Shaw® Shaw Environmental, Inc.

Date: June 30, 2011

Project No.:133363

TRANSMITTAL LETTER:

To: Mr. Aaron Williams

Address: US Army Corps of Engineers - Tulsa

CESWT-PP-M

1645 South 101st East Ave

Tulsa, Oklahoma 74128

Re: Final Munitions Constituents Data Summary Report for South Test Area/Bomb Test Area, LHAAP-001-R and Ground Signal Test Area, LHAAP-003-R Longhorn Army Ammunition Plant

Contract No. W912QR-04-D-0027/DS02

For: Review ____ As Requested ____ Approval ____ Corrections ____ Submittal ____ Other X ____

Item No:	*No. of Copies*	*Date:*	*Document Title*
1	2	June 2011	**Final Munitions Constituents Data Summary Report for South Test/Bomb Test Area, LHAAP-001-R and Ground Signal Test Area, LHAAP-003-R, Longhorn Army Ammunition Plant, Karnack, Texas**

Aaron,
Enclosed are two copies of the above-named document. Copies have been distributed as indicated below. Please call with any questions or comments.

Sincerely:

John Elliott
Project Manager

CC: **Distribution List:**
Mr. J. Lambert – USACE, Tulsa (sent to A. Williams for distribution)
Ms. M. Plitnik – USAEC
Ms. Rose Zeiler – BRAC-LHAAP
Mr. S. Tzhone – EPA Region 6 (2)
Ms. F. Duke– TCEQ, Austin (2)
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DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

June 30, 2011

DAIM-ODB-LO

Ms. Fay Duke (MC-136)
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Remediation Division
Texas Commission on Environmental Quality
12100 Park 35 Circle, Bldg D
Austin, TX 78753

Re: Final 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, June 2011
SUP 126

Dear Ms. Duke,

The above-referenced document is being transmitted to you for your records.

The point of contact for this action is the undersigned. I ask that John Elliott, Shaw's Project Manager be copied on any communications related to the project. 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:
S. Tzhone, USEPA Region 6, Dallas, TX
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DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

June 30, 2011

DAIM-ODB-LO

Mr. Stephen Tzhone
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Superfund Division (6SF-AT)
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Dallas, TX 75202-2733

Re: Final 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, June 2011

Dear Mr. Tzhone,

The above referenced document is being transmitted to you for your records.

The point of contact for this action is the undersigned. I ask that John Elliott, Shaw's Project Manager, be copied on any communications related to the project. 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:
F. Duke, TCEQ, Austin, TX
D. Vodak, TCEQ, Tyler, TX
P. Bruckwicki, Caddo Lake NWR, TX
J. Lambert, USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
M. Plitnik, USAEC, TX
J. Elliott, Shaw – Houston, TX (for project files)

FINAL

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

Prepared for

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

Prepared by

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

Contract No. W912BV-07-D-2004, Task Order No. 0007
Shaw Project No. 133363

June 2011

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Acronyms and Abbreviations

BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	chemical of potential concern
CSM	conceptual site model
DNT	dinitrotoluene
DOD	Department of Defense
e^2M	engineering-environmental Management
Ebasco	Ebasco Services, Inc.
EE/CA	Engineering Evaluation/Cost Analysis
EPS	Environmental Protection Systems, Inc.
GW-Ind	groundwater MSC for industrial use
GWP-Ind	soil MSC for industrial use based on groundwater protection
HMX	high-molecular-weight RDX
HRR	historic records review
HTRW	hazardous, toxic, and radioactive waste
IRP	Installation Restoration Program
LHAAP	Longhorn Army Ammunition Plant
MC	munitions constituents
MCL	maximum contaminant level
MEC	munitions and explosives of concern
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm	millimeter
MMRP	Military Munitions Response Program
MPPEH	material potentially presenting explosive hazard
MRS	Munitions Response Sites
MSC	medium-specific concentration
NFA	no further action
OB/OD	open burn/open detonation
PCB	polychlorinated biphenyls
RDX	royal demolition explosive (hexahydro-1,3,5-trinitro-1,3,5-triazine)
RI	remedial investigation
ROD	Record of Decision
SI	site inspection
STEP	Solutions to Environmental Problems

Acronyms and Abbreviations (continued)

SVOC	semivolatile organic compound
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TNT	2,4,6-trinitrotoluene
USACE	U.S. Army Corps of Engineers
USAEC	U.S Army Environmental Center
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound
WP	white phosphorus

1.0 Introduction

This Munitions Constituent (MC) data summary was prepared by Shaw Environmental, Inc. for the U.S. Army Corps of Engineers (USACE), Tulsa District, under Contract No. W912BV-07-D-2004, Task Order No. 0007, and presents a compilation of MC data from previous investigations at Munitions Response Sites (MRS) Site 27 – South Test Area/Bomb Test Area (LHAAP-001-R) and Site 54 – Ground Signal Test Area (LHAAP-003-R) at the former Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas (**Figure 1-1**). This MC data summary for LHAAP-001-R and LHAAP-003-R was developed in response to the regulatory request that all MC data collected for the two MRS sites be compiled in one stand alone document. This report was generated based on information presented in previous investigations. It is noted that the MC Summary resummarizes metals and explosives, as well as other constituent data that were used to characterize risk for the IRP No Further Action (NFA) Record of Decision (ROD) that was approved in 1998 for both sites. Although the non-MC data is not relevant to the MC data set, it is included here because it is not easily extracted from the original data sets and evaluations. Perchlorate data for environmental media were collected at the two sites after the 1998 ROD was signed.

Data summary tables from previous investigation reports are attached to this report. The following conservative comparison criteria were utilized for evaluation of the data:

- Soil and sediment: Texas Commission on Environmental Quality (TCEQ) soil medium-specific concentrations (MSC) for industrial use based on groundwater protection (GWP-Ind) values. The GWP-Ind values were utilized instead of the soil MSC as a more conservative comparison criteria.
- Groundwater: maximum contaminant levels (MCLs) and, where not available, TCEQ groundwater MSC for industrial use (GW-Ind)
- Surface water: MCLs and, where not available, Texas surface water quality standards since Caddo Lake is a drinking water source

Although this MC data summary confirms the determination of no risk to human health or the environment in soil as identified in the Engineering Evaluation/Cost Analysis (EE/CA) (CAPE, 2007), additional groundwater sampling conducted by EPA in 2009 resulted in some uncertainty with regard to MC in groundwater (USEPA, 2010). Both metals and perchlorate were detected above screening levels by EPA, although the single exceedance of the perchlorate GW-Ind in a well at LHAAP-001-R was not confirmed by U.S. Army's split sample result. USEPA, TCEQ, and U.S. Army have agreed to address the metals constituents in the groundwater as stated in the U.S. Army letter dated March 10, 2011 under the 1998 IRP RODs (U.S. Army, 2011, USEPA, 2011).

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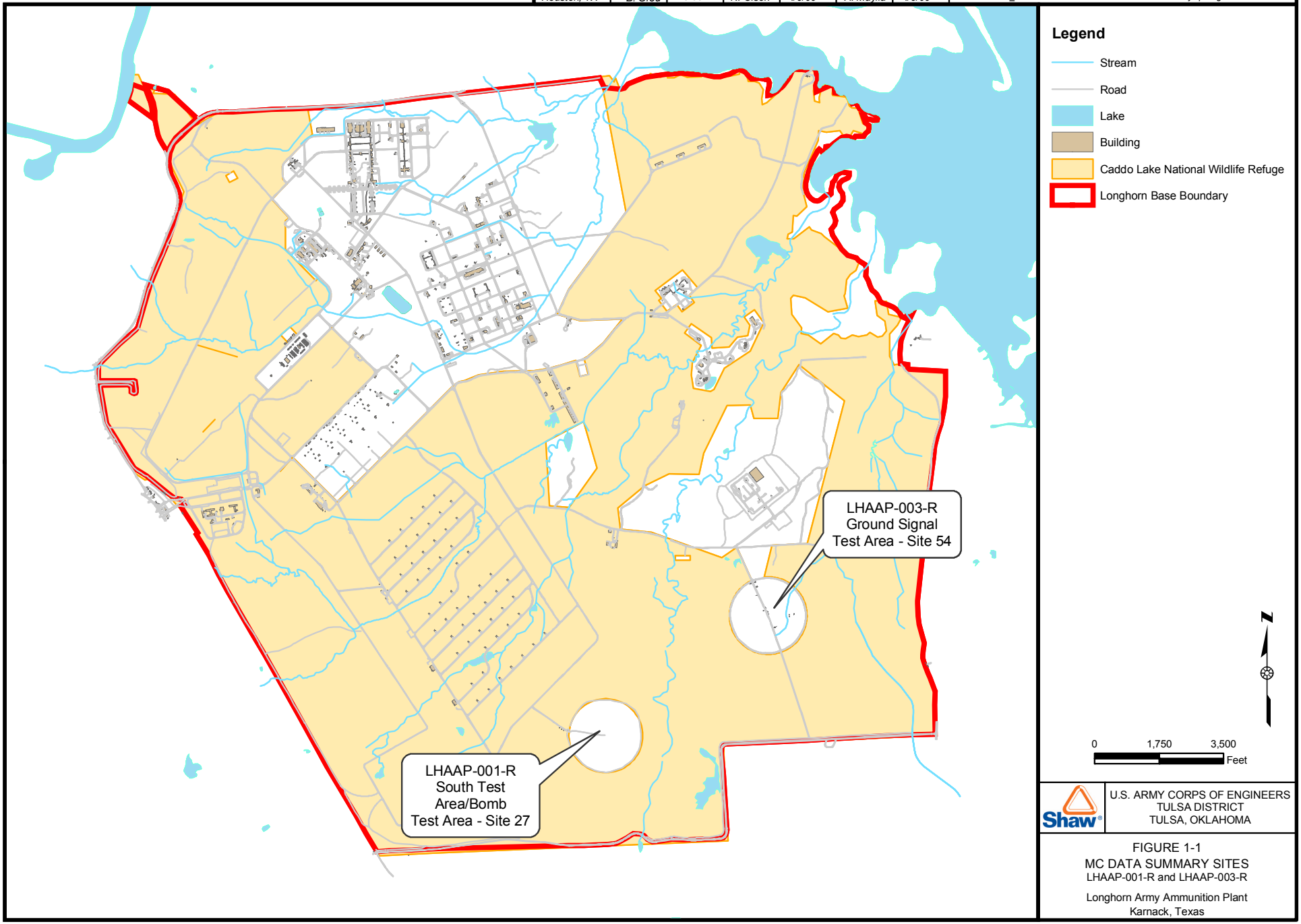

Legend

- Stream
- Road
- Lake
- Building
- Caddo Lake National Wildlife Refuge
- Longhorn Base Boundary

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Shaw

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

FIGURE 1-1
MC DATA SUMMARY SITES
LHAAP-001-R and LHAAP-003-R

Longhorn Army Ammunition Plant
Karnack, Texas

2.0 The South Test Area/Bomb Test Area, LHAAP-001-R

2.1 Site Description and History

The Site 27 – South Test Area/Bomb Test Area (LHAAP-001-R) is approximately 79 acres and located southeast of Avenue P and the magazine area at the end of 70th Street, near the southern boundary of LHAAP (**Figure 1-1**). The site was identified in the U.S. Army Closed, Transferring, and Transferred 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 USACE and U.S. Army Environmental Center (USAEC) indicate the site should be 79 acres including Demolition Sub Areas 1, 2 and 3.

The South Test Area/Bomb Test Area is co-located with the Installation Restoration Program (IRP) site LHAAP-27 for which a NFA ROD under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for Hazardous, Toxic, and Radioactive Waste (HTRW) was signed with regulatory concurrence in January 1998 (USACE, 1998).

The South Test Area/Bomb Test Area 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 was a small (approximately 1- by 1.25-inch) anti-intrusion mine also referred to as a "Gravel" Mine, which exploded on impact. Leaking white phosphorus (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.

Based on the visual confirmation of Munitions and Explosives of Concern (MEC), the South Test Area/Bomb Test Area was identified as an MEC area of concern. Based on the potential

presence of WP and to address the WP data gap, the South Test Area/Bomb Test Area was also identified as a MC area of concern.

2.2 Previous Environmental Investigations

Environmental media including soil, groundwater, surface water, and sediment have been sampled and analyzed to identify potential contamination, including site-related MC. Investigations were conducted during the environmental contamination survey, multiple phases of the remedial investigation (RI), basewide perchlorate investigation, contaminants investigation, site inspection (SI), and the EE/CA. The on-site sample locations are shown on **Figures 2-1** and **2-2**. **Tables 2-1, 2-2,** and **2-3** provide the maximum concentrations of contaminants in soil, groundwater, surface water, and sediment, respectively, at the site. Data summary tables from previous investigation reports are included in **Appendix A**. In response to U.S. Environmental Protection Agency's (USEPA) comments on the Draft MC Summary Report, tables listing all parameters analyzed for each previous sampling event, including associated analytical methods and detection limits, are also included in **Appendix A**.

2.2.1 Environmental Contamination Survey

In 1982, the site was investigated by EPS for U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) (EPS, 1984).

2.2.1.1 Soil Investigation

Three surface soil samples (0401, 0402, and 0403) were collected and analyzed for metals, explosives, and anions. Chromium and lead were detected at maximum concentrations of 16.3 and 26.3 milligrams per kilograms (mg/kg) which exceeds their GWP-Ind values of 10 and 1.5 mg/kg, respectively. All other metals were detected at concentrations lower than their respective GWP-Ind values and at levels similar to background values. 2,4,6- trinitrotoluene (TNT) was detected in the surface soil samples from locations 0401 and 0402 at concentrations of 10,150 and 4,610 micrograms per kilogram (µg/kg), respectively. The TNT concentration of 10,150 µg/kg at sample location 0401 exceeded the GWP-Ind value of 5,100 µg/kg. Reference **Appendix A**, Pages A-1 and A-2, Tables 11-1 and 11-1b, respectively.

2.2.1.2 Groundwater Investigation

Two monitoring wells (MW-131 and MW-132) were installed and groundwater samples were collected from the wells. The water samples from both wells were analyzed for metals, explosives, and anions. In addition, groundwater from well MW-131 was analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and pesticides. Except for cadmium and thallium, all other metals were detected at concentrations lower than their respective GW-Ind values or the MCLs. Cadmium and thallium were detected at maximum concentrations of 0.009 and 0.1 milligrams per liter (mg/L) above their MCL of 0.005 and

0.002 mg/L, respectively. Ethylene glycol and di-n-butylphthalate were the only SVOCs detected at concentrations of 24 and 52 micrograms per liter (µg/L), respectively, in well MW-131. Both detected SVOCs were below their respective GW-Ind values. Phthalates are a common laboratory contaminant. No VOCs or explosives were detected. Reference **Appendix A**, Pages A-17 and A-18 through A-21, Tables 11-6 and 11-6b, respectively.

