enforcing the ICs, the next phase is selecting the ICs. The following sections contain a discussion of the CERCLA and RCRA factors that site managers should generally consider when evaluating ICs during the FS or CMS. If the site manager proposes to layer or use the ICs in series, he or she should also characterize the likelihood that this approach can actually be achieved. It is important to note that at CERCLA sites, the statute requires the site manager to evaluate ICs, just like other remedy components, against the nine NCP criteria. The site manager must ensure that remedies are protective of human health and the environment. ICs may be an important element in this determination. RCRA sites managers have the latitude to use balancing criteria, but unlike CERCLA, RCRA regulations do not require this balancing step. The CERCLA and RCRA criteria are categorized below in three groups: threshold, balancing, and modifying.

Threshold Criteria

ICs in CERCLA Removal Actions

ICs will rarely be a component of true emergencies where a time critical action serves as the only response at a site. It is more likely that a site manager will choose ICs as a component of a non-time critical removal action or during a follow-up remedial action. A post-removal site control agreement must be completed before commencing a fund-financed removal action where ICs are included in post-removal site control (OSWER Directive No. 9360.22-02). As in the remedial process, begin considering ICs when conducting an analysis of land use assumptions during the removal decision-making process. Where a final, site-wide, non-time critical removal remedy decision will be made, ICs should be thoroughly and rigorously evaluated with all other response actions in the Engineering Evaluation/Cost Analysis (EE/CA). In short, because ICs are considered to be actions, apply the full criteria required by the NCP for EE/CA evaluations. It is anticipated that ICs would not be chosen as the sole action for a removal.

It is fundamental that a remedy under RCRA or CERCLA that includes ICs meet the following threshold criteria:

- protect human health and the environment; and

- for CERCLA sites, comply with Applicable or Relevant and Appropriate Requirements (ARARs).

The site manager for RCRA facilities should also consider whether remedies that include ICs:

- attain media cleanup standards or comply with applicable standards for waste management; and
- control the source(s) of releases so as to reduce or eliminate, to the extent practicable, further releases of hazardous waste that might cause threats to human health and the environment.

Balancing Criteria

The site manager evaluates the individual, layered or series of ICs to determine their respective strengths and weaknesses. ICs are also evaluated in combination with engineered controls to identify the key tradeoffs that should be balanced for the site. Following are balancing criteria required by CERCLA and the NCP and recommended by the RCRA program in guidance.

Long-term effectiveness and permanence (CERCLA) or reliability (RCRA)—Under both CERCLA and RCRA, this factor assesses the permanence/reliability and effectiveness of ICs that may be used to manage treatment residuals or untreated wastes that remain at the site over time. When evaluating whether an IC will be effective over the long-term, the site manager should consider factors such as: whether the property is a government-owned site or a privately-owned site that is likely to change hands; the applicability of ICs to multiple property owners; the size of the area to be managed; the number of parcels; the contaminated media to be addressed; the persistence of the contamination; whether site contamination is well-defined; and whether local governments or other governing bodies are willing and able to monitor and enforce long-term ICs. The site manager should also consider the contaminated media to be addressed by the ICs. Different ICs may be required for different media.

Where ICs must be effective for a long period, either proprietary or governmental controls should be considered because they generally run with the land and are enforceable. However, both proprietary and governmental controls have weaknesses in terms of long-term reliability. For example, with proprietary controls, common law doctrines may restrict enforcement by parties who do not own adjoining land. This can render proprietary controls ineffective if EPA or another party capable of enforcing the control is not the owner of the adjacent property. To eliminate this problem, proprietary controls may be established "in gross," signifying that the holder of the control does not need to be the owner of the adjacent property. However, some courts do not recognize in gross proprietary controls.

At some sites, governmental controls may be preferable to proprietary controls. For example, the site manager might work with a local government to pass an ordinance to restrict construction or invasive digging that might disturb or cause exposure to covered residual lead contamination in a large residential area. The implementation of government controls might be considered a beneficial addition to information tools that may be forgotten over the long term or an enforcement action that would be binding only on certain parties. Proprietary controls would likely be deemed impractical at such a site due to the complex and uncertain task of obtaining easements from multiple property owners.

Like proprietary controls, the use of governmental controls may not be effective over the long term. Of primary concern are the political and fiscal constraints that may affect the ability of a state or local government to enforce the controls. Similarly, governmental controls may be problematic when the local or state government is or may become the site owner or operator because of the appearance of a conflict of interest. Regardless of the control selected, its viability over the long term needs to be closely evaluated.

Reduction of toxicity, mobility, or volume through treatment—
This CERCLA and RCRA criterion does not apply since ICs are not treatment measures.

Short-term Effectiveness—Short-term effectiveness of ICs at CERCLA and RCRA sites should be evaluated with respect to potential effects on human health and the environment during construction and implementation of the remedy. In order to satisfy this criterion, the remedy might entail the use of an IC through an enforcement order to compel the PRP to restrict certain uses of the groundwater at or down gradient from the site during remediation. After remediation is complete, other ICs might be implemented if residual contamination remains on site (i.e., implementing ICs in series).

Implementability—This CERCLA and RCRA criterion evaluates the administrative feasibility of an action and/or the activities that need to be coordinated with other offices and agencies. Implementation factors that generally should be considered for ICs include whether the entity responsible for implementation possesses the jurisdiction, authority, willingness and capability to establish, monitor and enforce ICs. A proper analysis of implementability can be complex, considering such diverse factors as the extent to which land being restricted is owned by liable parties and the willingness and capability of the local government or other authority responsible for establishing controls for land or resource use.

Cost—This CERCLA and RCRA criterion includes estimated capital and O&M costs. In CERCLA, estimated costs for implementing, monitoring, and enforcing ICs should be developed. For example, cost estimates for ICs might include legal fees associated with obtaining easements restricting land use, the costs of purchasing property rights (e.g.., groundwater rights, easements), or the wages of the state or local government personnel that will regularly monitor the IC to ensure that it has not been violated. It is interesting to note that once the total life-cycle costs of implementing, monitoring and enforcing an IC – which may exceed 30 years – are fully calculated, it may actually be less costly in the long term to implement a remedy that requires treatment of the waste. For more information on estimating response costs, see “A Guide to Developing and Documenting Cost Estimates During the Feasibility Study,” EPA 540-R-00-002, OSWER 9355.0-075. In RCRA, costs historically have played a less prominent role in remediation selection. Typically cost estimates are expected to be developed at the discretion of the owner/operator, although implementors should take into account sites where ICs are inappropriately costly.

Modifying Criteria

Typically the site manager presents the proposed remedy, including ICs to the state, local government, and community for comment prior to implementation. The issues and concerns of these stakeholders may result in modifications to the remedy and are addressed by the site manager in the remedy decision document. Following is a discussion of these modifying criteria *(note: these criteria are only recommended in RCRA guidance)*.

State Acceptance—The site manager should make the appropriate state authorities aware of the basis and scope of the ICs to be implemented under CERCLA or RCRA, and what role, if any, the state is expected to play to make ICs an effective part of the remedy. The state can formally express its concerns about the use of ICs, in general, and its role, in particular, or indicate its willingness to take on the responsibility for implementing and enforcing the proposed ICs.

If the state's position is uncertain at the time the remedy is selected (e.g., for CERCLA sites, when the ROD is signed or, for RCRA facilities, when the permit/order is issued or modified), it may be necessary to outline contingent remedial approaches in the decision documents. Specifically, remedies that require long-term ICs to remain protective may require alternative actions (e.g., additional soil removal) if the ICs are later determined to be unenforceable or cannot meet the remedial objectives. Alternatively, at a RCRA site, it may be necessary to leave a facility under a permit or other mechanism enforceable by the regulating agency. If the state's willingness or ability to implement or enforce an IC changes after remedy selection, the protectiveness of the remedy should generally be re-evaluated and, when necessary, remedial decisions revised. Under CERCLA, this may require an Explanation of Significant Differences (ESD), or even a ROD amendment. Under RCRA, a permit modification or change to a corrective action order may be necessary. It is important to note that under no circumstances can a Fund-financed CERCLA remedial action be initiated without receiving state assurances on ICs and property transfer.

Local Government and Community Acceptance—Involving the community and local government early during the remedy decision process will enable the site manager to more fully evaluate IC options. Discussions with the local government and community give the site manager the opportunity to:

- gather local government and community input on the proposed ICs;
- identify whether a particular stakeholder group may be harmed as a result of a proposed IC (for example, will a ban on fishing cause an economic hardship in the community);
- receive comment on the impacts of the potential ICs on religious or cultural customs and beliefs (e.g., preventing access to property which grows the plants that are used in a tribal ceremony); and
- determine if the community has special needs in regards to the IC (for example, will it be necessary to publish informational devices in multiple languages).

In addition, the local government and community's response to certain types of ICs and the willingness and capability of the local government to monitor ICs will help the site manager determine whether the ICs will be effective overall. This is especially important if nearby property owners will need to agree to implement proprietary controls or if other governmental ICs (e.g., zoning changes) will have an impact on the community. Early involvement will also enable the community to work with the local government to develop innovative approaches to using ICs, especially in light of any future land use plans.

As with other aspects of the proposed remedy, the community should have the opportunity to comment on the proposed IC component of the remedy during the public comment period. It may be necessary to educate the community about ICs so that its members understand how the different ICs may impact their property and activities. Under CERCLA, it may also be possible, as long as all appropriate requirements are met, to provide a Technical Assistance Grant to the community so they can hire a technical expert to assist them in evaluating ICs and the overall remedy.

In some cases, it may be appropriate not to identify the exact IC required at the time of the remedy decision. In these instances the critical evaluation of the available ICs should still be conducted and the specific objective(s) of the ICs should be clearly stated in the ROD or other decision document. Examples of when this flexibility may be appropriate are contingent remedies based on pilot studies or if a remedy would not be implemented for several years and the state is developing enabling language for Conservation Easements authority.

Site Manager Responsibilities After ICs are Selected

The site manager's responsibilities for ICs does not end once the ICs are selected. Site managers also should ensure that the ICs are actually implemented, are reliable, are enforced, and remain effective. It should be noted that NPL sites cannot be deleted until the entire remedy, including ICs, have been implemented. This may involve the following:

- working with state and local governmental entities to obtain commitments and resources for implementing and enforcing ICs, including negotiating a CERCLA SSC with the state to obtain assurances that the ICs will be put in place, are reliable and will remain in place after initiation of O&M activities;
- ensuring that the PRP or facility owner complies with the provisions in the enforcement tools to implement the ICs and provides notice of the ICs to potential future users/owners of the property;
- working with other Federal agencies to implement and enforce ICs;
- acquiring property for implementation of the CERCLA remedy; and
- checking the status of ICs during the CERCLA five-year review.

Conclusion

The ICs outlined in this fact sheet can be important elements of environmental cleanups. ICs play an important role in limiting risk and are often needed to ensure that engineered remedies are not affected by future site activities. When selecting ICs, the site manager needs to evaluate the situation at the site, define the needs that ICs are intended to address, identify the kinds of legal and other tools available to meet these needs, and ensure the ICs are implemented effectively. All of this requires up-front planning and working closely with the Regional office attorneys, the state, community, and PRPs or facility owner/operators. Key concepts to keep in mind when implementing ICs are provided in the text box below.

If you have questions regarding the material covered in this fact sheet, consult the draft document, "Institutional Controls: A Reference Manual" or contact your Regional Coordinator in the OERR Technical Regional Response Center. For information on model language for enforcement or legal documents used to implement ICs, consult your Regional Counsel, OSRE or the Office of General Counsel.

Key Concepts

- Under the NCP, the use of ICs should not substitute for active response measures (unless active measures are not practicable).
- If the site cannot accommodate unrestricted use and unlimited exposure, an IC will generally be required.
- Make sure the objective(s) of the IC are clear in the decision document.
- Coordinate early with state and local governments.
- Layer ICs and/or place them in series depending upon site circumstances.
- Evaluate ICs as rigorously as other remedial alternatives.
- Understand the life-cycle strengths, weaknesses and costs for the implementation, monitoring and enforcement of ICs.
- Get assurances, in writing, from entities that will implement, monitor, and enforce ICs.
- Remember that since all ICs have weaknesses, the role of the RCRA/CERCLA decision makers is to select the best ICs to protect human health and the environment.

Checklist for Implementing ICs

During the initial phase of cleanup (i.e., RI/FS or RFI/CMS), the site manager should:

- establish clear objectives (what are you trying to accomplish through the use of ICs?)
- discuss future land use plans with the community and local government to help in analyzing the appropriate ICs and other remedial alternatives
- evaluate ICs using the appropriate threshold, balancing, and modifying criteria
- coordinate with regional attorneys on legal matters and the State as appropriate
- be innovative/creative but realistic

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During remedy selection, the site manager should:

- present information that helps the public understand the impacts of the specific ICs and their relationship with the overall remedy
- clearly describe the objectives to be attained by ICs
- specify performance standards (e.g., prevent exposure to contaminated ground water by prohibiting well drilling)
- consider layering ICs to enhance their overall effectiveness
- discussions with entities (e.g., local/state governments) involved in implementing ICs
- discuss the kinds of controls envisioned and include enough information to show that effective implementation of the ICs can reasonably be expected
- discuss plans for monitoring land use and other aspects of the remedy that depend on ICs
- discuss the enforcement mechanisms that are anticipated to ensure the long-term reliability of the ICs
- continue coordination with attorneys

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During remedy implementation (i.e., RD/RA and CMI), the site manager should:

- ensure that appropriate measures are taken to implement the ICs (e.g., arrange discussions between PRPs, other property owners, and local government or state officials)
- be aware that ICs need to be fully implemented to obtain a RCRA permit termination, or for CERCLA sites, fully implemented to obtain RA completion, a site completion, and partial or full deletion
- prepare an ESD or ROD amendment for CERCLA sites or a permit modification or order revision for RCRA sites if the ICs will not result in the remedy being protective of human health and the environment; if this becomes necessary, also ensure that the public is provided an opportunity to comment on the proposed replacement ICs

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During Post-Remediation activities (e.g., a CERCLA five-year review), the site manager should:

- Evaluate both the administrative/legal components as well as the physical evidence to ensure that ICs are both implemented and fully effective
- Document these results in the Five-Year Review Report (for CERCLA sites)

Type of Institutional Control	Definition & Example	Benefits	Limitations	
GOVERNMENTAL CONTROLS	Controls using the regulatory authority of a governmental entity to impose restrictions on citizens or property under its jurisdiction. Generally, EPA must turn to state or local governments to establish controls of this type. For example, a local jurisdiction may zone the site to disallow uses that are incompatible with the remedy.	Do not require the negotiation, drafting, or recording of parcel-by-parcel proprietary controls. This is important with large numbers of distinct parcels, particularly where some of the landowners are not liable parties. The legal impediments (e.g., whether the control "runs with the land"; whether the right to enforce the control can be transferred to other parties) to long-term enforcement of proprietary controls can be avoided; governmental controls remain effective so long as they are not repealed and are enforced.	Will almost always have to be adopted and enforced by a governmental entity other than EPA (e.g., state or local governments). Thus, their effectiveness depends in most cases upon the willingness of state or local governments to adopt them, keep them in force, and enforce them over the long term. There may also be enforcement costs for the state or local jurisdiction.	Usually enforced by the state or local government. The willingness and capability of the state or local government to enforce the IC should be 12given due consideration.

Type of Institutional Control	Definition & Example	Benefits	Limitations	
1. Zoning	A common land use restriction specifying allowed land uses for certain areas Example: A local government could prohibit residential development in an area of contamination or limit gardening in certain areas	Zoning can be used to prohibit activities that could disturb certain aspects of a remedy or to control certain exposures not otherwise protected under a remedy.	Zoning ordinances are not necessarily permanent; they can be repealed or local governments can grant exceptions after public hearings. Typical zoning classifications such as “industrial” and “commercial” may not be stringent enough for a remedial context. For example, many zoning ordinances allow land uses below a certain level of intensity (e.g., allowing residential uses in industrial districts.) In addition, existing “blanket” zoning districts may not provide appropriate restrictions for specific remedy considerations, and local authorities may be concerned about potential legal challenges for “spot zoning” when rezoning a single parcel or small group of parcels. Therefore, an amendment to, or creative application of the zoning ordinance may be necessary	Zoning laws may not be fully effective unless they are monitored and enforced over the long term and local governments may not have or be able to commit the resources necessary to such oversight.

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Type of Institutional Control	Definition & Example	Benefits	Limitations	
2. Local permits	Special permits outlining specific requirements before an activity can be authorized Example: An ordinance requiring that anyone seeking a building permit in a particular area be notified of contamination	Can take advantage of existing restrictions and apply them to site-specific situations	Often permits are narrowly focused and the requirements can be modified over time.	Effectiveness of enforcement depends on the willingness and capability of the local governmental entity to monitor compliance and take enforcement action.
3. Other police power ordinances	Controls placed on access or use of certain areas Example: Placing bans on fishing and swimming in specified areas	Can take advantage of existing restrictions and apply them to site-specific situations	Bans on fishing or swimming may be communicated through posting of the ordinance. However, postings, by themselves, may not be effective in preventing incidental contact or consumption.	Effectiveness of enforcement depends on the willingness and ability of the local governmental entity to monitor compliance and take enforcement action
4. Ground water use restrictions	Restrictions directed at limiting or prohibiting certain uses of ground water which may include limitations or prohibitions on well drilling. Example: Establishment of ground water management zones or protection areas; capping or closing of wells	Can take advantage of existing restrictions and apply them to site-specific situations	Implementation of such restrictions are dependent on a state’s ground water ownership and use laws. Local or state expenditures may be necessary to compensate owners of condemned property.	Effectiveness of enforcement depends on the willingness and ability of the local governmental entity to monitor compliance and take enforcement action

Type of Institutional Control	Definition & Example	Benefits	Limitations	
5. Condemnation of property	Taking over title of a property by condemning it under a government entity's eminent domain authority. Example: Taking over title through condemnation to prevent the site from being used.	Used as a way to take title of a property to control land use or impose a desired land use for a public purpose. Property may be condemned under Federal, state, or local authority.	The owner of the property is entitled to compensation, may be recoverable under section 107 of CERCLA.	Not applicable.

Type of Institutional Control	Definition & Example	Benefits	Limitations	
PROPRIETARY CONTROLS	Tools based on private property law used to restrict or affect the use of property	Can be implemented without the intervention of any federal, state, or local regulatory authority Advisable when restrictions on activities are intended to be long-term or permanent (contaminants will be left in place that prevent unrestricted use)	Since property laws vary by state, always check whether or not there are court-recognized doctrines that would limit the extent to which the controls run with the land or are transferable to other parties Property law requires a conveyance of a property interest from a landowner to another party for a restriction to be enforceable	To be enforceable in most courts, the instrument used for the conveyance of any property right should clearly state: C the nature and extent of the control to be imposed; C whether the control will "run with the land" (i.e., be binding on subsequent purchasers); C whether the right to enforce the control can be transferred to other parties

Type of Institutional Control	Definition & Example	Benefits	Limitations	
1. Easements	A property right conveyed by a landowner to another party which gives the second party rights with regard to the first party's land. An "affirmative" easement allows the holder to enter upon or use another's property for a particular purpose. A "negative" easement imposes limits on how the landowner can use his or her own property. Examples: Affirmative easement - access by a non-landowner to a property to conduct monitoring Negative easement - prohibit well-drilling on the property by the landowner	Most flexible and commonly used proprietary control EPA can hold an "in gross" easement since it generally will not own an adjacent parcel of land. An "appurtenant" easement can only be given to adjacent landowners. (Note: the site manager or Regional Counsel should check all applicable state property laws and should not consider "in gross" easements to be transferable). Most useful in situations where a single parcel of land is involved and the current owner of the land is subject to regulation under CERCLA or RCRA	For an easement to be created there must be a conveyance from one party to another. An easement cannot be established unless there is a party willing to hold the easement. This can present difficulties since EPA cannot hold an easement under the NCP without compliance with all procedures required by section 104(j) of CERCLA. Furthermore, some state governments cannot hold easements, and other parties may be unwilling to do so. Since the owner may not be the only party with whom it is necessary to negotiate, a title search should be conducted to ensure that agreements have been obtained from all necessary parties (e.g., holders of prior easements with right of access) Less useful where a large number of parcels are involved and the owners are not PRPs because	In general, an easement is fully enforceable as long as its nature and scope are clear and notice is properly given to the parties against whom the agreements are binding (e.g. by recording the easement in land records) Use caution when determining who will hold the easement. Sometimes PRPs acquire easements from other landowners thus taking on the burden of negotiating and paying for them. However, as a third party, EPA may not have the right to enforce or transfer the easement unless that right is specified in the agreement between the PRP and other landowners. The terms of easements are enforceable by the holder in the state court with jurisdiction over the property's location.

Type of Institutional Control	Definition & Example	Benefits	Limitations	Enforcement
2. Covenants	A covenant is an agreement between one landowner to another made in connection with a conveyance of property to use or refrain from using the property in a certain manner. Similar to easements but are subject to a somewhat different set of formal requirements Example: A covenant not to dig on a certain portion of the property.	Can be used to establish an institutional control where the remediated property is being transferred from the current owner to another party	This agreement is binding on subsequent owners of the land if: (1) notice is given to the subsequent land owner, (2) there is a clear statement of intent to bind future owners, (3) the agreement "touches and concerns" the land, and (4) there is vertical and horizontal privity between the parties.[1]	Enforcement of covenants is subject to state law and enforceable by the holder in the state court with jurisdiction over the property's location.

[1] Horizontal privity means that only a contract party may claim relief for a breach of a contract warranty or a condition. In other words, no person other than the buyer can sue for damages that arise out of the breach of a contract warranty or condition. Vertical privity means that each party in a distribution chain only has a contract with the person ahead of him or her in the chain. For example, vertical privity would mean a consumer only has a remedy against the person from whom he or she purchased a particular item and could not sue the manufacturer.

Type of Institutional Control	Definition & Example	Benefits	Limitations	
3. Equitable Servitude	Closely related to covenants, equitable servitudes arose when courts of equity enforced agreements that did not meet all of the formal requirements of covenants.	Most likely to have value as an institutional control where a party responsible for cleanup expects to own neighboring property for a long period (as might be the case in partial military base closures)	The agreement is binding on subsequent owners of the land if: (1) notice is given to the subsequent land owner, (2) there is a clear statement of intent to bind future owners, (3) the agreement "touches and concerns" the land. The third requirement should be met by any agreement that restricts what the owner can do with the land.	The ability to enforce an equitable servitude "in gross" against subsequent landowners is less likely to be recognized compared to easements and covenants, but this depends greatly on jurisdiction. The terms of equitable servitudes are enforceable by the holder in the state court with jurisdiction over the property's location.
4. Reversionary Interest	A reversionary interest is created when a landowner deeds property to another, but the deed specifies that the property will revert to the original owner under specified conditions. It places a condition on the transferee's right to own and occupy the land. If the condition is violated, the property is returned to the original owner or the owner's successors. Example: Failure to maintain the integrity of a cap	Binding upon any subsequent purchasers Most useful where it can be assumed that the original owner will be available over a long period to conduct further response determined to be necessary (e.g., where a Federal agency is selling the property)	Not useful if there is a chance that the original owner will not remain in existence for a long time	Each owner in the chain of title must comply with conditions placed on the property. If a condition is violated, the property can revert to the original owner, even if there have been several transfers in the chain of title. The terms of reversionary interests are enforceable by the holder in the state court with jurisdiction over the property's location.

Type of Institutional Control	Definition & Example	Benefits	Limitations	Enforcement
5. State Use Restrictions	State statutes providing owners of contaminated property with the authority to establish use restrictions specifically for contaminated property For example, Connecticut property owners who wish to file an environmental use restriction must demonstrate that each person holding an interest in the land irrevocably subordinates their interest in the land to the environmental use restriction, and that the use restriction shall run with the land.[2]	Overrides common law impediments to allow for long term enforceability of real property interests	In some cases, the authority to acquire or enforce the restrictions is conferred only on the state. Therefore, the state's assistance is necessary to implement and enforce.	Determine whether the restriction can be federally enforced; if not, investigate whether the state is willing to take on the role of enforcement

[2] CT General Statutes, 1997, Vol. 8, Title 22a, Section 22a-133n through 22a-133s, contains the following provision: "No owner of land may record an environmental use restriction on the land records of the municipality in which such land is located unless he simultaneously records documents which demonstrate that each person holding an interest ... irrevocably subordinates such interest to the environmental use restriction. An environmental use restriction shall run with
land, shall bind the owner of the land and his successors and assigns, and shall be enforceable ....."

Type of Institutional Control	Definition & Example	Benefits	Limitations	
6. Conservation Easements	Statutes adopted by some states that establish easements to conserve and protect property and natural resources Example: Open space or recreational space is maintained to prevent exposure or prevent uses that might degrade a landfill cap	These statutes override common law technicalities and barriers that may pertain to traditional easements and covenants (e.g., “in gross” easements are not upheld in some jurisdictions).	May only be used for a narrow range of possible purposes which could limit their usefulness as institutional controls	In general, the holder must be a governmental body, a charitable corporation, association, or trust
ENFORCEMENT TOOLS (With IC Components)	Enforcement authority is used to either (1) prohibit a party from using land in certain ways or from carrying out certain activities at a specified property or (2) require a settling party to put in place some other form of control. This section addresses Federal enforcement tools as opposed to those that may be available to state or local governments.	May be easier to establish than proprietary controls because EPA is not dependent on 3rd parties to establish and enforce them.	Typically only binding on the original signatories of the agreement; or binding only the party(ies) to whom it is issued in the case of a Unilateral Administrative Order. Negotiations and finalization of AOCs and CDs can be lengthy.	Enforceable by EPA under CERCLA and RCRA or by a state if state enforcement tools are used.

Type of Institutional Control	Definition & Example	Benefits	Limitations	
1. Administrative Orders	An order directly restricting the use of property by a named party An order also can used to restrict the use of land owned by a *non-liable party*. This approach would be used if no other method (e.g., proprietary control, governmental control) is successful (see limitations). Example: An order prohibiting the transfer of drums off site or dredging in a containment area.	EPA has broad scope of authority to issue orders to protect public health and the environment (section 106 of CERCLA) Can be implemented without the execution of any further property instruments Can include provisions requiring the property owner to disclose the order's existence to any potential purchaser or lessee, and notify EPA of any anticipated change in ownership, the identities of any potential purchasers or lessees. Does not require an agreement with the landowner (though consent orders are generally considered more desirable). Unilateral orders can be easily modified in the event that the control needs to be modified or withdrawn	Does not bind subsequent owners or parties not named in the order (e.g., lessees). However, depending upon the facts of the case, an environmental regulator may have the authority to issue a new order to the new owner. An order to restrict a *non-liable party*, may result in a claim for compensation under section 106(b).	Enforcement is by EPA (or state if issued under state authority). Creates the threat of potential penalties for violations as an incentive to properly maintain the control

Type of Institutional Control	Definition & Example	Benefits	Limitations	Enforcement
2. Consent Decrees	A CD is signed by a judge and documents the settlement of an enforcement case. Similar to an Administrative Order, it is used to specify restrictions on use of land by the settling party. Example: No well drilling on the property.	Can be used to require a settling party to: 1. file a separate instrument conveying a proprietary control, such as an easement or covenant to EPA or a third party; 2. notify successors-in-title of the CD, site, and any easements; 3. notify EPA of any anticipated change in ownership and the name and address of the potential purchaser or lease; and 4. can be used to require settling non-property owners (PRPs) to attempt to obtain easements from parties that own land contaminated by the PRP in order to restrict land or resource use.	CDs alone are not binding on subsequent owners and occupants.	Enforced by EPA (or state if issued under state authority); failure to comply can result in penalties.[3]

[3]While EPA may not be able to enter into CDs with federal agencies, states can.

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Type of Institutional Control	Definition & Example	Benefits	Limitations	
INFORMATIONAL DEVICES	Tools, which often rely on property record systems, used to provide public information about risks from contamination	May effectively discourage inappropriate land users from acquiring the property Easier to implement than other controls because they do not require a conveyance to be negotiated	Has little or no effect on a property owner’s legal rights regarding the future use of the property If not drafted well, informational devices may discourage appropriate development and uses of land	Not legally enforceable

Type of Institutional Control	Definition & Example	Benefits	Limitations	
1. Deed notices	Commonly refers to a non-enforceable, purely informational document filed in public land records that alerts anyone searching the records to important information about the property Example: Notice may state that the property is located within a Superfund site, identify the kinds of contaminants present and the risks they create, or describe activities that could result in undesirable exposures to the contaminants left on site.	May discourage inappropriate land use Easier to implement than easements because they do not require a conveyance to be negotiated Use only as a means of alerting and informing the public about information related to a particular piece of property	Because deed notices are not a traditional real estate interest, proper practice in using them is not well established. Investigate state law and local practice in advance to determine whether such a notice will be recorded, how it should be drafted, and who would be entitled to revoke it. Before filing a notice, obtain the property owner's consent to avoid the risk of claims for slander of title. If not written properly, the notice may discourage all development, including uses that would be appropriate for the site, by creating a perceived liability risk.	A deed notice is not an interest in real property, so recording a notice has little or no effect on a property owner's legal rights regarding the future use of the property (i.e., they are non-enforceable).

Type of Institutional Control	Definition & Example	Benefits	Limitations	
2. State registries of hazardous waste sites	Registries containing elements that can be used as institutional controls Examples: Compilation of hazardous waste sites in the state; annual reports summarizing the status of each site on the registry; notice with the deed for sites on the registry that the site is contaminated; and the requirement that any person conveying title to property on the registry to disclose to all potential purchasers the fact that the property is on the registry	With the cooperation of the state, registries can be useful with other measures as part of an overall remedy, especially in providing information to the public. Some laws provide that the use of a property on the registry cannot be substantially changed without state approval.	The procedure for listing and removing sites from registries is solely at the state’s discretion	Any requirements are only enforceable by the state

Type of Institutional Control	Definition & Example	Benefits	Limitations	
3. Advisories	Warnings that provide notice to potential users of land, surface water or ground water of some existing or impending risk associated with their use. Advisories are usually issued by public health agencies, either at the Federal, state or local level. Example: An advisory issued to owners of private wells in a particular area that contamination has been detected in the ground water	Can be useful with other measures as part of an overall remedy, especially in providing information to the public	These types of warnings, by themselves, are not likely to prevent incidental contact or consumption. Use advisories also have a very short useful life and must continually be enforced.	Advisories do not have any legal effect nor do they create any enforceable restrictions.

GLOSSARY OF TERMS

Administrative Orders on Consent (AOC) - A legal agreement signed by EPA and the potentially responsible parties (PRPs) through which the PRP agrees to pay for or take the required corrective or cleanup actions, or refrain from an activity. It describes the actions to be taken, may be subject to a comment period, applies to civil actions, and can be enforced in court.

Advisories - Warnings, usually issued by public health agencies, either at the federal, state or local level, that provide notice to potential users of land, surface water, or ground water of some existing or impending risk associated with their use.

Appurtenant - A traditional property law term used to describe an easement that is created to benefit an adjacent parcel of land (and it is held by the owner of that land). For example, an easement allowing the owner of one parcel the right to cross an adjoining parcel would be appurtenant. (See also "In Gross")

Chain of Title - A history of conveyances and encumbrances affecting a title from the time that the original patent was granted, or as far back as records are available.

Common Law - The body of law developed primarily from judicial decisions based on custom and precedent, unwritten in statute or code, and constituting the basis of the legal system in all of the U.S. except Louisiana**.**

Condemnation of Property - When a local government, exercising eminent domain, condemns a property in order to take over title.

Consent Decree (CD) - A legal document, approved by a judge, that formalizes an agreement reached between EPA and PRPs through which PRPs will conduct all or part of a cleanup action at a Superfund site, cease or correct actions or processes that are polluting the environment, or otherwise comply with EPA initiated regulatory enforcement action. The consent decree describes the actions PRPs will take and is subject to a public comment period.

Conservation Easements - Statutes adopted by some states that establish easements to conserve and protect property and natural resources.