2.2.2 Phase I Remedial Investigation

In 1993, Ebasco Services, Inc. (Ebasco), completed a Phase I RI. Soil, groundwater, surface water, and sediment samples were collected during the RI activities (Ebasco, 1993).

2.2.2.1 Soil Investigation

Ten borings, 27SB30 through 27SB39, were completed at the site and 20 soil samples were collected from the borings. Soil samples were collected from several depth intervals ranging from the surface to 8 feet below the ground surface (bgs). In addition, four surface soil samples (SS01 through SS04) were collected from the four cratered areas west of the test pad to identify contaminants from detonated explosives. All soil samples were analyzed for metals, VOCs, SVOCs, explosives, and anions. Additionally, samples from six borings were analyzed for pesticides and herbicides.

Soil analytical results indicated that three metals; arsenic, chromium, and lead at maximum concentrations of 2.3, 22.2, and 9 mg/kg were detected in soil samples at above their respective GWP-Ind values of 1, 10, and 1.5 mg/kg, respectively. Except for two phthalates; bis(2-ethylhexyl)phthalate and di-n-butylphthalate detected in a few soil samples and at concentrations that were lower than their respective GWP-Ind values, no other SVOCs were detected. Phthalates are a common laboratory contaminant. No VOCs, explosives, pesticides, or herbicides were detected. Reference **Appendix A**, Pages A-4 through A-8 and A-9 through A-11, Tables 11-2 and 11-2b, respectively.

2.2.2.2 Groundwater Investigation

Groundwater samples were collected from existing monitoring wells MW-131 and MW-132. Groundwater from the wells was analyzed for metals, VOCs, SVOCs, explosives, and anions. Groundwater analytical results indicated that barium was the only metal detected at 0.25 mg/L. This concentration is well below the barium MCL of 2 mg/L. No VOCs, SVOCs, or explosives were detected. Reference **Appendix A**, Pages A-17 and A-18 through A-21, Tables 11-6 and 11-6b, respectively.

In addition, ten groundwater grab samples (27GG30 through 27GG39) were collected from the soil borings. Samples were collected from the borings to obtain preliminary field screening data for potential contaminants in groundwater underlying the site. Groundwater grab samples were analyzed for explosives, anions, total organic halogens, and total organic carbon. Analytical

results indicated that nitrobenzene and royal demolition explosive [(hexahydro-1,3,5-trinitro-1,3,5-triazine) (RDX)] at concentrations of 6.58 and 18.4 µg/L, respectively, were detected in sample 27GG33, collected from the boring located in the cratered hillocks west of the test pad. Both nitrobenzene and RDX were detected at concentrations that were below their respective GW-Ind values of 51.1 and 3,100 µg/L, respectively. Reference **Appendix A**, Page A-22, Paragraph 1.

2.2.2.3 Surface Water and Sediment Investigation

Four surface water and four sediment samples were collected from site drainage ditch locations (SW/SD03 and SW/SD04) (**Figure 2-1**) and Harrison Bayou (SW/SD02 and SW/SD05) (**Figure 2-2**). Surface water and sediment samples were analyzed for metals, VOCs, SVOCs, explosives, and anions. Results indicated that metals were detected sporadically in both surface water and sediment samples. The two metals detected in surface water, barium and lead, were both at concentrations that were below comparison criteria. Out of the seven metals detected in sediment samples, only three metals: arsenic, barium, and lead were detected at maximum concentrations of 1.1, 254, and 9 mg/kg that were above their respective GWP-Ind values of 1, 200, and 1.5 mg/kg, respectively. Except for di-n-butylphthalate in two of the sediment samples at concentrations lower than the GWP-Ind, all other SVOCs were below detection limits in both surface water and sediment samples. Phthalates are a common laboratory contaminant. No VOCs or explosives were detected in surface water and sediment samples. Reference **Appendix A**, Pages A-24, A-25 through A-27, A-28, and A-29 through A-31, Tables 11-8, 11-8b, 11-9, and 11-9b, respectively.

2.2.3 Phase II Remedial Investigation

In 1994, Sverdrup completed a Phase II RI. Soil and groundwater samples were collected from the site (Sverdrup, 1995).

2.2.3.1 Soil Investigation

Because explosives were detected in a groundwater grab sample from boring 27SB33, four additional soil borings were installed in the vicinity and completed as monitoring wells (27WW01 through 27WW04). A total of 12 soil samples were collected from the soil borings. Soil samples were analyzed for metals, explosives, and anions. Arsenic, barium, chromium, and lead were detected at maximum concentrations of 5.2, 639, 15.4, and 12.6 mg/kg that were above their respective GWP-Ind values of 1, 200, 10, and 1.5 mg/kg, respectively. No explosives were detected. In addition, three surface soil samples (27SS21, 27SS22, and 27SS23) were collected and analyzed for chromium and mercury. Only chromium was detected at a maximum concentration of 10.6 mg/kg (27SS21), slightly above the GWP-Ind value of 10 mg/kg in the surface soil samples. Reference **Appendix A**, Pages A-12, A-13, and A-14, Tables 11-3, 11-4 and 11-4b, respectively.

2.2.3.2 Groundwater Investigation

Groundwater samples were collected from each of the newly installed monitoring wells. The water samples were analyzed for metals, SVOCs, explosives, and anions. All metals were detected at concentrations below their respective MCLs. No explosives or SVOCs were detected. Reference **Appendix A**, Pages A-22 and A-23, Tables 11-7 and 11-7b, respectively.

2.2.4 Risk Assessment

In 1997 USACE conducted a baseline risk assessment to support site management decisions for the site. Potential human health and ecological impacts resulting from contaminant releases at the site in the absence of remediation were evaluated. Chemicals of potential concern (COPCs) evaluated included metals present in both site soils and ditch sediments. COPCs in groundwater included metals within background ranges and below drinking water standards except for nickel that exceeded its MCL. No organics were detected in any medium at the site. For human health evaluation, carcinogenic risk estimates were well within the acceptable range at 1×10^{-7} and 3×10^{-5} for current recreational and future industrial land uses, respectively. Non-cancer hazard indices were below the critical value of 1.0 at 1×10^{-2} (current land use) and 6×10^{-1} (future industrial land use). Despite elevated concentrations of nickel in groundwater, exposure to this metal via groundwater ingestion was a minor contributor to overall non-carcinogenic risk (hazard quotient of 0.13). Based on these results, no unacceptable risks to human health were identified for the South Test Area/Bomb Test Area (USACE, 1997).

Screening-level ecological risks for the site were driven solely by metals present in soil at concentrations approximating background values. Four metals: barium, chromium, lead, and nickel were identified as main contributors to screening level risk estimates. Based on these conservative analyses, no ecological concerns were associated with the site and further ecological evaluations and remediation are unwarranted.

2.2.4.1 Supplemental Soil Sampling and Risk Characterization

In August 1996, the USACE collected surface soil samples from nine locations (RASS27-01 through RASS27-09) in support of the risk assessment for the site. The nine surface soil samples were collected from an elevated "pad" area formerly used in testing photo flash bombs at the site. The area covers approximately one-third of an acre and is located in the vicinity of former soil boring 0402 (**Figure 2-1**). As the area represents a potential location for accumulation of surface contaminants, the primary objective was to evaluate this limited area as a potential "hot spot" for human exposure and to evaluate the potential for explosives, in particular TNT, in surface soils at this location. Additionally, these samples were collected to evaluate the similarity between chemical concentrations in 0- to 6-inch-soil-depths and slightly deeper depths utilized in original risk evaluations and expansions of the numbers of metals used in risk characterization. The soil samples were analyzed for explosives including 2,4,6-TNT. In

addition, samples from four locations (RASS27-02, RASS27-04, RASS27-06, and RASS27-08) were analyzed for 11 metals (arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, antimony, and thallium). In February 1997, surface soil samples were collected at the four locations (RASS27-02, RASS27-04, RASS27-06, and RASS27-08) and analyzed for 12 metals (aluminum, beryllium, calcium, cobalt, copper, iron, potassium, manganese, magnesium, strontium, vanadium and zinc). The sampling was initiated to support additional human health risk characterization for a limited area identified during the original risk assessment results as a potential "hot spot" area for human exposure.

Soil analytical results (**Appendix A**, Page A-44, Table 4A-1) indicated that metals including arsenic (13.1 mg/kg), beryllium (1.16 mg/kg), and chromium (36.3 mg/kg) were detected at concentrations that were generally higher than those of previous sampling events and above their respective GWP-Ind values, while barium (123 mg/kg) and nickel (2.41 mg/kg) levels were lower than those of previous sampling events and lower than their respective GWP-Ind values of 200 and 204.4 mg/kg, respectively. Vanadium was detected at a maximum concentration of 72.4 mg/kg, slightly above the GWP-Ind value of 72 mg/kg. No explosive compounds were detected in any soil samples from the area. Reference **Appendix A**, Pages A-15 and A-16, Tables 11-5 and 11-5b, respectively.

While risk calculations based on the additional sampling at the limited site area were higher than original estimates for the site as a whole, all estimates were within acceptable risk ranges. For human health evaluation, carcinogenic risk estimates of 3×10^{-6} and 5×10^{-5} were obtained for current recreational and future industrial land uses, respectively. Non-cancer hazard indices were below the critical value of 1.0 at 9×10^{-2} (current land use) and 9×10^{-1} (future industrial land use). The additional risk evaluation substantiated conclusions of the original assessment and failed to support the need for site remediation for protection of human health (USACE, 1997).

Based on the results of the investigations and the risk assessment, a no further action ROD under CERCLA for HTRW was signed with regulatory concurrence in January of 1998 for LHAAP-001-R.

2.2.5 Perchlorate Investigation

2.2.5.1 Soil

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 feet and 1 to 2 feet bgs. Perchlorate was detected in only one of the 26 soil samples at a concentration of 28.9 µg/kg, a level lower than the GWP-Ind value of 7,200 µg/kg. Reference **Appendix A**, Pages A-32 and A-34, Tables 1-17 and 1-18b, respectively.

2.2.5.2 Groundwater

During three consecutive quarterly sampling events, groundwater samples were collected from existing shallow monitoring wells to determine whether perchlorate contamination had occurred 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 GW-Ind value of 72 µg/L. No MCL exists for perchlorate. Perchlorate concentrations were below detection limits in all the six monitoring wells 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. Reference **Appendix A**, Pages A-33 and A-34, Tables 1-18 and 1-18b, respectively.

2.2.6 U.S. Fish and Wildlife Investigation

In March 2003, U.S. Fish and Wildlife Service (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-55, FWS-56, FWS-58, FWS-63, and FWS-201) within the South Test Area/Bomb Test Area. Soil analytical results indicated that metals and SVOCs were detected at low concentrations, and the site was not included as one of the areas requiring further evaluation. Perchlorate was not detected above the reporting limit. Reference **Appendix A**, Pages A-35 through A-37 and A-38 through A-43, Tables 2 and 2b, respectively.

2.2.7 Military Munitions Response Program Site Inspection

Between 2002 and 2004, a Military Munitions Response Program (MMRP) SI was conducted for the South Test Area/Bomb Test Area to determine the presence or absence of MEC and/or MC at the site which may have remained from activities conducted by the Department of Defense (DOD) during operations of the MRS, and may pose a threat to human health and/or the environment (engineering-environmental Management [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 the South Test Area/Bomb Test Area. This area was reportedly designed for detonation of dangerous/unserviceable ammunition.
- Spent flares, a 155 millimeter (mm) WP projectile, shrapnel from photoflash bombs, and ordnance related scrap found on the site during site visits.

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.

2.2.8 Engineering Evaluation/Cost Analysis

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 MC data gaps at the site. Soil samples were collected within the South Test Area/Bomb Test Area to determine if evidence of WP existed, and to determine the presence of MC in areas where MC was most likely to exist based on the heaviest Material Potentially Presenting Explosive Hazard (MPPEH) concentrations or historical detonations. One soil sample was collected near the center of the open burn/open detonation area. A second soil sample was collected in a scarred area identified as the photo flash cartridge disposal area in the historical review. Both areas are located 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 no WP and MC constituents (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, high-molecular-weight RDX [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 MC in any of the pre- or post-detonation samples. The removal action objective of protection of human health from MC at unacceptable concentrations had been achieved as demonstrated by the soil analytical results. Reference **Appendix A**, Page A-45, Table 3.

2.2.9 October 2009 Groundwater Confirmation Sampling

2.2.9.1 USEPA Region 6 Confirmation Sampling

In October 2009, USEPA collected additional groundwater samples from the existing six monitoring wells (MW-131, MW-132, 27WW01 through 27WW04) to confirm groundwater conditions at the site. The groundwater was analyzed for metals, explosives and perchlorate. Groundwater analytical results indicated that except for 2-amino-4,6-DNT, no other explosives

were detected in the groundwater samples. 2-amino-4,6-DNT was detected in monitoring well 27WW04 at a concentration of 0.14J µg/L, which is well below the GW-Ind value of 17.03 µg/L. Perchlorate was detected in three wells, MW-132, 27WW02, and 27WW03 at concentrations of 2.6, 3.2, and 76 µg/L, respectively. Perchlorate detected in monitoring well 27WW03 was slightly above the GW-Ind value of 72 µg/L.

Except for beryllium, chromium, and manganese, all other metals were detected at concentrations lower than their respective MCLs or GW-Ind values. Beryllium was detected at concentrations of 0.00454 mg/L in well 27WW02 and 0.0251 mg/L in well 27WW03 and chromium was detected at a concentration of 0.122 mg/L in well 27WW02 above their respective MCLs of 0.004 and 0.1 mg/L, respectively. Manganese was detected at a concentration of 24.8 mg/L in well 27WW03 above the GW-Ind value of 14.3 mg/L. Reference **Appendix A**, Pages A-46 through A-47 and A-48, Tables A-1 and A-1b, respectively.

2.2.9.2 U.S. Army Confirmation Split Sampling

The U.S. Army collected split samples at the same time that the USEPA collected additional groundwater samples from the existing six monitoring wells (MW-131, MW-132, and 27WW01 through 27WW04). The groundwater was analyzed for metals, explosives and perchlorate. Groundwater analytical results indicated that no explosives were detected in any of the groundwater samples. Perchlorate was detected in two of the wells, 27WW02 and 27WW03, at concentrations of 3.4 and 50 µg/L, respectively. Both levels were below the GW-Ind value of 72 µg/L.

Except for beryllium, chromium, and manganese, all other metals were detected at concentrations lower than their respective MCLs or GW-Ind values. Beryllium and chromium were detected at concentrations of 0.0194 in well 27WW03 and 0.119 mg/L in well 27WW02 above their MCLs of 0.004 and 0.1 mg/L, respectively. Manganese was detected at a concentration of 27.9 mg/L in well 27WW03 above the GW-Ind value of 14.3 mg/L. Reference **Appendix A**, Pages A-49 through A-50 and A-51, Tables A-2 and A-2b, respectively.