Conveyance - The transfer of title to property or a right of that property (i.e. easement) from one person to another.

Cooperative Agreement - An assistance agreement whereby EPA transfers money, property, services or anything else of value to a state, university, or non-profit or not-for-profit organization for the accomplishment of authorized activities or tasks.

Covenants - A promise by one landowner to another made in connection with a conveyance of property. Generally, a covenant is a promise by the holder of a possessory interest in property to use or refrain from using the property in a certain manner. Covenants are similar to easements but have been traditionally subject to somewhat different formal requirements.

Deed - A signed and usually sealed instrument containing some legal transfer, bargain, or contract.

Deed Notice - Commonly refers to a non-enforceable, purely informational document filed in public land records that alerts anyone searching the records to important information about the property.

Deed Restriction - Not a traditional property law term, but rather is used in the NCP as a shorthand way to refer to types of institutional controls.

Easements - A property right conveyed by a landowner to another party which gives the second party rights with regard to the first party's land. An "affirmative" easement allows the holder to enter upon or use another's property for a particular purpose. A "negative" easement imposes limits on how the landowner can use his or her own property.

Enforcement Tools - Tools, such as administrative orders or consent decrees, available to EPA under CERCLA and RCRA that can be used to restrict the use of land. Enforcement authority can be used to either (1) prohibit a party from using land in certain ways or from carrying out certain activities at a specified property, or (2) require a settling party to put in place some other form of control, such as a proprietary control.

Equitable Servitude - A real estate interest, similar to a covenant, that arose when courts of equity enforced agreements that did not meet all of the formal requirements for a covenant.

Government Controls - Controls using the regulatory authority of a governmental entity to impose restrictions on citizens or sites under its jurisdiction. Generally, EPA must turn to state or local governments to establish controls of this type.

In Gross - A traditional property law term used to describe easements that provide a benefit not related to any property owned by the holder of the easement. Easements used under CERCLA and RCRA will generally be "in gross" because the restrictions are generally not for the benefit of any particular neighboring parcel owned by the holder of the easement.

Informational Devices - Informational tools that provide information or notification that residual or capped contamination may remain on site. Common examples include state registries of contaminated properties, deed notices, and advisories.

Institutional Controls - Non-engineering measures intended to affect human activities in such a way as to prevent or reduce exposure to hazardous substances. They are almost always used in conjunction with, or as a supplement to, other measures such as waste treatment or containment. There are four categories of institutional controls: governmental controls; proprietary controls; enforcement tools; and informational devices.

Local Permits - Special permits outlining specific requirements before an activity can be authorized.

Memorandum of Understanding - A document which outlines an agreement in principle between its signatories.

Proprietary Controls - Tools based on private property law used to restrict or affect the use of property.

Reversionary Interest - A real estate interest created when a landowner deeds property to another, but the deed specifies that the property will revert to the original owner under specified conditions.

"run with the land" - An expression indicating a right or restriction that affects all current and future owners of a property.

State Use Restrictions - Statutes enacted by some states providing authority to establish use restrictions specifically for contaminated property.

State Registries of Hazardous Waste Sites - Registries established by state legislatures that contain information about properties. Types of registries include a list of hazardous waste sites in the state; annual reports submitted to the legislature summarizing the status of each site on the registry; and notice with the deed for sites on the registry that the site is contaminated.

Superfund State Contract (SSC) - An agreement between EPA and the state before remedial action begins (at Superfund sites where EPA is leading the response activities) that documents the state's assurances under the law and outlines the roles and responsibilities of both parties.

Tailored Ordinances - Ordinances put in place by local governments with broad land use authority to control access to or the use of certain areas. For example, ordinances that require fences or buffers around or that ban fishing or swimming in contaminated areas.

Technical Assistance Grant - A EPA grant awarded to eligible community groups for the purpose of hiring an independent technical advisor, enabling community members to participate more effectively in the decision-making process at Superfund sites.

Unilateral Administrative Order (UAO) - A legal document signed by EPA directing the PRPs to take corrective action or refrain from an activity. It describes the violations and actions to be taken, and can be enforced in court.

Zoning Restriction - Zoning authority exercised by local governments to specify land use for certain areas. For example, a local government could prohibit residential development in an area of contamination or limit gardening in certain areas.

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OSWER 9283.1-34
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United States Environmental Protection Agency

Groundwater Road Map

Recommended Process for Restoring Contaminated Groundwater at Superfund Sites

Note: All bold-faced words in the text are defined in the glossary at the end of this fact sheet. Cited references and additional references are located at the end of this fact sheet. Cited references include the page number from the reference, as appropriate.

Purpose and Scope

This fact sheet focuses on those groundwater response actions where the decision has been or may be made to restore all or part of the aquifer that are undertaken using cleanup authority under the **Comprehensive Environmental Response, Compensation, and Liability Act** (CERCLA), as amended. Portions of this guidance may also be useful to groundwater remedial actions that do not have restoration as an objective. For purposes of this guidance, "restoration remedies" are remedial actions with the objective of returning all or part of groundwater aquifer to cleanup levels specified in the Record of Decision (ROD) and "restoration" refers to the reduction of contaminant concentrations to cleanup levels that are selected as part of a response action under Superfund.

The fact sheet addresses all types of site leads—fund-lead, potentially responsible party (PRP)-lead, and federal facility lead.

This fact sheet addresses groundwater restoration remedies which may include **pump-and-treat systems,** in situ **treatment systems, monitored natural attenuation** (MNA) or a combination of one or more of these and other remedies. As part of an overall site remediation strategy, groundwater remedies may also be selected in conjunction with in situ source remedies. It is important to note that source control measures and plume containment activities are often critical to the success of aquifer restoration efforts. Although not the focus of this document, these remedy components are generally discussed when evaluating restoration remedies' progress towards their goals.

In addition, institutional controls (ICs), vapor intrusion mitigation measures, alternative water supply, well-head treatment, and Technical Impracticability (TI) ARAR waivers can all be part of a comprehensive groundwater remedy. These components are generally monitored and evaluated throughout the groundwater restoration process; however, these activities are not the focus in this document.

More than half of the RODs through 2008 contain groundwater remedies, many of which are still being implemented (Ref. 1). This fact sheet is intended as a quick reference guide for remedial project managers (RPM) and other site managers of final groundwater **restoration** remedies for all or part of the contaminated plume, and discusses some of the key steps in the groundwater restoration process from remedial investigation to completion. It describes a recommended process (see Figure 1), consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), that can be used for groundwater restoration remedies.

This document does not provide new guidance, but compiles key relevant highlights of previous Superfund law, regulation, policy, and guidance regarding the overall groundwater restoration process; some portions of existing guidance are directly quoted for purposes of easier reference. This recommended road map summarizes the steps and decisions related to:

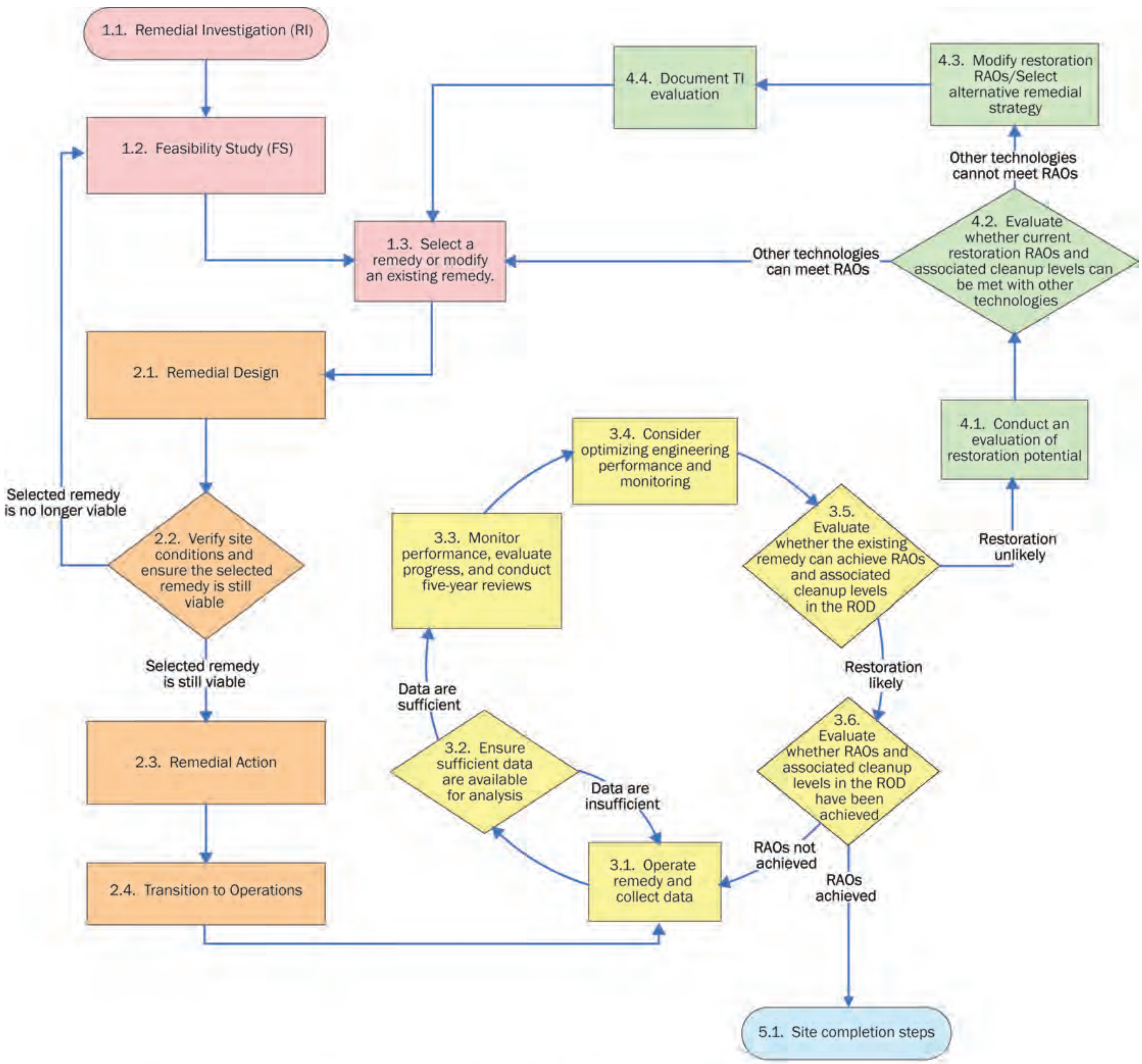


Figure 1: Recommended Process for Restoring Contaminated Groundwater at Superfund Sites

- selecting a groundwater restoration remedy;
- designing, constructing, and initiating the remedy;
- operating, monitoring, evaluating, and optimizing the remedy;
- modifying the remedy, as appropriate; and
- documenting completion of the site response actions.

This fact sheet may be useful at Superfund sites where remedial systems (1) will be selected, designed and operated, or (2) are currently operating as the final remedy to restore all or part of the contaminated groundwater to its beneficial use.

The flow chart in Figure 1 shows a recommended road map of the groundwater evaluation and remediation process. Each section in the document includes a snapshot of this figure highlighting the portion of the process being discussed. Each step in the process is color-coded. The shape of each step indicates whether the step includes activities (rectangle) or factors to consider (diamond). Start and endpoints are indicated by ovals. It should be noted that the steps discussed in this guidance do not represent a comprehensive set of steps or factors to consider when reviewing remedy implementation.

Additional policy and guidance documents in the references section of this fact sheet can be consulted as a source for additional information about each step in the process. Key portions of existing guidance are quoted in this fact sheet for the convenience of the reader.

Background

Under CERCLA 121(d)(2)(A), groundwater response actions are governed in part by the following mandate established by Congress:

> *"…Such remedial action shall require a level or standard of control which at least attains Maximum Contaminant Level Goals established under the Safe Drinking Water Act and water quality criteria established under section 304 or 303 of the Clean Water Act, where such goals or criteria are relevant and appropriate under the circumstances of the release or potential release"* (Ref. 2, p. 2).

Furthermore, the NCP includes general expectations for purposes of groundwater restoration as follows:

> *"EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site. When restoration of ground water to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction"* (Ref. 3).

OSWER Directive 9283.1, 1-33, *Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration*, summarizes five key principles that stem from the overarching expectations for groundwater restoration. They are:

1. *"If groundwater that is a current or potential source of drinking water is contaminated above protective levels (e.g., for drinking water aquifers, contamination exceeds Federal or State MCLs or non-zero MCLGs), a remedial action under CERCLA should seek to restore that aquifer to beneficial use (e.g., drinking water standards) wherever practicable.*
2. *Groundwater contamination should not be allowed to migrate and further contaminate the aquifer or other media (e.g., vapor intrusion into buildings; sediment; surface water; or wetland).*
3. *Technical impracticability waivers and other waivers may be considered, and under appropriate circumstances granted if the statutory criteria are met, when groundwater cleanup is impracticable; the*

waiver decision should be scientifically supported and clearly documented.

4. *Early actions (such as source removal, plume containment, or provision of an alternative water supply) should be considered as soon as possible. ICs related to groundwater use or even surface use, may be useful to protect the public in the short-term, as well as in the long-term.*
5. *ICs should not be relied upon as the only response to contaminated groundwater or as a justification for not taking action under CERCLA. To ensure protective remedies, CERCLA response action cleanup levels for contaminated groundwater should generally address all pathways of exposure that pose an actual or potential risk to human health and the environment"* (Ref. 2, p. 3-4).

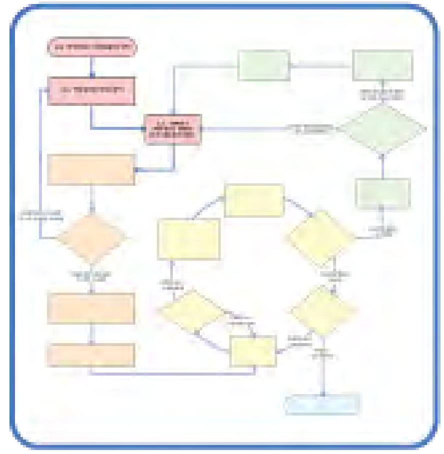
To address the principles discussed above, EPA may use a phased approach for remediating contaminated groundwater. *"In a phased response approach, site response activities are implemented in a sequence of steps, or phases, such that information gained from earlier phases is used to refine subsequent investigations, objectives or actions"* (Ref. 4, p. 5). Implementing investigations and actions in phases can be advantageous for several reasons, including:

- *"Data from earlier response actions are used to further characterize the site and assess restoration potential;*
- *Attainable objectives can be set for each response phase;*
- *Flexibility is provided to adjust the remedy in response to unexpected site conditions;*
- *Remedy performance is increased, decreasing remediation timeframe and cost; and*
- *Likely remedy refinements are built into the selected remedy, better defining the potential scope and minimizing the need for additional decision documents" (*Ref. 4, p. 6).

Phased remedy approaches may include the implementation of early and interim actions. For early actions, "*early refers to the timing of the start of an action with respect to other response actions at a given site. For Superfund sites, early actions could include removal actions, interim remedial actions, or early final remedial actions*" (Ref. 4, p. 6). *"An interim action is limited in scope and only addresses areas/media that also will be addressed by a final site/operable unit Record of Decision*" (Ref. 5, p. 8-2). Both source and groundwater actions may be implemented as either early or interim actions. These actions generally may address exposure to contaminated groundwater, or prevent further migration of groundwater, or prevent further migration of contaminants from sources.

Generally, groundwater restoration is considered a final action; however, "*site characterization and performance data from early or interim groundwater actions should be used to assess the likelihood of restoring groundwater to ARAR or risk-based cleanup levels*" (Ref. 4, p. 7). In addition, "*final remedial actions must address the cleanup levels and other remediation requirements for the site and, therefore, must be based on completed characterization reports. Information from early and interim actions also should be factored into these reports and final remedy decisions*" (Ref. 6, p. 4).

1. Remedy Selection for Groundwater Restoration



Three important steps in the typical groundwater remedy selection process include: (1.1) remedial investigation, (1.2) feasibility study, and (1.3) selection of a remedy. As part of the remedy selection process, a **remedial investigation** and **feasibility study** (RI/FS) should be conducted to characterize site conditions, evaluate risks posed by the site, and identify and evaluate remedial alternatives; after the RI/FS, a proposed plan with the preferred remedy is published to provide an opportunity for public comment, and then a remedy is selected in the ROD.

1.1 Remedial investigation (RI)

The remedial investigation generally has four major components: conducting a field investigation, defining the nature and extent of contamination, identifying federal/state chemical- and location-specific **applicable or relevant and appropriate requirements** (ARARs) and conducting baseline human health and ecological **risk assessments**.

"*Data* [obtained during the field investigation] *on the physical characteristics of the site and surrounding areas should be collected to the extent necessary to define potential transport pathways and receptor populations and to provide sufficient engineering data for development and screening of remedial action alternatives*" (Ref. 7, p. 3-5). Particular to groundwater, it is recommended that the following information be collected:

> The remedial project manager is encouraged to assemble a multi-disciplinary technical review team who, throughout the remedial process outlined in this document, provides technical assistance. This assistance may include the review of important deliverables and monitoring of progress. Technical review team members may include, but are not limited to, the State RPM, Geologist/ Hydrogeologist, Human Health and Ecological Risk Assessors, Chemist, Geochemist, Environmental Engineer, Cost Engineer, EPA Technical Support Project Forums and Centers, and Community Involvement Coordinator.

- *"Nature and extent of groundwater contamination including source(s) of contamination, contaminants of concern (COCs), estimated extent and volume of contaminated plume and the potential for migration of the contaminant plume.*
- *Geology and hydrogeology of the site and surroundings (in addition to the topography and geography), including the following:*
  - *Aquifer(s) affected or threatened by site contamination, types of geologic materials, approximate depths, whether aquifer is confined or unconfined.*
  - *Groundwater flow directions within each aquifer and between aquifers and groundwater discharge locations (e.g.,*

> Community involvement generally is an important aspect of the Superfund program. Community involvement typically is the vehicle EPA uses to get community concerns and interests to the decision-making table. The active involvement of the project manager should help promote public participation among all team members and should ensure the integration of community involvement in the cleanup process (Ref. 8, p. 3).

surface waters, wetlands, other aquifers).

- *Interconnection between surface contamination (e.g., soils) and groundwater contamination*
- *Confirmed or suspected presence and location of NAPLs*" (Ref. 5, p. 9-5, 9-6).

From information collected at the site, it may be determined that MNA or other in situ technologies may be considered as a remedial approach. If this is the case, certain aspects of site characterization may require more detail or additional information gathering during the remedial investigation (as compared to the items referenced above), such as biological and geochemical data.

The information gathered generally is used to develop a **conceptual site model** (CSM). "*Analyses of the data collected should focus on the development or refinement of the conceptual site model by presenting and analyzing data on source characteristics, the nature and extent of contamination, the contaminated transport pathways and fate, and the effects on human health and the environment*" (Ref 7, p. 3-19). To support the CSM, three dimensional visualization platforms are also available to RPMs to assist in evaluating the data collected during the remedial investigation. The CSM may also serve as a guide to the decision-making throughout the remedial process discussed in this document.

In order to determine if groundwater restoration is appropriate, the groundwater use for the impacted aquifers is generally evaluated in accordance with the NCP which states that the lead agency should assess the "*characteristics or classification of air, surface water, and ground water*" as part of the RI (Ref. 9). Designation of groundwater classification should be based on the following: "*While a State's designation of groundwater use will be considered for establishing remediation goals, EPA's classification scheme (EPA Guidelines/or Ground-Water Classification [Final Draft, December 1986]) will generally be used if a state's classification would lead to a less stringent solution. In 1997, EPA initiated a policy of deferring to a State's determination of current and future groundwater uses, when based on criteria or methodology that are specified in an EPA endorsed CSGWPP* [Comprehensive State Groundwater Protection Program], *and can be applied at specific sites or facilities*" (Ref. 2, p. 7).

The CSM is a three-dimensional "picture" of site conditions that illustrates contaminant sources, release mechanisms, exposure pathways, migration routes, and potential human and ecological receptors. The CSM documents current and potential future site conditions and is supported by maps, cross sections, and site diagrams that illustrate what is known about human and environmental exposure through contaminant release and migration to potential receptors (Ref. 5, p. 6-10).

Based upon the identified exposure pathways, baseline human health and ecological risk assessments normally are conducted. "*CERCLA response actions that clean up contaminated groundwater generally address all pathways of exposures that pose an actual or potential risk to human health and the environment. For example, groundwater response actions should generally address the actual or potential direct contact risk posed by contaminated groundwater (e.g., human consumption, dermal contact, or inhalation), and also should consider the potential for the contaminated groundwater to serve as a source of contamination into other media (e.g., for vapor intrusion into buildings; sediment; surface water; or wetlands)*" (Ref. 2, p. 3).

"*Under existing Agency policy, groundwaters that are current or potential sources of drinking water that exceed risk-based standards (e.g., Maximum Concentration Limits [MCLs]) or pose an unacceptable risk generally warrant action under CERCLA*" (Ref. 2, p. 5).

During the RI, EPA generally identifies potential ARARs. "*The lead and support agency shall identify their respective potential ARARs related to the location of and contaminants at the site in a timely manner. The lead and support agencies may also, as appropriate, identify other pertinent advisories, criteria, or guidance in a timely manner*" (Ref. 10). "*CERCLA 121(d) specifically identifies Safe Drinking Water Act MCLs and nonzero MCLGs, as well as Clean Water Act Water Quality Criteria as potentially relevant and appropriate standards to be attained by the remedial action*" (Ref. 2, p. 8). These ARARs are used in developing the appropriate cleanup levels for the remedial action.

The results of the RI will be used in developing remedial alternatives in the feasibility study.

1.2 Feasibility study (FS)

The FS generally serves as the mechanism for the development, screening, and detailed evaluation of alternative remedial actions. "*For groundwater response actions, the lead agency shall develop a limited number of remedial alternatives that attain site-specific remediation levels within different restoration time periods utilizing one or more different technologies*" (Ref. 11). The FS normally includes several steps: developing remedial action objectives (RAOs); determining cleanup levels; identifying potential treatment and containment technologies or natural processes that will satisfy these RAOs; screening the technologies based on their effectiveness, implementability, and cost; and assembling technologies and their associated containment or disposal requirements into alternatives for the contaminated media (Ref. 7, chapter 4).

"*RAOs provide a general description of what the cleanup will accomplish (e.g., restoration of groundwater to drinking water levels)*" (Ref. 5, p. 6-26). "*A range of RAOs may be applicable to groundwater remedy decisions. Some of these objectives may be achievable in a relatively short time frame (e.g., exposure control, plume containment), while other objectives may require a much longer time frame (e.g., plume restoration)*" (Ref. 5, p. 9-6). The RAOs should clearly indicate which objectives are to be achieved over which portion of the plume and in what timeframes these objectives are expected to be achieved. Basic groundwater RAOs generally include one or more of the following:

- *"Prevent exposure to contaminated groundwater, above acceptable risk levels.*
- *Prevent or minimize further migration of the contaminant plume (source control).*
- *Prevent or minimize further migration of contaminants from source materials to groundwater (source control).*
- *Return groundwater to its expected beneficial uses wherever practicable (aquifer restoration)"* (Ref. 5, p. 9-6).

The basic RAOs above are generally used as a starting point for RAO development and should be modified to include site-specific exposure scenarios and more specificity.

Once RAOs are established, "*the preliminary remediation goals are developed on the basis of chemical-specific ARARs, when available, other available information (e.g., Rfds), and site-specific risk-related factors*" (Ref. 7, p. 4-3). Preliminary remediation goals are generally finalized in the remedy decision document as cleanup levels. "*Groundwater cleanup levels are established based on promulgated standards (e.g., Federal or State MCLs or non-zero MCLGs, or other standards found to be ARARs), or risk-based levels (e.g., for contaminants when there are no standards that define protectiveness). Where ARARs are not available or are not sufficiently protective, EPA generally sets site-specific remediation levels for: 1) carcinogens at a level that represents an excess upper bound lifetime cancer risk to an individual of between 10-4 to 10-6; and for 2) non-carcinogens such that the cumulative risks from exposure will not result in adverse effects to human* *populations (including sensitive sub-populations) that may be exposed during a lifetime or part of a lifetime, incorporating an adequate margin of safety*" (Ref. 2, p. 8-9).

After developing preliminary remediation goals, a remediation timeframe is typically developed as a baseline to reach these levels. This timeframe depends on a number of site specific factors, including the current and future use of the aquifer, complexity of site contamination and hydrogeology, and available remediation strategies. "*More rapid restoration of groundwater is favored in situations where a future demand for drinking water from groundwater is likely and other potential sources are not sufficient. Rapid restoration may also be appropriate where the institutional controls to prevent the utilization of contaminated groundwater for drinking water purposes are not clearly effective or reliable*" (Ref. 12, p. 171).

As discussed in existing guidance, "*in cases where there is a high degree of certainty that cleanup levels cannot be achieved, a final ROD that invokes a TI waiver and establishes an alternative remedial strategy may be the most appropriate option*" (Ref. 13, p. 5). "*Adequate site characterization data must be presented to demonstrate, not only that the constraint exists, but that the effect of the constraint on contaminant distribution and recovery potential poses a critical limitation to the effectiveness of available technologies*" (Ref. 13, p. 11).

Typically, during the FS, different remedial alternatives for restoration of the groundwater, containment of the plume and source remediation, and restoration timeframes are compared. If MNA is being evaluated as a remedial alternative, the results of the RI should have "*site-specific data sufficient to estimate with an acceptable level of confidence both the rate of attenuation processes and the anticipated time required to achieve remediation objectives*" (Ref. 6, p. 15). Typically, multiple lines of evidence will be used to determine that MNA is occurring and provides a remedy that is protective of human health and the environment (Ref. 6, p. 15 -16). "*The decision to implement MNA should include a comprehensive site characterization, risk assessment where appropriate, and measures to control sources. In addition, the progress of natural attenuation towards a site's remediation objectives should be carefully monitored and compared with expectations to ensure that it will meet site remediation objectives within a timeframe that is reasonable compared to timeframes associated with other methods. Where MNA's ability to meet these expectations is uncertain and based predominantly on predictive analyses, decision-makers should incorporate contingency measures into the remedy*" (Ref. 13, p. 25).

Typically, all alternatives are initially screened for implementability, effectiveness, and cost. Once this screening is done, a detailed analysis is generally done using the nine evaluation criteria specified in the NCP. This detailed evaluation is the basis for the remedy decision (Ref. 7, Chapters 5 and 6).

1.3 Select a remedy or modify an existing remedy

"*The Preferred Alternative for a site is presented to the public in a Proposed Plan. The Proposed Plan briefly summarizes the alternatives studied in the detailed analysis phase of the RI/FS, highlighting the key factors that led to identifying the Preferred Alternative. The Proposed Plan, as well as the RI/FS and the other information that forms the basis for the lead agency's response selection, is made available for public comment in the Administrative Record file. Following receipt of public comments and final comments from the support agency, the lead agency selects and documents the remedy selection decision in a record of decision (ROD)*" (Ref. 5, p. 1-5).

"*To support the selection of a remedial action, all facts, analyses of facts, and site-specific policy determinations considered in the course of carrying out activities . . . shall be documented, as appropriate, in a record of decision, in a level of detail appropriate to the site situation. . .*" (Ref. 14).

The ROD should include RAOs that clearly describe the intended results of the remedial action. In addition, the selected remedy section in a ROD should include: "*a brief discussion of the monitoring program necessary to ensure remedy effectiveness as well as the entity responsible for maintaining the monitoring program (especially important for remedies with long durations such as natural attenuation); and provisions for groundwater monitoring once the system is shut off to ensure cleanup levels are maintained*" (Ref. 5, p. 9-7).

- The expected outcome of the groundwater remedy should be discussed, including the following: "*Available uses of groundwater upon achieving cleanup levels. Note time frame to achieve available use; and*
- *Final cleanup levels for each medium (i.e., contaminant-specific remediation goals), basis for cleanup level, and risk at cleanup levels (if appropriate)*" (Ref. 5, p. 6-45).

A post-ROD change to a selected remedy is a site-specific determination and generally should be consistent with Section 300.435(c)(2) of the NCP, as summarized below:

Scope. Does the change alter the scope of the remedy (for example, type of treatment technology, remediation goals to be achieved, type of waste to be addressed, amount of waste to be addressed)?

Performance. Would the change alter the performance (for example, treatment levels to be attained, long-term reliability of the remedy)?

Cost. Are there significant changes in costs from estimates in the ROD, taking into account the recognized uncertainties associated with the hazardous waste engineering process selected? "*Feasibility cost estimates generally are expected to provide an accuracy of +50% to -30%*" (Ref. 5, p. 7-1).

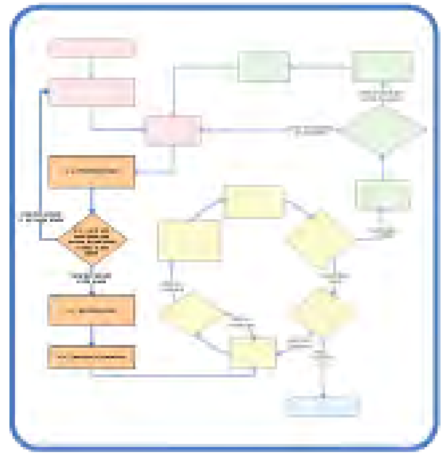
"*Based on this evaluation, and depending on the extent or scope of modification being considered, the lead agency must make a determination as to the type of change involved (i.e., nonsignificant or minor, significant, or fundamental change). Remedy changes should fall along a continuum from minor to fundamental. Similarly, an aggregate of nonsignificant or significant changes could result in a fundamental change*" (Ref. 5, p. 7-1). Examples of the potential types of changes identified and associated documentation modifications are summarized below:

Nonsignificant or Minor Change. This change typically arises during design and construction, when modifications are made to the functional specifications of the remedy to address issues such as performance optimization, new technical information, support agency/community concerns and/or cost minimization (e.g., value engineering process). Such changes may affect things such as the type or cost of materials, equipment, facilities, services, and supplies used to implement the remedy. The change should not have a significant impact on the scope, performance or cost of the remedy. This change should be documented with a brief memorandum to the site file.

Significant change. This change generally involves a change to a component of the remedy that does not fundamentally alter the overall cleanup approach. For example, changing to the contingency remedy selected in the ROD or a large increase of contaminant volume being remediated, would generally be considered a significant change. Significant changes are documented with an Explanation of Significant Differences (ESD) post-ROD document.

Fundamental Change. This change typically involves an appreciable change or changes in the scope, performance, and/or cost—or may be composed of a number of significant changes that together have the effect of a fundamental change. An example of a fundamental change is one that results in a reconsideration of the overall waste management approach selected in the original ROD. For example, change from restoration to containment, or a decision to invoke a technical impracticability waiver would generally be a fundamental change. Fundamental changes are documented with a ROD amendment (ROD-A). (Ref. 5, p. 7-1, 7-2)

2. Remedial Design and Remedial Action



The remedial design and remedial action process typically involve four elements: (2.1) **remedial design (RD)**, (2.2) verify the site conditions and ensure the remedy is still viable, (2.3) **remedial action (RA)**, and (2.4) transition to operations. Each of these steps is discussed below.

2.1 Remedial design

"*The purpose of data collection during the RD is not to recharacterize the site but to obtain data to support the design effort*" (Ref. 15, p. 48). "*If the CSM does not adequately identify or explain (1) historical and continuing sources of groundwater contamination, both above ground and below the surface, (2) historical growth and/or retreat of the groundwater plume, (3) groundwater flow velocity (horizontal and vertical) and other parameters controlling contaminant fate and transport, (4) potential human and ecological receptors, and (5) anticipated results of remedial actions, the data gaps should be addressed with a focused investigation*" (Ref. 16, p. 2). As a result, "*new information may be received or generated that will modify the CSM and could affect implementation of the remedy selected in the ROD, or could prompt a reassessment of that remedy*" (Ref. 5, p. 7-1). "*Because capital costs for installation and annual costs for operation and maintenance are significantly higher than the costs of designing a system, it is often appropriate to request a design review from a third party*" (Ref. 17, p. 1)." *The* [Federal Acquisition Regulation] *FAR has two types of Value Engineering requirements. The first type of requirement is for the RD phase of a project*" (Ref. 18, p. 1). "*Value Engineering (VE) is a highly beneficial technique used to reduce nonessential procurement and program costs. VE uses systematic and creative methods to reduce costs without sacrificing the reliability, efficiency, or original objectives of the project*" (Ref. 19, p. 1). All Superfund RDs that will lead to Fund-lead RAs should undergo the VE process (Ref. 18, p. 2). Although not required, **optimization** approaches may also be employed during design in accordance with EPA's goal to integrate optimization into the overall Superfund cleanup process (Ref. 20, p. 1). During remedial design, new information should be evaluated and may result in a re-evaluation of the selected remedial action (see 2.2).

2.2 Verify the site conditions and ensure the selected remedy is still viable

The information and data collected during remedial design is typically evaluated against the CSM and the assumptions made at the time of remedy selection to ensure the selected remedy is still viable. Where appropriate, changes to these assumptions made at the time of remedy selection are generally documented and incorporated into an updated CSM.

Possible results include:

Selected remedy is still viable: If the collected data and information indicate that the selected remedy does not need to be changed fundamentally, the design is finalized, and non-significant and significant changes to the remedy are documented if necessary (documentation is discussed in 1.3), and remedial action begins as described in 2.3.

Selected remedy is no longer viable: In some instances, data and information collected during the RD may determine that the selected remedy is no longer viable. In this case, the remedy generally needs to be changed fundamentally; the processes described in 1.2 and 1.3 usually are conducted. The following are common examples of changes in site conditions that may necessitate a fundamental change in the remedy:

- Changed or newly discovered hydrogeologic conditions
- Change in surrounding use of the aquifer
- Newly discovered constituents
- Newly identified sources

2.3 Remedial action

Typically, after all final design criteria have been approved, and all detailed system specifications have been selected, the engineering remedy components are constructed. Remedy construction can be phased, which involves implementing certain groundwater remedy elements as their designs are completed. The construction phase may include building the remedial system and installing the monitoring network. In some cases, the need for changes to the selected remedy becomes evident during the remedial action. Any remedy modifications are generally carried out in accordance with CERCLA, the NCP, and existing guidance and policy regarding ROD modifications and the Administrative Record. These changes are typically analyzed and documented in the appropriate decision document before they are implemented (see step 1.3). As part of the RA, an **operation and maintenance** (O&M) plan typically is finalized. The O&M plan generally "documents" the monitoring plan for groundwater restoration which should include, at a minimum, the components selected in the ROD.

For purposes of this guidance, "*monitoring is [defined as] the collection and analysis of data over a sufficient period of time and frequency to determine the status and/or trend in one or more environmental parameters or characteristics. Monitoring should not produce a 'snapshot in time' measurement, but rather should involve repeated sampling over time in order to define site-wide remedy performance and the trends in the parameters of interest relative to clearly defined management objectives*" (Ref. 19, p. Intro-3). In this case, these objectives are typically aquifer restoration in the long-term and plume containment in the short-term.

In order to evaluate these management objectives, "*several types of monitoring may be conducted at a site, such as detection monitoring (to detect changes in ambient conditions), compliance monitoring (to evaluate compliance with regulatory requirements), and remedial* [performance] *monitoring (to evaluate remedy effectiveness)*" (Ref. 19, p. Intro-3).

"*The predicted time frame for operation and completion of the groundwater remedial action is critical to monitoring plan development because it identifies and provides parameters for the monitoring objectives and subsequent monitoring studies*" (Ref. 19, p. 1-2).

These monitoring parameters generally determine the following data collection characteristics (Ref. 19, p. 4-2, 4-4):

- What data are needed?
- How should samples be collected?
- Where should samples be collected?
- When should samples be collected?
- How long should sampling continue?
- How often should sampling occur?

The monitoring plan generally addresses how the data will be analyzed to discern contaminant distribution changes, remedy performance, and, as appropriate, plume capture efficacy based on the established objectives and monitoring parameters. The monitoring plan at a site should be considered a dynamic document; the types of data collected and the sampling frequency may change as both restoration progresses and based on additional information collected during the operation and maintenance of the remedy. Capture zone analysis is generally performed to assess if the short-term RAO of plume containment is being achieved. EPA has developed technical guidance to help evaluate capture zones for groundwater P&T systems and to help determine appropriate frequency for capture zone analysis. The basis for evaluating capture usually includes a lines of evidence approach considering concentration trends and water level data, among other factors (Ref. 21). "*In cases where monitoring is being conducted to identify individual exceedance of some critical environmental conditions, statistical analysis may not be necessary. Use of an appropriate statistical method can help support or refute the monitoring hypotheses and thus help answer the monitoring questions*" (Ref. 19, p. 4-5).

If the groundwater remedy is the last remedy to be implemented at the site, completion of physical construction normally would signify achievement of **construction completion**, and a **preliminary close out report** (PCOR) should be prepared to document this milestone (Ref. 22, p. 3-2 – 3-3). Completion of physical construction of typical groundwater remedies is generally documented in a remedial action (RA) report, which is typically prepared when all construction activities are complete (including site restoration and demobilization), and a successful contract final inspection or equivalent has been conducted (Ref. 22, p. 2-4 – 2-6).

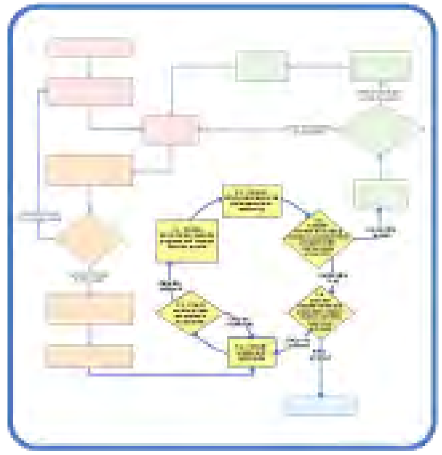
2.4 Transition to operations

"*The phase following construction of the remedy and before* [the] *Operational & Functional (O&F)* [determination] *is often referred to as the shakedown, where the constructor makes minor modifications as necessary to ensure the remedy is operating as designed*" (Ref. 22, p. 2-8).

O&F Determination: "*A remedy becomes O&F either one year after construction is complete, or when the remedy is determined concurrently by EPA and the State to be functioning properly and performing as designed, whichever is earlier. EPA may grant extensions to the one-year period in writing, as appropriate*" (Ref. 22, p. 2-8). Typically, the attainment of O&F is documented in a letter to the interested parties.

As discussed in the NCP section 300.435, for fund-lead groundwater restoration actions, once EPA and the State make the O&F determination, the remedy enters the **long-term response action** (LTRA) phase that involves operation, monitoring, optimization, and evaluation of the remedy. LTRA typically is conducted by EPA for up to 10 years with a 10% cost share by the State (Ref. 3). After 10 years, the remedy normally enters the O&M phase, which is conducted by the State. For groundwater remedies that do not include a restoration objective, once EPA and the State make the O&F determination the remedy generally should enter the operation and maintenance (O&M) phase. Consistent with CERCLA section 104(c), O&M is funded 100% by the State. For PRP-lead sites, the O&F determination normally triggers the **long-term response** (LR) phase. The PRPs generally conduct all activities during the LR and O&M phases. For federal facility-lead sites, groundwater restoration remedies normally enter the O&M phase when determined to be **operating properly and successfully** (OPS). Under Section 120(h) of CERCLA, the OPS determination is a required part of transfers of federal property (Ref. 22, p. 2-3). The federal facility conducts all O&M activities unless otherwise specified in facility transfer documentation.

3. Operate, Monitor and Evaluate Remedy



The operate, monitor and evaluate remedy stage typically involves six steps: (3.1) operate remedy and collect data, (3.2) ensure sufficient data are available for analysis, (3.3) monitor performance, evaluate progress, and conduct **five-year reviews**, (3.4) consider optimizing remedy (engineering) performance and monitoring, (3.5) evaluate whether the existing remedy can achieve RAOs and associated cleanup levels in the ROD, and (3.6) evaluate whether RAOs and associated cleanup levels established in the ROD are met. Once the groundwater restoration remedy is determined to be O&F, the remedy typically enters the operations stage.

> For purposes of this guidance, long-term monitoring is defined as monitoring conducted after some active, passive, or containment remedy has been selected and constructed, and is generally used to evaluate the degree to which the remedial action objectives and associated cleanup levels are being achieved (Ref. 25, p. 1).

During a long-term monitoring effort, groundwater sampling and monitoring data typically are collected to evaluate contaminant migration and changes in chemical suites and concentrations through time at appropriate locations. The site technical review team may use this information to verify that contaminants are not migrating to potential receptors, that remediation is occurring at a rate to achieve the RAOs and associated cleanup levels in a reasonable timeframe, and all sources have been identified (Ref. 23, p. 6). Data collected are also evaluated to determine if the remedy either has achieved the RAOs and associated cleanup levels or is likely to achieve these under current conditions. Data may also be used to determine if both the treatment system and monitoring network are operating efficiently. Not all steps discussed in this section need to be conducted in sequence; they can be conducted and considered at any point throughout the long-term operation of the remedy.

3.1 Operate remedy and collect data

Sampling and monitoring data are collected in accordance with the monitoring plan (see 2.3). Sampling and monitoring data are analyzed to fulfill several purposes: (1) to evaluate how the remedy is performing with regard to RAOs and conduct five-year reviews, (2) to optimize the long-term monitoring, and (3) to optimize engineering/remedial components of the remedy.

3.2 Ensure sufficient data are available for analysis

As data are obtained, data assessment occurs and results should be interpreted. Generally, the goal of data collection is to obtain enough data in a usable (typically electronic) format so that trends, if present, may be identified, and progress or lack of progress may be appropriately documented. Several years of data are generally appropriate to identify meaningful trends, patterns, or changes in contaminant reductions and/or to effectively evaluate plume capture. The following items should be considered when making this determination:

- Can an analysis for changes in the groundwater contaminants and extent of the plume be reliably conducted with the methods outlined in the monitoring plan?
- Can a capture zone analysis be conducted with the data that have been collected?
- Are monitoring parameters sufficient to evaluate site conditions illustrated in the CSM?
- Are operational data adequate to evaluate operational performance of engineered remedies?

Possible results include:

Data are insufficient: If data are insufficient to analyze trends or evaluate progress and effectiveness in achieving RAOs and associated cleanup levels, the remedy should continue to be operated and additional data should be collected as described in 3.1.

Data are sufficient: If enough data are available to analyze trends, changes, and patterns and evaluate progress and effectiveness in achieving RAOs and associated cleanup levels, the activities described in 3.3 and 3.4 are recommended.

3.3 Monitor performance, evaluate progress, and conduct five-year reviews

It is important to note that this section discusses discrete activities typically conducted during the long-term operation of the remedy. In addition to the highlighted activities, the RPM and project team should continue to collect and evaluate system performance and monitoring data and make appropriate changes.

Monitor performance and evaluate progress: The data should be used to monitor the effectiveness of the subsurface remedy and evaluate it in relation to the CSM and any site groundwater flow models. "*New data should be interpreted and compared to historical data on a regular basis*" (Ref. 16, p. 8). The progress of remedial systems in achieving RAOs and associated cleanup levels should also be evaluated to determine if actual progress is consistent with progress predicted at the time of remedy decision.

Five-year Reviews: "*The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is or will be protective of human health and the environment. Protectiveness is generally defined in the NCP by the risk range and the hazard index (HI). Evaluation of the remedy and the determination of protectiveness should be based on and sufficiently supported by data and observations*" (Ref. 24, p. 1-1).

In general, FYRs are required whenever a remedial action results in hazardous substances, pollutants, or contaminants remaining on site. "*Under the Agency's interpretation contained in the NCP* [40 CFR 300.430(f)(4)(ii)], *the requirement in CERCLA Section 121(c) is triggered when remaining on-site hazardous substances, pollutants, or contaminants are above levels that allow for 'unlimited use and unrestricted exposure*'" (Ref. 24, p. 1-1). "*'Unlimited use and unrestricted exposure' (UU/UE) means that the selected remedy* *will place no restrictions on the potential use of land or other natural resources*" (Ref. 24, p. 1-2). CERCLA requires FYRs if both the following conditions are true:

1. *"Upon completion of the remedial action, hazardous substances, pollutants, or contaminants will remain on site; and*
2. *The ROD of the site was signed on or after October 17, 1986 and the remedial action was selected under CERCLA §121"* (Ref. 24, p. 1-2).

The five-year review guidance addresses remedy assessment through site inspections, monitoring data review, and document review. Five-year reviews generally are conducted in conjunction with and supported by the continuous, effective monitoring of groundwater remedies. To evaluate remedy protectiveness, the guidance recommends three technical assessment questions.

Question A: Is the remedy functioning as intended by the decision documents? When answering this question, site inspection and O&M data are examined to assess if (1) the remedy continues to operate and function as designed, (2) if the remedy has attained, or is expected to attain, cleanup levels, (3) O&M is being implemented (e.g. monitoring activities designed to ensure the effectiveness of the remedy are being conducted and whether they are adequate), and (4) opportunities for optimization are identified.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid? In order to answer this question, Regions should evaluate a number of factors, including any changes to standards and assumptions made since the time of remedy selection. If ARARs have been modified or a new standard has been promulgated, Regions should determine if the cleanup level selected in the ROD remains protective. Review of risk parameters used to support the remedy selection, such as reference doses, cancer potency factors, and exposure pathways of concern should also be evaluated. Furthermore, evaluation of the assumptions regarding current and future groundwater uses and contaminants of concern should be reviewed to ensure that they are still valid. All these factors should be considered when updating the CSM and when evaluating exposure pathways and remedy implementation effectiveness to ensure that the remedial action objectives at the site are still valid and remain protective.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy? When answering this question, consider and evaluate any new information that may change the protectiveness of the operating remedy. (Ref. 24, p. 4-1 – 4-9)

The FYR process may identify issues and recommendations that generally address either 1) the performance of the remedy, 2) modifications to the monitoring well network, or 3) modifications to the monitoring plan. Typically, all changes or modifications to the remedy considered significant or fundamental should be appropriately documented in a decision document prior to implementation, as discussed in Step 1.3. However, minor changes to the remedy typically do not require modification of the decision document, which normally allows them to be implemented more quickly, as resources allow.

Recommendations from the five-year review may provide support for the decision made in Step 3.5 described below.

3.4 Consider optimizing engineering performance and monitoring

Optimize remedy (engineering) performance: As discussed in the 2000 Superfund Reform Strategy Implementation Manual, EPA's remedy optimization initiative is "*intended to encourage systematic review and modification to the existing P&T systems to enhance overall remedy effectiveness and cost effectiveness, without compromising protectiveness or other objectives of the Superfund program*" (Ref. 23, p. 1). "*Because site conditions change over time and these changes can have implications on the cost and effectiveness of a remedy, P&T managers should routinely compare design parameters versus actual parameters for treatment process parameters*" (Ref. 16, p. 7). Although this strategy focused on pump-and-treat systems, optimization generally may be applied to groundwater restoration remedial actions. This effort [optimization] "*recognizes that remedial approaches should not remain static, that site conditions change over time, and that better tools and strategies have evolved which allow continuous improvement of remedy performance*" (Ref. 23, p. 1). If the result of optimization is a recommendation for a change in technology or the RAOs, then the recommended procedures in Step 4 below should be considered. Optimization actions for the selected remedy may include the following scenarios:

- Altering remedial system parameters (e.g., flow rate, well locations, hydraulic capacity)
- Enhancing or simplifying existing treatment train components (e.g., removing a metals precipitation unit, modifying off-gas treatment)
- Addressing uncertainties in the CSM
- Ensuring that groundwater migration is under control
- Identifying and providing alternatives for addressing source area contamination
- Changing data evaluation and management practices
- Improving or streamlining project management or oversight
- Adjusting groundwater amendments, delivery mechanisms, and location/depths to enhance in situ treatment efficiency

Optimize monitoring: RPMs generally should consider and revisit the use of **long-term monitoring optimization** (LTMO) throughout the lifetime of the operating system to evaluate whether acquisition and assessment of appropriate remedy data are occurring. Moreover, "*LTMO offers an opportunity to improve cost-effectiveness of the long-term monitoring effort by assuring that monitoring achieves its objectives with an appropriate level of effort*" (Ref. 25, p. 1). LTMOs are routine evaluations of existing monitoring data, frequency and location of data acquisition, and objectives. LTMO recommendations may include the following activities:

- A reduction or increase in effort spatially (number of wells/locations)
- A reduction or increase in effort temporally (sampling frequency)
- Evaluation of areas where the plume is moving or changing
- Information related to remedy efficacy/performance (Ref. 25)

Care should be exercised to ensure that sufficient monitoring wells are in place to allow continued evaluation of the groundwater, even after RAOs and cleanup levels have been achieved. Information from these wells is needed to evaluate remedy performance and protectiveness.

Typically, all changes or modifications to the remedy considered significant or fundamental should be appropriately documented in a decision document prior to implementation, as discussed in Step 1.3. However, minor changes to the remedy typically do not require modification of the decision document, which normally allows them to be implemented more quickly, as resources allow. The results of the engineering and monitoring optimization activities may provide support for the decision made in the next step (3.5).

3.5 Evaluate whether the existing remedy can achieve RAOs and associated cleanup levels in the ROD

The remedy (with any necessary modifications resulting from steps 3.3 and step 3.4) and the data collected during operation are generally analyzed and compared to the CSM. The results from this analysis typically are used to evaluate whether data indicate that attainment of RAOs and associated cleanup levels is likely or attainment of RAOs and associated cleanup levels is unlikely under current conditions.

Possible results include:

Long-term restoration is likely and plume is contained in short-term: Typically, restoration is considered likely when the contaminant reductions and plume capture, as identified through monitoring data and analysis, indicate that RAOs and cleanup levels may be attained in the established timeframe. If concentrations are decreasing in a timely manner, it is likely that the current remedial approach is adequate and is functioning as intended by the decision documents and design documents. If the concentrations are decreasing in a less than timely manner, but restoration of the aquifer is still a feasible goal within a timeframe that supports future intended aquifer uses, review and optimization of the existing remedy may be appropriate (see step 3.3 and 3.4). If it is determined that the existing remedy is likely to achieve RAOs and associated cleanup levels, Regions should then begin to evaluate whether these have been achieved. (see 3.6).

Long-term restoration is not likely and/or plume is not contained: Generally, if monitoring data and analysis, five-year reviews, long term monitoring optimization, or remedy optimization results indicate that contaminant concentrations are not progressing towards success, it is likely that the plume is not contained, hydrogeologic conditions have changed, or a new site condition has emerged; in this situation, the remedy generally should be revisited and the technology or remedy may require modification (see section 4). The following are examples of remedy evaluation outcomes that may indicate that restoration is not likely under current site conditions:

- Data analysis indicates that concentration reductions are not occurring at the rate anticipated
- Data analysis shows that groundwater concentrations are increasing
- Data analysis shows that groundwater concentrations are asymptotic and not decreasing
- Contaminant properties and groundwater data analysis indicate that contaminant mass may be either sorbed (by adsorption or absorption) on or into the soil or rock matrix comprising the aquifer
- Technology selected in the ROD does not adequately address contaminants or hydrogeologic conditions
- Hydrogeologic conditions have changed or are found to be different than previously thought and remedy design is not effective
- A capture zone analysis and monitoring show that plume capture is not sufficient or is uncertain
- Aquifer behavior has changed due to external influences which may affect effectiveness
- New contaminants sources have been identified that may impact remedy effectiveness
- New groundwater pathways have been identified that may need to be addressed

3.6 Evaluate whether RAOs and associated cleanup levels in the ROD have been achieved

If data analysis and evaluation indicate that the remedy is likely to achieve the specified RAOs and associated cleanup levels in step 3.5, the RPM and project team should generally determine whether these levels actually have been attained. Possible results include:

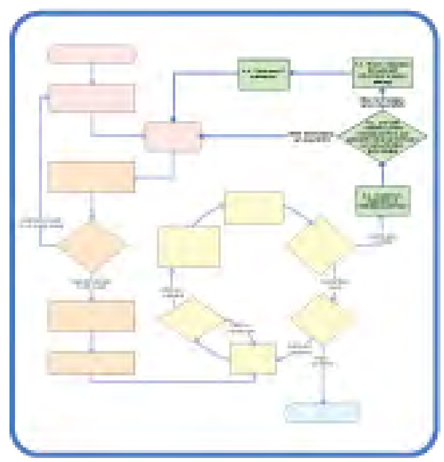
RAOs and associated cleanup levels are achieved: Cleanup levels are generally attained when monitoring throughout the area of attainment or at the point of compliance indicates that contaminant concentrations have met the groundwater cleanup levels established in the decision document (e.g., MCLs) and will not increase in the future. In general, "*the area of attainment/point of compliance for achieving groundwater cleanup levels is generally expected to be throughout the plume or, where there is a waste management area, at the edge of the waste management area*" (Ref. 2, p. 10).

When cleanup levels are attained through implementation of an active treatment system (for example, pump-and-treat and in situ treatment), it may be appropriate to shut down the system and proceed with site completion activities (see section 5), depending on the site-specific facts. Monitoring normally should continue after cleanup levels have been attained since contaminant levels in the aquifer may increase when pumping is terminated (e.g., because contaminants are allowed to re-equilibrate in the groundwater). "*Monitoring programs should therefore ensure that groundwater is sampled until any residual contaminants could have desorbed from the aquifer material*" (Ref. 26, p. 7-4).

If contaminant concentrations rebound and remain above cleanup levels, the recommendations in step 3.5 should be revisited.

RAOs and associated cleanup levels are not achieved: If cleanup levels have not yet been attained, the remedy generally continues to operate; and long-term monitoring data collection and analysis continue (see 3.1 through 3.2).

4. Technology or Remedy Modification



If the data analysis of long-term monitoring and the current CSM indicate that the existing remedy will not achieve the RAOs and associated cleanup levels, either the remedial technology or the comprehensive remedy generally should be modified. In situations where EPA determines it is impracticable to attain the groundwater cleanup levels in the ROD, but no contingency had been previously specified in the ROD, a ROD amendment typically is used to document fundamental changes that are made in the remedy based on the information gained during implementation of the cleanup (Ref. 27). "*It is also generally appropriate to prepare an ESD document when the lead agency decides to exercise a contingency remedy that was previously described in the ROD*" (Ref. 5, p. 7-2).

The recommended remedy modification step may involve the following activities: (4.1) conduct an evaluation of restoration potential, (4.2) evaluate whether current restoration RAOs and associated cleanup levels can be met with other technologies, (4.3) modify restoration RAOs and select an alternative remedial strategy, and (4.4) document **technical impracticability** (TI) evaluation. If restoration is still appropriate with a different technology or if RAOs and associated cleanup levels are modified, then Regions should proceed to select a modified remedy (see step 1.3).

4.1. Conduct an evaluation of restoration potential

Generally, the evaluation of restoration potential includes: evaluation of source control measures, remedial action performance analysis, restoration timeframe analysis, consideration of other applicable technologies, and additional considerations (Ref. 13, p. 13 – 19).

Source control measures are "*critical to the success of aquifer restoration efforts*" (Ref. 13, p. 13). When evaluating restoration potential, there should be a "*demonstration that contamination sources have been, or will be, identified and removed or treated to the extent practicable*" (Ref. 13, p. 13). If additional source material is identified or data indicate that source material is present during the long-term monitoring activities, additional site investigation is generally necessary to characterize the source, and evaluate source removal or source control activities (Ref. 13, p. 19 – 20) (see steps 1.1 and 1.2).

The remedial action performance analysis should:

- *"Demonstrate that the groundwater monitoring program within and outside of the aqueous contaminant plume is of sufficient quality and detail to fully evaluate remedial action performance (e.g., to analyze plume migration or containment and identify concentration trends within the remediation zone).*
- *Demonstrate that the existing remedy has been effectively operated and adequately maintained.*
- *Describe and evaluate the effectiveness of any remedy modifications (whether variations in operation, physical changes, or augmentations to the system) designed to enhance performance.*
- *Evaluate trends in subsurface contaminant concentrations. Consider such factors as whether the aqueous plume has been contained, whether the areal extent of the plume is being reduced, and the rates of contaminant concentration decline and contaminant mass removal" (*Ref. 13, p. 16).

Timeframes to achieve restoration may be considered in restoration potential evaluations. "*While restoration timeframes may be an important consideration in remedy selection, no single timeframe can be specified during which restoration must be achieved to be considered technically practicable*" (Ref. 13, p. 16). Lastly, when reviewing restoration potential, other technologies should be reviewed. This should consist of:

- *"A review of the technical literature to identify candidate technologies;*
- *A screening of the candidate technologies based on general site conditions to identify potential applicable technologies; and*
- *An analysis, using site hydrogeologic and chemical data, of the capability of any of the applicable technologies to achieve the required cleanup standards" (*Ref. 13, p. 18).

If source control measures are necessary, the restoration potential evaluation may analyze whether the current groundwater remedial approach being employed at the site is expected to remain effective in restoring all or part of the aquifer after these source controls are implemented.

If, after reviewing restoration potential, it is determined that the "*lack of progress in achieving the required cleanup levels has resulted from system design inadequacies, poor system operation, or unsuitability of the technology for site conditions, the EPA generally will require that the existing remedy be enhanced, augmented, or replaced by a different technology*" (Ref. 13, p. 16).

The data collected and analyzed and remedial options evaluated during the evaluation of restoration potential should support the decision made in the next step (4.2).

4.2 Evaluate whether current restoration RAOs and associated cleanup levels can be met with other technologies

Based on the results of the evaluation of restoration potential discussed in step 4.1, the RPM should determine if the current restoration RAOs and associated cleanup levels can be met with other actions.

Possible options include:

Other actions can achieve current restoration RAOs and associated cleanup levels: If the assessment indicates that other source control or groundwater actions can achieve current restoration RAOs and associated cleanup levels, it may be appropriate to modify an existing remedy or select a new remedy (see step 1.3) and implement these actions (see section 2).

Other actions cannot achieve current restoration RAOs and associated cleanup levels: If the assessment indicates that no actions can achieve current restoration RAOs and associated cleanup levels throughout the area of attainment where groundwater restoration is the goal, it may be appropriate to modify the restoration RAOs/select alternative remedial strategy (see step 4.3).

4.3 Modify restoration RAOs/Select alternative remedial strategy

If monitoring trends or the evaluation of restoration potential indicate that current RAOs and cleanup levels in the ROD will not likely be achieved, it may be appropriate to modify the restoration RAOs. "*EPA's goal of restoring contaminated groundwater within a reasonable timeframe at Superfund sites will be modified where complete restoration is found to be technically impracticable. In such cases, EPA will select an alternative remedial strategy that is technically practicable, protective of human health and the environment, and satisfies the statutory and regulatory requirements of Superfund*" (Ref. 13, p. 19).

"*ARARs may be waived by EPA for any of the six reasons specified by CERCLA and the NCP, including technical impracticability from an engineering perspective. TI waivers generally will be applicable only for ARARs that are used to establish cleanup performance standards or levels, such as chemical-specific MCLs or State groundwater quality criteria*" (Ref. 13, p. 9). If data indicate that restoration RAOs require modification (e.g., MCL cannot be met throughout the plume), it may be appropriate to consider a technical impracticability waiver for the specific ARAR that cannot be met.

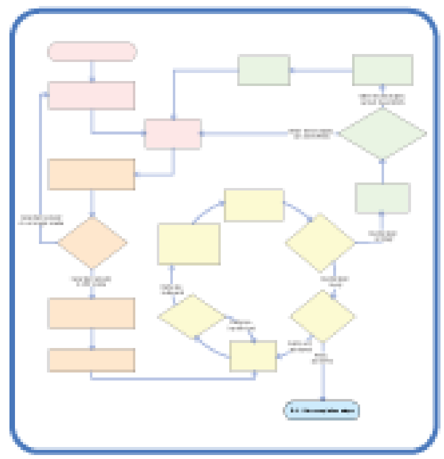
An alternative remedial strategy typically will address (1) the prevention of exposure to contaminated groundwater through institutional controls, (2) source remediation and controls through treatment and containment, and (3) aqueous plume remediation through treatment, containment, and natural attenuation. Alternative remedial strategies may include combinations of two or more options (Ref. 13, p. 19, 20, 21).

For those portions of the aquifer where restoration is technically practicable, a remedial technology considered in the evaluation of restoration potential should be selected or the current groundwater remedy should continue to be operated. For additional source materials that may have been identified, a source removal or source control measure should be evaluated and implemented. The basis for determining that restoration is technically impracticable should be documented in a TI evaluation discussed in step 4.4.

4.4 Document TI evaluation

Determinations of technical impracticability are made by EPA based on site-specific information evaluated when reviewing restoration potential (see step 4.1). The TI evaluation documents the results of this evaluation. The TI evaluation generally should include the following components: (1) specific ARARs (e.g., media cleanup levels) for which TI waiver determinations are sought, (2) spatial area over which the TI waiver decision will apply, (3) current CSM, (4) the results of the evaluation of restoration potential of the site, (5) estimates of the costs of the existing remedy and proposed alternative remedial strategy, and (6) any additional information EPA deems necessary. "*A TI decision* [including the alternative remedial strategy], *must be incorporated into a Superfund ROD or be incorporated into a modification or amendment to an original document*" (Ref. 13, p. 23). A modification to a signed ROD invoking a TI ARAR waiver generally is accomplished through a ROD amendment, since an ARAR waiver usually constitutes a fundamental change in the remedy. In addition to the TI waiver, the decision document should incorporate all components of the alternative remedial strategy (see step 1.3).

5. Site Completion



Site completion activities are typically initiated when RAOs (either the original restoration RAOs or modified RAOs) and associated cleanup levels have been attained. The site completion step typically involves: (5.1) site completion activities.

5.1 Site completion steps

The site typically is eligible for site completion when all remedial actions have been implemented and all site completion criteria are met. Generally, this means that "*all remedial decision documents have been completed and selected remedy is consistent with CERCLA, the NCP, and EPA policy and guidance; all response actions have been completed and appropriately documented in the site file; and all institutional controls are in place*" (Ref. 22, p. 4-1). Site completion typically is documented through a **final close out report** (FCOR) (Ref. 22, p. 4-5 – 4-6).

The site may also be deleted from the NPL either in whole or in part after site completion. Deletion from the NPL is accomplished through EPA notice and rule-making; the proposed deletion notice is published in the Federal Register for public comment, public comment is addressed, and if appropriate, a final notice of deletion is published in the Federal Register (Ref. 22, p. 5-1 – 5-7).

Conclusion

This groundwater road map fact sheet summarizes some of the key recommended steps and factors to consider when selecting a groundwater restoration remedy; designing, constructing, and initiating the remedy; operating, monitoring, evaluating, and optimizing the remedy; modifying the remedy, as appropriate; and documenting completion of the site response actions. The road map is intended to be a quick reference for RPMs and other site managers of groundwater restoration remedies, and provides a broad overview of the recommended Superfund cleanup process; it does not modify or supersede any existing

Agency guidance. The laws, regulations, policy documents, and technical guidance cited in the fact sheet and listed below should be consulted to obtain additional information and details about each step and factors to consider in the process.

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Reference 17: EPA. Cost-Effective Design of Pump and Treat Systems. April 2005. OSWER Directive No. 9283.1-20FS. www.epa.gov/superfund/cleanup/postconstruction/ptdesign.pdf.

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EPA. Five-Year Review Process in the Superfund Program. April 2003. OSWER Directive No. 9355.7-08FS. www.epa.gov/superfund/cleanup/postconstruction/5yr.htm.