USEPA Region 6 groundwater confirmation analytical results were comparable to the U.S. Army split sample results. Although the USEPA detected one explosive in one groundwater sample, whereas the U.S. Army did not, the explosive was at an estimated concentration that was well below its GW-Ind value. The three metals that were detected at concentrations above their respective MCLs or GW-Ind values were detected by both USEPA and U.S. Army in the same wells and at comparable concentrations. Perchlorate was also detected at comparable concentrations in both USEPA and U.S. Army samples.

2.3 Media Investigation Summary and Contaminant Assessment

Data presented in previous investigations and the risk assessment for the site indicate that compounds detected in soil, groundwater, surface water, and sediment pose no risk to human health or the environment.

2.3.1 Soil

Between 1982 and 2003 a total of 86 surface and subsurface soil samples were collected for characterization of constituents of concern in the soil at the site. Samples were collected from all areas of the site with special emphasis on likely source areas; the open pit burning and explosive detonation area and the test pad area formerly used in testing photo flash bombs. Eight metals including aluminum (10,300 mg/kg), arsenic (13.1 mg/kg), barium (639 mg/kg), beryllium (1.16 mg/kg), cadmium (21 mg/kg), chromium (36.3 mg/kg), lead (26.3 mg/kg), and vanadium (72.4 mg/kg) were detected at levels above their respective GWP-Ind values, all other metals were detected at concentrations below their GWP-Ind values and approximating background values. Despite the common detection of metals during the multiple sampling events, none of the metals was determined to have an unacceptable risk to human health or the environment.

Although in 1982, 2,4,6-TNT was detected in two surface soil samples, no explosives were detected in any of the surface or subsurface soil samples collected in subsequent multiple sampling events at the site. The presence of explosives, the most likely contaminant at the site was not confirmed.

Except for the detection of bis(2-ethyhexyl)phthalate and di-n-butyl phthalate in a limited number of soil samples, and at concentrations lower than GWP-Ind values, other SVOCs were not detected in soil samples. Phthalates are common plasticizers, and a common laboratory contaminant. No VOCs, pesticides, or herbicides were detected.

Eighteen of the surface soil samples (0 to 0.5 feet) and 13 subsurface soil samples (1 to 2 feet) were analyzed for perchlorate at the 18 locations indicated on **Figure 2-1**. The sample locations are spread across the entire site. Perchlorate was detected in one of the 31 samples. The concentration was 28.9 µg/kg, well below the GWP-Ind value of 7,200 µg/kg.

An additional two soil samples were collected during the EE/CA field activities (2006) to determine the presence of WP and if MC existed in areas where MC was likely to exist based on heaviest MPPEH: near the center of the open burn/open detonation area and a scarred area previously noted as photo flash cartridge disposal area. No WP or MC was identified in the soil samples and there was no indication of the presence of MC in any pre- or post-detonation samples.

Table 2-4 presents the media investigation summary including the number of soil samples collected during each sampling event.

2.3.2 Groundwater

From 1982 through 2001, a total of 24 groundwater samples were collected from monitoring wells and an additional 10 water samples were grab samples collected from soil borings installed at the site for identification of constituents of concern in the underlying groundwater. Groundwater analytical results from multiple sampling events indicated that cadmium and thallium, were the only metals detected above their MCLs. Despite the common detection of metals during the multiple sampling events, none of the metals was determined to have an unacceptable risk to human health or the environment.

In October 2009, groundwater samples were collected from six monitoring wells by both the USEPA and the U.S. Army for confirmation of groundwater conditions at the site. Initial detections of cadmium and thallium above their MCLs were not confirmed by the sampling. Except for beryllium, chromium and manganese, all the other metals were detected at concentrations below their respective MCLs or GW-Ind values.

Except for a single detection each of ethylene glycol and di-n-butyl phthalate during the initial sampling event in 1982, there were no detections of VOCs or SVOCs in groundwater samples in subsequent sampling events. Phthalates are a common laboratory contaminant. No pesticides were detected.

In 1993, explosives nitrobenzene, and RDX, were detected in one groundwater grab sample collected from a boring located west of the test pad, but at levels below their respective GW-Ind values. To further investigate the potential for explosive contamination in the area, four wells were installed and sampled. No explosives were detected in any soil or groundwater samples collected from the newly installed wells.

The USEPA groundwater confirmation sampling detected the presence of 2-amino-4,6-DNT in only one well at a concentration of 0.14 J µg/L, well below the GW-Ind value of 17.03 µg/L. No explosives were detected in any of the six U.S. Army split samples. Reference **Appendix A**, Pages A-49 and A-50, Table A-2. Both the previous and the October 2009 data indicate that explosives, the most likely contaminants at the site, are not of concern in the South Test Area/Bomb Test Area.

Sixteen of the groundwater samples were collected from 6 wells from April 2000 through February 2001. Perchlorate was detected in two of four wells during the first quarter sampling event, with a maximum concentration of 52.6 µg/L, below the GW-Ind value of 72 µg/L. The initial detections of perchlorate in groundwater were not confirmed in subsequent sampling. During the second and third quarter sampling events, no perchlorate was detected in any of the

samples. Perchlorate was also not detected in October 2009 in the two wells with perchlorate detections in the April-May 2000 first quarter sampling event.

Perchlorate was detected in three of the wells during the October 2009 sampling event. In monitoring well 27WW03, the USEPA analytical results indicated that perchlorate was detected at a concentration of 76 µg/L, slightly above the GW-Ind value of 72 µg/L. The U.S. Army analytical results indicated that perchlorate was detected in the same monitoring well (27WW03) at a concentration of 50 µg/L, a level below the GW-Ind value of 72 µg/L.

Table 2-4 presents the media investigation summary including the number of groundwater samples collected during each sampling event.

2.3.3 Surface Water and Sediment

A total of four surface water and four sediment samples were collected from drainage ditch locations and Harrison Bayou. Metals were detected sporadically in both surface water and sediment samples. All metals were below comparison criteria in surface water. Except for arsenic, barium, and lead that were detected in sediment samples at concentrations above their respective GWP-Ind, other metals were detected at low concentrations approximating background values. Except for di-n-butylphthalate in two of the sediment samples and at concentrations below comparison criteria, all other SVOCs were below detection limits in both surface water and sediment samples. Phthalates are a common laboratory contaminant. No VOCs or explosives were detected in surface water or sediment samples.

Table 2-4 presents the media investigation summary including the number of surface and sediment samples collected during the RI. Summary results from the Final Installation-Wide Baseline Ecological Risk Assessment (BERA) (Shaw, 2007) 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.

2.4 Conclusion

With the exception of the 2009 EPA groundwater sampling, the results of the multiple investigations presented above indicated that no contaminants of concern were identified in soil, groundwater, surface water, and sediments at the site. The human health risk assessment evaluation of potential migration pathways for potential receptors indicated that carcinogenic risk estimates were within the acceptable range at 1×10^{-7} and 3×10^{-5} for current recreational and future industrial land uses, respectively. Non-cancer hazard indices were below the critical value of 1.0 at 1×10^{-2} (current land use) and 6×10^{-1} (future industrial land use). Based on the evaluation, no unacceptable risks to human health were identified for the site. The screening-level ecological risk evaluation indicated that there are no ecological concerns associated with

the site and that further evaluations and remediation are unwarranted. Summary results from the Final Installation-Wide BERA (Shaw, 2007) 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, no WP or MC was identified in any soil samples and there was no indication of the presence of MC in any pre- or post-detonation samples. Results from the October 2009 confirmation sampling, further confirms that explosives are not a concern at the site. Therefore, this MC data summary confirms the determination of no risk to human health or the environment as identified in the EE/CA for the South Test Area/Bomb Test Area, LHAAP-001-R.

For perchlorate, the soil data is spread across the entire site. Perchlorate was detected in one of 31 samples, at a concentration of 28.9 µg/kg, well below the GWP-Ind value of 7,200 µg/kg. The groundwater data was collected from 6 locations that characterize the flow in and from the area of highest potential impact. A total of 16 groundwater samples were collected from 6 wells from April 2000 through February 2001. Two initial detections of perchlorate (27WW01 and 27WW04), both below the GW-Ind value of 72 µg/L, were not confirmed in the subsequent sampling events nor during the October 2009 USEPA and U.S. Army confirmation sampling event. Perchlorate was detected in three other monitoring wells (MW-132, 27WW02, and 27WW03) during the October 2009 sampling event. In two of the monitoring wells (MW-132 and 27WW02) perchlorate was at concentrations well below the GW-Ind value. In the third monitoring well (27WW03), the USEPA analytical results indicated that perchlorate was detected at a concentration of 76 µg/L slightly above the GW-Ind value of 72 µg/L. The USEPA detection was an estimated value from a diluted sample and elevated reporting limit using analytical method 314 (ion chromatography). For the same monitoring well, the U.S. Army split sample results indicated that perchlorate was at a concentration of 50 µg/L, a level below the GW-Ind value of 72 µg/L. The U.S. Army used analytical method 6850 for detection of perchlorate in this well which is the preferred method due to mass spectrometry's superior selectivity for the perchlorate ion. The U.S. Army result reflects closely previous detected levels for the site. Historically, the maximum detected perchlorate concentration at the site was 52.6 µg/L in well 27WW01 which is comparable to the level detected in monitoring well 27WW03. During the August-October 2000 sampling event, perchlorate was below the detection limit in monitoring well 27WW03. No well has seen repeat detections of perchlorate at the site. The two monitoring wells that have had the highest detections of perchlorate, 27WW01 and 27WW03 at 56.2 and 50 µg/L, respectively, are the farthest up-gradient wells within the open burn/open detonation (OB/OD) area. The wells 27WW02 and 27WW04, that are located down-gradient (north-northeast of 27WW01 and 27WW03), have been with no detection of perchlorate with the exception of one detection each at 3.4 µg/L (2009) and 16.4 µg/L (2000), respectively.

All previous soil data from across the site indicate that there is no known source of perchlorate in soil and therefore, there is no potential source of perchlorate contamination to the underlying groundwater. Furthermore, historical data trends show that the previous groundwater perchlorate detections were not duplicated in the same wells by subsequent sampling, indicating that the detections are single isolated occurrences. The single exceedance of the GW-Ind of 72 µg/L was an estimated result from a diluted sample and was not confirmed by U.S. Army's split sample result. U.S. Army's data support the conclusion that perchlorate is not a contaminant of concern at the South Test Area/Bomb Test Area. However, to address the uncertainty arising from the exceedance of the perchlorate GW-Ind in 27WW03 in USEPA's data set, it is recommended that limited sampling for perchlorate be conducted. USEPA, TCEQ. and U.S. Army have agreed to address the 2009 metals exceedances in the groundwater under a path separate from the MMRP. U.S. Army will address the metals constituents in the groundwater as stated in the U.S. Army letter dated March 10, 2011 under the 1998 IRP ROD (U.S. Army, 2011).

Table 2-1
Summary of Detected Constituents in Soil
South Test Area/Bomb Test Area, LHAAP-001-R

Analyte Detected	Maximum Concentration	TCEQ GWP-Ind
SVOCs (µg/kg)		
Di-n-butylphthalate *	2,610	1,000,000
Bis(2-ethylhexyl)phthalate *	380	600
Explosives (µg/kg)		
2,4,6-TNT	10,150	5,100
Metals (mg/kg)		
Aluminum	10,300	10,220
Arsenic	13.1	1
Barium	639	200
Beryllium	1.16	0.4
Cadmium	21	0.5
Calcium	809	NA
Chromium	36.3	10
Copper	41.1	130
Iron	70,000	NA
Lead	26.3	1.5
Magnesium	635	NA
Manganese	223	1431
Mercury	0.08	0.2
Nickel	18.6	204.4
Potassium	513	NA
Selenium	0.83	5
Strontium	16.8	6132
Vanadium	72.4	72
Zinc	41.3	3066
Perchlorate (µg/kg)	28.9	7200

Notes and Abbreviations:

*common laboratory contaminant

GWP-Ind - soil MSC for industrial use based on groundwater protection

mg/kg - milligrams per kilogram

NA - Not Available

SVOC - semivolatile organic compound

TCEQ - Texas Commission on Environmental Quality

TNT - trinitrotoluene

µg/kg - micrograms per kilogram

Table 2-2
Summary of Detected Constituents in Groundwater
South Test Area/Bomb Test Area, LHAAP-001-R

Analyte Detected	Maximum Concentration		TCEQ GW-Ind	MCL
	US Army	USEPA		
VOCs (µg/L)				
Ethylene glycol	24		204,400	
SVOC (µg/L)				
Di-n-butylphthalate *	52		10,220	
Explosives (µg/L)				
Nitrobenzene**	6.58		51.1	
RDX**	18.4		3100	
2- Amino-4,6-dinitrotoluene		0.14 J	17.03	
Metals (mg/L)				
Aluminum	7.32		102.2	
Antimony		0.000134 J		0.006
Arsenic	0.006			0.01
Barium	0.25			2
Berryllium	0.0194	0.0251		0.004
Cadmium	0.009			0.005
Chromium	0.119	0.122		0.1
Cobalt	1.17		6.132	
Copper	0.0108			1.3
Lead	0.016			0.015
Manganese	27.9		14.3	
Nickel	0.49		2.044	
Selenium	0.00692			0.5
Silver		0.000289	0.511	
Strontium	2.64		61.32	
Thallium	0.1			0.002
Vanadium		0.00236 J	0.715	
Zinc	0.254		30.66	
Perchlorate (µg/L)	52.6	76	72	

Notes and Abbreviations:

* common laboratory contaminant

** detected in one grab sample 27GG33

GW-Ind - groundwater MSC for industrial use

J - estimated results detected above the method detection limit but below the reporting limit

MCL - maximum contaminant level

mg/L - milligrams per liter

SVOC - semivolatile organic compound

TCEQ - Texas Commission on Environmental Quality

µg/L - micrograms per liter

USEPA - U.S. Environmental Protection Agency

VOC - volatile organic compound

Table 2-3
Summary of Detected Constituents in Surface Water and Sediments
South Test Area/Bomb Test Area, LHAAP-001-R and Harrison Bayou

Analyte Detected	Maximum Concentration South Test Area/ Bomb Test Area	Maximum Concentration Harrison Bayou	TCEQ GWP-Ind	MCL
Surface Water				
Metals (mg/L)				
Barium	0.29	0.12		2
Lead	0.015	ND		0.015
Sediments				
SVOCs (µg/L)				
Di-n-butylphthalates *	2,170	1,760	10,200	
Metals (mg/kg)				
Arsenic	1.1	1.1	1	
Barium	254	91.8	200	
Chromium	5.2	4.6	10	
Lead	8	9	1.5	
Mercury	ND	0.03	0.2	
Nickel	3.9	6	204.4	
Selenium	0.2	ND	5	

Notes and Abbreviations:

*common laboratory contaminant

GWP-Ind - soil MSC for industrial use based on groundwater protection

MCL - maximum contaminant level

mg/kg - milligrams per kilogram

mg/L - milligrams per lit

ND - not detected

SVOC - semivolatile organic compound

TCEQ - Texas Commission on Environmental Quality

µg/L - micrograms per liter

Table 2-4
Media Investigation Summary
South Test Area/Bomb Test Area, LHAAP-001-R

Investigated By	Date	Medium Investigated	Number of Samples	Analytical Parameters	Sample ID
EPS	1982	soil - surface	3	metals, explosives, anions	0401 through 0403
		groundwater - wells	2	metals, explosives, anions, organics, pesticides/PCBs	MW131 and MW132
EBASCO	1993	soil - 10 borings	20	metals, VOCs, SVOCs, explosives, anions	Borings 27SB30 through 27SB39
		soil - surface	4	metals, VOCs, SVOCs, explosives, anions	27SS01 through 27SS04
		groundwater - grab from borings	10	explosives, anions, total organic halogens, TOC	27GG30 through27GG39
		groundwater - wells	2	metals, VOCs, SVOCs, explosives, anions	MW131 and MW132
		surface water	4	metals, VOCs, SVOCs, explosives, anions	27SW02 through 27SW05
		sediment	4	metals, VOCs, SVOCs, explosives, anions	27SD02 through 27SD05
SVERDRUP	1994	soil - surface	3	chromium, mercury	27SS21 through 27SS23
		soil - monitoring well borings	12	metals, explosives, anions	27WW01 through 27WW04
		groundwater - wells	4	metals, SVOCs, explosives, anions	27WW01 through 27WW04
USACE	1996/97	soil - surface	9	explosives + 11 metals	RASS27-01 through RASS27-09
		soil - surface	4	12 metals	RASS27-02,RASS27-04, RASS27-06, RASS27-08
STEP	2000/01	soil - 13 borings	26	perchlorate	27SB01 through 27SB13
	1st Quarter	groundwater - wells	4	perchlorate	MW131, MW132, 27WW01, 27WW04
	2nd Quarter	groundwater - wells	6	perchlorate	MW131, MW132, 27WW01 through 27WW04
	3rd Quarter	groundwater - wells	3	perchlorate	MW131, 27WW01, 27WW04
	4th Quarter	groundwater - wells	3	perchlorate	MW131, 27WW01, 27WW04
USFWS	2003	soil	5	metals, SVOCs, pesticides, PCBs, perchlorate	55, 56, 58, 63, 201
CAPE	2006	soil	2	MC (explosives), WP	BTA-27-LHAAP-001-RS-01A, BTA-27-LHAAP-002-RS-01B
USEPA	October 2009	groundwater - wells	6	metals, explosives, perchlorate	131-05, 132-06, 27WW-01-01, 27WW-02-02, 27WW-03-03, 27WW-04-04
U.S. ARMY	October 2009	groundwater - wells	6	metals, explosives, perchlorate	131-05, 132-06, 27WW-01-01, 27WW-02-02, 27WW-03-03, 27WW-04-04

Notes and Abbreviations:

MC - munitions constituents
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
TOC - total organic carbon
VOC - volatile organic compound
WP - white phosphorus

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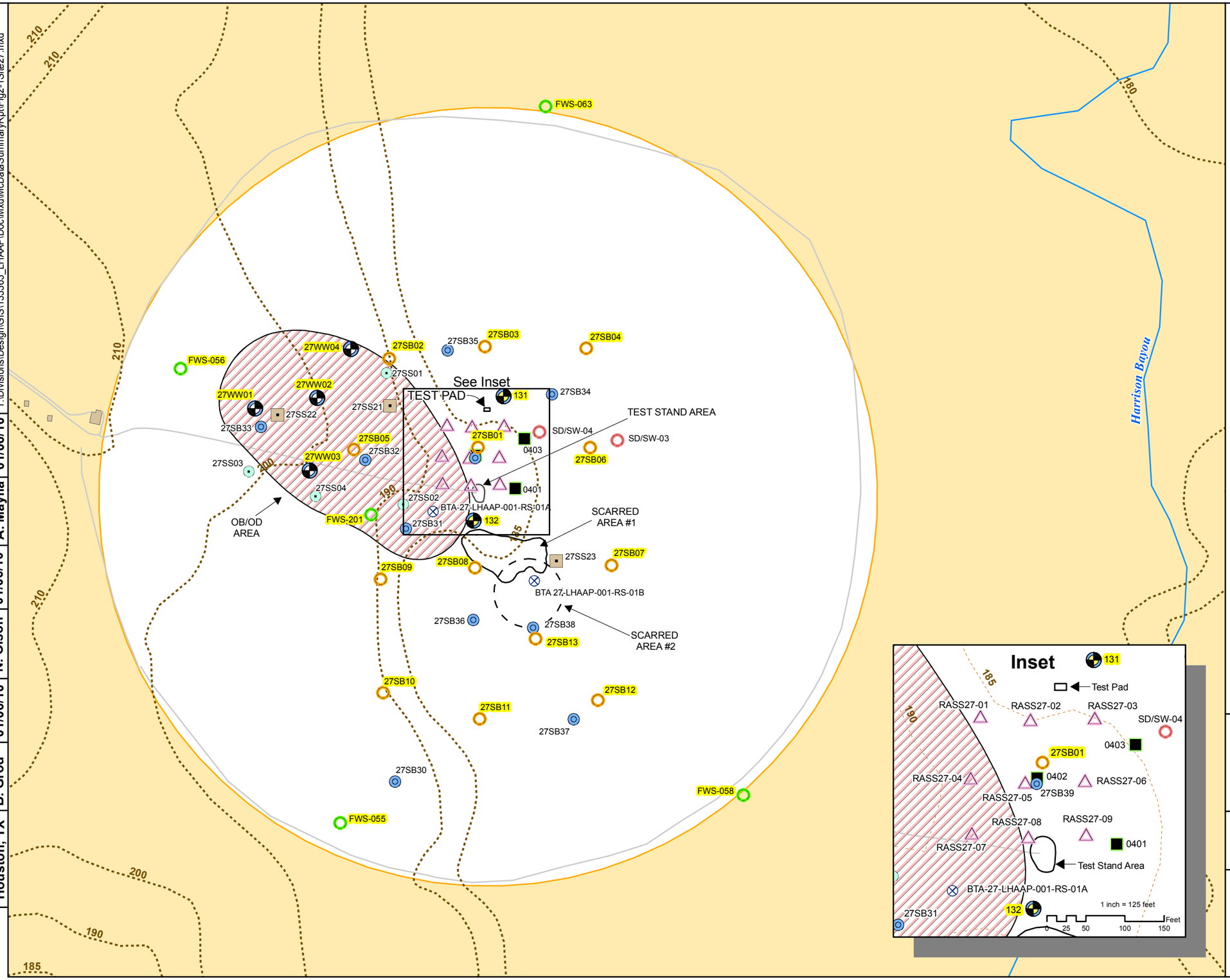

LEGEND

- 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)
- 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.

1 inch = 250 feet

0 125 250 500 Feet

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
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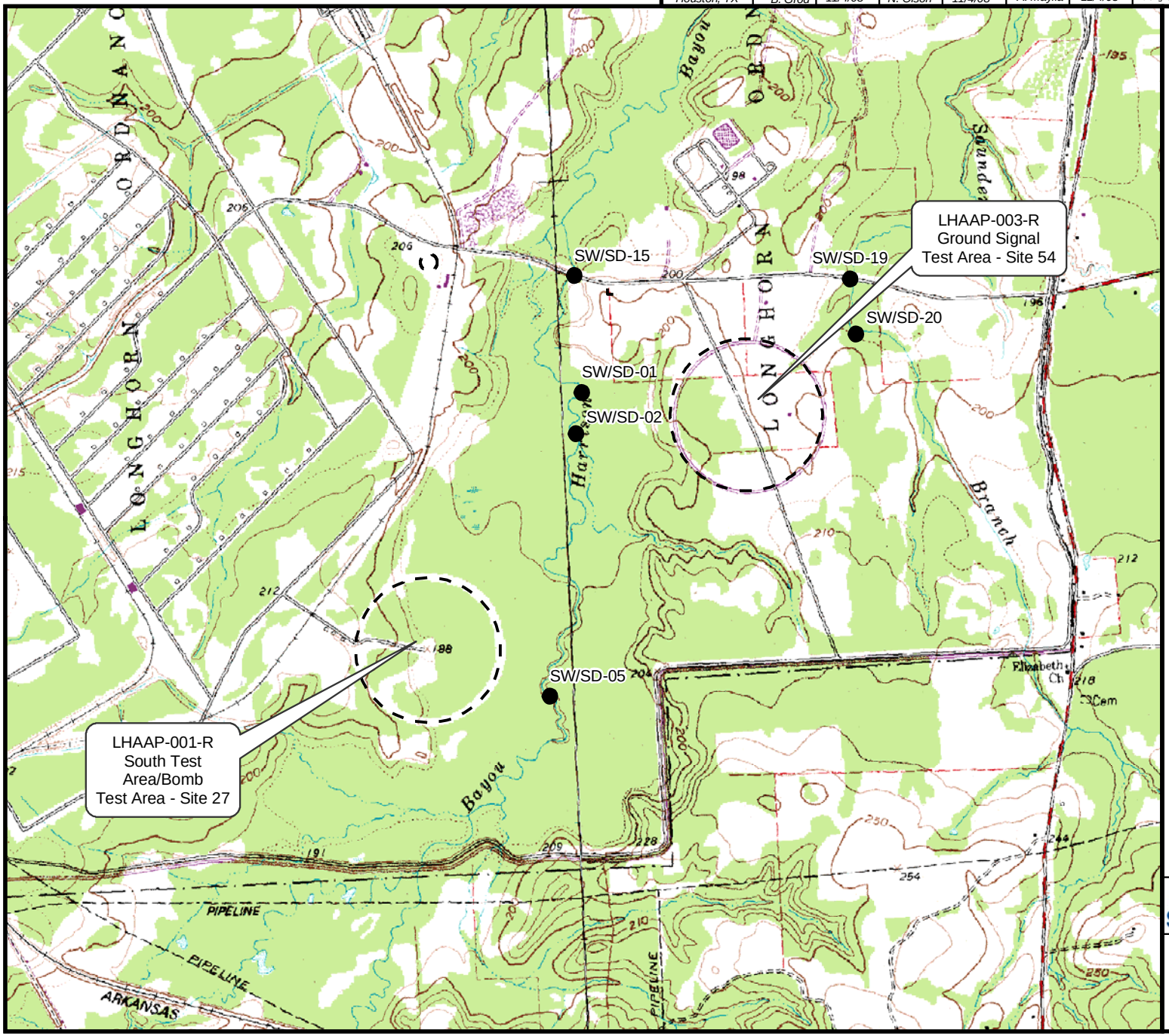

Legend

- MC Data Summary Sites
- Surfacewater/Sediment

N

0 1,000 2,000 Feet

U.S. ARMY CORPS OF ENGINEERS
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TULSA, OKLAHOMA

FIGURE 2-2
SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
LHAAP-001-R and LHAAP-003-R
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

3.0 The Ground Signal Test Area, LHAAP-003-R

3.1 Site Description and History

The Site 54 – Ground Signal Test Area (LHAAP-003-R) encompasses approximately 80 acres and is located in the southeastern portion of LHAAP. The site is accessed by an asphalt road (Haystack Road) that intersects Long Point Road just east of its intersection with Avenue Q (**Figure 1-1**). The site is currently undeveloped and has become overgrown with woody vegetation.

The Ground Signal Test Area is co-located with the IRP site LHAAP-54 for which a NFA ROD under CERCLA for HTRW was signed with regulatory concurrence in January 1998 (USACE, 1998).

This area 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. Around 1970, a Sergeant rocket motor reportedly exploded in an excavated pit near the center of the site, however, later MEC clearance to depth in the area found no rocket motor. Debris was reportedly placed in the resulting crater and backfilled. 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 U.S. and the former Soviet Union. Occasionally, leaking WP munitions were burned at the site as a demilitarization activity.

The Ground Signal Test Area was identified as a MEC area of concern based on the reported presence of MEC. Because of the potential presence of WP and to address the WP data gap, the Ground Signal Test Area was also identified as a MC area of concern.

3.2 Previous Environmental Investigations

Environmental media including soil, groundwater, surface water, and sediment have been sampled and analyzed to identify potential MC contamination. Investigations were conducted during the environmental contamination survey, multiple phases of the RI, basewide perchlorate investigation, SI, and the EE/CA. The onsite sample locations are shown on **Figures 3-1** and **2-2**. **Tables 3-1**, **3-2**, and **3-3** provide the maximum concentrations of contaminants in soil, groundwater, surface water, and sediment, respectively, at the site. Data summary tables from previous investigation reports are included in **Appendix B**. In response to USEPA's comments

on the Draft MC Summary Report, tables listing all parameters analyzed for each previous sampling event including associated analytical methods and detection limits are also included in **Appendix B**,

3.2.1 Environmental Contamination Survey

In 1982, the site was investigated by EPS for USATHAMA (EPS, 1984).

3.2.1.1 Soil Investigation

Three surface soil samples (0501, 0502, and 0503) were collected and analyzed for metals, explosives, and anions. Metals were detected at low concentrations similar to background values and below their respective GWP-Ind values. No explosives were detected. Reference **Appendix B**, Pages B-1 and B-2, Tables 10-1 and 10-1b, respectively.

3.2.1.2 Groundwater Investigation

Two monitoring wells (MW-127 and MW-128) were installed and groundwater samples were collected from the wells. The water samples from both wells were analyzed for metals, explosives, and anions. In addition, groundwater from well MW-128 was analyzed for VOCs and SVOCs. Cadmium and thallium were detected at maximum concentrations of 0.01and 0.14 mg/L, above their MCLs of 0.005 and 0.002 mg/L, respectively. No VOCs, SVOCs, or explosives were detected. Reference **Appendix B**, Pages B-18 and B-19 through B-22, Tables 10-5 and 10-5b, respectively.

3.2.2 Phase I Remedial Investigation

In 1993, Ebasco completed a Phase I RI. Soil, groundwater, surface water, and sediment samples were collected during the RI activities (Ebasco, 1993).

3.2.2.1 Soil Investigation

Seven borings were completed at the site and 15 soil samples were collected from the borings. Boring XXSB15 was completed within the rocket motor testing blast area. Borings XXSB16, XXSB17, and XXSB18 were completed near the southern boundary, in the eastern portion, and in the western part of the site, respectively. Borings XXSB19, XXSB20, and XXSB21, were completed in the former mortar test area, the north western portion of the site, and the northeastern part of the site, respectively. Soil samples were collected from several depth intervals ranging from the surface to 18 bgs. Soil samples were analyzed for metals, VOCs, SVOCs, explosives, and anions.