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Helpful Web Sites

EPA TSP Issue Papers: www.epa.gov/tio/tsp/issue.htm

Cleanup Information: www.clu-in.org

EPA Ground Water and Ecosystems Restoration Research: www.epa.gov/ada

Triad: www.triadcentral.org

Green Remediation: www.clu-in.org/greenremediation

Glossary

The following definitions are used for purposes of this guidance:

Applicable or relevant and appropriate requirements (ARAR): An ARAR is a requirement under other environmental laws that is either applicable or relevant and appropriate to the remedial action under CERCLA. Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate. ARARs must be attained (or waived) for hazardous substances, pollutants, or contaminants remaining on-site at the completion of the remedial action [NCP, 40 CFR 300.5].

Area of attainment/point of compliance: The area of attainment/point of compliance for achieving groundwater cleanup levels is generally expected throughout the contaminated plume or, at and beyond the edge of the waste management area, when waste is left in place [55 FR 8753 (March 8, 1990)].

Beneficial future uses: Beneficial future uses of groundwater are determined based on EPA's groundwater classification system or on an EPA-approved Comprehensive State Groundwater Protection Program. Beneficial use is defined by the groundwater's actual use, potential use, vulnerability, ability to be replaced, ecological value, yield, and total dissolved solids levels [EPA, Guidelines for Ground-Water Classification, 1986 Draft Federal Guidelines]. In accordance with the NCP, EPA expects to return usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site [NCP, 40 CFR 300.430(a)(1)(iii)(F)].

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (several other times thereafter) that authorizes the assessment and cleanup of hazardous substances, pollutants, or contaminants that have been released into the environment.

Cleanup Levels: Final cleanup levels establish acceptable contaminant-specific exposure levels that are protective of human health and the environment. They are not formally determined until the site remedy is ready to be selected and are established in the ROD. In the ROD, it is preferable to use the term "remediation level" or "cleanup level" rather than "remediation goal" in order to make clear that the Selected Remedy establishes binding requirements [EPA, A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, July 1999].

Conceptual site model (CSM): a three-dimensional "picture" of site conditions that illustrates contaminant sources, release mechanisms, exposure pathways, migration routes, and potential human and ecological receptors. The CSM documents current and potential future site conditions and is supported by text, tables, maps, cross sections, 3D visualizations, and site diagrams that illustrate what is known about human and environmental exposure through contaminant release and migration to potential receptors. The CSM is initially developed during the scoping phase of the RI/FS and should be modified as additional information becomes available. A graphical depiction of the CSM may be appropriate to include in the ROD as it provides a good presentation of the overall site conditions and basis for taking an action, and can be referenced when discussing the overall site management strategy and the specific remedial action objectives addressed by the Selected Remedy. [EPA, A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, July 1999].

Construction completion: A Superfund program milestone that indicates that all physical construction of all cleanup actions for a site are complete, including actions to address all immediate threats and to bring all long-term threats under control [EPA, Closeout Procedures for National Priorities List Sites, May 2011].

Deletion from the NPL: The removal of a site from the NPL, in accordance with NCP Section 300.425(e), where it is determined that no response or no further response is appropriate [EPA, Closeout Procedures for National Priorities List Sites, May 2011].

Explanation of Significant Differences (ESD): The ESD documents significant changes to a component of a remedy. The ESD must comply with CERCLA Section 117(c) and NCP Sections 300.435(c)(2)(i) and 300.825(a)(2). An ESD must describe to the public the nature of the significant changes, summarize the information that led to making the changes, and affirm that the revised remedy complies with the NCP and the statutory requirements of CERCLA. It is recommended that the ESD provide a side-by-side comparison of the original and proposed remedy components to clearly display the significant differences [EPA, A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, July 1999].

Feasibility study (FS): FS means a study undertaken by the lead agency to develop and evaluate options for remedial action. The FS emphasizes data analysis and is generally performed concurrently and in an interactive fashion with the remedial investigation (RI), using data gathered during the RI. The RI data are used to define the objectives of the response action, to develop remedial action alternatives, and to undertake an initial screening and detailed analysis of the alternatives. The term also refers to a report that describes the results of the study [NCP, 40 CFR 300.5].

Final close out report (FCOR): The FCOR documents site completion. The FCOR documents compliance with statutory requirements and provides a consolidated record of all removal and remedial activities for the entire site. [EPA, Closeout Procedures for National Priorities List Sites, May 2011].

Five-year reviews: Five-year reviews generally are required by CERCLA or program policy when hazardous substances remain on site above levels which allow for unrestricted use and unlimited exposure. Five-year reviews provide an opportunity to evaluate the implementation and performance of a remedy to determine whether it remains protective of human health and the environment. Generally, reviews are performed five years following the initiation of a CERCLA response action, and are repeated every five years so long as future uses remain restricted. Five-year reviews can be performed by EPA or the lead agency for a site, but EPA retains responsibility for determining the protectiveness of the remedy [EPA, Superfund Post Construction Completion Activities, June 2001].

In situ treatment systems: In situ treatment remedies for groundwater restoration could include chemical oxidation, other types of chemical treatment, biological treatment, thermal treatment (using steam or other heating methods), air sparging, permeable reactive barriers and other similar technologies. In situ treatment remedies for groundwater typically involve adding treatment agents to the subsurface. Treatment agents could include chemical agents (e.g., oxidants or surfactants); agents to facilitate microbiological activity; heating agents (e.g., steam, or electric current); physical reactants (such as zero valent iron, oxygen or air); or other agents [EPA, Closeout Procedures for National Priorities List Sites, May 2011].

Long-term monitoring optimization (LTMO): LTMO refers to efforts to improve the cost-effectiveness of long-term monitoring by assuring that monitoring achieves its objectives with an appropriate level of effort [USACE, Roadmap to Long-Term Monitoring Optimization, May 2005].

Long-term response (LR): LR is the name for the specific type of O&M performed by PRPs for groundwater or surface water restoration remedies. EPA uses the term "PRP LR" for tracking and reporting purposes [EPA, Closeout Procedures for National Priorities List Sites, May 2011].

Long-term response action (LTRA): LTRA is the Fund-financed operation of groundwater and surface water restoration measures, including monitored natural attenuation, for first 10 years of operation following the O&F determination or until cleanup levels are achieved, whichever is earlier [EPA, Closeout Procedures for National Priorities List Sites, May 2011].

Maximum Contaminant Level: MCLs are enforceable standards established under the Safe Drinking Water Act which apply to specified contaminants which EPA has determined have an adverse effect on human health. MCLs are set at levels that are protective of human health, and are set as close to MCLGs as is feasible taking into account available treatment technologies and the costs to large public water systems. CERCLA and the NCP establish MCLs as relevant and appropriate to contaminated groundwater that is or may be used as drinking water [EPA, CERCLA Compliance with Other Laws Manual, August 1988].

Maximum Contaminant Level Goals: MCLGs are strictly health-based levels established under the Safe Drinking Water Act and do not take cost or feasibility into account. MCLGs for carcinogenic compounds are always established at zero, which is an unachievable cleanup level. Therefore, in accordance with

CERCLA and the NCP, only non-zero MCLGs are considered relevant and appropriate to contaminated groundwater that is or may be used as drinking water. When both an MCL and non-zero MCLG exist for a contaminant, generally the lower of the two levels is used as the groundwater ARAR [EPA, CERCLA Compliance with Other Laws Manual, August 1988].

Monitored natural attenuation (MNA): Physical or biological processes (unassisted by human intervention) that effectively reduce contaminant concentrations such that remedial objectives in the contaminant plume (or certain portions of the plume) may be achieved in a reasonable timeframe without active remediation [EPA, Guidance for Evaluating Technical Impracticability of Ground-Water Restoration, September 1993].

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): The NCP is applicable to response actions taken pursuant to the authorities under CERCLA and section 311 of the Clean Water Act. It provides the organization structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants [NCP, 40 CFR 300.1 and 300.2].

National Priorities List (NPL): The NPL means the list, compiled by EPA pursuant to CERCLA section 105, of uncontrolled hazardous substance releases in the United States that are priorities for long-term remedial evaluation and response [NCP, 40 CFR 300.5].

Operable unit (OU): Operable unit means a discrete action that comprises an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration, or eliminates or mitigates a release, threat of a release, or pathway of exposure. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site. Operable units may address geographical portions of a site, specific site problems, or initial phases of an action, or may consist of any set of actions performed over time or any actions that are concurrent but located in different parts of a site [NCP, 40 CFR 300.5] .

Operating properly and successfully (OPS): OPS is a determination, similar to O&F, that is sometimes made at federal facility projects for purposes of property transfer under CERCLA Section 120(h)3(B) [EPA, Closeout Procedures for National Priorities List Sites, May 2011].

Operation and functional (O&F): O&F activities are generally conducted after physical construction of the remedy is complete to ensure that it is functioning properly and operating as designed. O&F determinations are generally made for containment remedies (all media), as well as groundwater and surface water restoration remedies (including monitored natural attenuation). A remedy becomes O&F either one year after construction is complete, or when the remedy is determined to be functioning properly and is performing as designed, whichever is earlier. For groundwater P&T systems, the O&F determination marks the beginning of the LTRA period [EPA, Closeout Procedures for National Priorities List Sites, May 2011].

Operation and maintenance (O&M): O&M means measures required to maintain the effectiveness of response actions. O&M are the activities required to maintain the effectiveness and integrity of the remedy, and, in the case of Fund-financed measures to restore groundwater or surface water, continued operation of such measures beyond the LTRA period until cleanup levels are achieved [EPA, Closeout Procedures for National Priorities List Sites, May 2011].

Optimize: Efforts to improve the performance and/or reduce the annual operating cost of groundwater remediation systems [EPA, Superfund Post Construction Completion Activities, June 2001].

Preliminary Close Out Report (PCOR): The report that documents that construction completion has been achieved. It is prepared when the final operable unit for a site achieves construction completion but final cleanup goals have not yet been achieved [EPA, Closeout Procedures for National Priorities List Sites, May 2011].

Pump-and-treat systems (P&T systems): Groundwater remedies consisting of groundwater extraction, above ground treatment, disposal of treated water, groundwater monitoring in the subsurface to determine if cleanup levels are decreasing or have been achieved, and process monitoring of the treatment plant [EPA, Elements for Effective Management of Operating Pump and Treats Systems. December 2002].

Reasonable timeframe: A reasonable timeframe for restoring groundwater to beneficial use depends on the particular circumstances of the site and the restoration method employed. The most appropriate timeframe generally is determined through an analysis of alternatives. The NCP also specifies that: "For groundwater response actions, the lead agency shall develop a limited number of remedial alternatives that attain site-specific remediation levels within different restoration periods utilizing one or more different technologies." Thus, a comparison of restoration alternatives from most aggressive to passive (i.e., natural attenuation) will provide information concerning the approximate range of time periods needed to attain groundwater cleanup levels. Although restoration timeframe is an important consideration, no single time period can be specified which would be considered excessively long for all site conditions [EPA, Guidance for Evaluating Technical Impracticability of Ground-Water Restoration, September 1993].

Record of Decision (ROD): The ROD is the decision document issued by the lead agency that selects a remedial action and documents the basis for that selection. The ROD documents the remedial action plan for a site or operable unit and serves the following three basic functions: (1) it certifies that the remedy selection process was carried out in accordance with CERCLA and, to the extent practicable, with the NCP; (2) it describes the technical parameters of the remedy, specifying the methods selected to protect human health and the environment including treatment, engineering, and institutional controls components, as well as cleanup levels; and (3) it provides the public with a consolidated summary of information about the site and the chosen remedy, including the rationale behind the selection [EPA, A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, July 1999].

Remedial action (RA): RA means those actions consistent with permanent remedy taken instead of, or in addition to, removal action in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health and welfare, or the environment [NCP, 40 CFR 300.5].

Remedial action objectives (RAO): RAOs provide a general description of what the cleanup will accomplish (e.g., restoration of groundwater to drinking water levels). [EPA, A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, July 1999].

Remedial design (RD): RD means the technical analysis and procedures which follow the selection of remedy for a site and result in a detailed set of plans and specifications for implementation of the remedial action [NCP, 40 CFR 300.5].

Remedial investigation (RI): The RI is a process undertaken by the lead agency to determine the nature and extent of the problem presented by the release. The RI emphasizes data collection and site characterization, and is generally performed concurrently and in an interactive fashion with the feasibility study. The RI includes sampling and monitoring, as necessary, and includes the gathering of sufficient information to determine the necessity for remedial action and to support the evaluation of remedial alternatives [NCP, 40 CFR 300.5].

Restoration: Reduction of contaminant concentrations to levels required under Superfund or RCRA Corrective Action programs. For groundwater currently or potentially used for drinking water purposes, these levels may be MCLs or non-zero MCLGs established under the SDWA; State MCLs or other cleanup requirements; or risk-based levels for compounds not covered by specific State of Federal MCLs or MCLGs. Other cleanup levels may be appropriate for groundwaters used for non-drinking purposes [EPA, Guidance for Evaluating Technical Impracticability of Ground-Water Restoration, September 1993].

Risk assessment: The risk assessment is the evaluation of the human health and environmental risks presented by the release and potential release of hazardous substances from a site. The risk assessment (1) provides an analysis of baseline risks and helps determine the need for action; (2) provides a basis for determining levels of chemicals that can remain on site and still be adequately protective of public health and the environment; (3) provides a basis for comparing potential health and environmental impacts of various remedial alternatives; and (4) provides a consistent process for evaluating and documenting public health and environmental threats [EPA, Risk Assessment Guidance For Superfund, Volume I, Part A: Human Health Evaluation Manual, Interim Final, March 1989].

Technical impracticability (TI): TI refers to an ARAR waiver authorized under CERCLA. The TI waiver is used when an ARAR specified in a ROD cannot be met because achieving the ARAR is technically impracticable from an engineering perspective. The TI waiver can be used to waive meeting groundwater restoration ARARs such as MCLs and non-zero MCLGs. Use of the term "engineering perspective" implies that a TI determination should primarily focus on the technical capability of achieving the cleanup level, with cost playing a subordinate role. The preamble to the March 8, 1990 NCP states that TI determinations should be based on "…engineering feasibility and reliability, with cost generally not a major factor unless compliance would be inordinately costly." [EPA, Guidance for Evaluating Technical Impracticability of Ground-Water Restoration, September 1993].

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Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)

Background Information:

Section 335.558(d) of the existing Risk Reduction Rules indicates that the Commission will periodically revise the example unadjusted Standard No. 2 MSCs presented in the Appendix II table to reflect newly promulgated standards and to provide MSCs based on current toxicological data. Additionally, §335.556(b) requires consideration of other exposure pathways by which human populations are likely to be exposed (e.g., dermal absorption and vegetable uptake) when setting MSCs.

However, because no specific equations or parameters were provided in the rule, consideration of the dermal absorption pathway has not been addressed in a consistent manner. Therefore, in order to facilitate implementation of Standard No. 2, the MSC values have been updated to reflect current standards (e.g., MCLs), toxicological factors, the soil dermal absorption exposure pathway where appropriate (see Section VII of the memo entitled Implementation of the Existing Risk Reduction Rule for more detail), and to identify contaminants where exposure through vegetable consumption is of particular concern (i.e., cadmium). The updated Standard No. 2 MSCs are provided below for your convenience.

The updated Standard No. 2 Soil MSCs have been calculated using the Risk Reduction Standard No. 2 equations, with the addition of the dermal pathway, updated toxicity factors, and updated chemical/physical properties. In calculating the updated Standard No. 2 Soil MSCs, a risk level of 10-6 was used for Class A and B carcinogens and a risk level of 10-5 was used for Class C carcinogens, and a hazard quotient of 1 was used for all noncarcinogens. In cases where contaminants had both carcinogenic and noncarcinogenic toxicity factors, both types of MSCs (carcinogenic and noncarcinogenic) were calculated and the lowest value (i.e., most conservative) was selected as the updated Standard No. 2 Soil MSC.

The updated Standard No. 2 Groundwater MSCs have been calculated using the MCL (when available) or Risk Reduction Standard No. 2 equations with updated toxicity factors when MCLs were not available. In calculating the updated Standard No. 2 Groundwater MSCs, a risk level of 10-6 was used for Class A and B carcinogens and a risk level of 10-5 was used for Class C carcinogens, and a hazard quotient of 1 was used for all noncarcinogens. In cases where contaminants had both carcinogenic and noncarcinogenic toxicity factors, both types of MSCs (carcinogenic and noncarcinogenic) were calculated and the lowest value (i.e., most conservative) was selected as the updated Standard No. 2 Groundwater MSC.

Abbreviations:

CAS# - Chemical Abstracts Service number GW-Res - Groundwater MSC for Residential Use
GW-Ind - Groundwater MSC for Industrial Use GWP-Res - Soil MSC for Residential Use Based on Groundwater Protection
GWP-Ind - Soil MSC for Industrial Use Based on Groundwater Protection
SAI-Res - Soil MSC for Residential Use Based on Inhalation, Ingestion, and Dermal Contact
SAI-Ind - Soil MSC for Industrial Use Based on Inhalation, Ingestion, and Dermal Contact

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)

Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Acenaphthylene	208-96-8	2.2E+00	6.1E+00	2.2E+02	6.1E+02	8.2E+03	5.3E+04
Acetaldehyde	75-07-0	3.7E+00	1.0E+01	3.7E+02	1.0E+03	5.2E+00	8.8E+00
Acetate, 2-ethoxyethanol	111-15-9	6.2E-01	1.7E+00	6.2E+01	1.7E+02	4.7E+03	3.5E+04
Acetate, isoamyl	123-92-2	2.6E+00	7.4E+00	2.6E+02	7.4E+02	3.2E+03	5.1E+03
Acetate, isobutyl	110-19-0	1.8E+00	4.9E+00	1.8E+02	4.9E+02	3.1E+03	5.3E+03
Acetate, sec-butyl	105-46-4	1.8E+00	4.9E+00	1.8E+02	4.9E+02	1.3E+04	9.8E+04
Acetic acid*	64-19-7	---	---	---	---	---	---
Acetone (2-propanone)	67-64-1	3.3E+01	9.2E+01	3.3E+03	9.2E+03	1.7E+03	2.5E+03
Acetone cyanohydrin	75-86-5	2.9E-02	8.2E-02	2.9E+00	8.2E+00	1.2E+02	8.2E+02
Acetonitrile	75-05-8	1.2E+00	3.3E+00	1.2E+02	3.3E+02	1.8E+02	2.6E+02
Acetophenone	98-86-2	3.7E+00	1.0E+01	3.7E+02	1.0E+03	2.7E+03	4.3E+03
Acetylaminofluorene, 2-	53-96-3	2.2E-04	7.5E-04	2.2E-02	7.5E-02	1.3E+00	7.5E+00
Acifluorfen, sodium	62476-59-9	4.7E-01	1.3E+00	4.7E+01	1.3E+02	2.0E+03	1.3E+04
Acridine	260-94-6	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Acrolein	107-02-8	1.8E-02	5.1E-02	1.8E+00	5.1E+00	1.4E+02	1.0E+03

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)

Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Acrylamide	79-06-1	1.9E-05	6.4E-05	1.9E-03	6.4E-03	1.1E-01	6.4E-01
Acrylic acid (propenoic acid)	79-10-7	1.8E+01	5.1E+01	1.8E+03	5.1E+03	1.4E+05	1.0E+06
Acrylonitrile	107-13-1	1.6E-04	5.3E-04	1.6E-02	5.3E-02	7.9E-02	1.4E-01
Adipic acid (hexanedioic acid)	124-04-9	1.8E+02	5.1E+02	1.8E+04	5.1E+04	7.7E+05	5.1E+06
Alachlor	15972-60-8	2.0E-03	2.0E-03	2.0E-01	2.0E-01	6.1E+00	3.6E+01
Aldicarb	116-06-3	7.0E-03	7.0E-03	7.0E-01	7.0E-01	1.5E+02	1.0E+03
Aldicarb sulfone	1646-88-4	7.0E-03	7.0E-03	7.0E-01	7.0E-01	1.5E+02	1.0E+03
Aldrin	309-00-2	5.0E-06	1.7E-05	5.0E-04	1.7E-03	2.7E-02	1.4E-01
Allyl alcohol	107-18-6	1.8E-01	5.1E-01	1.8E+01	5.1E+01	1.4E+03	1.0E+04
Allyl chloride	107-05-1	3.7E-01	1.0E+00	3.7E+01	1.0E+02	1.3E+00	1.8E+00
Aluminum	7429-90-5	3.7E+01	1.0E+02	3.7E+03	1.0E+04	1.5E+05	1.0E+06
Ametryn	834-12-8	3.3E-01	9.2E-01	3.3E+01	9.2E+01	1.4E+03	9.2E+03
Aminobiphenyl, 4- (1,1-biphenyl-4-amine)	92-67-1	1.4E-05	4.7E-05	1.4E-03	4.7E-03	8.0E-02	4.7E-01
Amino-2,6-dinitrotoluene, 4-	19406-51-0	6.1E-03	1.7E-02	6.1E-01	1.7E+00	2.6E+01	1.7E+02
Amino-4,6-dinitrotoluene, 2-	35572-78-2	6.1E-03	1.7E-02	6.1E-01	1.7E+00	2.6E+01	1.7E+02
Aminopyridine, 4-	504-24-5	7.3E-04	2.0E-03	7.3E-02	2.0E-01	3.1E+00	2.0E+01
Ammonia	7664-41-7	---	---	---	---	1.6E+02	2.3E+02
Ammonium polyphosphate*	68333-79-9	---	---	---	---	---	---
Ammonium salts*	NA	---	---	---	---	---	---
Aniline	62-53-3	1.5E-02	5.0E-02	1.5E+00	5.0E+00	8.6E+01	5.0E+02
Anthracene	120-12-7	1.1E+01	3.1E+01	1.1E+03	3.1E+03	4.1E+04	2.7E+05
Anthraquinone, 9,10-	84-65-1	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.1E+03	2.0E+04
Antimony	7440-36-0	6.0E-03	6.0E-03	6.0E-01	6.0E-01	7.2E+01	4.9E+02
Aramite	140-57-8	3.4E-03	1.1E-02	3.4E-01	1.1E+00	2.0E+01	1.1E+02
Arsenic	7440-38-2	1.0E-02	1.0E-02	1.0E+00	1.0E+00	2.0E+01[b]	2.0E+02[b]
Arsine	7784-42-1	---	---	---	---	---	---
Asbestos	1332-21-4	---	---	---	---	---	---
Atrazine	1912-24-9	3.0E-03	3.0E-03	3.0E-01	3.0E-01	2.2E+01	1.3E+02
Azinphos-methyl (guthion)	86-50-0	5.5E-02	1.5E-01	5.5E+00	1.5E+01	2.3E+02	1.5E+03
Azobenzene	103-33-3	7.7E-04	2.6E-03	7.7E-02	2.6E-01	4.3E+00	2.3E+01
Barium	7440-39-3	2.0E+00	2.0E+00	2.0E+02	2.0E+02	2.6E+04	1.7E+05
Bayleton	43121-43-3	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.6E+03	3.1E+04
Benefin (benfluralin)	1861-40-1	1.1E+01	3.1E+01	1.1E+03	3.1E+03	4.6E+04	3.1E+05
Benomyl	17804-35-2	1.8E+00	5.1E+00	1.8E+02	5.1E+02	7.7E+03	5.1E+04
Benz-a-anthracene	56-55-3	2.0E-04	3.9E-04	2.0E-02	3.9E-02	6.3E-01	3.4E+00
Benzaldehyde	100-52-7	3.7E+00	1.0E+01	3.7E+02	1.0E+03	3.2E+02	4.5E+02
Benzene	71-43-2	5.0E-03	5.0E-03	5.0E-01	5.0E-01	8.8E-01	1.6E+00
Benzenedicarbonitrile, 1,3-	626-17-5	2.2E-01	6.1E-01	2.2E+01	6.1E+01	9.3E+02	6.1E+03
Benzenethiol	108-98-5	3.7E-04	1.0E-03	3.7E-02	1.0E-01	1.5E+00	3.9E+00
Benzidine	92-87-5	3.7E-07	1.2E-06	3.7E-05	1.2E-04	2.1E-03	1.2E-02
Benzo-a-pyrene	50-32-8	2.0E-04	2.0E-04	2.0E-02	2.0E-02	6.3E-02	3.4E-01
Benzo-b-fluoranthene	205-99-2	2.0E-04	3.9E-04	2.0E-02	3.9E-02	6.3E-01	3.4E+00
Benzo-j-fluoranthene	205-82-3	1.2E-03	3.9E-03	1.2E-01	3.9E-01	6.2E+00	3.4E+01
Benzo-e-pyrene	192-97-2	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.1E+03	2.7E+04
Benzo-g,h,i-perylene	191-24-2	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.1E+03	2.7E+04
Benzoic acid	65-85-0	1.5E+02	4.1E+02	1.5E+04	4.1E+04	6.2E+05	4.1E+06
Benzo-k-fluoranthene	207-08-9	1.2E-03	3.9E-03	1.2E-01	3.9E-01	6.3E+00	3.4E+01
Benzophenone	119-61-9	2.4E-01	6.8E-01	2.4E+01	6.8E+01	1.0E+03	6.8E+03
Benzotrichloride	98-07-7	6.6E-06	2.2E-05	6.6E-04	2.2E-03	3.8E-02	2.2E-01
Benzoyl peroxide	94-36-0	1.8E+00	5.1E+00	1.8E+02	5.1E+02	7.7E+03	5.1E+04
Benzyl alcohol	100-51-6	1.1E+01	3.1E+01	1.1E+03	3.1E+03	4.6E+04	3.1E+05

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)								
Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Benzyl chloride	100-44-7	5.0E-04	1.7E-03	5.0E-02	1.7E-01	3.8E+00	3.4E+01
Benzyl dichloride	98-87-3	5.0E-04	1.7E-03	5.0E-02	1.7E-01	2.9E+00	1.7E+01
Beryllium	7440-41-7	4.0E-03	4.0E-03	4.0E-01	4.0E-01	4.6E+01	2.7E+02
Biphenyl, 1,1-	92-52-4	1.8E+00	5.1E+00	1.8E+02	5.1E+02	1.9E+02	2.7E+02
Biquinoline, 2,2'-	119-91-5	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Bis (2-chloroethoxy) methane	111-91-1	7.7E-05	2.6E-04	7.7E-03	2.6E-02	2.9E-01	9.0E-01
Bis (2-chloroethyl) ether	111-44-4	7.7E-05	2.6E-04	7.7E-03	2.6E-02	1.5E-01	3.2E-01
Bis (2-chloroisopropyl) ether	108-60-1	1.2E-02	4.1E-02	1.2E+00	4.1E+00	4.8E+01	1.5E+02
Bis (2-chloromethyl) ether	542-88-1	3.9E-07	1.3E-06	3.9E-05	1.3E-04	1.1E-04	1.9E-04
Bis (2-ethyl-hexyl) phthalate	117-81-7	6.0E-03	6.0E-03	6.0E-01	6.0E-01	1.7E+01	6.5E+01
Bismuth	7440-69-9	1.8E+01	5.1E+01	1.8E+03	5.1E+03	9.9E+04	6.8E+05
Bisphenol A	80-05-7	1.8E+00	5.1E+00	1.8E+02	5.1E+02	7.7E+03	5.1E+04
Boron	7440-42-8	7.3E+00	2.0E+01	7.3E+02	2.0E+03	5.1E+04	3.7E+05
Bromacil	314-40-9	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Bromobenzene	108-86-1	7.3E-01	2.0E+00	7.3E+01	2.0E+02	1.1E+02	1.6E+02
Bromo-2-chloroethane, 1-	107-04-0	1.5E+00	4.1E+00	1.5E+02	4.1E+02	3.0E+02	4.3E+02
Bromodichloromethane[c]	75-27-4	1.4E-03	4.6E-03	1.4E-01	4.6E-01	1.0E+01	9.2E+01
Bromoform[c]	75-25-2	1.1E-02	3.6E-02	1.1E+00	3.6E+00	3.4E+01	8.5E+01
Bromomethane (methyl bromide)	74-83-9	5.1E-02	1.4E-01	5.1E+00	1.4E+01	3.5E+00	4.9E+00
Bromophenyl phenylether, 4-	101-55-3	5.7E-05	1.9E-04	5.7E-03	1.9E-02	3.1E-01	1.6E+00
Butadiene, 1,3-	106-99-0	---	---	---	---	6.6E-02	1.1E-01
Butadiene, 2-methyl-1,3- (isoprene)	78-79-5	2.2E+00	6.1E+00	2.2E+02	6.1E+02	9.7E+03	2.6E+04
Butanal (butyraldehyde)	123-72-8	2.2E+00	6.1E+00	2.2E+02	6.1E+02	3.7E+03	6.4E+03
Butane, 2,3-dimethyl-	79-29-8	2.2E+00	6.1E+00	2.2E+02	6.1E+02	8.1E+03	1.9E+04
Butanoic acid (butyric acid)	107-92-6	1.8E+01	5.1E+01	1.8E+03	5.1E+03	7.7E+04	5.1E+05
Butanol, 2-	78-92-2	3.7E+00	1.0E+01	3.7E+02	1.0E+03	4.9E+03	7.9E+03
Butanol, 2-methyl-2-	75-85-4	3.7E-01	1.0E+00	3.7E+01	1.0E+02	2.3E+03	1.1E+04
Butanol, n-	71-36-3	3.7E+00	1.0E+01	3.7E+02	1.0E+03	2.7E+04	2.0E+05
Butene, 1-	106-98-9	2.2E+00	6.1E+00	2.2E+02	6.1E+02	5.3E+03	1.0E+04
Butene, cis-2-	590-18-1	2.2E+00	6.1E+00	2.2E+02	6.1E+02	5.8E+03	1.1E+04
Butene, trans-2-	624-64-6	2.2E+00	6.1E+00	2.2E+02	6.1E+02	5.8E+03	1.1E+04
Butoxy ethanol, 2- (Ethylene glycol monobutyl ether; EGBE	111-76-2	1.8E+01	5.1E+01	1.8E+03	5.1E+03	7.7E+04	5.1E+05
Butyl acetate	123-86-4	5.1E+00	1.4E+01	5.1E+02	1.4E+03	7.4E+02	1.0E+03
Butyl acrylate	141-32-2	3.3E-01	9.2E-01	3.3E+01	9.2E+01	8.6E+01	1.2E+02
Butyl benzyl phthalate	85-68-7	7.3E+00	2.0E+01	7.3E+02	2.0E+03	3.1E+04	2.0E+05
Butylate	2008-41-5	1.8E+00	5.1E+00	1.8E+02	5.1E+02	7.7E+03	5.1E+04
Butylbenzene, n-	104-51-8	1.5E+00	4.1E+00	1.5E+02	4.1E+02	2.7E+03	5.7E+03
Butylbenzene, sec-	135-98-8	1.5E+00	4.1E+00	1.5E+02	4.1E+02	3.0E+03	5.4E+03
Butylbenzene, tert-	98-06-6	1.5E+00	4.1E+00	1.5E+02	4.1E+02	2.6E+03	4.5E+03
Butyl ether, n- (dibutyl ether)	142-96-1	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+03	2.3E+03
Cacodylic acid	75-60-5	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Cadmium	7440-43-9	5.0E-03	5.0E-03	5.0E-01	5.0E-01	2.4E+02[d]	1.5E+03
Calcium*	7440-70-2	---	---	---	---	---	---
Caprolactam	105-60-2	1.8E+01	5.1E+01	1.8E+03	5.1E+03	7.7E+04	5.1E+05
Captan	133-06-2	2.4E-02	8.2E-02	2.4E+00	8.2E+00	1.4E+02	8.2E+02
Carbaryl	63-25-2	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Carbazole	86-74-8	4.3E-03	1.4E-02	4.3E-01	1.4E+00	2.4E+01	1.4E+02
Carbofuran	1563-66-2	4.0E-02	4.0E-02	4.0E+00	4.0E+00	7.7E+02	5.1E+03
Carbon disulfide	75-15-0	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.0E+03	1.5E+03
Carbon tetrachloride	56-23-5	5.0E-03	5.0E-03	5.0E-01	5.0E-01	3.5E-01	6.3E-01
Carbophenothion	786-19-6	4.7E-01	1.3E+00	4.7E+01	1.3E+02	2.0E+03	1.3E+04

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)

Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Carbosulfan	55285-14-8	3.7E-01	1.0E+00	3.7E+01	1.0E+02	1.5E+03	1.0E+04
Carboxin	5234-68-4	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Chloral	75-87-6	3.7E+00	1.0E+01	3.7E+02	1.0E+03	2.7E+04	2.0E+05
Chloral hydrate (1,1-ethanediol, 2,2,2-trichloro-)	302-17-0	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Chloramben (amiben; 3-amino-2,5-dichlorobenzoic acid)	133-90-4	5.5E-01	1.5E+00	5.5E+01	1.5E+02	2.3E+03	1.5E+04
Chlordane (technical)	12789-03-6	2.0E-03	2.0E-03	2.0E-01	2.0E-01	1.6E+00	1.1E+01
Chlordane, cis- (alpha chlordane)	5103-71-9	2.4E-04	8.2E-04	2.4E-02	8.2E-02	1.4E+00	8.0E+00
Chlordane, gamma	57-74-9	2.4E-04	8.2E-04	2.4E-02	8.2E-02	1.4E+00	7.6E+00
Chlorfenvinphos	470-90-6	2.6E-02	7.2E-02	2.6E+00	7.2E+00	1.1E+02	7.2E+02
Chloride*	16887-00-6	---	---	---	---	---	---
Chlorine	7782-50-5	4.0E+00	4.0E+00	4.0E+02	4.0E+02	2.0E+04	1.4E+05
Chloroaniline, p-	106-47-8	1.5E-01	4.1E-01	1.5E+01	4.1E+01	6.2E+02	4.1E+03
Chlorobenzene	108-90-7	1.0E-01	1.0E-01	1.0E+01	1.0E+01	4.0E+02	5.9E+02
Chlorobenzilate	510-15-6	3.2E-04	1.1E-03	3.2E-02	1.1E-01	1.8E+00	1.1E+01
Chlorobromomethane (bromochloromethane)	74-97-5	1.5E+00	4.1E+00	1.5E+02	4.1E+02	2.4E+02	3.4E+02
Chloro-1,3-butadiene, 2-	126-99-8	---	---	---	---	1.0E+01	1.4E+01
Chlorodifluoromethane	75-45-6	---	---	---	---	1.1E+04	1.5E+04
Chloroethane (ethyl chloride)	75-00-3	1.5E+01	4.1E+01	1.5E+03	4.1E+03	1.1E+04	1.7E+04
Chloroethanol, 2-	107-07-3	1.5E+01	4.1E+01	1.5E+03	4.1E+03	1.1E+05	8.2E+05
Chloroethoxy ethene, 2- (2-chloroethylvinylether)	110-75-8	7.7E-04	2.6E-03	7.7E-02	2.6E-01	2.1E+00	3.0E+00
Chloroform[c]	67-66-3	3.7E-01	1.0E+00	3.7E+01	1.0E+02	3.1E-01	5.1E-01
Chlorohexane, 1-	544-10-5	1.5E+00	4.1E+00	1.5E+02	4.1E+02	4.1E+03	8.4E+03
Chloromethane (methyl chloride)	74-87-3	6.6E-02	2.2E-01	6.6E+00	2.2E+01	2.3E+00	3.8E+00
Chloro-3-methylphenol, 4-	59-50-7	1.8E-01	5.1E-01	1.8E+01	5.1E+01	7.7E+02	5.1E+03
Chloronaphthalene, 1- (Chloronaphthalene, alpha-)	90-13-1	2.9E+00	8.2E+00	2.9E+02	8.2E+02	1.1E+04	7.1E+04
Chloronaphthalene, 2- (chloronaphthalene, beta)	91-58-7	2.9E+00	8.2E+00	2.9E+02	8.2E+02	1.1E+04	7.1E+04
Chloronitrobenzene, p- (1-chloro-4-nitrobenzene)	100-00-5	4.7E-03	1.6E-02	4.7E-01	1.6E+00	2.7E+01	1.6E+02
Chlorophenol, 2-	95-57-8	1.8E-01	5.1E-01	1.8E+01	5.1E+01	1.1E+03	4.0E+03
Chlorophenol, 3-	108-43-0	1.8E-01	5.1E-01	1.8E+01	5.1E+01	7.7E+02	5.1E+03
Chlorophenol, 4-	106-48-9	1.8E-01	5.1E-01	1.8E+01	5.1E+01	7.7E+02	5.1E+03
Chlorophenyl phenylether, 4-	7005-72-3	5.7E-05	1.9E-04	5.7E-03	1.9E-02	2.8E-01	1.2E+00
Chloropropane, 2-	75-29-6	1.1E+00	3.1E+00	1.1E+02	3.1E+02	1.3E+02	1.9E+02
Chloro-2-propanol, 1-	127-00-4	7.3E-01	2.0E+00	7.3E+01	2.0E+02	5.5E+03	4.1E+04
Chlorothalonil	1897-45-6	7.7E-03	2.6E-02	7.7E-01	2.6E+00	4.4E+01	2.6E+02
Chlorotoluene, o- (2-chlorotoluene)	95-49-8	7.3E-01	2.0E+00	7.3E+01	2.0E+02	1.5E+03	3.5E+03
Chlorotoluene, p- (4-chlorotoluene)	106-43-4	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.4E+00	4.8E+00
Chlorpyrifos	2921-88-2	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Chromium (III) (total chromium)	16065-83-1/ 7440-47-3	1.0E-01	1.0E-01	1.0E+01	1.0E+01	5.9E+04	3.5E+05
Chromium (VI)	18540-29-9	1.0E-01	1.0E-01	1.0E+01	1.0E+01	2.0E+02	1.2E+03
Chrysene	218-01-9	1.2E-02	3.9E-02	1.2E+00	3.9E+00	6.3E+01	3.4E+02
Cobalt	7440-48-4	2.2E+00	6.1E+00	2.2E+02	6.1E+02	1.5E+04	1.1E+05
Copolymer acrylamide	69418-26-4	7.3E-03	2.0E-02	7.3E-01	2.0E+00	3.1E+01	2.0E+02
Copper	7440-50-8	1.3E+00	1.3E+00	1.3E+02	1.3E+02	1.0E+04	7.4E+04
Coronene	191-07-1	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Coumaphos	56-72-4	2.6E-01	7.2E-01	2.6E+01	7.2E+01	1.1E+03	7.2E+03
Cresol	1319-77-3	1.8E+00	5.1E+00	1.8E+02	5.1E+02	7.7E+03	5.1E+04
Cresol, m- (3-methylphenol)	108-39-4	1.8E+00	5.1E+00	1.8E+02	5.1E+02	7.7E+03	5.1E+04
Cresol, o- (2-methylphenol)	95-48-7	1.8E+00	5.1E+00	1.8E+02	5.1E+02	7.7E+03	5.1E+04
Cresol, p- (4-methylphenol)	106-44-5	1.8E-01	5.1E-01	1.8E+01	5.1E+01	7.7E+02	5.1E+03
Crotonaldehyde	123-73-9	4.5E-04	1.5E-03	4.5E-02	1.5E-01	3.4E+00	3.0E+01

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)							
Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Cumene (isopropylbenzene)	98-82-8	3.7E+00	1.0E+01	3.7E+02	1.0E+03	5.4E+03	9.0E+03
Cyanazine	21725-46-2	1.0E-03	3.4E-03	1.0E-01	3.4E-01	5.8E+00	3.4E+01
Cyanide	57-12-5	2.0E-01	2.0E-01	2.0E+01	2.0E+01	5.1E+03	3.7E+04
Cyanogen	460-19-5	1.5E+00	4.1E+00	1.5E+02	4.1E+02	4.3E+00	6.0E+00
Cycloate	1134-23-2	2.0E+00	5.6E+00	2.0E+02	5.6E+02	8.5E+03	5.6E+04
Cyclohexane	110-82-7	1.8E+02	5.1E+02	1.8E+04	5.1E+04	1.2E+04	1.7E+04
Cyclohexanol	108-93-0	1.8E+02	5.1E+02	1.8E+04	5.1E+04	7.7E+05	5.1E+06
Cyclohexanone	108-94-1	1.8E+02	5.1E+02	1.8E+04	5.1E+04	2.1E+03	3.0E+03
Cyclopentane, methyl-	96-37-7	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+03	2.3E+03
Cyclotetramethylenetetranitramine (HMX)	2691-41-0	1.8E+00	5.1E+00	1.8E+02	5.1E+02	2.2E+03	1.3E+04
Cyclotrimethylenetrinitramine (RDX)	121-82-4	7.7E-03	2.6E-02	7.7E-01	2.6E+00	3.6E+01	5.4E+01
Cymene (isopropyltoluene)	99-87-6	3.7E+00	1.0E+01	3.7E+02	1.0E+03	4.2E+03	6.7E+03
Cymoxanil	57966-95-7	4.7E-01	1.3E+00	4.7E+01	1.3E+02	2.0E+03	1.3E+04
Dacthal (DCPA)	1861-32-1	3.7E-01	1.0E+00	3.7E+01	1.0E+02	1.5E+03	1.0E+04
Dalapon, sodium salt (2,2-dichloropropanoic acid)	75-99-0	2.0E-01	2.0E-01	2.0E+01	2.0E+01	4.6E+03	3.1E+04
DDD	72-54-8	3.5E-04	1.2E-03	3.5E-02	1.2E-01	2.4E+00	1.8E+01
DDE	72-55-9	2.5E-04	8.4E-04	2.5E-02	8.4E-02	1.7E+00	1.3E+01
DDT	50-29-3	2.5E-04	8.4E-04	2.5E-02	8.4E-02	1.7E+00	1.2E+01
Demeton	8065-48-3	1.5E-03	4.1E-03	1.5E-01	4.1E-01	6.2E+00	4.1E+01
Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone)	123-42-2	1.5E+00	4.1E+00	1.5E+02	4.1E+02	6.2E+03	4.1E+04
Diallate	2303-16-4	1.4E-03	4.7E-03	1.4E-01	4.7E-01	8.0E+00	4.7E+01
Diazinon	333-41-5	3.3E-02	9.2E-02	3.3E+00	9.2E+00	1.4E+02	9.2E+02
Dibenz-a,h-acridine	226-36-8	7.1E-04	2.4E-03	7.1E-02	2.4E-01	4.1E+00	2.4E+01
Dibenz-a,h-anthracene	53-70-3	2.0E-04	2.0E-04	2.0E-02	2.0E-02	6.3E-02	3.4E-01
Dibenz-a,j-acridine	224-42-0	1.2E-03	3.9E-03	1.2E-01	3.9E-01	6.3E+00	3.4E+01
Dibenzo(a,e)pyrene	192-65-4	1.2E-04	3.9E-04	1.2E-02	3.9E-02	6.7E-01	3.9E+00
Dibenzo(a,h)pyrene	189-64-0	1.2E-05	3.9E-05	1.2E-03	3.9E-03	6.7E-02	3.9E-01
Dibenzo(a,i)pyrene	189-55-9	1.2E-05	3.9E-05	1.2E-03	3.9E-03	6.7E-02	3.9E-01
Dibenzofuran	132-64-9	1.5E-01	4.1E-01	1.5E+01	4.1E+01	6.2E+02	4.1E+03
Dibenzothiophene	132-65-0	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Dibromochloromethane (chlorodibromomethane)[c]	124-48-1	1.0E-02	3.4E-02	1.0E+00	3.4E+00	7.6E+01	6.8E+02
Dibromo-3-chloropropane, 1,2-	96-12-8	2.0E-04	2.0E-04	2.0E-02	2.0E-02	3.5E-01	2.0E+00
Dibromofluoromethane	1868-53-7	7.3E+00	2.0E+01	7.3E+02	2.0E+03	1.1E+04	1.9E+04
Dicamba	1918-00-9	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.6E+03	3.1E+04
Dichlormid	37764-25-3	9.1E-01	2.6E+00	9.1E+01	2.6E+02	3.9E+03	2.6E+04
Dichlorobenzene, 1,2-	95-50-1	6.0E-01	6.0E-01	6.0E+01	6.0E+01	5.6E+02	8.0E+02
Dichlorobenzene, 1,3-	541-73-1	1.1E+00	3.1E+00	1.1E+02	3.1E+02	5.1E+01	7.1E+01
Dichlorobenzene, 1,4-	106-46-7	7.5E-02	7.5E-02	7.5E+00	7.5E+00	2.7E+02	2.4E+03
Dichlorobenzidine, 3,3-	91-94-1	1.9E-04	6.4E-04	1.9E-02	6.4E-02	1.1E+00	6.4E+00
Dichlorobutane, 2,3-	7581-97-7	3.7E-01	1.0E+00	3.7E+01	1.0E+02	4.3E+01	6.1E+01
Dichloro-2-butene, 1,4-	764-41-0	---	---	---	---	2.3E-02	3.8E-02
Dichloro-2-butene, 1,4- trans	110-57-6	---	---	---	---	2.3E-02	3.9E-02
Dichlorodifluoromethane	75-71-8	7.3E+00	2.0E+01	7.3E+02	2.0E+03	2.2E+03	3.1E+03
Dichloroethane, 1,1-	75-34-3	3.7E+00	1.0E+01	3.7E+02	1.0E+03	8.9E+02	1.3E+03
Dichloroethane, 1,2-	107-06-2	5.0E-03	5.0E-03	5.0E-01	5.0E-01	2.7E-01	4.7E-01
Dichloroethylene, 1,1-	75-35-4	7.0E-03	7.0E-03	7.0E-01	7.0E-01	2.7E+02	3.8E+02
Dichloroethylene, cis-1,2-	156-59-2	7.0E-02	7.0E-02	7.0E+00	7.0E+00	1.2E+03	2.5E+03
Dichloroethylene, trans-1,2	156-60-5	1.0E-01	1.0E-01	1.0E+01	1.0E+01	1.4E+03	2.4E+03
Dichlorofluoromethane	75-43-4	7.3E+00	2.0E+01	7.3E+02	2.0E+03	5.4E+01	7.6E+01
Dichlorophenol, 2,3-	576-24-9	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Dichlorophenol, 2,4-	120-83-2	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)

Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Dichlorophenol, 2,5-	583-78-8	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Dichlorophenol, 2,6-	87-65-0	3.7E-02	1.0E-01	3.7E+00	1.0E+01	1.5E+02	1.0E+03
Dichlorophenol, 3,4-	95-77-2	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Dichlorophenol, 3,5-	591-35-5	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Dichlorophenoxyacetic acid, 2,4- (2,4-D)	94-75-7	7.0E-02	7.0E-02	7.0E+00	7.0E+00	2.0E+03	1.4E+04
Dichlorophenoxy, 2,4- butyric acid, 4- (2,4-DB)	94-82-6	2.9E-01	8.2E-01	2.9E+01	8.2E+01	1.2E+03	8.2E+03
Dichloroprop (2-(2,4-dichlorophenoxy) propanoic acid)	120-36-5	3.7E-01	1.0E+00	3.7E+01	1.0E+02	1.5E+03	1.0E+04
Dichloropropane, 1,2-	78-87-5	5.0E-03	5.0E-03	5.0E-01	5.0E-01	9.4E+00	2.5E+01
Dichloropropane, 1,3-	142-28-9	8.5E-03	2.9E-02	8.5E-01	2.9E+00	3.0E+01	8.0E+01
Dichloropropane, 2,2-	594-20-7	1.3E-02	4.2E-02	1.3E+00	4.2E+00	1.7E+01	2.4E+01
Dichloropropanol, 2,3-	616-23-9	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Dichloropropene, 1,1-	563-58-6	8.5E-04	2.9E-03	8.5E-02	2.9E-01	9.9E-01	1.9E+00
Dichloropropene, 1,3- (mixed isomers)	542-75-6	8.5E-04	2.9E-03	8.5E-02	2.9E-01	1.9E+00	4.2E+00
Dichloropropene, cis 1,3-	10061-01-5	1.6E-03	5.3E-03	1.6E-01	5.3E-01	1.2E+01	3.4E+01
Dichloropropene, trans 1,3-	10061-02-6	8.5E-03	2.9E-02	8.5E-01	2.9E+00	1.8E+01	4.0E+01
Dichlorvos	62-73-7	2.9E-04	9.9E-04	2.9E-02	9.9E-02	1.7E+00	9.9E+00
Dicrotophos (bidrin)	141-66-2	3.7E-03	1.0E-02	3.7E-01	1.0E+00	1.5E+01	1.0E+02
Dicyclopentadiene	77-73-6	1.1E+00	3.1E+00	1.1E+02	3.1E+02	8.2E+03	6.1E+04
Dieldrin	60-57-1	5.3E-06	1.8E-05	5.3E-04	1.8E-03	3.1E-02	1.8E-01
Diethanolamine	111-42-2	1.8E-02	5.1E-02	1.8E+00	5.1E+00	7.7E+01	5.1E+02
Diethyl phthalate	84-66-2	2.9E+01	8.2E+01	2.9E+03	8.2E+03	1.2E+05	8.2E+05
Diethylene glycol	111-46-6	7.3E+01	2.0E+02	7.3E+03	2.0E+04	3.1E+05	2.0E+06
Diethylene glycol monobutyl ether	112-34-5	3.3E+00	9.2E+00	3.3E+02	9.2E+02	1.4E+04	9.2E+04
Diethylhexyl adipate	103-23-1	4.0E-01	4.0E-01	4.0E+01	4.0E+01	4.1E+03	2.4E+04
Diethylstilbestrol	56-53-1	1.8E-08	6.1E-08	1.8E-06	6.1E-06	1.0E-04	6.1E-04
Diisobutylene (trimethyl-1-pentene, 2,4,4-)	107-39-1	2.2E+00	6.1E+00	2.2E+02	6.1E+02	3.7E+02	5.2E+02
Diisopropyl ether (2,2'-oxybis-propane)	108-20-3	3.7E+00	1.0E+01	3.7E+02	1.0E+03	3.7E+03	5.8E+03
Dimethenamid	87674-68-8	5.5E-01	1.5E+00	5.5E+01	1.5E+02	2.3E+03	1.5E+04
Dimethoate	60-51-5	7.3E-03	2.0E-02	7.3E-01	2.0E+00	3.1E+01	2.0E+02
Dimethoxybenzidine, 3,3'-	119-90-4	6.1E-03	2.0E-02	6.1E-01	2.0E+00	3.5E+01	2.0E+02
Dimethylaminoazobenzene, p-	60-11-7	3.7E-04	1.0E-03	3.7E-02	1.0E-01	1.5E+00	1.0E+01
Dimethylbenz-a-anthracene, 7,12-	57-97-6	3.4E-06	1.1E-05	3.4E-04	1.1E-03	1.8E-02	1.0E-01
Dimethylbenzidine, 3,3'-	119-93-7	9.3E-06	3.1E-05	9.3E-04	3.1E-03	5.3E-02	3.1E-01
Dimethylnaphthalene, 1,3-	575-41-7	1.5E+00	4.1E+00	1.5E+02	4.1E+02	5.5E+03	3.6E+04
Dimethyl phenol, 2,4-	105-67-9	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.1E+03	2.0E+04
Dimethylphenethylamine, alpha, alpha-	122-09-8	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Dimethylphthalate	131-11-3	2.9E+01	8.2E+01	2.9E+03	8.2E+03	1.2E+05	8.2E+05
Di-n-butyl phthalate	84-74-2	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Dinitrobenzene, 1,3- (dinitrobenzene, 2,4-)	99-65-0	3.7E-03	1.0E-02	3.7E-01	1.0E+00	1.5E+01	1.0E+02
Dinitrobenzene, 1,4-	100-25-4	1.5E-02	4.1E-02	1.5E+00	4.1E+00	6.2E+01	4.1E+02
Dinitro-2-methylphenol, 4,6- (dinitro-o-cresol, 4, 6-)	534-52-1	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Dinitrophenol, 2,4-	51-28-5	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Dinitrophenol, 2,5-	329-71-5	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Dinitrotoluene, 2,4-	121-14-2	1.3E-04	4.2E-04	1.3E-02	4.2E-02	7.2E-01	4.2E+00
Dinitrotoluene, 2,6-	606-20-2	1.3E-04	4.2E-04	1.3E-02	4.2E-02	7.2E-01	4.2E+00
Di-n-octyl phthalate	117-84-0	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.1E+03	2.0E+04
Dinoseb	88-85-7	7.0E-03	7.0E-03	7.0E-01	7.0E-01	1.5E+02	1.0E+03
Dioxane 1,4-	123-91-1	7.7E-03	2.6E-02	7.7E-01	2.6E+00	5.8E+01	5.2E+02
Diphenylamine	122-39-4	9.1E-01	2.6E+00	9.1E+01	2.6E+02	3.9E+03	2.6E+04
Diphenylhydrazine, 1,2-	122-66-7	1.1E-04	3.6E-04	1.1E-02	3.6E-02	6.1E-01	3.6E+00
Diphenyl ether	101-84-8	2.3E-01	6.3E-01	2.3E+01	6.3E+01	6.0E+02	1.6E+03

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)

Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Dipropylene glycol	110-98-5	4.2E+00	1.2E+01	4.2E+02	1.2E+03	1.8E+04	1.2E+05
Diquat	85-00-7	2.0E-02	2.0E-02	2.0E+00	2.0E+00	3.4E+02	2.2E+03
Disodium iminodiacetate (iminodiacetic acid, disodium salt)	928-72-3/ 142-73-4	3.7E-01	1.0E+00	3.7E+01	1.0E+02	1.5E+03	1.0E+04
Disulfoton	298-04-4	1.5E-03	4.1E-03	1.5E-01	4.1E-01	6.2E+00	4.1E+01
Diuron	330-54-1	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Dodecylphenol, 4-	27193-86-8/ 104-43-8	1.8E+00	5.1E+00	1.8E+02	5.1E+02	7.7E+03	5.1E+04
Endosulfan	115-29-7	2.2E-01	6.1E-01	2.2E+01	6.1E+01	6.2E+01	9.2E+01
Endosulfan I	959-98-8	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Endosulfan II	33213-65-9	2.2E-01	6.1E-01	2.2E+01	6.1E+01	9.3E+02	6.1E+03
Endosulfan sulfate	1031-07-8	2.2E-01	6.1E-01	2.2E+01	6.1E+01	9.3E+02	6.1E+03
Endothall	145-73-3	1.0E-01	1.0E-01	1.0E+01	1.0E+01	3.1E+03	2.0E+04
Endrin	72-20-8	2.0E-03	2.0E-03	2.0E-01	2.0E-01	4.6E+01	3.1E+02
Endrin aldehyde	7421-93-4	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.1E+02
Endrin ketone	53494-70-5	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.1E+02
Epichlorohydrin	106-89-8	8.6E-03	2.9E-02	8.6E-01	2.9E+00	7.2E+00	1.0E+01
EPN (o-ethyl o-(4-nitrophenyl)phenylphosphonothioate)	2104-64-5	3.7E-04	1.0E-03	3.7E-02	1.0E-01	1.5E+00	1.0E+01
Esfenvalerate	66230-04-4	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Ethalfluralin (sonolan)	55283-68-6	9.6E-03	3.2E-02	9.6E-01	3.2E+00	5.5E+01	3.2E+02
Ethanol	64-17-5	1.2E+03	3.4E+03	1.2E+05	3.4E+05	9.1E+06	6.7E+07
Ethion	563-12-2	1.8E-02	5.1E-02	1.8E+00	5.1E+00	7.7E+01	5.1E+02
Ethoprop	13194-48-4	3.0E-03	1.0E-02	3.0E-01	1.0E+00	1.5E+01	1.0E+02
Ethoxy ethanol, 2-	110-80-5	1.5E+01	4.1E+01	1.5E+03	4.1E+03	4.3E+00	6.0E+00
Ethyl acetate	141-78-6	3.3E+01	9.2E+01	3.3E+03	9.2E+03	8.9E+03	1.3E+04
Ethyl acrylate	140-88-5	1.8E-03	6.0E-03	1.8E-01	6.0E-01	1.3E+01	1.2E+02
Ethyl benzene	100-41-4	7.0E-01	7.0E-01	7.0E+01	7.0E+01	4.3E+03	6.9E+03
Ethyl dipropylthiocarbamate, S-	759-94-4	9.1E-01	2.6E+00	9.1E+01	2.6E+02	3.9E+03	2.6E+04
Ethylene*	74-85-1	---	---	---	---	---	---
Ethylenediamine	107-15-3	7.3E-01	2.0E+00	7.3E+01	2.0E+02	5.5E+03	4.1E+04
Ethylene dibromide (dibromoethane, 1,2-)	106-93-4	5.0E-05	5.0E-05	5.0E-03	5.0E-03	5.3E-02	1.0E-01
Ethylene glycol	107-21-1	7.3E+01	2.0E+02	7.3E+03	2.0E+04	3.1E+05	2.0E+06
Ethylenimine	151-56-4	1.3E-05	4.4E-05	1.3E-03	4.4E-03	9.9E-02	8.8E-01
Ethylene oxide	75-21-8	8.3E-05	2.8E-04	8.3E-03	2.8E-02	7.5E-02	1.4E-01
Ethylene thiourea	96-45-7	7.7E-04	2.6E-03	7.7E-02	2.6E-01	4.4E+00	2.6E+01
Ethyl ether	60-29-7	7.3E+00	2.0E+01	7.3E+02	2.0E+03	3.8E+03	5.7E+03
Ethyl-1-hexanol, 2-	104-76-7	5.5E+00	1.5E+01	5.5E+02	1.5E+03	1.3E+04	3.1E+04
Ethyl-2-hexenal, 2-	645-62-5	5.5E+00	1.5E+01	5.5E+02	1.5E+03	3.0E+03	4.5E+03
Ethylhexyl acrylate, 2-	103-11-7	1.8E-03	6.0E-03	1.8E-01	6.0E-01	1.0E+01	6.0E+01
Ethyl methacrylate	97-63-2	3.3E+00	9.2E+00	3.3E+02	9.2E+02	5.7E+03	9.9E+03
Ethyl methanesulfonate	62-50-0	8.6E-03	2.9E-02	8.6E-01	2.9E+00	4.9E+01	2.9E+02
Ethyl-2-methyl benzene, 1-	611-14-3	7.3E+00	2.0E+01	7.3E+02	2.0E+03	5.5E+03	8.4E+03
Ethyl-4-methyl benzene, 1-	622-96-8	7.3E+00	2.0E+01	7.3E+02	2.0E+03	4.8E+03	7.2E+03
Ethyl tert-butyl ether (2-ethyl-2-ethoxypropane)	637-92-3	3.7E-02	1.0E-01	3.7E+00	1.0E+01	2.2E+02	9.3E+02
Famphur	52-85-7	1.1E-03	3.1E-03	1.1E-01	3.1E-01	4.6E+00	3.1E+01
Fensulfothion	115-90-2	3.7E-02	1.0E-01	3.7E+00	1.0E+01	1.5E+02	1.0E+03
Fenthion	55-38-9	2.6E-03	7.2E-03	2.6E-01	7.2E-01	1.1E+01	7.2E+01
Fluoranthene	206-44-0	1.5E+00	4.1E+00	1.5E+02	4.1E+02	5.5E+03	3.6E+04
Fluorene	86-73-7	1.5E+00	4.1E+00	1.5E+02	4.1E+02	5.5E+03	3.6E+04
Fluorine (soluble fluoride)	7782-41-4	4.0E+00	4.0E+00	4.0E+02	4.0E+02	1.5E+04	1.1E+05
Fluorochloridone	61213-25-0	2.7E-01	7.7E-01	2.7E+01	7.7E+01	1.2E+03	7.7E+03

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)							
Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Fonofos	944-22-9	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Formaldehyde	50-00-0	7.3E+00	2.0E+01	7.3E+02	2.0E+03	5.5E+04	4.1E+05
Formic acid	64-18-6	7.3E+01	2.0E+02	7.3E+03	2.0E+04	5.5E+05	4.1E+06
Furan	110-00-9	3.7E-02	1.0E-01	3.7E+00	1.0E+01	3.9E+01	6.1E+01
Furfural	98-01-1	1.1E-01	3.1E-01	1.1E+01	3.1E+01	8.2E+02	6.1E+03
Glycidylaldehyde	765-34-4	1.5E-02	4.1E-02	1.5E+00	4.1E+00	1.1E+02	8.2E+02
Glyphosate	1071-83-6	7.0E-01	7.0E-01	7.0E+01	7.0E+01	1.5E+04	1.0E+05
Heptachlor	76-44-8	4.0E-04	4.0E-04	4.0E-02	4.0E-02	9.3E-02	4.1E-01
Heptachlor epoxide	1024-57-3	2.0E-04	2.0E-04	2.0E-02	2.0E-02	5.4E-02	3.1E-01
Heptane, n-	142-82-5	2.2E+00	6.1E+00	2.2E+02	6.1E+02	1.1E+04	3.4E+04
Heptanoic acid, n-	111-14-8	1.8E+01	5.1E+01	1.8E+03	5.1E+03	7.7E+04	5.1E+05
Hexachlorobenzene	118-74-1	1.0E-03	1.0E-03	1.0E-01	1.0E-01	2.5E-01	1.0E+00
Hexachlorobutadiene	87-68-3	7.3E-03	2.0E-02	7.3E-01	2.0E+00	1.6E+01	3.2E+01
Hexachlorocyclohexane, alpha (alpha-BHC)	319-84-6	1.4E-05	4.5E-05	1.4E-03	4.5E-03	9.0E-02	6.5E-01
Hexachlorocyclohexane, beta (beta-BHC)	319-85-7	4.7E-04	1.6E-03	4.7E-02	1.6E-01	3.2E+00	2.3E+01
Hexachlorocyclohexane, delta (delta-BHC)	319-86-8	4.7E-05	1.6E-04	4.7E-03	1.6E-02	3.2E-01	2.3E+00
Hexachlorocyclohexane, gamma (lindane; gamma-BHC)	58-89-9	2.0E-04	2.0E-04	2.0E-02	2.0E-02	4.4E-01	3.1E+00
Hexachlorocyclohexane, techn (technical-BHC)	608-73-1	4.7E-05	1.6E-04	4.7E-03	1.6E-02	3.2E-01	2.3E+00
Hexachlorocyclopentadiene (HCCPD)	77-47-4	5.0E-02	5.0E-02	5.0E+00	5.0E+00	1.0E+01	1.4E+01
Hexachloroethane	67-72-1	3.7E-02	1.0E-01	3.7E+00	1.0E+01	1.5E+02	7.5E+02
Hexachlorophene	70-30-4	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.1E+02
Hexachloropropylene	1888-71-7	3.7E-02	1.0E-01	3.7E+00	1.0E+01	1.5E+02	7.6E+02
Hexanal, 2-ethyl-	123-05-7	5.5E+00	1.5E+01	5.5E+02	1.5E+03	3.0E+03	4.6E+03
Hexane, n-	110-54-3	2.2E+00	6.1E+00	2.2E+02	6.1E+02	2.0E+02	2.8E+02
Hexanediol, 1,6-	629-11-8	1.8E+02	5.1E+02	1.8E+04	5.1E+04	7.7E+05	5.1E+06
Hexanoic acid	142-62-1	2.3E+00	6.5E+00	2.3E+02	6.5E+02	9.9E+03	6.5E+04
Hexanone, 2-	591-78-6	2.2E+00	6.1E+00	2.2E+02	6.1E+02	6.2E+01	8.7E+01
Hexazinone	51235-04-2	1.2E+00	3.4E+00	1.2E+02	3.4E+02	5.1E+03	3.4E+04
Hexylene glycol (2-methyl-2,4-pentanediol)	107-41-5	1.1E+01	3.1E+01	1.1E+03	3.1E+03	4.6E+04	3.1E+05
Hydrazine	302-01-2	2.8E-05	9.5E-05	2.8E-03	9.5E-03	2.1E-01	1.9E+00
Hydrogen chloride (hydrochloric acid)*	7647-01-0	---	---	---	---	---	---
Hydroquinone	123-31-9	1.5E+00	4.1E+00	1.5E+02	4.1E+02	6.2E+03	4.1E+04
Indene	95-13-6	7.3E-01	2.0E+00	7.3E+01	2.0E+02	7.9E+01	1.1E+02
Indeno-1,2,3-cd-pyrene	193-39-5	2.0E-04	3.9E-04	2.0E-02	3.9E-02	6.3E-01	3.4E+00
Iron*	7439-89-6	---	---	---	---	---	---
Isoamyl alcohol	123-51-3	1.8E-01	5.1E-01	1.8E+01	5.1E+01	1.2E+03	6.6E+03
Isobutyl alcohol	78-83-1	1.1E+01	3.1E+01	1.1E+03	3.1E+03	3.0E+03	4.3E+03
Isobutylene (2-methyl-1-propene)	115-11-7	---	---	---	---	1.8E+03	2.5E+03
Isobutyric acid (2-methylpropanoic acid)	79-31-2	1.8E+01	5.1E+01	1.8E+03	5.1E+03	7.7E+04	5.1E+05
Isodecanol	25339-17-7	5.8E-02	1.6E-01	5.8E+00	1.6E+01	2.5E+02	1.6E+03
Isodrin	465-73-6	5.0E-06	1.7E-05	5.0E-04	1.7E-03	2.8E-02	1.6E-01
Isophorone	78-59-1	9.0E-01	3.0E+00	9.0E+01	3.0E+02	5.2E+03	3.0E+04
Isopropyl acetate	108-21-4	2.6E+00	7.2E+00	2.6E+02	7.2E+02	1.9E+04	1.4E+05
Isopropyl alcohol	67-63-0	7.3E+00	2.0E+01	7.3E+02	2.0E+03	5.5E+04	4.1E+05
Isosafrole	120-58-1	3.9E-04	1.3E-03	3.9E-02	1.3E-01	1.7E+00	6.0E+00
Kelthane (dicofol)	115-32-2	2.2E-01	6.1E-01	2.2E+01	6.1E+01	9.3E+02	6.1E+03
Kepone (chlordecone)	143-50-0	5.3E-05	1.8E-04	5.3E-03	1.8E-02	3.1E-01	1.8E+00
Lead (inorganic)	7439-92-1	1.5E-02	1.5E-02	1.5E+00	1.5E+00	5.0E+02[e]	1.0E+03[e]
Limonene, d-*	5989-27-5	---	---	---	---	---	---
Lithium	7439-93-2	7.3E-01	2.0E+00	7.3E+01	2.0E+02	5.1E+03	3.7E+04
Magnesium*	7439-95-4	---	---	---	---	---	---