Soil analytical results indicated that acetone at a concentration of 10,300 µg/kg in the sample collected from boring XXSB19 at a depth interval of 2.5 to 5 feet bgs and trichloroethene (TCE) at a concentration of 42 µg/kg in a sample collected from boring XXSB17 at a depth interval of 5 to 7 feet bgs were the only VOCs detected. Acetone and TCE concentrations were below their

respective GWP-Ind values of 9.2 $x10^6$, and 500 µg/kg, respectively. Except for di-n-butyl phthalate that was detected at levels below the GWP-Ind value, all other SVOCs were below detection limits. Arsenic, chromium, and lead were detected at maximum concentrations of 6, 15.9, and 11 mg/kg above their GWP-Ind values of 1, 10, and 1.5 mg/kg, respectively. All other metals were detected at concentrations below their respective GWP-Ind values in all soil samples. No explosives were detected. Reference **Appendix B**, Pages B-3 through B-5 and B-6 through B-8, Tables 10-2 and 10-2b, respectively.

3.2.2.2 Groundwater Investigation

Groundwater samples were collected from the two already existing monitoring wells MW-127 and MW-128. Groundwater from the wells was analyzed for metals, VOCs, SVOCs, explosives, and anions. Groundwater analytical results indicated that no VOCs, SVOCs, or explosives were detected. No elevated metal levels were reported in either well; the initially (1982) detected elevated values of cadmium and thallium above comparison criteria in well MW-127 were not confirmed by the RI sampling event in 1993. Reference **Appendix B**, Pages B-18 and B-19 through B-22, Tables 10-5 and 10-5b, respectively.

In addition, six groundwater grab samples were collected from six of the seven borings which yielded water (XXSB15 through XXSB17 and XXSB19 through XXSB21). Samples were collected from the borings to obtain preliminary field screening data for potential contaminants in groundwater underlying the site. Groundwater grab samples were analyzed for VOCs, explosives, anions, total organic halogens, and total organic carbon. Analytical results indicated that VOCs and explosives were not detected.

3.2.2.3 Surface Water and Sediment Investigation

Seven surface water and seven sediment samples were collected from collocated site drainage ditch locations (SW/SD16, SW/SD17, and SW/SD18) (**Figure 3-1**), Harrison Bayou (SW/SD01 and SW/SD15), and Saunders Branch (SW/SD19 and SW/SD20) (**Figure 2-2**). Surface water and sediment samples were analyzed for metals, VOCs, SVOCs, explosives, and anions. Results indicated that metals were detected sporadically in both surface water and sediment samples. The two detected (barium and lead) metals were below GW-Ind values in surface water samples. Except for arsenic and lead, all other metals were below GWP-Ind values in all sediment samples. Arsenic concentrations ranged from 0.9 to 3.5 mg/kg, above the GWP-Ind value of 1 mg/kg, and lead concentrations ranged from 4 to 9 mg/kg, above the GWP-Ind value of 1.5 mg/kg. Except for bis(2-ethylhexyl)phthalate in four sediment samples and di-n-butylphthalate in two of the sediment samples, all other SVOCs were below detection limits in both surface water and sediment samples. Detected concentrations for the two phthalate analytes did not exceed respective GWP-Ind values of 600 and 1,000,000 µg/kg. Phthalates are a common laboratory contaminant. No VOCs or explosives were detected in surface water or

sediment samples. Reference **Appendix B**, Pages B-23, B-24 through B-26, B-27, and B-31 through B-33, Tables 10-6, 10-6b, 10-7 and 10-7b, respectively.

3.2.3 Phase II Remedial Investigation

In 1994, Sverdrup completed a Phase II RI. Soil and groundwater samples were collected and a soil gas survey conducted at the site (Sverdrup, 1995).

3.2.3.1 Soil Investigation

One soil boring, XXSB01, was completed in the immediate vicinity of boring XXSB19 and three soil samples collected from the boring for confirmation of the elevated acetone levels detected during the Phase I RI activities. Soil samples were analyzed for VOCs. No acetone was detected in the soil samples collected from the boring. Methylene chloride at a concentration of 18 µg/kg was detected in the soil sample collected from the depth interval of 0 to 2 feet bgs, a concentration below the GWP-Ind value of 38,000 µg/kg. Methylene chloride is a common laboratory contaminant. Reference **Appendix B**, Page B-5 and B-9, Tables 10-3 and 10-3b, respectively.

An active soil gas survey was conducted in the immediate vicinity of boring XXSB19 to further investigate potential VOC contamination in the area. Soil gas samples were collected from five sampling points (XXSG01 through XXSG05) and analyzed on site for acetone, methylene chloride, and TCE. Results of the soil gas survey indicated that acetone, methylene chloride, and TCE were all below detection limits. Reference **Appendix B**, Page B-27, Paragraph 10.2.2.

3.2.3.2 Groundwater Investigation

One groundwater grab sample was collected from the newly installed boring XXSB01. The sample was analyzed for VOCs, SVOCs, and explosives. Acetone was the only VOC that was detected at a concentration of 17 µg/L, well below the GW-Ind of 92,000 µg/L. Acetone was also detected in the trip blank at a similar concentration. Acetone is a common laboratory contaminant and sampling device decontamination agent. No SVOCs or explosives were detected. Reference **Appendix B**, Page B-27, Paragraph 10.2.2 and Pages B-28 through B-30, Table B-3.

3.2.4 Additional Investigations

3.2.4.1 Soil Investigation

In August 1996, the USACE collected surface soil samples from two locations in support of the risk assessment for the site; RASSXX-01 located within the former motor blast area and RASSXX-02 located within the nearby mortar test area. The soil samples were analyzed for VOCs and 11 metals (arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, antimony, and thallium). Analytical results indicated that metals arsenic, chromium, and lead were detected at RASSXX-01 at maximum concentrations of 32.8, 28.9, and 11 mg/kg,

above their respective GWP-Ind values of 1, 10, and 1.5 mg/kg, respectively. Cadmium was detected at RASSXX-02 at a maximum concentration of 5.42 mg/kg, above the GWP-Ind value of 0.5 mg/kg. Reference **Appendix B**, Page B-10 and B-11 through B-17, Tables 10-4 and 10-4b, respectively.

3.2.4.2 Risk Assessment

In 1997, USACE conducted a baseline risk assessment to support site management decisions for the site. Potential human health and ecological impacts resulting from contaminant releases at the site in the absence of remediation were evaluated. COPCs evaluated included metals present in both site soils and ditch sediments. COPCs in groundwater included metals within background ranges and below drinking water standards. For human health evaluation, conservative carcinogenic risk estimates of 3×10^{-7} and 2×10^{-6} were obtained for current recreational and future industrial land uses, respectively. Hazard indices were well below the critical value of 1.0 at 2×10^{-2} (current land use) and 1×10^{-1} (future industrial land use). Based on these results, no unacceptable risks to human health were identified for the Ground Signal Test Area (USACE, 1997).

Screening-level ecological risks for the site were driven solely by metals present in soil at concentrations approximating background values. Two metals; chromium and nickel, were identified as main contributors to screening level risk estimates. Based on these conservative analyses, no ecological concerns were associated with the site and further ecological evaluations and remediation are unwarranted. (Shaw, 2007)

3.2.4.3 Supplemental Soil Sampling and Risk Characterization

Following a review of the initial RI data (Phase I and II RI) and human health and ecological risk characterization based on RI results, limited additional surface soil sampling was conducted at the site in February 1997 (USACE, 1997). The sampling was initiated to support additional human health risk characterization for a limited area identified during the original risk assessment results as a potential "hot spot" area for human exposure.

Additional surface soil samples were collected from two adjacent locations (RASSXX-01 and RASSXX-02); the same locations sampled previously in 1996 (**Figure 3-1**). The samples were analyzed for SVOCs, explosives, pesticides, and polychlorinated biphenyls (PCBs). A sample from RASSXX-02 was also analyzed for 12 metals (aluminum, beryllium, calcium, cobalt, copper, iron, potassium, magnesium, manganese, strontium, vanadium, and zinc). Soil analytical results (**Appendix B**, Page B-44, Table 5A-1) indicated that metals were detected at concentrations that were generally higher [arsenic (73.8 mg/kg), cadmium (6.95 mg/kg), and lead 24 (mg/kg)] than those of previous sampling events and above their respective GWP-Ind values, and provided justification for further evaluation of the potential "hot spot" area. No VOCs, SVOCs, explosives, pesticide, or PCBs were detected in the surface soil samples. Reference

Appendix B, Pages B-10, B-44, and B-11 through 17, Tables 10-4, Table 5A-1 and 10-4b, respectively.

Further supplemental risk characterization was conducted for a potential "hot spot" area at the site and to expand the list of parameters for risk evaluation. While risk calculations based on the additional sampling at the limited site area were higher than original estimates for the site as a whole, all estimates were within acceptable risk ranges. For human health evaluation, carcinogenic risk estimates of 6×10^{-6} and 4×10^{-5} were obtained for current recreational and future industrial land uses, respectively. Non-cancer hazard indices were below the critical value of 1.0 at 2×10^{-1} (current land use) and 6×10^{-1} (future industrial land use). The additional risk evaluation substantiated conclusions of the original assessment and failed to support the need for site remediation for protection of human health (USACE, 1997).

Based on the results of the investigations and the risk assessment, a NFA ROD under CERCLA for HTRW was signed in January of 1998 for LHAAP-003-R.

3.2.5 Perchlorate Investigation

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 Ground Signal Test Area. Because the shallow groundwater flow pattern is heavily influenced by surface flow in this climate, 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. Groundwater samples were also collected from Geoprobe points (GPSAS54-01, GPSAS54-02, and GPSAS54-03) installed in June 2001. Perchlorate was below detection limits in all three grab samples. Reference **Appendix B**, Pages B-34 and B-35, Tables 1-32 and 1-32b, respectively.

3.2.6 U.S. Fish and Wildlife Investigation

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-95 and FWS-223) within the Ground Signal Test Area. These two locations are

along the surface drainage that flows toward Saunders Branch on the east side of the area. Soil analytical results indicated that metals were detected at low concentrations confirming previous findings. Perchlorate was not detected. Reference **Appendix B**, Pages B-36 through B-37 and B-38 through B-43, Tables 2 and 2b, respectively.

3.2.7 Military Munitions Response Program Site Inspection

Between 2002 and 2004, a MMRP SI was conducted for the Ground Signal Test Area 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 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 burn-out of Pershing and Sergeant rocket motor, 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 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.

3.2.8 Engineering Evaluation/Cost Analysis

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 MC data gap at the site. Soil samples were collected within the Ground Signal Test Area to determine if evidence of WP existed, and to determine the presence of MC in areas where MC was most likely to exist based on the heaviest MPPEH concentrations or historical detonations. One soil sample was collected within the area identified as the mortar firing range. A second soil sample 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 and MC constituents (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 MC in any of the pre- or post-detonation samples. The removal action objective of protection of human health from MC at unacceptable concentrations had been achieved as demonstrated by the soil analytical results. Reference **Appendix B**, Page B-45, Table 3.

3.2.9 October 2009 Groundwater Confirmation Sampling

3.2.9.1 USEPA Region 6 Confirmation Sampling

In October 2009, the USEPA collected additional groundwater samples from the existing four monitoring wells (MW-127, MW-128, 18WW01 and 18WW16) to confirm groundwater conditions at the site. The groundwater was analyzed for metals, explosives and perchlorate. Groundwater analytical results indicated that except for 2-amino-4,6-DNT and 3-nitrotoluene, no other explosives were detected in the groundwater samples. 2-amino-4,6-DNT was detected in two monitoring wells at concentrations of 0.22 µg/L in monitoring well MW-127 and 0.30 µg/L in monitoring well MW-128, below the GW-Ind value of 17.03 µg/L. 3-nitrotoluene was detected in monitoring well MW-128 at a concentration of 0.24J µg/L below the GW-Ind value of 1,022 µg/L. Perchlorate was detected in only one of the monitoring wells, 18WW16, at a concentration of 4.6 µg/L, a level well below the GW-Ind value of 72 µg/L.

Except for chromium, all other metals were detected at concentrations lower than their respective MCLs or GW-Ind values. Chromium was detected at a concentration of 6.62 mg/L in monitoring well 18WW16 above the MCL of 0.1 mg/L. Reference **Appendix B**, Pages B-46 through B-47 and Page B-48, Tables B-1 and B-1b, respectively.

3.2.9.2 U.S. Army Confirmation Split Sampling

In October 2009, the U.S. Army collected spilt samples at the same time that the USEPA collected additional groundwater samples from the existing four monitoring wells (MW-127, MW-128, 18WW01 and 18WW16). The groundwater was analyzed for metals, explosives and perchlorate. Groundwater analytical results indicated that no explosives were detected in any of the groundwater samples. Perchlorate was detected in monitoring well 18WW16 at a concentration of 5.4 µg/L, a level well below the GW-Ind value of 72 µg/L.

Except for arsenic and chromium, all other metals were detected at concentrations lower than their respective MCLs or GW-Ind values. Arsenic and chromium were detected in monitoring well 18WW16 at concentrations of 0.019 and 31.7 mg/L above their MCL of 0.01 and 0.1 mg/L, respectively. Reference **Appendix B,** Pages B-49 through B-50 and B-51, Tables B-2 and B-2b, respectively.

USEPA Region 6 groundwater confirmation analytical results were comparable to the U.S. Army split sample results. Although the USEPA detected two explosives in the groundwater samples,

whereas the U.S. Army did not, the explosive were at concentrations that were well below their GW-Ind values. Chromium was the only metal that was detected by both agencies at a concentration above the MCL. Arsenic was detected by only the U.S. Army above the MCL. Perchlorate was detected by both USEPA and U.S. Army in the same monitoring well at comparable concentrations that were lower than the GW-Ind value of 72 µg/L.

3.3 Media Investigation Summary and Contaminant Assessment

Data presented in previous investigations and the risk assessment for the site indicate that compounds detected in soil, groundwater, surface water, and sediment pose no risk to human health or the environment.

3.3.1 Soil

Between 1982 and 2003, a total of 27 surface and subsurface soil samples were collected for characterization of constituents of concern in the soil at the site. Samples were collected from all areas of the site with special emphasis on likely source areas; the former motor blast area and the nearby mortar test area. Five metals including arsenic (73.8 mg/kg), barium (904 mg/kg), cadmium (6.95 mg/kg), chromium (28.9 mg/kg), and lead (24 mg/kg), were detected at concentrations above their respective GWP-Ind values. All other metals were detected at levels approximating background values and below the comparison criteria. Despite the common detection of metals during the multiple sampling events, none of the metals was determined to have an unacceptable risk to human health or the environment.