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)

Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Malathion	121-75-5	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.1E+03	2.0E+04
Maleic anhydride	108-31-6	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Maleic hydrazide	123-33-1	1.8E+01	5.1E+01	1.8E+03	5.1E+03	7.7E+04	5.1E+05
Malononitrile	109-77-3	7.3E-04	2.0E-03	7.3E-02	2.0E-01	3.1E+00	2.0E+01
Mancozeb	8018-01-7	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.6E+03	3.1E+04
Manganese	7439-96-5	1.7E+00	1.4E+01	1.7E+02	1.4E+03	1.7E+04	1.1E+05
MCPA (4-(chloro-2-methylphenoxy) acetic acid)	94-74-6	1.8E-02	5.1E-02	1.8E+00	5.1E+00	7.7E+01	5.1E+02
MCPP (2-(4-chloro-2-methylphenoxy) propanoic acid)	7085-19-0/ 93-65-2	3.7E-02	1.0E-01	3.7E+00	1.0E+01	1.5E+02	1.0E+03
Merphos	150-50-5	1.1E-03	3.1E-03	1.1E-01	3.1E-01	4.6E+00	3.1E+01
Mercury (pH = 4.9)[f]	7439-97-6/ 7487-94-7	2.0E-03	2.0E-03	2.0E-01	2.0E-01	1.1E-01	1.5E-01
Methacrylic acid (2-methyl-2-propenoic acid)	79-41-4	3.7E-01	1.0E+00	3.7E+01	1.0E+02	2.4E+01	3.4E+01
Methacrylonitrile	126-98-7	3.7E-03	1.0E-02	3.7E-01	1.0E+00	1.1E+01	2.2E+01
Methanol	67-56-1	1.8E+01	5.1E+01	1.8E+03	5.1E+03	1.4E+05	1.0E+06
Methapyrilene	91-80-5	1.8E-04	6.1E-04	1.8E-02	6.1E-02	1.0E+00	6.1E+00
Methomyl	16752-77-5	9.1E-01	2.6E+00	9.1E+01	2.6E+02	3.9E+03	2.6E+04
Methoxychlor	72-43-5	4.0E-02	4.0E-02	4.0E+00	4.0E+00	7.5E+02	4.4E+03
Methoxyethanol, 2-	109-86-4	---	---	---	---	6.1E+00	8.5E+00
Methyl acetate (acetic acid, methyl ester)	79-20-9	3.7E+01	1.0E+02	3.7E+03	1.0E+04	2.1E+03	3.0E+03
Methyl acrylate	96-33-3	7.3E-02	2.0E-01	7.3E+00	2.0E+01	2.8E+01	4.1E+01
Methyl amyl ketone (2-heptanone)	110-43-0	1.8E+00	5.1E+00	1.8E+02	5.1E+02	4.2E+03	7.7E+03
Methyl-1-butene, 2-	563-46-2	2.2E+00	6.1E+00	2.2E+02	6.1E+02	5.8E+03	1.1E+04
Methyl-2-butene, 2-	513-35-9	2.2E+00	6.1E+00	2.2E+02	6.1E+02	7.3E+03	1.6E+04
Methylcholanthrene, 3-	56-49-5	3.9E-05	1.3E-04	3.9E-03	1.3E-02	2.1E-01	1.1E+00
Methyl chrysene, 1-	3351-28-8	1.2E-01	3.9E-01	1.2E+01	3.9E+01	6.3E+02	3.4E+03
Methyl chrysene, 2-	3351-32-4	1.2E-01	3.9E-01	1.2E+01	3.9E+01	6.3E+02	3.4E+03
Methyl chrysene, 6-	1705-85-7	1.2E-02	3.9E-02	1.2E+00	3.9E+00	6.3E+01	3.4E+02
Methyl cyclohexane	108-87-2	1.8E+02	5.1E+02	1.8E+04	5.1E+04	7.1E+03	1.0E+04
Methylene-bis (2-chloroaniline) 4,4'-	101-14-4	6.6E-04	2.2E-03	6.6E-02	2.2E-01	3.8E+00	2.2E+01
Methylene bromide (dibromomethane)	74-95-3	1.1E-01	3.8E-01	1.1E+01	3.8E+01	1.9E+02	2.7E+02
Methylene chloride (dichloromethane)	75-09-2	5.0E-03	5.0E-03	5.0E-01	5.0E-01	8.7E+00	1.6E+01
Methyl ethyl ketone (2-butanone)	78-93-3	2.2E+01	6.1E+01	2.2E+03	6.1E+03	2.6E+04	4.2E+04
Methyl iodide (iodomethane)	74-88-4	5.1E-02	1.4E-01	5.1E+00	1.4E+01	1.8E+01	2.6E+01
Methyl isobutyl ketone (4-methyl-2-pentanone)	108-10-1	2.9E+00	8.2E+00	2.9E+02	8.2E+02	1.3E+04	3.5E+04
Methyl mercury	22967-92-6	3.7E-03	1.0E-02	3.7E-01	1.0E+00	2.5E+01	1.9E+02
Methylmecury hydroxide	1184-57-2	3.7E-03	1.0E-02	3.7E-01	1.0E+00	1.5E+01	1.0E+02
Methyl methacrylate	80-62-6	5.1E+01	1.4E+02	5.1E+03	1.4E+04	5.8E+03	8.2E+03
Methyl methanesulfonate	66-27-3	8.6E-03	2.9E-02	8.6E-01	2.9E+00	4.9E+01	2.9E+02
Methylnaphthalene, 1-	90-12-0	2.6E+00	7.2E+00	2.6E+02	7.2E+02	9.6E+03	6.2E+04
Methylnaphthalene, 2-	91-57-6	1.5E-01	4.1E-01	1.5E+01	4.1E+01	5.5E+02	3.6E+03
Methyl-5-nitroaniline, 2- (5-nitro-o-toluidine)	99-55-8	2.6E-02	8.7E-02	2.6E+00	8.7E+00	1.5E+02	8.7E+02
Methyl parathion	298-00-0	9.1E-03	2.6E-02	9.1E-01	2.6E+00	3.9E+01	2.6E+02
Methyl-2-pentenal, 2-	623-36-9	4.5E-04	1.5E-03	4.5E-02	1.5E-01	3.4E+00	3.0E+01
Methyl-1-propanal, 2- (isobutyraldehyde)	78-84-2	1.5E+00	4.1E+00	1.5E+02	4.1E+02	1.3E+03	1.9E+03
Methylpyrrolidone, N-	872-50-4	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.1E+03	2.0E+04
Methyltetrahydrofuran, 2-	96-47-9	1.1E-01	3.8E-01	1.1E+01	3.8E+01	7.0E+01	1.3E+02
Methyltetrahydropyran, 2-	10141-72-7	1.1E-01	3.8E-01	1.1E+01	3.8E+01	1.1E+02	2.0E+02
Metolachlor	51218-45-2	5.5E+00	1.5E+01	5.5E+02	1.5E+03	2.3E+04	1.5E+05
Metribuzin	21087-64-9	9.1E-01	2.6E+00	9.1E+01	2.6E+02	3.9E+03	2.6E+04
Mirex	2385-85-5	7.3E-03	2.0E-02	7.3E-01	2.0E+00	3.1E+01	2.0E+02

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)

Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Molinate	2212-67-1	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Molybdenum	7439-98-7	1.8E-01	5.1E-01	1.8E+01	5.1E+01	1.1E+03	8.1E+03
Monocrotophos	2157-98-4	2.2E-02	6.1E-02	2.2E+00	6.1E+00	9.3E+01	6.1E+02
Morpholine	110-91-8	1.8E+04	5.1E+04	1.8E+06	5.1E+06	1.4E+08	1.0E+09
MTBE (methyl tert-butyl ether)	1634-04-4	7E-01/1.5E-0	E+00/1.5E-	3.7E+01	1.0E+02	3.8E+02	7.1E+02
Naled	300-76-5	7.3E-02	2.0E-01	7.3E+00	2.0E+01	1.1E+02	2.2E+02
Naphthalene	91-20-3	7.3E-01	2.0E+00	7.3E+01	2.0E+02	1.8E+02	2.7E+02
Naphthoquinone, 1,4-	130-15-4	2.6E-01	7.2E-01	2.6E+01	7.2E+01	1.1E+03	7.2E+03
Naphthylamine, 1-	134-32-7	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.1E+03	2.0E+04
Naphthylamine, 2-	91-59-8	4.7E-04	1.6E-03	4.7E-02	1.6E-01	2.7E+00	1.6E+01
Napropamide	15299-99-7	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Neopentyl glycol	126-30-7	1.1E+01	3.1E+01	1.1E+03	3.1E+03	4.6E+04	3.1E+05
Nickel and compounds	7440-02-0	7.3E-01	2.0E+00	7.3E+01	2.0E+02	1.9E+03	1.2E+04
Nitrate	14797-55-8	1.0E+01	1.0E+01	1.0E+03	1.0E+03	4.1E+05	3.0E+06
Nitrite	14797-65-0	1.0E+00	1.0E+00	1.0E+02	1.0E+02	2.5E+04	1.9E+05
Nitroaniline, 2-	88-74-4	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.1E+02
Nitroaniline, 3-	99-09-2	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.1E+02
Nitroaniline, 4-	100-01-6	2.2E-02	7.5E-02	2.2E+00	7.5E+00	1.3E+02	7.5E+02
Nitrobenzene	98-95-3	1.8E-02	5.1E-02	1.8E+00	5.1E+00	6.5E+01	2.7E+02
Nitroglycerin	55-63-0	2.6E-03	7.2E-03	2.6E-01	7.2E-01	1.1E+01	7.2E+01
Nitrophenol, 2-	88-75-5	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Nitrophenol, 3-	554-84-7	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Nitrophenol, 4-	100-02-7	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Nitropropane, 2-	79-46-9	5.1E-03	1.4E-02	5.1E-01	1.4E+00	4.2E-02	7.0E-02
Nitroquinoline-N-oxide, 4-	56-57-5	9.1E-06	3.0E-05	9.1E-04	3.0E-03	5.2E-02	3.0E-01
Nitrosodiethanolamine, N-	1116-54-7	3.0E-05	1.0E-04	3.0E-03	1.0E-02	1.7E-01	1.0E+00
Nitrosodiethylamine, N-	55-18-5	5.7E-07	1.9E-06	5.7E-05	1.9E-04	4.3E-03	3.8E-02
Nitrosodimethylamine, N-	62-75-9	1.7E-06	5.6E-06	1.7E-04	5.6E-04	1.3E-02	1.1E-01
Nitrosodi-n-butylamine, N-	924-16-3	1.6E-05	5.3E-05	1.6E-03	5.3E-03	4.1E-02	1.0E-01
Nitrosodi-n-propylamine, N-	621-64-7	1.2E-05	4.1E-05	1.2E-03	4.1E-03	4.1E-02	1.6E-01
Nitrosodiphenylamine, N-	86-30-6	1.7E-02	5.8E-02	1.7E+00	5.8E+00	5.9E+01	2.3E+02
Nitroso-methyl-ethyl-amine, N-	10595-95-6	3.9E-06	1.3E-05	3.9E-04	1.3E-03	2.9E-02	2.6E-01
Nitrosomorpholine, N-	59-89-2	1.3E-04	4.3E-04	1.3E-02	4.3E-02	7.3E-01	4.3E+00
Nitroso-N-ethylurea, N-	759-73-9	6.1E-07	2.0E-06	6.1E-05	2.0E-04	3.5E-03	2.0E-02
Nitrosopiperidine, N-	100-75-4	9.1E-05	3.0E-04	9.1E-03	3.0E-02	5.2E-01	3.0E+00
Nitrosopyrrolidine, N-	930-55-2	4.1E-05	1.4E-04	4.1E-03	1.4E-02	2.3E-01	1.4E+00
Nitrotoluene, m-	99-08-1	3.7E-01	1.0E+00	3.7E+01	1.0E+02	4.4E+02	7.9E+02
Nitrotoluene, o-	88-72-2	3.7E-01	1.0E+00	3.7E+01	1.0E+02	4.7E+02	8.6E+02
Nitrotoluene, p-	99-99-0	3.7E-01	1.0E+00	3.7E+01	1.0E+02	4.4E+02	7.9E+02
Nonachlor, cis-	5103-73-1	2.4E-04	8.2E-04	2.4E-02	8.2E-02	1.4E+00	7.8E+00
Nonachlor, trans-	39765-80-5	2.4E-04	8.2E-04	2.4E-02	8.2E-02	1.4E+00	7.8E+00
Nonanal	124-19-6	7.3E+00	2.0E+01	7.3E+02	2.0E+03	3.1E+04	2.0E+05
Nonylphenol	25154-52-3/ 84852-15-3/ 104-40-5	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Nonylphenol ethoxylate	104-35-8	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	9.8E+04
Octamethylpyrophosphoramide	152-16-9	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Octanone	106-68-3	2.2E+00	6.1E+00	2.2E+02	6.1E+02	1.6E+04	1.1E+05
Oxamyl	23135-22-0	2.0E-01	2.0E-01	2.0E+01	2.0E+01	3.9E+03	2.6E+04
Oxychlordane	27304-13-8	2.4E-04	8.2E-04	2.4E-02	8.2E-02	1.4E+00	7.8E+00
Paraquat	1910-42-5	1.6E-01	4.6E-01	1.6E+01	4.6E+01	7.0E+02	4.6E+03

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Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)							
Contaminant	**CAS #**	**GW-Res (mg/l)**	**GW-Ind (mg/l)**	**GWP-Res (mg/kg)**	**GWP-Ind (mg/kg)**	**SAI-Res[a] (mg/kg)**	**SAI-Ind[a] (mg/kg)**
Parathion (ethyl parathion)	56-38-2	2.2E-01	6.1E-01	2.2E+01	6.1E+01	9.3E+02	6.1E+03
Pebulate	1114-71-2	1.8E+00	5.1E+00	1.8E+02	5.1E+02	7.7E+03	5.1E+04
Pendimethalin	40487-42-1	1.5E+00	4.1E+00	1.5E+02	4.1E+02	6.2E+03	4.1E+04
Pentachlorobenzene	608-93-5	2.9E-02	8.2E-02	2.9E+00	8.2E+00	1.2E+02	8.0E+02
Pentachloroethane	76-01-7	3.3E-02	1.1E-01	3.3E+00	1.1E+01	5.2E+01	1.1E+02
Pentachloronitrobenzene	82-68-8	3.3E-03	1.1E-02	3.3E-01	1.1E+00	1.9E+01	1.1E+02
Pentachlorophenol	87-86-5	1.0E-03	1.0E-03	1.0E-01	1.0E-01	3.0E+00	1.4E+01
Pentadiene, 1,3-trans-	2004-70-8	2.2E+00	6.1E+00	2.2E+02	6.1E+02	1.0E+04	2.9E+04
Pentaerythritol tetranitrate (PETN)	78-11-5	1.5E+01	4.1E+01	1.5E+03	4.1E+03	6.2E+04	4.1E+05
Pentane	109-66-0	2.6E+01	7.2E+01	2.6E+03	7.2E+03	1.7E+02	2.3E+02
Pentane, 2-methyl-	107-83-5	2.2E+00	6.1E+00	2.2E+02	6.1E+02	8.0E+03	1.9E+04
Pentane, 3-methyl-	96-14-0	2.2E+00	6.1E+00	2.2E+02	6.1E+02	8.4E+03	2.0E+04
Pentanediol, 1,5-	111-29-5	1.8E+02	5.1E+02	1.8E+04	5.1E+04	7.7E+05	5.1E+06
Pentanol, 1-	71-41-0	1.2E+00	3.4E+00	1.2E+02	3.4E+02	9.1E+03	6.7E+04
Pentanol, 4-methyl-2-	108-11-2	9.5E-01	2.7E+00	9.5E+01	2.7E+02	2.3E+03	4.2E+03
Pentanone, 2-	107-87-9	1.5E+00	4.1E+00	1.5E+02	4.1E+02	3.8E+03	7.5E+03
Pentyne, 1-	627-19-0	2.2E+00	6.1E+00	2.2E+02	6.1E+02	9.9E+03	2.7E+04
Perchlorate	14797-73-0	2.6E-02	7.2E-02	2.6E+00	7.2E+00	1.4E+02	9.5E+02
Perylene	198-55-0	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.1E+03	2.0E+04
Phenacetin	62-44-2	3.9E-02	1.3E-01	3.9E+00	1.3E+01	2.2E+02	1.3E+03
Phenanthrene	85-01-8	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.1E+03	2.7E+04
Phenanthridine	229-87-8	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Phenol	108-95-2	1.1E+01	3.1E+01	1.1E+03	3.1E+03	4.6E+04	3.1E+05
Phenol, 4-tert-butyl-	98-54-4	1.8E-01	5.1E-01	1.8E+01	5.1E+01	7.7E+02	5.1E+03
Phenothiazine	92-84-2	4.0E-02	1.1E-01	4.0E+00	1.1E+01	1.7E+02	1.1E+03
Phenylene diamine, m-	108-45-2	2.2E-01	6.1E-01	2.2E+01	6.1E+01	9.3E+02	6.1E+03
Phenylene diamine, p-	106-50-3	6.9E+00	1.9E+01	6.9E+02	1.9E+03	2.9E+04	1.9E+05
Phenyl mercuric acetate	62-38-4	2.9E-03	8.2E-03	2.9E-01	8.2E-01	1.2E+01	8.2E+01
Phorate	298-02-2	7.3E-03	2.0E-02	7.3E-01	2.0E+00	1.6E+01	3.8E+01
Phosalone	2310-17-0	7.3E-02	2.0E-01	7.3E+00	2.0E+01	3.1E+02	2.0E+03
Phosdrin (mevinphos)	7786-34-7	9.1E-04	2.6E-03	9.1E-02	2.6E-01	3.9E+00	2.6E+01
Phosmet	732-11-6	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.1E+03	2.0E+04
Phosphine	7803-51-2	1.1E-02	3.1E-02	1.1E+00	3.1E+00	5.9E+01	4.1E+02
Phosphorus, total*	7723-14-0	---	---	---	---	---	---
Phosphorus, white	7723-14-0	7.3E-04	2.0E-03	7.3E-02	2.0E-01	4.0E+00	2.7E+01
Phthalic anhydride	85-44-9	7.3E+01	2.0E+02	7.3E+03	2.0E+04	3.1E+05	2.0E+06
Picloram	1918-02-1	5.0E-01	5.0E-01	5.0E+01	5.0E+01	1.1E+04	7.2E+04
Picoline, 2- (2-methylpyridine)	109-06-8	3.3E-01	9.2E-01	3.3E+01	9.2E+01	9.7E+00	1.4E+01
Polybrominated biphenyls (PBBs)	67774-32-7	9.6E-06	3.2E-05	9.6E-04	3.2E-03	5.5E-02	3.2E-01
Polychlorinated biphenyls (PCBs)	1336-36-3	5.0E-04	5.0E-04	5.0E-02	5.0E-02	1.0E+01[h]	1.0E+01[h]
Potassium*	7440-09-7	---	---	---	---	---	---
Primene	68955-53-3	2.2E-01	6.1E-01	2.2E+01	6.1E+01	6.9E+02	2.3E+03
Prometon (pramitol)	1610-18-0	5.5E-01	1.5E+00	5.5E+01	1.5E+02	2.3E+03	1.5E+04
Pronamide	23950-58-5	2.7E+00	7.7E+00	2.7E+02	7.7E+02	1.2E+04	7.7E+04
Propanal (propionaldehyde)	123-38-6	2.9E-01	8.2E-01	2.9E+01	8.2E+01	5.3E+02	9.2E+02
Propanil	709-98-8	1.8E-01	5.1E-01	1.8E+01	5.1E+01	7.7E+02	5.1E+03
Propanoic acid (propionic acid)	79-09-4	1.8E+01	5.1E+01	1.8E+03	5.1E+03	1.4E+05	1.0E+06
Propanol, 1-	71-23-8	7.3E+00	2.0E+01	7.3E+02	2.0E+03	5.5E+04	4.1E+05
Propargite	2312-35-8	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.1E+03	2.0E+04
Propargyl alcohol	107-19-7	7.3E-02	2.0E-01	7.3E+00	2.0E+01	5.5E+02	4.1E+03
Propazine	139-40-2	1.9E-02	6.4E-02	1.9E+00	6.4E+00	1.1E+02	6.4E+02

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)

Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Propham	122-42-9	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.1E+03	2.0E+04
Propionitrile (propane nitrile)	107-12-0	1.5E-02	4.1E-02	1.5E+00	4.1E+00	4.3E+01	8.9E+01
Propyl acetate, n-	109-60-4	3.3E+00	9.2E+00	3.3E+02	9.2E+02	2.5E+04	1.8E+05
Propylbenzene, n-	103-65-1	1.5E+00	4.1E+00	1.5E+02	4.1E+02	3.2E+03	5.9E+03
Propylene glycol	57-55-6	7.3E+02	2.0E+03	7.3E+04	2.0E+05	3.1E+06	2.0E+07
Propylene glycol monomethyl ether	107-98-2	2.6E+01	7.2E+01	2.6E+03	7.2E+03	1.9E+05	1.4E+06
Propylene oxide	75-56-9	3.5E-04	1.2E-03	3.5E-02	1.2E-01	1.2E+00	3.1E+00
Propylene tetramer	6842-15-5	3.7E+00	1.0E+01	3.7E+02	1.0E+03	5.3E+03	1.0E+04
Prothiofos (Tokuthion)	34643-46-4	3.7E-03	1.0E-02	3.7E-01	1.0E+00	1.5E+01	1.0E+02
Pyrene	129-00-0	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.1E+03	2.7E+04
Pyridine	110-86-1	3.7E-02	1.0E-01	3.7E+00	1.0E+01	8.2E+00	1.2E+01
Quinoline	91-22-5	2.8E-05	9.5E-05	2.8E-03	9.5E-03	1.6E-01	9.5E-01
Ronnel	299-84-3	1.8E+00	5.1E+00	1.8E+02	5.1E+02	7.7E+03	5.1E+04
Safrole	94-59-7	3.9E-03	1.3E-02	3.9E-01	1.3E+00	1.5E+01	5.0E+01
Selenium	7782-49-2	5.0E-02	5.0E-02	5.0E+00	5.0E+00	1.3E+03	9.3E+03
Selenourea	630-10-4	1.8E-01	5.1E-01	1.8E+01	5.1E+01	1.4E+03	1.0E+04
Silver	7440-22-4	1.8E-01	5.1E-01	1.8E+01	5.1E+01	4.7E+02	2.9E+03
Simazine	122-34-9	4.0E-03	4.0E-03	4.0E-01	4.0E-01	4.1E+01	2.4E+02
Sodium*	7440-23-5	---	---	---	---	---	---
Sodium diethyldithiocarbamate	148-18-5	3.2E-03	1.1E-02	3.2E-01	1.1E+00	2.4E+01	2.1E+02
Sodium hypochlorite	7681-52-9	7.7E+00	2.1E+01	7.7E+02	2.1E+03	4.2E+04	2.9E+05
Sodium polyacrylate	9003-04-7	1.8E+01	5.1E+01	1.8E+03	5.1E+03	1.4E+05	1.0E+06
Strontium	7440-24-6	2.2E+01	6.1E+01	2.2E+03	6.1E+03	1.2E+05	8.2E+05
Strychnine	57-24-9	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.1E+02
Styrene	100-42-5	1.0E-01	1.0E-01	1.0E+01	1.0E+01	1.3E+04	2.3E+04
Sulfate*	14808-79-8	---	---	---	---	---	---
Sulfide*	18496-25-8	---	---	---	---	---	---
Sulfolane	126-33-0	7.3E-04	2.0E-03	7.3E-02	2.0E-01	3.1E+00	2.0E+01
Sulfur*	7704-34-9	---	---	---	---	---	---
Tebuconazole	107534-96-3	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.6E+03	3.1E+04
Tebuthiuron	34014-18-1	2.6E+00	7.2E+00	2.6E+02	7.2E+02	1.1E+04	7.2E+04
Terbufos	13071-79-9	9.1E-04	2.6E-03	9.1E-02	2.6E-01	3.9E+00	2.6E+01
Tert-amyl-methyl ether (TAME)	994-05-8	1.5E+00	4.1E+00	1.5E+02	4.1E+02	2.9E+02	4.2E+02
Tert-butyl alcohol (2-methyl-2-propanol)	75-65-0	3.3E+00	9.2E+00	3.3E+02	9.2E+02	4.2E+03	6.9E+03
Tetrachlorobenzene, 1,2,3,4-	634-66-2	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.1E+02
Tetrachlorobenzene, 1,2,3,5-	634-90-2	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.1E+02
Tetrachlorobenzene, 1,2,4,5-	95-94-3	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.0E+02
Tetrachloroethane, 1,1,1,2-	630-20-6	3.3E-02	1.1E-01	3.3E+00	1.1E+01	5.2E+01	1.0E+02
Tetrachloroethane, 1,1,2,2-	79-34-5	4.3E-03	1.4E-02	4.3E-01	1.4E+00	5.1E+00	9.8E+00
Tetrachloroethylene (perchlorethylene)	127-18-4	5.0E-03	5.0E-03	5.0E-01	5.0E-01	6.0E+00	1.7E+01
Tetrachlorophenol, 2,3,4,5-	4901-51-3	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.6E+03	3.1E+04
Tetrachlorophenol, 2,3,4,6-	58-90-2	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.6E+03	3.1E+04
Tetrachlorophenol, 2,3,5,6-	935-95-5	1.1E+00	3.1E+00	1.1E+02	3.1E+02	1.1E+02	1.5E+02
Tetrachlorvinphos (Stirophos)	22248-79-9	1.5E+00	4.3E+00	1.5E+02	4.3E+02	6.5E+03	4.3E+04
Tetradifon	116-29-0	7.3E-01	2.0E+00	7.3E+01	2.0E+02	3.1E+03	2.0E+04
Tetraethyl dithiopyrophosphate (sulfotep)	3689-24-5	1.8E-02	5.1E-02	1.8E+00	5.1E+00	7.7E+01	5.1E+02
Tetraethylene glycol	112-60-7	1.2E+01	3.4E+01	1.2E+03	3.4E+03	5.1E+04	3.4E+05
Tetraethyl lead	78-00-2	3.7E-06	1.0E-05	3.7E-04	1.0E-03	1.5E-02	9.7E-02
Tetrahydrofuran	109-99-9	1.1E-01	3.8E-01	1.1E+01	3.8E+01	5.4E+01	9.5E+01
Tetrahydropyran	142-68-7	1.1E-01	3.8E-01	1.1E+01	3.8E+01	8.5E+01	1.5E+02
Thallium and compounds (as thallium chloride)	7791-12-0	2.0E-03	2.0E-03	2.0E-01	2.0E-01	2.0E+01	1.5E+02

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)

Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Thiofanox	39196-18-4	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.1E+02
Thionazin	297-97-2	2.6E-03	7.2E-03	2.6E-01	7.2E-01	1.1E+01	7.2E+01
Thiophanate-methyl	23564-05-8	2.9E+00	8.2E+00	2.9E+02	8.2E+02	1.2E+04	8.2E+04
Thiram	137-26-8	1.8E-01	5.1E-01	1.8E+01	5.1E+01	7.7E+02	5.1E+03
Tin	7440-31-5	2.2E+01	6.1E+01	2.2E+03	6.1E+03	9.3E+04	6.1E+05
Titanium	7440-32-6	1.8E+04	5.1E+04	1.8E+06	5.1E+06	3.8E+07	2.4E+08
Toluene	108-88-3	1.0E+00	1.0E+00	1.0E+02	1.0E+02	1.1E+04	2.5E+04
Toluenediamine, 2,4-	95-80-7	2.7E-05	8.9E-05	2.7E-03	8.9E-03	1.5E-01	8.9E-01
Toluenediamine, 2,6-	823-40-5	7.3E+00	2.0E+01	7.3E+02	2.0E+03	3.1E+04	2.0E+05
Toluene diisocyanate, 2,4/2,6-	26471-62-5	---	---	---	---	2.9E+02	4.1E+02
Toluidine, o-	95-53-4	3.5E-04	1.2E-03	3.5E-02	1.2E-01	2.0E+00	1.2E+01
Toluidine, p-	106-49-0	4.5E-03	1.5E-02	4.5E-01	1.5E+00	2.6E+01	1.5E+02
Toxaphene	8001-35-2	3.0E-03	3.0E-03	3.0E-01	3.0E-01	4.4E-01	2.6E+00
TP Silvex, 2,4,5-	93-72-1	5.0E-02	5.0E-02	5.0E+00	5.0E+00	1.2E+03	8.2E+03
Triademenol	55219-65-3	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.6E+03	3.1E+04
Triallate	2303-17-5	4.7E-01	1.3E+00	4.7E+01	1.3E+02	2.0E+03	1.3E+04
Triaminotrinitrobenzene (TATB)	3058-38-6	2.8E-02	9.5E-02	2.8E+00	9.5E+00	1.6E+02	9.5E+02
Tributyltin oxide	56-35-9	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.1E+02
Trichlorobenzene, 1,2,3-	87-61-6	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.2E+02	2.0E+03
Trichlorobenzene, 1,2,4-	120-82-1	7.0E-02	7.0E-02	7.0E+00	7.0E+00	1.4E+03	6.1E+03
Trichlorobenzene, 1,3,5-	108-70-3	1.1E-01	3.1E-01	1.1E+01	3.1E+01	3.7E+02	1.4E+03
Trichloroethane, 1,1,1-	71-55-6	2.0E-01	2.0E-01	2.0E+01	2.0E+01	2.3E+03	3.4E+03
Trichloroethane, 1,1,2-	79-00-5	5.0E-03	5.0E-03	5.0E-01	5.0E-01	9.7E+00	1.7E+01
Trichloroethylene	79-01-6	5.0E-03	5.0E-03	5.0E-01	5.0E-01	3.7E+00	6.6E+00
Trichlorofluoromethane	75-69-4	1.1E+01	3.1E+01	1.1E+03	3.1E+03	2.6E+03	3.8E+03
Trichloronate	327-98-0	1.1E-01	3.1E-01	1.1E+01	3.1E+01	4.6E+02	3.1E+03
Trichlorophenol, 2,3,4-	15950-66-0	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Trichlorophenol, 2,3,5-	933-78-8	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Trichlorophenol, 2,3,6-	933-75-5	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+03	2.3E+03
Trichlorophenol, 2,4,5-	95-95-4	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Trichlorophenol, 2,4,6-	88-06-2	7.7E-03	2.6E-02	7.7E-01	2.6E+00	4.4E+01	2.6E+02
Trichlorophenol, 3,4,5-	609-19-8	3.7E+00	1.0E+01	3.7E+02	1.0E+03	1.5E+04	1.0E+05
Trichlorophenoxyacetic acid, 2,4,5-	93-76-5	3.7E-01	1.0E+00	3.7E+01	1.0E+02	1.5E+03	1.0E+04
Trichloropropane, 1,1,2-	598-77-6	1.8E-01	5.1E-01	1.8E+01	5.1E+01	1.7E+02	2.7E+02
Trichloropropane, 1,2,3-	96-18-4	1.2E-05	4.1E-05	1.2E-03	4.1E-03	9.1E-02	8.2E-01
Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1	1.1E+03	3.1E+03	1.1E+05	3.1E+05	4.3E+04	6.0E+04
Triethanolamine	102-71-6	7.3E+00	2.0E+01	7.3E+02	2.0E+03	3.1E+04	2.0E+05
Triethylamine	121-44-8	---	---	---	---	3.7E+01	5.2E+01
Triethylene glycol	112-27-6	1.1E+02	3.1E+02	1.1E+04	3.1E+04	4.6E+05	3.1E+06
Triethylphosphorothioate, O, O, O-	126-68-1	3.0E-04	8.5E-04	3.0E-02	8.5E-02	1.3E+00	8.5E+00
Trifluralin	1582-09-8	1.1E-01	3.7E-01	1.1E+01	3.7E+01	6.4E+02	3.7E+03
Trimethylamine	75-50-3	---	---	---	---	8.3E+01	1.2E+02
Trimethylbenzene, 1,2,3-	526-73-8	1.8E+00	5.1E+00	1.8E+02	5.1E+02	8.6E+01	1.2E+02
Trimethylbenzene, 1,2,4-	95-63-6	1.8E+00	5.1E+00	1.8E+02	5.1E+02	9.6E+01	1.4E+02
Trimethylbenzene, 1,3,5-	108-67-8	1.8E+00	5.1E+00	1.8E+02	5.1E+02	8.3E+01	1.2E+02
Trinitrobenzene, 1,3,5-	99-35-4	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.6E+03	3.1E+04
Trinitrophenylmethylnitramine (tetryl; nitramine)	479-45-8	3.7E-01	1.0E+00	3.7E+01	1.0E+02	1.5E+03	1.0E+04
Trinitrotoluene, 2,4,6-	118-96-7	1.8E-02	5.1E-02	1.8E+00	5.1E+00	7.7E+01	5.1E+02
Uranium (soluble salts)	7440-61-1	3.0E-02	3.0E-02	3.0E+00	3.0E+00	7.6E+02	5.6E+03
Valeric acid (pentanoic acid)	109-52-4	1.8E+01	5.1E+01	1.8E+03	5.1E+03	7.7E+04	5.1E+05
Vanadium	7440-62-2	2.6E-01	7.2E-01	2.6E+01	7.2E+01	4.8E+02	3.0E+03

Last update: March 31, 2006

Updated Examples of Standard No. 2, Appendix II Medium-Specific Concentrations (MSCs)

Contaminant	CAS #	GW-Res (mg/l)	GW-Ind (mg/l)	GWP-Res (mg/kg)	GWP-Ind (mg/kg)	SAI-Res[a] (mg/kg)	SAI-Ind[a] (mg/kg)
Vernam	1929-77-7	3.7E-02	1.0E-01	3.7E+00	1.0E+01	1.5E+02	1.0E+03
Vinyl acetate	108-05-4	3.7E+01	1.0E+02	3.7E+03	1.0E+04	5.7E+02	8.0E+02
Vinyl chloride	75-01-4	2.0E-03	2.0E-03	2.0E-01	2.0E-01	3.6E-02	6.6E-02
Vinylcyclohexane	695-12-5	1.8E+01	5.1E+01	1.8E+03	5.1E+03	6.0E+01	8.4E+01
Warfarin	81-81-2	1.1E-02	3.1E-02	1.1E+00	3.1E+00	4.6E+01	3.1E+02
Xylene, m-	108-38-3	1.0E+01	1.0E+01	1.0E+03	1.0E+03	2.3E+03	3.3E+03
Xylene, o-	95-47-6	1.0E+01	1.0E+01	1.0E+03	1.0E+03	3.3E+04	4.8E+04
Xylene, p-	106-42-3	1.0E+01	1.0E+01	1.0E+03	1.0E+03	2.7E+03	3.8E+03
Xylenes	1330-20-7	1.0E+01	1.0E+01	1.0E+03	1.0E+03	5.8E+02	8.3E+02
Zinc	7440-66-6	1.1E+01	3.1E+01	1.1E+03	3.1E+03	5.9E+04	4.1E+05
6 C aliphatics (TPH)	NA	2.2E+00	6.1E+00	2.2E+02	6.1E+02	1.5E+02	2.1E+02
>6-8 C aliphatics (TPH)	NA	2.2E+00	6.1E+00	2.2E+02	6.1E+02	3.0E+02	4.2E+02
>8-10 C aliphatics (TPH)	NA	3.7E+00	1.0E+01	3.7E+02	1.0E+03	3.1E+03	4.8E+03
>10-12 C aliphatics (TPH)	NA	3.7E+00	1.0E+01	3.7E+02	1.0E+03	5.3E+03	1.0E+04
>12-16 C aliphatics (TPH)	NA	3.7E+00	1.0E+01	3.7E+02	1.0E+03	8.2E+03	2.0E+04
>16-21 C aliphatics (TPH)	NA	7.3E+01	2.0E+02	7.3E+03	2.0E+04	3.1E+05	2.0E+06
>16-21 C, >21-35 C aliphatics (TPH) (for transformer mineral oil releases only)	NA	5.8E+01	1.6E+02	5.8E+03	1.6E+04	2.5E+05	1.6E+06
>7-8 C aromatics (TPH)	NA	3.7E+00	1.0E+01	3.7E+02	1.0E+03	3.7E+03	5.8E+03
>8-10 C aromatics (TPH)	NA	1.5E+00	4.1E+00	1.5E+02	4.1E+02	1.7E+03	2.8E+03
>10-12 C aromatics (TPH)	NA	1.5E+00	4.1E+00	1.5E+02	4.1E+02	2.7E+03	5.8E+03
>12-16 C aromatics (TPH)	NA	1.5E+00	4.1E+00	1.5E+02	4.1E+02	4.0E+03	1.1E+04
>16-21 C aromatics (TPH)	NA	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.1E+03	2.7E+04
>21-35 C aromatics (TPH)	NA	1.1E+00	3.1E+00	1.1E+02	3.1E+02	4.1E+03	2.7E+04

Footnotes

[a]SAI was originally defined as "Soil/Air and Ingestion Standard." However, the SAI values provided in this table include the soil dermal absorption pathway where appropriate as well.

[b]The SAI-Res (20 mg/kg) and SAI-Ind (200 mg/kg) values for arsenic are based on the cleanup levels established by the Executive Director (interoffice memos entitled "Arsenic Soil Cleanup Standards" from Dan Pearson on May 19, 1995 and "Arsenic Soil Cleanup Standards for Commercial/Industrial Areas" from Jeff Saitas on September 11, 1998, respectively).

[c]The total MCL (GW-Res or GW-Ind) for trihalomethanes (bromodichloromethane, bromoform, chloroform, and dibromochloromethane) is 0.08 mg/L.

[d]The SAI-Res MSC value for cadmium does NOT account for vegetable ingestion. Please include this pathway when warranted due to site-specific conditions.

[e]The SAI-Res and SAI-Ind values for lead were calculated using the USEPA Lead Uptake/Biokinetic Model and the USEPA Model for Assessing Risks Associated with Adult Exposures to Lead in Soil, respectively.

[f]Note that much higher MSCs for mercury may be obtained using a pH-dependent Kd based on site-specific information.

[g]The first value for MTBE represents the health-based value; the second value for MTBE is based on odor and taste.

[h]The SAI-Res and SAI-Ind value for PCBs (10 mg/kg) is based on the TSCA limit defined in 40 CFR 761.125. An alternate cleanup level of 25 mg/kg may be appropriate for certain industrial sites, provided the site meets the requirements for a restricted access site (i.e., > 0.1 km from a residential/commercial area limited by man-made barriers) as defined in TSCA 40 CFR 761.123.

[*]These compounds are not necessarily of concern from a human health standpoint, therefore calculation of human health-based values is not required. However, aesthetics and ecological criteria would still apply. See table entitled "Compounds for which Calculation of a Human Health MSC is Not Required" available on the TCEQ website at http://www.tceq.state.tx.us/remediation/rrr.html.

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Risk-Based Screening Values

Background Information:

The risk-based screening values provided in this table are only to be used for eliminating contaminants from the baseline risk assessment; they are not for delineation or site investigation purposes. These values apply to all land use types.

The risk-based screening values for soil were calculated using the Risk Reduction Standard No. 2 equations, with the addition of the soil dermal absorption pathway where appropriate (see Section VII of the memo entitled Implementation of the Existing Risk Reduction Rule for more detail), the addition of the vegetable ingestion pathway for cadmium, updated toxicity factors, updated chemical/physical properties, and residential land use assumptions. In calculating the risk-based screening values for soil, a risk level of 10-6 was used for all carcinogens and a hazard quotient of 0.1 was used for all noncarcinogens. In cases where contaminants had both carcinogenic and noncarcinogenic toxicity factors, both types of values (carcinogenic and noncarcinogenic) were calculated and the lowest value (i.e., most conservative) was selected as the risk-based screening value for soil.

The risk-based screening values for groundwater were calculated using the MCL (when available) or Risk Reduction Standard No. 2 equations, with updated toxicity factors and residential land use assumptions when MCLs were not available. In calculating the risk-based screening values for groundwater, a risk level of 10-6 was used for all carcinogens and a hazard quotient of 0.1 was used for all noncarcinogens. In cases where contaminants had both carcinogenic and noncarcinogenic toxicity factors, both types of values (carcinogenic and noncarcinogenic) were calculated and the lowest value (i.e., most conservative) was selected as the risk-based screening value for groundwater.

Risk-Based Screening Values

Contaminant	CAS #	Soil (mg/kg)	Groundwater (mg/l)
Acenaphthene	83-32-9	8.2E+02	2.2E-01
Acenaphthylene	208-96-8	8.2E+02	2.2E-01
Acetaldehyde	75-07-0	4.4E+00	3.7E-01
Acetate, 2-ethoxyethanol	111-15-9	4.7E+02	6.2E-02
Acetate, isoamyl	123-92-2	3.2E+02	2.6E-01
Acetate, isobutyl	110-19-0	3.1E+02	1.8E-01
Acetate, sec-butyl	105-46-4	4.6E+02	1.8E-01
Acetic acid*	64-19-7	---	---
Acetone (2-propanone)	67-64-1	1.7E+02	3.3E+00
Acetone cyanohydrin	75-86-5	1.2E+01	2.9E-03
Acetonitrile	75-05-8	1.8E+01	1.2E-01
Acetophenone	98-86-2	2.7E+02	3.7E-01
Acetylaminofluorene, 2-	53-96-3	1.3E-01	2.2E-05
Acifluorfen, sodium	62476-59-9	2.0E+02	4.7E-02
Acridine	260-94-6	4.6E+01	1.1E-02
Acrolein	107-02-8	1.4E+01	1.8E-03
Acrylamide	79-06-1	1.1E-01	1.9E-05
Acrylic acid (propenoic acid)	79-10-7	1.4E+04	1.8E+00
Acrylonitrile	107-13-1	7.9E-02	1.6E-04
Adipic acid (hexanedioic acid)	124-04-9	7.7E+04	1.8E+01
Alachlor	15972-60-8	6.1E+00	2.0E-03
Aldicarb	116-06-3	1.5E+01	7.0E-03
Aldicarb sulfone	1646-88-4	1.5E+01	7.0E-03
Aldrin	309-00-2	2.7E-02	5.0E-06
Allyl alcohol	107-18-6	1.4E+02	1.8E-02
Allyl chloride	107-05-1	1.3E-01	3.7E-02
Aluminum	7429-90-5	1.5E+04	3.7E+00
Ametryn	834-12-8	1.4E+02	3.3E-02
Aminobiphenyl, 4- (1,1-biphenyl-4-amine)	92-67-1	8.0E-02	1.4E-05
Amino-2,6-dinitrotoluene, 4-	19406-51-0	2.6E+00	6.1E-04
Amino-4,6-dinitrotoluene, 2-	35572-78-2	2.6E+00	6.1E-04
Aminopyridine, 4-	504-24-5	3.1E-01	7.3E-05
Ammonia	7664-41-7	1.6E+01	---
Ammonium polyphosphate*	68333-79-9	---	---
Ammonium salts*	NA	---	---
Aniline	62-53-3	8.6E+01	1.5E-02

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Last update: March 31, 2006

Risk-Based Screening Values Contaminant	CAS #	Soil (mg/kg)	Groundwater (mg/l)
Anthracene	120-12-7	4.1E+03	1.1E+00
Anthraquinone, 9,10-	84-65-1	3.1E+02	7.3E-02
Antimony	7440-36-0	7.2E+00	6.0E-03
Aramite	140-57-8	2.0E+01	3.4E-03
Arsenic	7440-38-2	2.0E+01[a]	1.0E-02
Arsine	7784-42-1	—	—
Asbestos	1332-21-4	—	—
Atrazine	1912-24-9	2.2E+00	3.0E-03
Azinphos-methyl (guthion)	86-50-0	2.3E+01	5.5E-03
Azobenzene	103-33-3	4.3E+00	7.7E-04
Barium	7440-39-3	2.6E+03	2.0E+00
Bayleton	43121-43-3	4.6E+02	1.1E-01
Benefin (benfluralin)	1861-40-1	4.6E+03	1.1E+00
Benomyl	17804-35-2	7.7E+02	1.8E-01
Benz-a-anthracene	56-55-3	6.3E-01	2.0E-04
Benzaldehyde	100-52-7	3.2E+01	3.7E-01
Benzene	71-43-2	8.8E-01	5.0E-03
Benzenedicarbonitrile, 1,3-	626-17-5	9.3E+01	2.2E-02
Benzenethiol	108-98-5	1.5E-01	3.7E-05
Benzidine	92-87-5	2.1E-03	3.7E-07
Benzo-a-pyrene	50-32-8	6.3E-02	2.0E-04
Benzo-b-fluoranthene	205-99-2	6.3E-01	2.0E-04
Benzo-j-fluoranthene	205-82-3	6.2E-01	1.2E-04
Benzo-e-pyrene	192-97-2	4.1E+02	1.1E-01
Benzo-g,h,i-perylene	191-24-2	4.1E+02	1.1E-01
Benzoic acid	65-85-0	6.2E+04	1.5E+01
Benzo-k-fluoranthene	207-08-9	6.3E+00	1.2E-03
Benzophenone	119-61-9	1.0E+02	2.4E-02
Benzotrichloride	98-07-7	3.8E-02	6.6E-06
Benzoyl peroxide	94-36-0	7.7E+02	1.8E-01
Benzyl alcohol	100-51-6	4.6E+03	1.1E+00
Benzyl chloride	100-44-7	3.8E+00	5.0E-04
Benzyl dichloride	98-87-3	2.9E+00	5.0E-04
Beryllium	7440-41-7	4.6E+00	4.0E-03
Biphenyl, 1,1-	92-52-4	1.9E+01	1.8E-01
Biquinoline, 2,2'-	119-91-5	4.6E+01	1.1E-02
Bis (2-chloroethoxy) methane	111-91-1	2.9E-01	7.7E-05
Bis (2-chloroethyl) ether	111-44-4	1.5E-01	7.7E-05
Bis (2-chloroisopropyl) ether	108-60-1	4.8E+00	1.2E-03
Bis (2-chloromethyl) ether	542-88-1	1.1E-04	3.9E-07
Bis (2-ethyl-hexyl) phthalate	117-81-7	1.7E+01	6.0E-03
Bismuth	7440-69-9	9.9E+03	1.8E+00
Bisphenol A	80-05-7	7.7E+02	1.8E-01
Boron	7440-42-8	5.1E+03	7.3E-01
Bromacil	314-40-9	1.5E+03	3.7E-01
Bromobenzene	108-86-1	1.1E+01	7.3E-02
Bromo-2-chloroethane, 1-	107-04-0	3.0E+01	1.5E-01
Bromodichloromethane[b]	75-27-4	1.0E+01	1.4E-03
Bromoform[b]	75-25-2	3.4E+01	1.1E-02
Bromomethane (methyl bromide)	74-83-9	3.5E-01	5.1E-03
Bromophenyl phenylether, 4-	101-55-3	3.1E-02	5.7E-06
Butadiene, 1,3-	106-99-0	6.6E-02	—
Butadiene, 2-methyl-1,3- (isoprene)	78-79-5	9.7E+02	2.2E-01
Butanal (butyraldehyde)	123-72-8	3.7E+02	2.2E-01
Butane, 2,3-dimethyl-	79-29-8	8.1E+02	2.2E-01
Butanoic acid (butyric acid)	107-92-6	7.7E+03	1.8E+00
Butanol, 2-	78-92-2	4.9E+02	3.7E-01
Butanol, 2-methyl-2-	75-85-4	2.3E+02	3.7E-02
Butanol, n-	71-36-3	2.7E+03	3.7E-01
Butene, 1-	106-98-9	5.3E+02	2.2E-01
Butene, cis-2-	590-18-1	5.8E+02	2.2E-01

Last update: March 31, 2006

Risk-Based Screening Values			
Contaminant	CAS #	Soil (mg/kg)	Groundwater (mg/l)
Butene, trans-2-	624-64-6	5.8E+02	2.2E-01
Butoxy ethanol, 2- (Ethylene glycol monobutyl ether; EGE	111-76-2	7.7E+03	1.8E+00
Butyl acetate	123-86-4	7.4E+01	5.1E-01
Butyl acrylate	141-32-2	8.6E+00	3.3E-02
Butyl benzyl phthalate	85-68-7	3.1E+03	7.3E-01
Butylate	2008-41-5	7.7E+02	1.8E-01
Butylbenzene, n-	104-51-8	2.7E+02	1.5E-01
Butylbenzene, sec-	135-98-8	3.0E+02	1.5E-01
Butylbenzene, tert-	98-06-6	2.6E+02	1.5E-01
Butyl ether, n- (dibutyl ether)	142-96-1	1.5E+02	3.7E-01
Cacodylic acid	75-60-5	4.6E+01	1.1E-02
Cadmium	7440-43-9	5.2E+00[c] (comb PCL-res/10)	5.0E-03
Calcium*	7440-70-2	---	---
Caprolactam	105-60-2	7.7E+03	1.8E+00
Captan	133-06-2	1.4E+02	2.4E-02
Carbaryl	63-25-2	1.5E+03	3.7E-01
Carbazole	86-74-8	2.4E+01	4.3E-03
Carbofuran	1563-66-2	7.7E+01	4.0E-02
Carbon disulfide	75-15-0	1.0E+02	3.7E-01
Carbon tetrachloride	56-23-5	3.5E-01	5.0E-03
Carbophenothion	786-19-6	2.0E+02	4.7E-02
Carbosulfan	55285-14-8	1.5E+02	3.7E-02
Carboxin	5234-68-4	1.5E+03	3.7E-01
Chloral	75-87-6	2.7E+03	3.7E-01
Chloral hydrate (1,1-ethanediol, 2,2,2-trichloro-)	302-17-0	1.5E+03	3.7E-01
Chloramben (amiben; 3-amino-2,5-dichlorobenzoic acid)	133-90-4	2.3E+02	5.5E-02
Chlordane (technical)	12789-03-6	1.6E+00	2.0E-03
Chlordane, cis- (alpha chlordane)	5103-71-9	1.4E+00	2.4E-04
Chlordane, gamma	57-74-9	1.4E+00	2.4E-04
Chlorfenvinphos	470-90-6	1.1E+01	2.6E-03
Chloride*	16887-00-6	---	---
Chlorine	7782-50-5	2.0E+03	4.0E+00
Chloroaniline, p-	106-47-8	6.2E+01	1.5E-02
Chlorobenzene	108-90-7	4.0E+01	1.0E-01
Chlorobenzilate	510-15-6	1.8E+00	3.2E-04
Chlorobromomethane (bromochloromethane)	74-97-5	2.4E+01	1.5E-01
Chloro-1,3-butadiene, 2-	126-99-8	1.0E+00	---
Chlorodifluoromethane	75-45-6	1.1E+03	---
Chloroethane (ethyl chloride)	75-00-3	1.1E+03	1.5E+00
Chloroethanol, 2-	107-07-3	1.1E+04	1.5E+00
Chloroethoxy ethene, 2- (2-chloroethylvinylether)	110-75-8	2.1E-01	7.7E-05
Chloroform[b]	67-66-3	3.1E-01	3.7E-02
Chlorohexane, 1-	544-10-5	4.1E+02	1.5E-01
Chloromethane (methyl chloride)	74-87-3	2.3E-01	6.6E-03
Chloro-3-methylphenol, 4-	59-50-7	7.7E+01	1.8E-02
Chloronaphthalene, 1- (Chloronaphthalene, alpha-)	90-13-1	1.1E+03	2.9E-01
Chloronaphthalene, 2- (chloronaphthalene, beta)	91-58-7	1.1E+03	2.9E-01
Chloronitrobenzene, p- (1-chloro-4-nitrobenzene)	100-00-5	2.7E+01	4.7E-03
Chlorophenol, 2-	95-57-8	1.1E+02	1.8E-02
Chlorophenol, 3-	108-43-0	7.7E+01	1.8E-02
Chlorophenol, 4-	106-48-9	7.7E+01	1.8E-02
Chlorophenyl phenylether, 4-	7005-72-3	2.8E-02	5.7E-06
Chloropropane, 2-	75-29-6	1.3E+01	1.1E-01
Chloro-2-propanol, 1-	127-00-4	5.5E+02	7.3E-02
Chlorothalonil	1897-45-6	4.4E+01	7.7E-03
Chlorotoluene, o- (2-chlorotoluene)	95-49-8	1.5E+02	7.3E-02
Chlorotoluene, p- (4-chlorotoluene)	106-43-4	3.4E-01	7.3E-02
Chlorpyrifos	2921-88-2	4.6E+01	1.1E-02

Last update: March 31, 2006

Risk-Based Screening Values			
Contaminant	CAS #	Soil (mg/kg)	Groundwater (mg/l)
	16065-83-1/		
Chromium (III) (total chromium)	7440-47-3	5.9E+03	1.0E-01
Chromium (VI)	18540-29-9	2.0E+01	1.0E-01
Chrysene	218-01-9	6.3E+01	1.2E-02
Cobalt	7440-48-4	1.5E+03	2.2E-01
Copolymer acrylamide	69418-26-4	3.1E+00	7.3E-04
Copper	7440-50-8	1.0E+03	1.3E+00
Coronene	191-07-1	3.1E+01	7.3E-03
Coumaphos	56-72-4	1.1E+02	2.6E-02
Cresol	1319-77-3	7.7E+02	1.8E-01
Cresol, m- (3-methylphenol)	108-39-4	7.7E+02	1.8E-01
Cresol, o- (2-methylphenol)	95-48-7	7.7E+02	1.8E-01
Cresol, p- (4-methylphenol)	106-44-5	7.7E+01	1.8E-02
Crotonaldehyde	123-73-9	3.4E-01	4.5E-05
Cumene (isopropylbenzene)	98-82-8	5.4E+02	3.7E-01
Cyanazine	21725-46-2	5.8E-01	1.0E-04
Cyanide	57-12-5	5.1E+02	2.0E-01
Cyanogen	460-19-5	4.3E-01	1.5E-01
Cycloate	1134-23-2	8.5E+02	2.0E-01
Cyclohexane	110-82-7	1.2E+03	1.8E+01
Cyclohexanol	108-93-0	7.7E+04	1.8E+01
Cyclohexanone	108-94-1	2.1E+02	1.8E+01
Cyclopentane, methyl-	96-37-7	1.5E+02	3.7E-01
Cyclotetramethylenetetranitramine (HMX)	2691-41-0	2.2E+02	1.8E-01
Cyclotrimethylenetrinitramine (RDX)	121-82-4	3.6E+00	7.7E-04
Cymene (isopropyltoluene)	99-87-6	4.2E+02	3.7E-01
Cymoxanil	57966-95-7	2.0E+02	4.7E-02
Dacthal (DCPA)	1861-32-1	1.5E+02	3.7E-02
Dalapon, sodium salt (2,2-dichloropropanoic acid)	75-99-0	4.6E+02	2.0E-01
DDD	72-54-8	2.4E+00	3.5E-04
DDE	72-55-9	1.7E+00	2.5E-04
DDT	50-29-3	1.7E+00	2.5E-04
Demeton	8065-48-3	6.2E-01	1.5E-04
Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone)	123-42-2	6.2E+02	1.5E-01
Diallate	2303-16-4	8.0E+00	1.4E-03
Diazinon	333-41-5	1.4E+01	3.3E-03
Dibenz-a,h-acridine	226-36-8	4.1E-01	7.1E-05
Dibenz-a,h-anthracene	53-70-3	6.3E-02	2.0E-04
Dibenz-a,j-acridine	224-42-0	6.3E-01	2.0E-04
Dibenzo(a,e)pyrene	192-65-4	6.7E-02	1.2E-05
Dibenzo(a,h)pyrene	189-64-0	6.7E-03	1.2E-06
Dibenzo(a,i)pyrene	189-55-9	6.7E-03	1.2E-06
Dibenzofuran	132-64-9	6.2E+01	1.5E-02
Dibenzothiophene	132-65-0	4.6E+01	1.1E-02
Dibromochloromethane (chlorodibromomethane)[b]	124-48-1	7.6E+00	1.0E-03
Dibromo-3-chloropropane, 1,2-	96-12-8	3.5E-01	2.0E-04
Dibromofluoromethane	1868-53-7	1.1E+03	7.3E-01
Dicamba	1918-00-9	4.6E+02	1.1E-01
Dichlormid	37764-25-3	3.9E+02	9.1E-02
Dichlorobenzene, 1,2-	95-50-1	5.6E+01	6.0E-01
Dichlorobenzene, 1,3-	541-73-1	5.1E+00	1.1E-01
Dichlorobenzene, 1,4-	106-46-7	2.7E+01	7.5E-02
Dichlorobenzidine, 3,3-	91-94-1	1.1E+00	1.9E-04
Dichlorobutane, 2,3-	7581-97-7	4.3E+00	3.7E-02
Dichloro-2-butene, 1,4-	764-41-0	2.3E-02	---
Dichloro-2-butene, 1,4- trans	110-57-6	2.3E-02	---
Dichlorodifluoromethane	75-71-8	2.2E+02	7.3E-01
Dichloroethane, 1,1-	75-34-3	8.9E+01	3.7E-01
Dichloroethane, 1,2-	107-06-2	2.7E-01	5.0E-03
Dichloroethylene, 1,1-	75-35-4	2.7E+01	7.0E-03
Dichloroethylene, cis-1,2-	156-59-2	1.2E+02	7.0E-02

Last update: March 31, 2006

Risk-Based Screening Values			
Contaminant	CAS #	Soil (mg/kg)	Groundwater (mg/l)
Dichloroethylene, trans-1,2	156-60-5	1.4E+02	1.0E-01
Dichlorofluoromethane	75-43-4	5.4E+00	7.3E-01
Dichlorophenol, 2,3-	576-24-9	4.6E+01	1.1E-02
Dichlorophenol, 2,4-	120-83-2	4.6E+01	1.1E-02
Dichlorophenol, 2,5-	583-78-8	4.6E+01	1.1E-02
Dichlorophenol, 2,6-	87-65-0	1.5E+01	3.7E-03
Dichlorophenol, 3,4-	95-77-2	4.6E+01	1.1E-02
Dichlorophenol, 3,5-	591-35-5	4.6E+01	1.1E-02
Dichlorophenoxyacetic acid, 2,4- (2,4-D)	94-75-7	2.0E+02	7.0E-02
Dichlorophenoxy, 2,4- butyric acid, 4- (2,4-DB)	94-82-6	1.2E+02	2.9E-02
Dichloroprop (2-(2,4-dichlorophenoxy) propanoic acid)	120-36-5	1.5E+02	3.7E-02
Dichloropropane, 1,2-	78-87-5	1.8E+00	5.0E-03
Dichloropropane, 1,3-	142-28-9	3.0E+00	8.5E-04
Dichloropropane, 2,2-	594-20-7	1.7E+00	1.3E-03
Dichloropropanol, 2,3-	616-23-9	4.6E+01	1.1E-02
Dichloropropene, 1,1-	563-58-6	9.9E-01	8.5E-04
Dichloropropene, 1,3- (mixed isomers)	542-75-6	1.9E+00	8.5E-04
Dichloropropene, cis 1,3-	10061-01-5	1.2E+00	1.6E-04
Dichloropropene, trans 1,3-	10061-02-6	1.8E+00	8.5E-04
Dichlorvos	62-73-7	1.7E+00	2.9E-04
Dicrotophos (bidrin)	141-66-2	1.5E+00	3.7E-04
Dicyclopentadiene	77-73-6	8.2E+02	1.1E-01
Dieldrin	60-57-1	3.1E-02	5.3E-06
Diethanolamine	111-42-2	7.7E+00	1.8E-03
Diethyl phthalate	84-66-2	1.2E+04	2.9E+00
Diethylene glycol	111-46-6	3.1E+04	7.3E+00
Diethylene glycol monobutyl ether	112-34-5	1.4E+03	3.3E-01
Diethylhexyl adipate	103-23-1	4.1E+02	4.0E-01
Diethylstilbestrol	56-53-1	1.0E-04	1.8E-08
Diisobutylene (trimethyl-1-pentene, 2,4,4-)	107-39-1	3.7E+01	2.2E-01
Diisopropyl ether (2,2'-oxybis-propane)	108-20-3	3.7E+02	3.7E-01
Dimethenamid	87674-68-8	2.3E+02	5.5E-02
Dimethoate	60-51-5	3.1E+00	7.3E-04
Dimethoxybenzidine, 3,3'-	119-90-4	3.5E+01	6.1E-03
Dimethylaminoazobenzene, p-	60-11-7	1.5E-01	3.7E-05
Dimethylbenz-a-anthracene, 7,12-	57-97-6	1.8E-03	3.4E-07
Dimethylbenzidine, 3,3'-	119-93-7	5.3E-02	9.3E-06
Dimethylnaphthalene, 1,3-	575-41-7	5.5E+02	1.5E-01
Dimethyl phenol, 2,4-	105-67-9	3.1E+02	7.3E-02
Dimethylphenethylamine, alpha, alpha-	122-09-8	3.1E+01	7.3E-03
Dimethylphthalate	131-11-3	1.2E+04	2.9E+00
Di-n-butyl phthalate	84-74-2	1.5E+03	3.7E-01
Dinitrobenzene, 1,3- (dinitrobenzene, 2,4-)	99-65-0	1.5E+00	3.7E-04
Dinitrobenzene, 1,4-	100-25-4	6.2E+00	1.5E-03
Dinitro-2-methylphenol, 4,6- (dinitro-o-cresol, 4, 6-)	534-52-1	3.1E+01	7.3E-03
Dinitrophenol, 2,4-	51-28-5	3.1E+01	7.3E-03
Dinitrophenol, 2,5-	329-71-5	3.1E+01	7.3E-03
Dinitrotoluene, 2,4-	121-14-2	7.2E-01	1.3E-04
Dinitrotoluene, 2,6-	606-20-2	7.2E-01	1.3E-04
Di-n-octyl phthalate	117-84-0	3.1E+02	7.3E-02
Dinoseb	88-85-7	1.5E+01	7.0E-03
Dioxane 1,4-	123-91-1	5.8E+01	7.7E-03
Diphenylamine	122-39-4	3.9E+02	9.1E-02
Diphenylhydrazine, 1,2-	122-66-7	6.1E-01	1.1E-04
Diphenyl ether	101-84-8	6.0E+01	2.3E-02
Dipropylene glycol	110-98-5	1.8E+03	4.2E-01
Diquat	85-00-7	3.4E+01	2.0E-02
Disodium iminodiacetate (iminodiacetic acid, disodium sa	8-72-3/ 142-7	1.5E+02	3.7E-02
Disulfoton	298-04-4	6.2E-01	1.5E-04
Diuron	330-54-1	3.1E+01	7.3E-03