Except for a single detection each of acetone at 10,300 µg/kg, TCE at 42 µg/kg, and methylene chloride at 18 µg/kg, there were no detections of other VOCs in soil samples. The detected VOC concentrations were below comparison criteria. Soil samples from one soil boring completed in the immediate vicinity of where acetone was detected, and the results of an active soil gas survey to further investigate the presence of acetone, TCE, and methylene chloride indicated that the VOCs were below detection limits. Acetone is a common laboratory contaminant and cleaning agent for sampling equipment. Di-n-butyl phthalate was the only SVOC detected in the soil samples at levels below the comparison criteria. Phthalates are common plasticizers and were found in method blanks. No explosives, pesticides, or PCBs were detected in soil samples.

An active soil gas survey was conducted in the immediate vicinity of the boring XXSB19 where acetone was detected to further investigate potential VOC contamination in the area. Soil gas samples were collected from five sampling points and analyzed on site for acetone, methylene chloride, and TCE. Results of the soil gas survey indicated that acetone, methylene chloride, and TCE were all below detection limits.

Two of the surface soil samples were collected along a surface water feature draining the eastern portion of the site and analyzed for perchlorate. Both samples were non-detect for perchlorate.

An additional two soil samples were collected during the EE/CA field activities (2006) to determine the presence of WP and if MC existed in areas where MC was likely to exist based on heaviest MPPEH; the mortar firing area and the Rocket Motor Area. No WP or MC was identified in any soil samples and there was no indication of the presence of MC in any pre- or post-detonation samples.

Table 3-4 presents the media investigation summary including the number of soil samples collected during each sampling event.

3.3.2 Groundwater

From 1982 through 2001, a total of 13 groundwater samples were collected from monitoring wells and an additional 10 water samples were grab samples collected from soil borings installed at the site for identification of constituents of concern in the underlying groundwater. Groundwater analytical results from multiple sampling events indicated that cadmium and thallium were detected in groundwater above their respective MCLs in the initial sampling (1982), however, the concentrations were not reproducible in subsequent sampling events. Despite the common detection of metals during the multiple sampling events, none of the metals was determined to have an unacceptable risk to human health or the environment.

In October 2009, groundwater samples were collected from four monitoring wells by both the USEPA and the U.S. Army for confirmation of groundwater conditions at the site. Initial detections (1982) of cadmium and thallium above their MCLs were not confirmed by the sampling. Except for arsenic and chromium, all the other metals were detected at concentrations below their respective MCLs or GW-Ind values.

Except for a single detection of acetone in a grab sample collected in 1994 at a concentration of 17 µg/L, well below the GW-Ind of 92,000 µg/L, there were no detections of VOCs in other groundwater samples. Acetone was also detected at a similar concentration in the trip blank. SVOCs or explosives were not detected.

The October 2009 USEPA groundwater confirmation sampling detected the presence of 2-amino-4,6-DNT and 3-nitrotoluene. Both explosives were detected at concentrations well below their respective GW-Ind values. No explosives were detected in any of the four U.S. Army split samples. Reference **Appendix B**, Pages B-49 through 50 and B-51, Tables B-2 and B-2b, respectively. Both the previous and the October 2009 data indicate that explosives, the most likely contaminants at the site, are not of concern in the Ground Signal Test Area.

Twelve of the groundwater samples were collected from three locations and analyzed for perchlorate during four quarters from April 2000 to June 2001. Perchlorate was detected at a maximum concentration of 26.8 µg/L during the first quarter sampling event, a level well below

the GW-Ind value of 72 µg/L. No MCL exists for perchlorate. During the second quarter sampling event, perchlorate was not detected in any of the water samples. Perchlorate was detected during the third quarter sampling event in one well at 8 µg/L, which is well below the GW-Ind of 72 µg/L and not at all during the fourth quarter event. During the October 2009 sampling event, perchlorate was detected in monitoring well 18WW16 at a concentration of 5.4 µg/L, a level well below the GW-Ind value of 72 µg/L.

Table 3-4 presents the media investigation summary including the number of groundwater samples collected during each sampling event.

3.3.3 Surface Water and Sediment

A total of seven surface water and seven sediment samples were collected from drainage ditch locations, Harrison bayou, and Saunders Branch. Metals were detected sporadically in both surface water and sediment samples. All metals were below comparison criteria in surface water samples. Arsenic and lead were the only metals detected above their respective GWP-Ind values in sediment samples. All other metals were detected at concentrations below comparison criteria and approximating background values. Except for bis(2-ethylhexyl)phthalate in four sediment samples and di-n-butylphthalate in two of the sediment samples and at concentrations that were below comparison criteria, all other SVOCs were below detection limits in both surface water and sediment samples. Phthalates are a common laboratory contaminant. No VOCs or explosives were detected in surface water or sediment samples.

3.4 Conclusion

With the exception of the 2009 EPA groundwater sampling, the results of the multiple investigations presented above indicated that no contaminants of concern were identified in soil, groundwater, surface water, and sediments at the site. The human health risk assessment evaluation of potential migration pathways for potential receptors indicated that carcinogenic risk estimates were within the acceptable range at 6×10^{-6} and 4×10^{-5} for current recreational and future industrial land uses, respectively. Non-cancer hazard indices were below the critical value of 1.0 at 2×10^{-1} (current land use) and 6×10^{-1} (future industrial land use). Based on the evaluation, no unacceptable risks to human health were identified for the site. The screening-level ecological risk evaluation indicated that there are no ecological concerns associated with the site and that further evaluations and remediation are unwarranted. In addition, no WP or MC was identified in any soil samples and there was no indication of the presence of MC in any pre or post-detonation samples. Results from the October 2009 sampling detected two explosives at levels well below the risk-based criteria, further confirming that explosives are not a concern at the site. Therefore, this MC data summary confirms the determination of no risk to human health or the environment as identified in the EE/CA for LHAAP-003-R.

For perchlorate, soil sampling conducted along a surface water feature draining much of the site was non-detect. Additionally, three groundwater wells and the three geoprobe points placed strategically along flow paths that fully characterize the groundwater from the entire site were sampled for perchlorate. The results indicate that perchlorate was previously (2000 through 2001) detected in only three samples out of 12 and at concentrations below risk-based screening levels. During the October 2009 confirmation sampling, perchlorate was detected in only one out of the four monitoring wells at a concentration comparable with previous results and well below the screening criteria. This, together with the fact that no explosives were detected in any of the previous sampling conducted at the site, and that the October 2009 sampling detected explosives at levels below the risk-based criteria, supports a conclusion that perchlorate and explosives are not contaminants of concern at the Ground Signal Test Area.

USEPA, TCEQ, and U.S. Army have agreed to address the 2009 metals exceedances in the groundwater under a path separate from the MMRP. U.S. Army will address the metals constituents in the groundwater as stated in the Army letter dated March 10, 2011 under the 1998 IRP RODs (U.S. Army, 2011).

Table 3-1
Summary of Detected Constituents in Soil
Ground Signal Test Area, LHAAP-003-R

Analyte Detected	Maximum Concentration	TCEQ GWP-Ind
VOCs (µg/kg)		
Acetone	10,300	9.2×10^6
Trichloroethene	42	500
Methylene chloride *	18	38,000
SVOCs (µg/kg)		
Di-n-butylphthalate	2,790 B	10,000
Metals (mg/kg)		
Aluminum	8,050	10,220
Arsenic	73.8	1
Barium	904	200
Cadmium	6.95	0.5
Calcium	621	NA
Chromium	28.9 J	10
Cobalt	3.21	NA
Copper	6.21	130
Iron	13,500	NA
Lead	24	1.5
Magnesium	826	NA
Manganese	567	1431
Mercury	0.06	0.2
Nickel	43	204.4
Potassium	484	NA
Selenium	1.2	5
Strontium	18.9	6132
Thallium	0.2	0.2
Vanadium	24.3	72
Zinc	17.6	3066

Notes and Abbreviations:

* common laboratory contaminant

B - found in the method blanks

J - estimated value

GWP-Ind - soil MSC for industrial use based on groundwater protection

mg/kg - milligrams per kilogram

NA - Not Available

SVOC - semivolatile organic compound

TCEQ - Texas Commission on Environmental Quality

µg/kg - micrograms per kilogram

VOC - volatile organic compound

Table 3-2
Summary of Detected Constituents in Groundwater
Ground Signal Test Area, LHAAP-003-R

Analyte Detected	Maximum Concentration		TCEQ GW-Ind	MCL
	US Army	USEPA		
VOC (µg/L)				
Acetone	17*		92,000	
Explosives (µg/L)				
2- Amino-4,6-dinitrotoluene		0.3	17.03	
3-Nitrotoluene		0.24 J	1,022	
Metals (mg/L)				
Aluminum	2.04		102.2	
Antimony	0.00335 J			0.006
Arsenic	0.019			0.01
Barium	0.647			2
Beryllium	0.000818 J			0.004
Cadmium	0.01			0.005
Chromium	31.7			0.1
Cobalt	0.043		6.132	
Copper	1.06			1.3
Lead	0.011			0.015
Manganese	2.02		14.3	
Nickel	1.89		2.044	
Selenium	0.019			0.05
Silver		0.000235 J	0.511	
Strontium	4.12		61.32	
Thallium	0.14			0.002
Vanadium		0.00172 J	0.715	
Zinc	0.28		30.66	
Perchlorate (µg/L)	26.8		72	

Notes and Abbreviations:

* detected in a grab sample but also detected in the trip blank at the same concentration

GW-Ind - groundwater MSC for industrial use

J - estimated results detected above the method detection limit but below the reporting limit

MCL - maximum contaminant level

mg/L - milligrams per liter

TCEQ - Texas Commission on Environmental Quality

µg/L - micrograms per liter

USEPA - U.S. Environmental Protection Agency

VOC - volatile organic compound

Table 3-3
Summary of Detected Constituents in Surface Water and Sediments
Ground Signal Test Area, LHAAP-003-R, Harrison Bayou and Saunders Branch

Analyte Detected	Maximum Concentration				
	Ground Signal Test Area	Harrison Bayou	Saunders Branch	TCEQ GWP-Ind	MCL
Surface Water (mg/L)					
Barium	0.23	0.13	0.43		2
Lead	ND	ND	0.011		0.015
Sediments					
SVOCs (µg/kg)					
Bis(2-ethylhexyl)phthalate *	443	369	421	600	
Di-n-butylphthalate *	669	ND	ND	10,000	
Metals (mg/kg)					
Arsenic	1.9	2.4	3.5	1	
Barium	64.1	126	39.6	200	
Chromium	9.8	5.5	4.4	10	
Lead	7	9	8	1.5	
Mercury	0.03	0.03	0.03	0.2	
Nickel	5.1	14.7	4	204.4	
Selenium	0.4	0.3	0.3	5	

Notes and Abbreviations:

*common laboratory contaminant

GWP-Ind - soil MSC for industrial use based on groundwater protection

MCL - maximum contaminant level

mg/kg - milligrams per kilogram

mg/L - milligrams per lit

ND - not detected

SVOC - semivolatile organic compound

TCEQ - Texas Commission on Environmental Quality

µg/kg - micrograms per kilogram

Table 3-4
Media Investigation Summary
Ground Signal Test Area, LHAAP-003-R

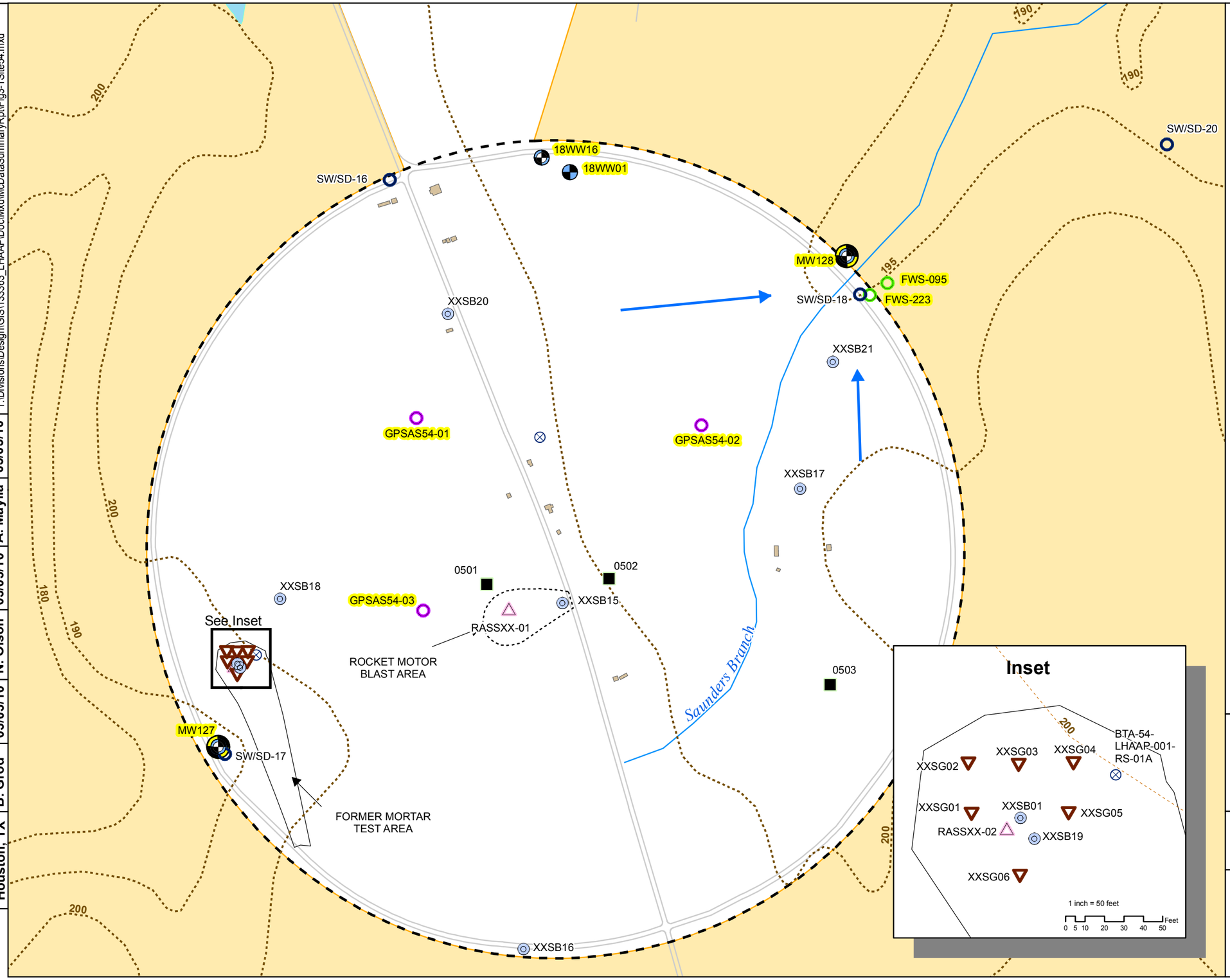
Investigated By	Date	Medium Investigated	Number of Samples	Analytical Parameters	Sample ID
EPS	1982	soil - surface	3	metals, explosives, anions	0501 through 0503
		groundwater - wells	2	metals, explosives, anions, VOCs, and SVOCs	MW127 and MW128
EBASCO	1993	soil - 7 borings	15	metals, VOCs, SVOCs, explosives, anions	Borings XXSB15 through XXSB21
		groundwater - grab from borings	6	VOCs, explosives, anions, total organic halogens, TOC	XXGG15 throughXXGG18, XXGG20 and
		groundwater - wells	2	metals, VOCs, SVOCs, explosives, anions	MW127 and MW128
		surface water	7	metals, VOCs, SVOCs, explosives, anions	XXSW01, XXSW15 through XXSW20
		sediment	7	metals, VOCs, SVOCs, explosives, anions	XXSD01, XXSD15 through XXSD20
SVERDRUP	1994	soil - boring	3	VOCs	XXSB01
		soil - gas sampling points	5	VOCs	XXSG01, XXSG03 through XXSG05, XXSG07
		groundwater - grab from boring	1	VOCs, SVOCs, explosives	XXGG01
USACE	1996/97	soil - surface	4	(2) VOCs + 11 metals; (2) SVOCs, pesticides, PCBs; (1) 12 metals, explosives	RASSXX-01, RASSXX-02
STEP	2000/01				
	1st Quarter	groundwater - wells	3	perchlorate	MW127, MW128, 18WW16
	2nd Quarter	groundwater - wells	3	perchlorate	MW127, MW128, 18WW16
	3rd Quarter	groundwater - wells	3	perchlorate	MW127, MW128, 18WW16
	3rd Quarter	groundwater - grab	3	perchlorate	GPSAS54-01 through GPSAS54-03
USFWS	2003	soil	2	metals, SVOCs, pesticides, PCBs, perchlorate	95, 223
CAPE	2006	soil	2	MC (explosives), WP	BTA-54-LHAAP-001-RS-01A, BTA-54-LHAAP-001-RS-01B
USEPA	October 2009	groundwater - wells	4	metals, explosives, perchlorate	127-09, 128-10, 18WW-01-07, 18WW-16-08
U.S. ARMY	October 2009	groundwater- wells	4	metals, explosives, perchlorate	127-09, 128-10, 18WW-01-07, 18WW-16-08

Notes and Abbreviations:

MC - munitions constituents
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
TOC - total organic carbon
VOC - volatile organic compound
WP - white phosphorus

FILE PATH: T:\Divisions\Design\GIS\133363_LHAAP\Doc\Mxd\McDataSummaryRpt\Fig3-1Site54.mxd

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY	
Houston, TX	B. Grod	03/03/10	N. Olson	03/03/10	A. Mayila	03/03/10



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)
- Contours
- Road
- Lake
- Stream
- Building
- Former Mortar Test Area
- Rocket Motor Blast Area
- Ground Signal Test Area
- 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.

N

1 inch = 250 feet

0 125 250 500 Feet

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

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

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

4.0 Conceptual Site Model

During the EE/CA a conceptual site model (CSM) was developed to provide a summary of the MC sources, potential pathways for MC exposure, and potential receptors to MC at the MRS sites. Since surface soil did not identify the presence of MC at LHAAP-001-R and LHAAP-003-R, there is no source area and there is not a complete pathway for MC. It is noted that perchlorate was detected once above the GW-Ind in a well at LHAAP-001-R by USEPA, although U.S. Army's split sample result was below the GW-Ind.

Based on MC data summary results and the determination of an incomplete pathway (since there is no MC at the surface), the MC Source-Receptor CSM presented in the EE/CA is accurate and is included as **Figure 4-1** in this report. In addition, the successful MEC removal action at LHAAP-001-R and LHAAP-003-R provides protection of human safety from explosive hazards to the extent practicable rendering the exposure pathway for MEC items an incomplete pathway as shown on **Figure 4-2**.

MC SOURCE-RECEPTOR CONCEPTUAL SITE MODEL

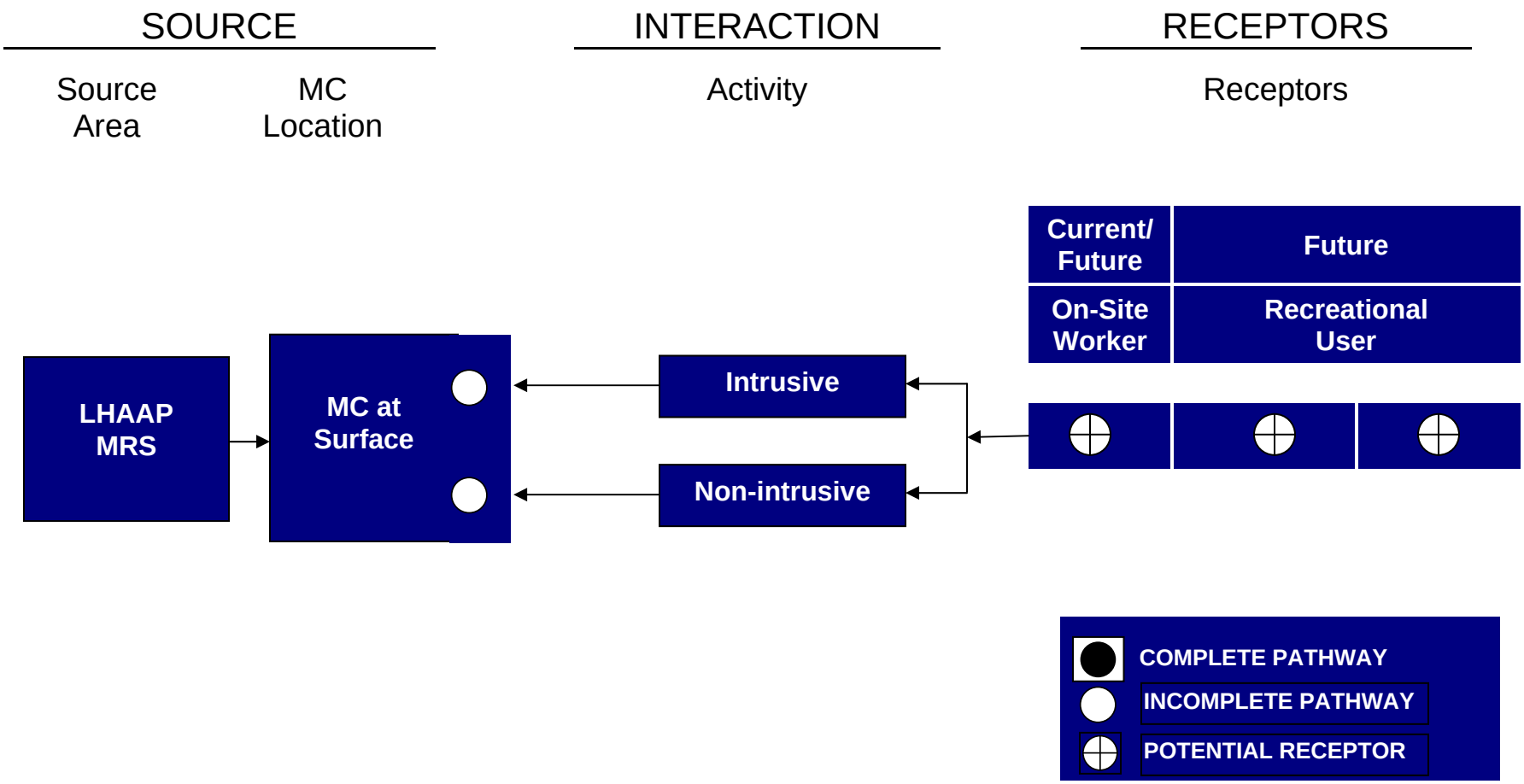

Figure 4-1

MEC SOURCE-RECEPTOR CONCEPTUAL SITE MODEL

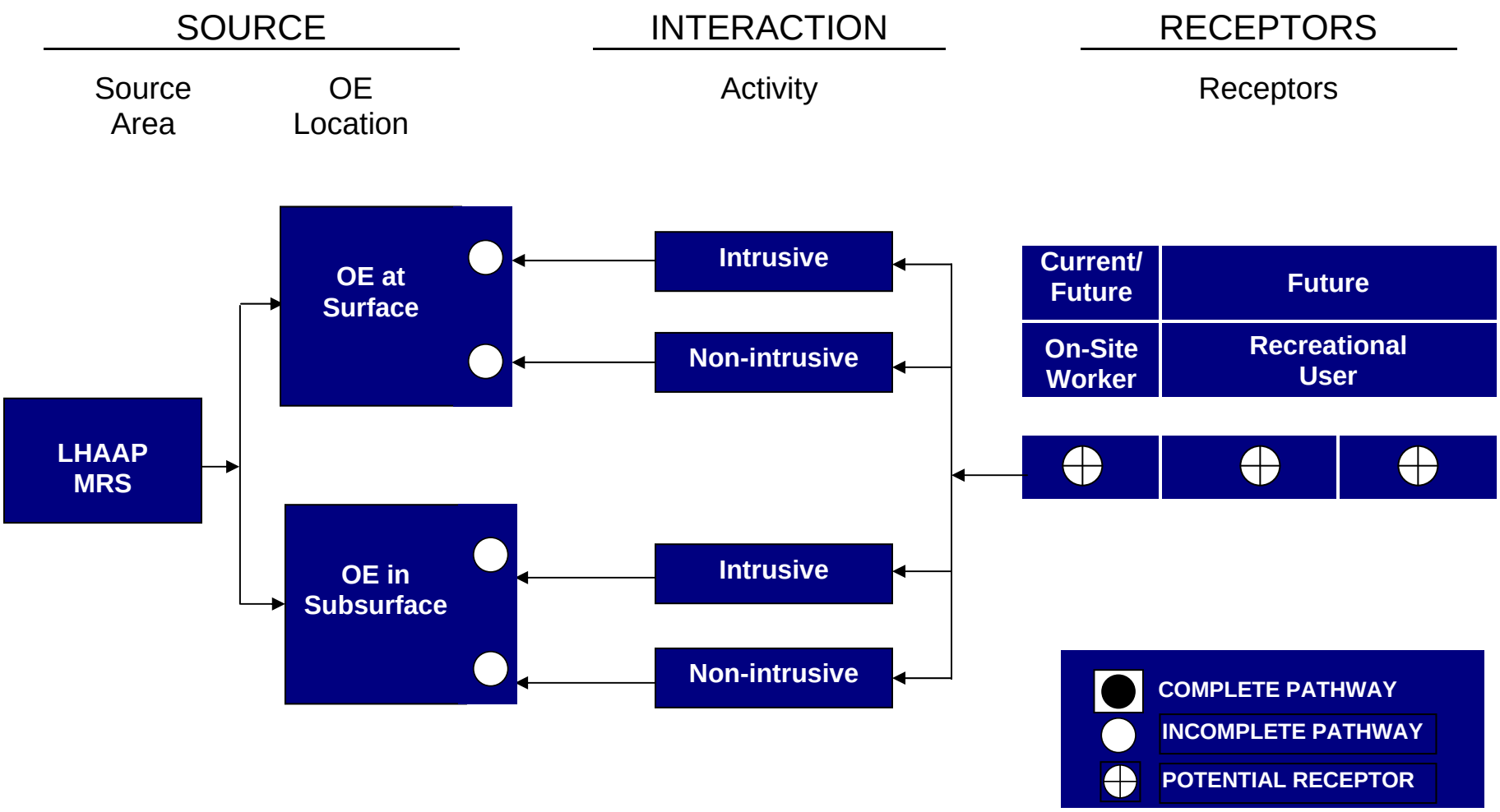

Figure 4-2

5.0 References.

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Appendix A

LHAAP-001-R Data Summary Tables

APPENDIX A
LHAAP-001-R

Page No.	Table No.	Reference
A-1 A-2	Table 11-1 Table 11-1b	Environmental Protection Systems, Inc (EPS) 1984, *Longhorn Army Ammunition Plant Contamination Survey,* June.
A-4 A-9	Table 11-2 Table 11-2b	Ebasco Services, Inc (Ebasco), 1993, *Sampling and Data Results Report, Site LH27, Remedial Investigation, Longhorn Army Ammunition Plant,* Volume VI, March.
A-12 A-12 A-14	Table 11-3 Table 11-4 Table 11-4b	Sverdrup Environmental, Inc (SVERDRUP), 1994, *Sampling and Data Results Report: Laboratory Report, Remedial Investigation Sites II, I, XX, 27, Longhorn Army Ammunition Plant, Karnack, Texas*, Volume I, November.
A-15	Table 11-5	U.S. Army Corps of Engineers (USACE), Tulsa District, 1997, *Remedial Investigation Report, Group 1 Sites (Sites 11, 1, XX, 27), Longhorn Army Ammunition Plant, Karnack, Texas*, Volume I, May.
A-16	Table 11-5b	U.S. Army Corps of Engineers (USACE), Southwestern Division Laboratory, 1996, *Results of Chemical Analyses of Soil Samples, South Test Area (27), Longhorn Army Ammunition Plant,* November. U.S. Army Corps of Engineers (USACE), Southwestern Division Laboratory, 1997, *Results of Chemical Analyses of Soil Samples, South Test Area (27), Longhorn Army Ammunition Plant,* March.
A-17 A-18	Table 11-6 Table 11-6b	Environmental Protection Systems, Inc (EPS) 1984, *Longhorn Army Ammunition Plant Contamination Survey,* June. Ebasco Services, Inc (Ebasco), 1993, *Sampling and Data Results Report, Site LH27, Remedial Investigation, Longhorn Army Ammunition Plant,* Volume VI, March.
A-22 A-23	Table 11-7 Table 11-7b	Sverdrup Environmental, Inc (SVERDRUP), 1994, *Sampling and Data Results Report: Laboratory Report, Remedial Investigation Sites II, I, XX, 27, Longhorn Army Ammunition Plant, Karnack, Texas*, Volume I, November.
A-24 A-25 A-28 A-29	Table 11-8 Table 11-8b Table 11-9 Table 11-9b	Ebasco Services, Inc (Ebasco), 1993, *Sampling and Data Results Report, Site LH27, Remedial Investigation, Longhorn Army Ammunition Plant,* Volume VI, March.