Last update: March 31, 2006

Risk-Based Screening Values

Contaminant	CAS #	Soil (mg/kg)	Groundwater (mg/l)
Dodecylphenol, 4-	27193-86-8/ 104-43-8	7.7E+02	1.8E-01
Endosulfan	115-29-7	6.2E+00	2.2E-02
Endosulfan I	959-98-8	3.1E+01	7.3E-03
Endosulfan II	33213-65-9	9.3E+01	2.2E-02
Endosulfan sulfate	1031-07-8	9.3E+01	2.2E-02
Endothall	145-73-3	3.1E+02	1.0E-01
Endrin	72-20-8	4.6E+00	2.0E-03
Endrin aldehyde	7421-93-4	4.6E+00	1.1E-03
Endrin ketone	53494-70-5	4.6E+00	1.1E-03
Epichlorohydrin	106-89-8	7.2E-01	7.3E-03
EPN (o-ethyl o-(4-nitrophenyl)phenylphosphonothioate)	2104-64-5	1.5E-01	3.7E-05
Esfenvalerate	66230-04-4	3.1E+01	7.3E-03
Ethalfluralin (sonolan)	55283-68-6	5.5E+00	9.6E-04
Ethanol	64-17-5	9.1E+05	1.2E+02
Ethion	563-12-2	7.7E+00	1.8E-03
Ethoprop	13194-48-4	1.5E+00	3.7E-04
Ethoxy ethanol, 2-	110-80-5	4.3E-01	1.5E+00
Ethyl acetate	141-78-6	8.9E+02	3.3E+00
Ethyl acrylate	140-88-5	1.3E+01	1.8E-03
Ethyl benzene	100-41-4	4.3E+02	7.0E-01
Ethyl dipropylthiocarbamate, S-	759-94-4	3.9E+02	9.1E-02
Ethylene*	74-85-1	—	—
Ethylenediamine	107-15-3	5.5E+02	7.3E-02
Ethylene dibromide (dibromoethane, 1,2-)	106-93-4	5.3E-02	5.0E-05
Ethylene glycol	107-21-1	3.1E+04	7.3E+00
Ethylenimine	151-56-4	9.9E-03	1.3E-06
Ethylene oxide	75-21-8	7.5E-02	8.3E-05
Ethylene thiourea	96-45-7	1.2E+00	2.9E-04
Ethyl ether	60-29-7	3.8E+02	7.3E-01
Ethyl-1-hexanol, 2-	104-76-7	1.3E+03	5.5E-01
Ethyl-2-hexenal, 2-	645-62-5	3.0E+02	5.5E-01
Ethylhexyl acrylate, 2-	103-11-7	1.0E+01	1.8E-03
Ethyl methacrylate	97-63-2	5.7E+02	3.3E-01
Ethyl methanesulfonate	62-50-0	4.9E+00	8.6E-04
Ethyl-2-methyl benzene, 1-	611-14-3	5.5E+02	7.3E-01
Ethyl-4-methyl benzene, 1-	622-96-8	4.8E+02	7.3E-01
Ethyl tert-butyl ether (2-ethyl-2-ethoxypropane)	637-92-3	2.2E+01	3.7E-03
Famphur	52-85-7	4.6E-01	1.1E-04
Fensulfothion	115-90-2	1.5E+01	3.7E-03
Fenthion	55-38-9	1.1E+00	2.6E-04
Fluoranthene	206-44-0	5.5E+02	1.5E-01
Fluorene	86-73-7	5.5E+02	1.5E-01
Fluorine (soluble fluoride)	7782-41-4	1.5E+03	4.0E+00
Fluorochloridone	61213-25-0	1.2E+02	2.7E-02
Fonofos	944-22-9	3.1E+01	7.3E-03
Formaldehyde	50-00-0	5.5E+03	7.3E-01
Formic acid	64-18-6	5.5E+04	7.3E+00
Furan	110-00-9	3.9E+00	3.7E-03
Furfural	98-01-1	8.2E+01	1.1E-02
Glycidylaldehyde	765-34-4	1.1E+01	1.5E-03
Glyphosate	1071-83-6	1.5E+03	7.0E-01
Heptachlor	76-44-8	9.3E-02	4.0E-04
Heptachlor epoxide	1024-57-3	5.4E-02	2.0E-04
Heptane, n-	142-82-5	1.1E+03	2.2E-01
Heptanoic acid, n-	111-14-8	7.7E+03	1.8E+00
Hexachlorobenzene	118-74-1	2.5E-01	1.0E-03
Hexachlorobutadiene	87-68-3	1.6E+00	7.3E-04
Hexachlorocyclohexane, alpha (alpha-BHC)	319-84-6	9.0E-02	1.4E-05
Hexachlorocyclohexane, beta (beta-BHC)	319-85-7	3.2E-01	4.7E-05
Hexachlorocyclohexane, delta (delta-BHC)	319-86-8	3.2E-01	4.7E-05

00113417

Last update: March 31, 2006

Risk-Based Screening Values

Contaminant	CAS #	Soil (mg/kg)	Groundwater (mg/l)
Hexachlorocyclohexane, gamma (lindane; gamma-BHC)	58-89-9	4.4E-01	2.0E-04
Hexachlorocyclohexane, techn (technical-BHC)	608-73-1	3.2E-01	4.7E-05
Hexachlorocyclopentadiene (HCCPD)	77-47-4	1.0E+00	5.0E-02
Hexachloroethane	67-72-1	1.5E+01	3.7E-03
Hexachlorophene	70-30-4	4.6E+00	1.1E-03
Hexachloropropylene	1888-71-7	1.5E+01	3.7E-03
Hexanal, 2-ethyl-	123-05-7	3.0E+02	5.5E-01
Hexane, n-	110-54-3	2.0E+01	2.2E-01
Hexanediol, 1,6-	629-11-8	7.7E+04	1.8E+01
Hexanoic acid	142-62-1	9.9E+02	2.3E-01
Hexanone, 2-	591-78-6	6.2E+00	2.2E-01
Hexazinone	51235-04-2	5.1E+02	1.2E-01
Hexylene glycol (2-methyl-2,4-pentanediol)	107-41-5	4.6E+03	1.1E+00
Hydrazine	302-01-2	2.1E-01	2.8E-05
Hydrogen chloride (hydrochloric acid)*	7647-01-0	---	---
Hydroquinone	123-31-9	6.2E+02	1.5E-01
Indene	95-13-6	7.9E+00	7.3E-02
Indeno-1,2,3-cd-pyrene	193-39-5	6.3E-01	2.0E-04
Iron*	7439-89-6	---	---
Isoamyl alcohol	123-51-3	1.2E+02	1.8E-02
Isobutyl alcohol	78-83-1	3.0E+02	1.1E+00
Isobutylene (2-methyl-1-propene)	115-11-7	1.8E+02	---
Isobutyric acid (2-methylpropanoic acid)	79-31-2	7.7E+03	1.8E+00
Isodecanol	25339-17-7	2.5E+01	5.8E-03
Isodrin	465-73-6	2.8E-03	5.0E-07
Isophorone	78-59-1	5.2E+02	9.0E-02
Isopropyl acetate	108-21-4	1.9E+03	2.6E-01
Isopropyl alcohol	67-63-0	5.5E+03	7.3E-01
Isosafrole	120-58-1	1.7E+00	3.9E-04
Kelthane (dicofol)	115-32-2	9.3E+01	2.2E-02
Kepone (chlordecone)	143-50-0	3.1E-02	5.3E-06
Lead (inorganic)	7439-92-1	5.0E+02[d]	1.5E-02
Limonene, d-*	5989-27-5	---	---
Lithium	7439-93-2	5.1E+02	7.3E-02
Magnesium*	7439-95-4	---	---
Malathion	121-75-5	3.1E+02	7.3E-02
Maleic anhydride	108-31-6	1.5E+03	3.7E-01
Maleic hydrazide	123-33-1	7.7E+03	1.8E+00
Malononitrile	109-77-3	3.1E-01	7.3E-05
Mancozeb	8018-01-7	4.6E+02	1.1E-01
Manganese	7439-96-5	1.7E+03	1.7E-01
MCPA (4-(chloro-2-methylphenoxy) acetic acid)	94-74-6	7.7E+00	1.8E-03
MCPP (2-(4-chloro-2-methylphenoxy) propanoic acid)	7085-19-0/ 93-65-2	1.5E+01	3.7E-03
Merphos	150-50-5	4.6E-01	1.1E-04
Mercury (pH = 4.9)[c]	7439-97-6/ 7487-94-7	1.1E-02	2.0E-03
Methacrylic acid (2-methyl-2-propenoic acid)	79-41-4	2.4E+00	3.7E-02
Methacrylonitrile	126-98-7	1.1E+00	3.7E-04
Methanol	67-56-1	1.4E+04	1.8E+00
Methapyrilene	91-80-5	1.0E-01	1.8E-05
Methomyl	16752-77-5	3.9E+02	9.1E-02
Methoxychlor	72-43-5	7.5E+01	4.0E-02
Methoxyethanol, 2-	109-86-4	6.1E-01	---
Methyl acetate (acetic acid, methyl ester)	79-20-9	2.1E+02	3.7E+00
Methyl acrylate	96-33-3	2.8E+00	7.3E-03
Methyl amyl ketone (2-heptanone)	110-43-0	4.2E+02	1.8E-01
Methyl-1-butene, 2-	563-46-2	5.8E+02	2.2E-01
Methyl-2-butene, 2-	513-35-9	7.3E+02	2.2E-01
Methylcholanthrene, 3-	56-49-5	2.1E-02	3.9E-06
Methyl chrysene, 1-	3351-28-8	6.3E+01	1.2E-02

Last update: March 31, 2006

Risk-Based Screening Values			
Contaminant	**CAS #**	**Soil (mg/kg)**	**Groundwater (mg/l)**
Methyl chrysene, 2-	3351-32-4	6.3E+01	1.2E-02
Methyl chrysene, 6-	1705-85-7	6.3E+00	1.2E-03
Methyl cyclohexane	108-87-2	7.1E+02	1.8E+01
Methylene-bis (2-chloroaniline) 4,4'-	101-14-4	3.8E+00	6.6E-04
Methylene bromide (dibromomethane)	74-95-3	1.9E+01	1.1E-02
Methylene chloride (dichloromethane)	75-09-2	8.7E+00	5.0E-03
Methyl ethyl ketone (2-butanone)	78-93-3	2.6E+03	2.2E+00
Methyl iodide (iodomethane)	74-88-4	1.8E+00	5.1E-03
Methyl isobutyl ketone (4-methyl-2-pentanone)	108-10-1	1.3E+03	2.9E-01
Methyl mercury	22967-92-6	2.5E+00	3.7E-04
Methylmecury hydroxide	1184-57-2	1.5E+00	3.7E-04
Methyl methacrylate	80-62-6	5.8E+02	5.1E+00
Methyl methanesulfonate	66-27-3	4.9E+00	8.6E-04
Methylnaphthalene, 1-	90-12-0	9.6E+02	2.6E-01
Methylnaphthalene, 2-	91-57-6	5.5E+01	1.5E-02
Methyl-5-nitroaniline, 2- (5-nitro-o-toluidine)	99-55-8	1.5E+01	2.6E-03
Methyl parathion	298-00-0	3.9E+00	9.1E-04
Methyl-2-pentenal, 2-	623-36-9	3.4E-01	4.5E-05
Methyl-1-propanal, 2- (isobutyraldehyde)	78-84-2	1.3E+02	1.5E-01
Methylpyrrolidone, N-	872-50-4	3.1E+02	7.3E-02
Methyltetrahydrofuran, 2-	96-47-9	7.0E+00	1.1E-02
Methyltetrahydropyran, 2-	10141-72-7	1.1E+01	1.1E-02
Metolachlor	51218-45-2	2.3E+03	5.5E-01
Metribuzin	21087-64-9	3.9E+02	9.1E-02
Mirex	2385-85-5	3.1E+00	7.3E-04
Molinate	2212-67-1	3.1E+01	7.3E-03
Molybdenum	7439-98-7	1.1E+02	1.8E-02
Monocrotophos	2157-98-4	9.3E+00	2.2E-03
Morpholine	110-91-8	1.4E+07	1.8E+03
MTBE (methyl tert-butyl ether)	1634-04-4	3.8E+01	1.5E-02[f]
Naled	300-76-5	1.1E+01	7.3E-03
Naphthalene	91-20-3	1.8E+01	7.3E-02
Naphthoquinone, 1,4-	130-15-4	1.1E+02	2.6E-02
Naphthylamine, 1-	134-32-7	3.1E+02	7.3E-02
Naphthylamine, 2-	91-59-8	2.7E-01	4.7E-05
Napropamide	15299-99-7	1.5E+03	3.7E-01
Neopentyl glycol	126-30-7	4.6E+03	1.1E+00
Nickel and compounds	7440-02-0	1.9E+02	7.3E-02
Nitrate	14797-55-8	4.1E+04	1.0E+01
Nitrite	14797-65-0	2.5E+03	1.0E+00
Nitroaniline, 2-	88-74-4	4.6E+00	1.1E-03
Nitroaniline, 3-	99-09-2	4.6E+00	1.1E-03
Nitroaniline, 4-	100-01-6	1.3E+01	2.2E-03
Nitrobenzene	98-95-3	6.5E+00	1.8E-03
Nitroglycerin	55-63-0	1.1E+00	2.6E-04
Nitrophenol, 2-	88-75-5	3.1E+01	7.3E-03
Nitrophenol, 3-	554-84-7	3.1E+01	7.3E-03
Nitrophenol, 4-	100-02-7	3.1E+01	7.3E-03
Nitropropane, 2-	79-46-9	4.2E-03	5.1E-04
Nitroquinoline-N-oxide, 4-	56-57-5	5.2E-02	9.1E-06
Nitrosodiethanolamine, N-	1116-54-7	1.7E-01	3.0E-05
Nitrosodiethylamine, N-	55-18-5	4.3E-03	5.7E-07
Nitrosodimethylamine, N-	62-75-9	1.3E-02	1.7E-06
Nitrosodi-n-butylamine, N-	924-16-3	4.1E-02	1.6E-05
Nitrosodi-n-propylamine, N-	621-64-7	4.1E-02	1.2E-05
Nitrosodiphenylamine, N-	86-30-6	5.9E+01	1.7E-02
Nitroso-methyl-ethyl-amine, N-	10595-95-6	2.9E-02	3.9E-06
Nitrosomorpholine, N-	59-89-2	7.3E-02	1.3E-05
Nitroso-N-ethylurea, N-	759-73-9	3.5E-03	6.1E-07
Nitrosopiperidine, N-	100-75-4	5.2E-02	9.1E-06
Nitrosopyrrolidine, N-	930-55-2	2.3E-01	4.1E-05

Last update: March 31, 2006

Risk-Based Screening Values

Contaminant	CAS #	Soil (mg/kg)	Groundwater (mg/l)
Nitrotoluene, m-	99-08-1	4.4E+01	3.7E-02
Nitrotoluene, o-	88-72-2	4.7E+01	3.7E-02
Nitrotoluene, p-	99-99-0	4.4E+01	3.7E-02
Nonachlor, cis-	5103-73-1	1.4E+00	2.4E-04
Nonachlor, trans-	39765-80-5	1.4E+00	2.4E-04
Nonanal	124-19-6	3.1E+03	7.3E-01
Nonylphenol	25154-52-3/ 84852-15-3/ 104-40-5	1.5E+03	3.7E-01
Nonylphenol ethoxylate	104-35-8	1.5E+03	3.7E-01
Octamethylpyrophosphoramide	152-16-9	3.1E+01	7.3E-03
Octanone	106-68-3	1.6E+03	2.2E-01
Oxamyl	23135-22-0	3.9E+02	2.0E-01
Oxychlordane	27304-13-8	1.4E+00	2.4E-04
Paraquat	1910-42-5	7.0E+01	1.6E-02
Parathion (ethyl parathion)	56-38-2	9.3E+01	2.2E-02
Pebulate	1114-71-2	7.7E+02	1.8E-01
Pendimethalin	40487-42-1	6.2E+02	1.5E-01
Pentachlorobenzene	608-93-5	1.2E+01	2.9E-03
Pentachloroethane	76-01-7	5.2E+00	3.3E-03
Pentachloronitrobenzene	82-68-8	1.9E+00	3.3E-04
Pentachlorophenol	87-86-5	3.0E+00	1.0E-03
Pentadiene, 1,3-trans-	2004-70-8	1.0E+03	2.2E-01
Pentaerythritol tetranitrate (PETN)	78-11-5	6.2E+03	1.5E+00
Pentane	109-66-0	1.7E+01	2.6E+00
Pentane, 2-methyl-	107-83-5	8.0E+02	2.2E-01
Pentane, 3-methyl-	96-14-0	8.4E+02	2.2E-01
Pentanediol, 1,5-	111-29-5	7.7E+04	1.8E+01
Pentanol, 1-	71-41-0	7.3E+02	1.2E-01
Pentanol, 4-methyl-2-	108-11-2	2.3E+02	9.5E-02
Pentanone, 2-	107-87-9	3.8E+02	1.5E-01
Pentyne, 1-	627-19-0	9.9E+02	2.2E-01
Perchlorate	14797-73-0	1.4E+01	2.6E-03
Perylene	198-55-0	3.1E+02	7.3E-02
Phenacetin	62-44-2	2.2E+02	3.9E-02
Phenanthrene	85-01-8	4.1E+02	1.1E-01
Phenanthridine	229-87-8	4.6E+01	1.1E-02
Phenol	108-95-2	4.6E+03	1.1E+00
Phenol, 4-tert-butyl-	98-54-4	7.7E+01	1.8E-02
Phenothiazine	92-84-2	1.7E+01	4.0E-03
Phenylene diamine, m-	108-45-2	9.3E+01	2.2E-02
Phenylene diamine, p-	106-50-3	2.9E+03	6.9E-01
Phenyl mercuric acetate	62-38-4	1.2E+00	2.9E-04
Phorate	298-02-2	1.6E+00	7.3E-04
Phosalone	2310-17-0	3.1E+01	7.3E-03
Phosdrin (mevinphos)	7786-34-7	3.9E-01	9.1E-05
Phosmet	732-11-6	3.1E+02	7.3E-02
Phosphine	7803-51-2	5.9E+00	1.1E-03
Phosphorus, total*	7723-14-0	---	---
Phosphorus, white	7723-14-0	4.0E-01	7.3E-05
Phthalic anhydride	85-44-9	3.1E+04	7.3E+00
Picloram	1918-02-1	1.1E+03	5.0E-01
Picoline, 2- (2-methylpyridine)	109-06-8	9.7E-01	3.3E-02
Polybrominated biphenyls (PBBs)	67774-32-7	5.5E-02	9.6E-06
Polychlorinated biphenyls (PCBs)	1336-36-3	1.0E+01[§]	5.0E-04
Potassium*	7440-09-7	---	---
Primene	68955-53-3	6.9E+01	2.2E-02
Prometon (pramitol)	1610-18-0	2.3E+02	5.5E-02
Pronamide	23950-58-5	1.2E+03	2.7E-01
Propanal (propionaldehyde)	123-38-6	5.3E+01	2.9E-02
Propanil	709-98-8	7.7E+01	1.8E-02

00113420

Last update: March 31, 2006

Risk-Based Screening Values			
Contaminant	CAS #	Soil (mg/kg)	Groundwater (mg/l)
Propanoic acid (propionic acid)	79-09-4	1.4E+04	1.8E+00
Propanol, 1-	71-23-8	7.0E+02	7.3E-01
Propargite	2312-35-8	3.1E+02	7.3E-02
Propargyl alcohol	107-19-7	5.5E+01	7.3E-03
Propazine	139-40-2	1.1E+01	1.9E-03
Propham	122-42-9	3.1E+02	7.3E-02
Propionitrile (propane nitrile)	107-12-0	4.3E+00	1.5E-03
Propyl acetate, n-	109-60-4	2.5E+03	3.3E-01
Propylbenzene, n-	103-65-1	3.2E+02	1.5E-01
Propylene glycol	57-55-6	3.1E+05	7.3E+01
Propylene glycol monomethyl ether	107-98-2	1.9E+04	2.6E+00
Propylene oxide	75-56-9	1.2E+00	3.5E-04
Propylene tetramer	6842-15-5	5.3E+02	3.7E-01
Prothiofos (Tokuthion)	34643-46-4	1.5E+00	3.7E-04
Pyrene	129-00-0	4.1E+02	1.1E-01
Pyridine	110-86-1	8.2E-01	3.7E-03
Quinoline	91-22-5	1.6E-01	2.8E-05
Ronnel	299-84-3	7.7E+02	1.8E-01
Safrole	94-59-7	1.5E+00	3.9E-04
Selenium	7782-49-2	1.3E+02	5.0E-02
Selenourea	630-10-4	1.4E+02	1.8E-02
Silver	7440-22-4	4.7E+01	1.8E-02
Simazine	122-34-9	4.1E+00	4.0E-03
Sodium*	7440-23-5	—	—
Sodium diethyldithiocarbamate	148-18-5	2.4E+00	3.2E-04
Sodium hypochlorite	7681-52-9	4.2E+03	7.7E-01
Sodium polyacrylate	9003-04-7	1.4E+04	1.8E+00
Strontium	7440-24-6	1.2E+04	2.2E+00
Strychnine	57-24-9	4.6E+00	1.1E-03
Styrene	100-42-5	1.3E+03	1.0E-01
Sulfate*	14808-79-8	—	—
Sulfide*	18496-25-8	—	—
Sulfolane	126-33-0	3.1E-01	7.3E-05
Sulfur*	7704-34-9	—	—
Tebuconazole	107534-96-3	4.6E+02	1.1E-01
Tebuthiuron	34014-18-1	1.1E+03	2.6E-01
Terbufos	13071-79-9	3.9E-01	9.1E-05
Tert-amyl-methyl ether (TAME)	994-05-8	2.9E+01	1.5E-01
Tert-butyl alcohol (2-methyl-2-propanol)	75-65-0	4.2E+02	3.3E-01
Tetrachlorobenzene, 1,2,3,4-	634-66-2	4.6E+00	1.1E-03
Tetrachlorobenzene, 1,2,3,5-	634-90-2	4.6E+00	1.1E-03
Tetrachlorobenzene, 1,2,4,5-	95-94-3	4.6E+00	1.1E-03
Tetrachloroethane, 1,1,1,2-	630-20-6	5.2E+00	3.3E-03
Tetrachloroethane, 1,1,2,2-	79-34-5	5.1E-01	4.3E-04
Tetrachloroethylene (perchlorethylene)	127-18-4	6.0E+00	5.0E-03
Tetrachlorophenol, 2,3,4,5-	4901-51-3	4.6E+02	1.1E-01
Tetrachlorophenol, 2,3,4,6-	58-90-2	4.6E+02	1.1E-01
Tetrachlorophenol, 2,3,5,6-	935-95-5	1.1E+01	1.1E-01
Tetrachlorvinphos (Stirophos)	22248-79-9	6.5E+02	1.5E-01
Tetradifon	116-29-0	3.1E+02	7.3E-02
Tetraethyl dithiopyrophosphate (sulfotep)	3689-24-5	7.7E+00	1.8E-03
Tetraethylene glycol	112-60-7	5.1E+03	1.2E+00
Tetraethyl lead	78-00-2	1.5E-03	3.7E-07
Tetrahydrofuran	109-99-9	5.4E+00	1.1E-02
Tetrahydropyran	142-68-7	8.5E+00	1.1E-02
Thallium and compounds (as thallium chloride)	7791-12-0	2.0E+00	2.0E-03
Thiofanox	39196-18-4	4.6E+00	1.1E-03
Thionazin	297-97-2	1.1E+00	2.6E-04
Thiophanate-methyl	23564-05-8	1.2E+03	2.9E-01
Thiram	137-26-8	7.7E+01	1.8E-02
Tin	7440-31-5	9.3E+03	2.2E+00

Last update: March 31, 2006

Risk-Based Screening Values			
Contaminant	CAS #	Soil (mg/kg)	Groundwater (mg/l)
Titanium	7440-32-6	3.8E+06	1.8E+03
Toluene	108-88-3	1.1E+03	1.0E+00
Toluenediamine, 2,4-	95-80-7	1.5E-01	2.7E-05
Toluenediamine, 2,6-	823-40-5	3.1E+03	7.3E-01
Toluene diisocyanate, 2,4/2,6-	26471-62-5	2.9E+01	---
Toluidine, o-	95-53-4	2.0E+00	3.5E-04
Toluidine, p-	106-49-0	2.6E+00	4.5E-04
Toxaphene	8001-35-2	4.4E-01	3.0E-03
TP Silvex, 2,4,5-	93-72-1	1.2E+02	5.0E-02
Triademenol	55219-65-3	4.6E+02	1.1E-01
Triallate	2303-17-5	2.0E+02	4.7E-02
Triaminotrinitrobenzene (TATB)	3058-38-6	1.6E+01	2.8E-03
Tributyltin oxide	56-35-9	4.6E+00	1.1E-03
Trichlorobenzene, 1,2,3-	87-61-6	4.2E+01	1.1E-02
Trichlorobenzene, 1,2,4-	120-82-1	1.4E+02	7.0E-02
Trichlorobenzene, 1,3,5-	108-70-3	3.7E+01	1.1E-02
Trichloroethane, 1,1,1-	71-55-6	2.3E+02	2.0E-01
Trichloroethane, 1,1,2-	79-00-5	9.7E-01	5.0E-03
Trichloroethylene	79-01-6	3.7E+00	5.0E-03
Trichlorofluoromethane	75-69-4	2.6E+02	1.1E+00
Trichloronate	327-98-0	4.6E+01	1.1E-02
Trichlorophenol, 2,3,4-	15950-66-0	1.5E+03	3.7E-01
Trichlorophenol, 2,3,5-	933-78-8	1.5E+03	3.7E-01
Trichlorophenol, 2,3,6-	933-75-5	1.5E+02	3.7E-01
Trichlorophenol, 2,4,5-	95-95-4	1.5E+03	3.7E-01
Trichlorophenol, 2,4,6-	88-06-2	4.4E+01	7.7E-03
Trichlorophenol, 3,4,5-	609-19-8	1.5E+03	3.7E-01
Trichlorophenoxyacetic acid, 2,4,5-	93-76-5	1.5E+02	3.7E-02
Trichloropropane, 1,1,2-	598-77-6	1.7E+01	1.8E-02
Trichloropropane, 1,2,3-	96-18-4	9.1E-02	1.2E-05
Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1	4.3E+03	1.1E+02
Triethanolamine	102-71-6	3.1E+03	7.3E-01
Triethylamine	121-44-8	3.7E+00	---
Triethylene glycol	112-27-6	4.6E+04	1.1E+01
Triethylphosphorothioate, O, O, O-	126-68-1	1.3E-01	3.0E-05
Trifluralin	1582-09-8	6.4E+01	1.1E-02
Trimethylamine	75-50-3	8.3E+00	---
Trimethylbenzene, 1,2,3-	526-73-8	8.6E+00	1.8E-01
Trimethylbenzene, 1,2,4-	95-63-6	9.6E+00	1.8E-01
Trimethylbenzene, 1,3,5-	108-67-8	8.3E+00	1.8E-01
Trinitrobenzene, 1,3,5-	99-35-4	4.6E+02	1.1E-01
Trinitrophenylmethylnitramine (tetryl; nitramine)	479-45-8	1.5E+02	3.7E-02
Trinitrotoluene, 2,4,6-	118-96-7	7.7E+00	1.8E-03
Uranium (soluble salts)	7440-61-1	7.6E+01	3.0E-02
Valeric acid (pentanoic acid)	109-52-4	7.7E+03	1.8E+00
Vanadium	7440-62-2	4.8E+01	2.6E-02
Vernam	1929-77-7	1.5E+01	3.7E-03
Vinyl acetate	108-05-4	5.7E+01	3.7E+00
Vinyl chloride	75-01-4	3.6E-02	2.0E-03
Vinylcyclohexane	695-12-5	6.0E+00	1.8E+00
Warfarin	81-81-2	4.6E+00	1.1E-03
Xylene, m-	108-38-3	2.3E+02	1.0E+01
Xylene, o-	95-47-6	3.3E+03	1.0E+01
Xylene, p-	106-42-3	2.7E+02	1.0E+01
Xylenes	1330-20-7	5.8E+01	1.0E+01
Zinc	7440-66-6	5.9E+03	1.1E+00
6 C aliphatics (TPH)	NA	1.5E+01	2.2E-01
>6-8 C aliphatics (TPH)	NA	3.0E+01	2.2E-01
>8-10 C aliphatics (TPH)	NA	3.1E+02	3.7E-01
>10-12 C aliphatics (TPH)	NA	5.3E+02	3.7E-01
>12-16 C aliphatics (TPH)	NA	8.2E+02	3.7E-01

Last update: March 31, 2006

Risk-Based Screening Values

Contaminant	CAS #	Soil (mg/kg)	Groundwater (mg/l)
>16-21 C aliphatics (TPH)	NA	3.1E+04	7.3E+00
>16-21 C, >21-35 C aliphatics (TPH) (for transformer mineral oil releases only)	NA	2.5E+04	5.8E+00
>7-8 C aromatics (TPH)	NA	3.7E+02	3.7E-01
>8-10 C aromatics (TPH)	NA	1.7E+02	1.5E-01
>10-12 C aromatics (TPH)	NA	2.7E+02	1.5E-01
>12-16 C aromatics (TPH)	NA	4.0E+02	1.5E-01
>16-21 C aromatics (TPH)	NA	4.1E+02	1.1E-01
>21-35 C aromatics (TPH)	NA	4.1E+02	1.1E-01

Footnotes

[a]The risk-based screening value for arsenic (20 mg/kg) is equivalent to the cleanup level established by the Executive Director (interoffice memo entitled "Arsenic Soil Cleanup Standards" from Dan Pearson on May 19, 1995).

[b]The MCL (and thus the risk-based screening value for groundwater) for total trihalomethanes (bromodichloromethane, bromoform, chloroform, and dibromochloromethane) is 0.08 mg/L. The total concentration of these COCs must not exceed 0.08 mg/L for these COCs to be eliminated from the baseline risk assessment using the risk-based screening approach.

[c]The risk-based screening value for cadmium also accounts for the vegetable ingestion pathway.

[d]The risk-based screening value for lead is based on values calculated by the USEPA using the Lead Uptake/Biokinetic Model.

[e]Note that much higher RBSVs for mercury may be obtained using a pH-dependent Kd based on site-specific information.

[f]The risk-based screening value for MTBE is based on taste and odor.

[g]The risk-based screening value for PCBs (10 mg/kg) is equivalent to the TSCA requirements.

*These compounds are not necessarily of concern from a human health standpoint, therefore calculation of human health-based values is not required. However, aesthetics and ecological criteria would still apply. See table entitled "Compounds for which Calculation of a Human Health MSC is Not Required" available on the TCEQ website at http://www.tceq.state.tx.us/remediation/rrr.html.