APPENDIX A (*continued*)
LHAAP-001-R

Page No.	Table No.	Reference
A-32 A-33 A-34	Table 1-17 Table 1-18 Table 1-18b	Solution to Environmental Problems (STEP), 2005, *Plant-wide Perchlorate Investigation, Longhorn Army Ammunition Plant, Karnack, Texas*, April.
A-35 A-38	Table 2 Table 2b	U.S. Fish and Wildlife Service (USFWS), 2003, *Contaminant Investigation of Northern, Central, and Eastern Portions of Caddo Lake National Wildlife Refuge, Texas*, November.
A-44	Table 4A-1	U.S. Army Corps of Engineers (USACE), Tulsa District, 1997, *Remedial Investigation Report, Group 1 Sites (Sites 11, 1, XX, 27), Longhorn Army Ammunition Plant, Karnack, Texas*, Volume II, May.
A-45	Table 3	CAPE, 2007, *Engineering Evaluation/Cost Analysis, Longhorn Army Ammunition Plant, Karnack, Texas*, Final, October.
A-46	Table A-1	Groundwater Analytical Results Summary Table provided by the USEPA from the October 2009 Groundwater Confirmation Sampling.
A-48	Table A-1b	Booz Allen Hamilton Inc., 2009, *Analytical Report, Longhorn Army Ammunition Plant*, November.
A-49	Table A-2	Groundwater Analytical Results Summary Table from the October 2009 Groundwater Confirmation Sampling by the U.S. Army
A-51	Table A-2b	ALS Laboratory Group USA, 2009, *Analytical Report, Longhorn Army Ammunition Plant*, November

LHAAP-001-R

A-1

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Table 11-1
Site 27 - South Test Area
EPS Surface Soil Analytical Summary (1982)

Parameter	Units	Sample 401	Sample 402	Sample 403
		EPS		
Explosives	ug/kg	<DL	<DL	<DL
TNT	ug/kg	10150	4610	<DL
Aluminum	mg/kg	1100	1386	1426
Barium	mg/kg	87	136.6	57.2
Chromium	mg/kg	16.3	12.3	10.3
Lead	mg/kg	25.5	26.3	24.6
Manganese	mg/kg	90	199.2	137.5
Strontium	mg/kg	5	9	4.3
Copper	mg/kg	2.7	41.1	2.8
Zinc	mg/kg	8.1	17.4	9.2
Nickel	mg/kg	1	4	2.2
Fluoride	mg/kg	6	5	6
Nitrate/Nitrite	mg/kg	15.8	22.3	0.96
Sulfate	mg/kg	38.2	37.5	33.25

TCEQ GWP-Ind

5,100
10,220
2.00
10
1.5
1422
6
130
3,066
204

Table 11-1b
Surface Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1982)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EPS	1982	Soil	***Metals***	EPS Method		
			Aluminum	1N	0.36	µg/g
			Arsenic	1J	0.3	µg/g
			Antimony	1J	0.76	µg/g
			Barium	1J	0.99	µg/g
			Beryllium	1N	0.5	µg/g
			Cadmium	1N	0.5	µg/g
			Chromium	1N	0.6	µg/g
			Copper	1N	0.5	µg/g
			Lead	1J	0.89	µg/g
			Manganese	1N	0.25	µg/g
			Mercury	2D	2.7	µg/g
			Nickel	1N	0.5	µg/g
			Selenium	1J	0.5	µg/g
			Silver	1N	0.5	µg/g
			Strontium	1N	0.5	µg/g
			Thallium	1N	3	µg/g
			Zinc	1N	0.5	µg/g
			Explosives			
			1,3-dinitrobenzene	7W	0.5	µg/g
			2,4,6-trinitrotoluene	7W	0.73	µg/g
			1,3,5-trinitrobenzene	7W	0.71	µg/g
			2,4 dinitrotoluene	7W	0.5	µg/g
			2,6-dinitrotoluene	7W	0.61	µg/g
			Nitrobenzene	7W	1.15	µg/g
			Anions			
			Nitrates	7U	5	µg/g
			Nitrites	7U	5	µg/g
			Sulfates	7U	25	µg/g
			Chloride	7U	7	µg/g
			Fluoride	7U	5	µg/g
			Chromate	7U	5	µg/g
			Thiocynate	7U	10	µg/g
			Cyanide	7U	5	µg/g

Note(s):

µg/g - micrograms per gram

018722

Table 11-1 (continued)
Site 27 - South Test Area
Ebasco Surface Soil Analytical Summary (1993)

Parameter	Units	Sample SS01	Sample SS02	Sample SS03	Sample SS04	TAGR Gnd Defined
		Ebasco				
Volatiles	ug/kg	<DL	<DL	<DL	<DL	
Semivolatiles	ug/kg	<DL	<DL	<DL	<DL	
Di-n-butylphthalate	ug/kg	2180	<DL	2610	<DL	1600,000
Bis(2-ethylhexyl)phthalate	ug/kg	360	380	360	<DL	600
Explosives	ug/kg	<DL	<DL	<DL	<DL	5,100
Arsenic	mg/kg	0.9	0.7	0.9	0.8	1
Barium	mg/kg	71.7	140	168	80.1	200
Chromium	mg/kg	3.8	2.3	3.9	5.7	10
Lead	mg/kg	5	2	7	7	1.5
Mercury	mg/kg	<DL	0.02	0.02	<DL	0.2
Nickel	mg/kg	1.8	2.5	3	2.9	2044
Selenium	mg/kg	<DL	0.2	0.2	0.3	5
Nitrate/Nitrite	mg/kg	2.24	2.14	2.05	<DL	
Sulfate	mg/kg	40	30		80	
pH	pH	5.6	6	5.6	5.2	
Conductivity	umhos/cm	98	90	43	30	

018723

Table 11-2
Site 27 - South Test Area
Ebasco Soil Analytical Summary (1993)

Parameter	Unit	Boring 27SB30		Boring 27SB31	
		0-2	3-4	0-2	4-6
Volatiles	ug/kg	<DL	<DL	<DL	<DL
Semivolatiles	ug/kg	<DL	<DL	<DL	<DL
Di-n-butylphthalate	ug/kg	443	<DL	<DL	<DL
Bis(2-ethylhexyl) phthalate	ug/kg	332	<DL	<DL	<DL
Explosives	ug/kg	<DL	<DL	<DL	<DL
Arsenic	mg/kg	1.3	1.2	1.1	2
Barium	mg/kg	131	54.3	60.8	19.2
Chromium	mg/kg	8.2	1.6	3.4	6.9
Lead	mg/kg	9	5	6	5
Mercury	mg/kg	0.02	0.03	0.03	0.02
Nickel	mg/kg	6.1	1.9	2.6	2.4
Selenium	mg/kg	0.3	<DL	<DL	0.2
Chloride	mg/kg	576	487	44	310
Nitrate/Nitrite	mg/kg	<DL	<DL	1.05	<DL
Sulfate	mg/kg	5400	6600	300	2100
pH	pH	5.7	8.3	5.6	5.8
Conductivity	umhos/cm	2520	1850	41	525

018724

Table 11-2 (continued)
Site 27 - South Test Area
Ebasco Soil Analytical Summary (1993)

Parameter	Units	Boring 27SB32		Boring 27SB33		TCEQ GW PCL
		0-2'	5-7'	0-2'	5-7'	
Volatiles	ug/kg	<DL	<DL	<DL	<DL	
Semivolatiles	ug/kg	<DL	<DL	<DL	<DL	
Explosives	ug/kg	<DL	<DL	<DL	<DL	
Arsenic	mg/kg	1.4	1.8	1.7	1.3	1
Barium	mg/kg	47.7	42.5	58	14	200
Chromium	mg/kg	5.9	5.8	4.1	8.8	10
Lead	mg/kg	7	6	5	5	1.5
Mercury	mg/kg	0.08	0.04	0.03	0.02	0.2
Nickel	mg/kg	5.6	2.9	2.1	1.7	204.4
Selenium	mg/kg	<DL	0.2	<DL	0.3	5
Chloride	mg/kg	133	399	44	310	
Nitrate/Nitrite	mg/kg	1.07	0.5	1.01	1.02	
Sulfate	mg/kg	540	300		190	
pH	pH	5.4	4.7	5.7	4.8	
Conductivity	umhos	193	1680	28	390	

018725

Table 11-2 (continued)
Site 27 - South Test Area
Ebasco Soil Analytical Summary (1993)

Parameter	Units	Boring 27SB31		Boring 27SB32		TCEQ GW-Ind
		0-2	8-10	0-2	8-10	
Volatiles	ug/kg	<DL	<DL	<DL	<DL	
Semivolatiles	ug/kg	<DL	<DL	<DL	<DL	
Pesticides/Herbicides	ug/kg	<DL	<DL	<DL	<DL	
Explosives	ug/kg	<DL	<DL	<DL	<DL	5100
Arsenic	mg/kg	1.1	1.7	1.1	1.1	1
Barium	mg/kg	38.1	9.8	33.7	26.3	200
Chromium	mg/kg	5.9	7.2	5.6	3.5	10
Lead	mg/kg	4	7	5	4	1.5
Mercury	mg/kg	0.02	<DL	0.03	<DL	0.2
Selenium	mg/kg	<DL	0.2	0.3	<DL	5
Nickel	mg/kg	4	3.5	1.4	1.6	204.4
Chloride	mg/kg	222	576	222	399	
Nitrate/Nitrite	mg/kg	1.49	0.66	<DL	<DL	
Sulfate	mg/kg	280	340	260	270	
pH	pH	5.4	4.6	4.7	4.7	
Conductivity	umhos/cm	1320	2280	1250	1690	

018726

Table 11-2 (continued)
Site 27 - South Test Area
Ebasco Soil Analytical Summary (1993)

Parameter	Units	Boring 27B030		Boring 27B037	
		0-2	0-2	0-2	5-7
Volatiles	ug/kg	<DL	<DL	<DL	<DL
Semivolatiles	ug/kg	<DL	<DL	<DL	<DL
Pesticides/Herbicides	ug/kg	<DL	<DL	<DL	<DL
Explosives	ug/kg	<DL	<DL	<DL	<DL
Arsenic	mg/kg	0.9	0.4	0.8	0.7
Barium	mg/kg	151	46.3	54.7	47.6
Chromium	mg/kg	6.8	4.3	4.2	3.2
Lead	mg/kg	7	5	5	4
Mercury	mg/kg	0.02	0.02	0.02	0.02
Nickel	mg/kg	4	3.1	3.8	2.9
Selenium	mg/kg	0.2	<DL	<DL	<DL
Chloride	mg/kg	1110	310	1290	931
Nitrate/Nitrite	mg/kg	<DL	<DL	<DL	<DL
Sulfate	mg/kg	4700	3900	5400	5800
pH	pH	8.8	9.1	8.9	9
Conductivity	umhos/cm	5260	1270	5170	3380

018727

Table 11-2 (continued)
Site 27 - South Test Area
Ebasco Soil Analytical Summary (1993)

Parameter	Units	Boring 27(S)38		Boring 27(S)39	
		0-2'	4-6'	0-2'	6-8'
Volatiles	ug/kg	<DL	<DL	<DL	<DL
Semivolatiles	ug/kg	<DL	<DL	<DL	<DL
Di-n-butylphthalate	ug/kg	<DL	<DL	<DL	513
Pesticides/Herbicides	ug/kg	<DL	<DL	<DL	<DL
Explosives	ug/kg	<DL	<DL	<DL	<DL
Arsenic	mg/kg	0.7	0.5	2.3	0.6
Barium	mg/kg	27.3	49.4	41.8	6.1
Chromium	mg/kg	6	5.3	22.2	<DL
Lead	mg/kg	5	4	5	6
Mercury	mg/kg	0.05	<DL	0.03	<DL
Nickel	mg/kg	<DL	2.6	<DL	<DL
Selenium	mg/kg	0.2	<DL	<DL	<DL
Chloride	mg/kg	310	665	<DL	487
Nitrate/Nitrite	mg/kg	<DL	<DL	<DL	<DL
Sulfate	mg/kg	4000	5600	<DL	4900
pH	pH	7.5	8.4	6.5	6.6
Conductivity	umhos/cm	908	2590	135	226

Table 11-2b
Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1993)

Investigated By /Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Soil - borings/surface soil				
			Metals			
			Arsenic	7060	0.1	mg/kg
			Antimony	6010	1	mg/kg
			Barium	6010	1	mg/kg
			Cadmium	6010	1	mg/kg
			Chromium	6010	1	mg/kg
			Lead	7421	1	mg/kg
			Mercury	7470/7471	0.01	mg/kg
			Nickel	6010	1	mg/kg
			Selenium	7740	0.1	mg/kg
			Silver	6010	1	mg/kg
			Thallium	7841	0.2	mg/kg
			VOCs			
			1,1,1-Trichloroethane	8240	5	µg/kg
			1,1,2,2-Tetrachloroethane	8240	5	µg/kg
			1,1,2-Trichloroethane	8240	5	µg/kg
			1,1-Dichloroethane	8240	5	µg/kg
			1,1-Dichloroethene	8240	5	µg/kg
			1,2-Dichloroethane	8240	5	µg/kg
			1,2-Dichloroethene	8240	5	µg/kg
			1,2-Dichloropropane	8240	5	µg/kg
			2-Butanone	8240	50	µg/kg
			2-Chloroethylvinylether	8240	10	µg/kg
			2-Hexanone	8240	50	µg/kg
			4-Methyl-2-pentanone	8240	50	µg/kg
			Acetone	8240	100	µg/kg
			Benzene	8240	5	µg/kg
			Bromodichloromethane	8240	5	µg/kg
			Bromoform	8240	5	µg/kg
			Bromomethane	8240	10	µg/kg
			Carbon disulfide	8240	5	µg/kg
			Carbon tetrachloride	8240	5	µg/kg
			Chlorobenzene	8240	5	µg/kg
			Chloroethane	8240	10	µg/kg
			Chloroform	8240	5	µg/kg
			Chloromethane	8240	10	µg/kg
			Chlorodibromomethane	8240	5	µg/kg
			Ethylbenzene	8240	5	µg/kg
			Methylene chloride	8240	5	µg/kg
			Styrene	8240	5	µg/kg
			Tetrachloroethene	8240	5	µg/kg
			Toluene	8240	5	µg/kg
			Trichloroethene	8240	5	µg/kg
			Vinyl acetate	8240	50	µg/kg
			Vinyl chloride	8240	10	µg/kg
			Xylenes	8240	5	µg/kg
			cis-1,3-Dichloropropene	8240	5	µg/kg
			trans-1,3-Dichloropropene	8240	5	µg/kg

Table 11-2b
Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1993)

Investigated By /Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Soil - borings/surface soil				
			SVOCs			
			1,2,4-Trichlorobenzene	8270	330	µg/kg
			1,2-Dichlorobenzene	8270	330	µg/kg
			1,3-Dichlorobenzene	8270	330	µg/kg
			1,4-Dichlorobenzene	8270	330	µg/kg
			2,4,5-Trichlorophenol	8270	1650	µg/kg
			2,4,6-Trichlorophenol	8270	330	µg/kg
			2,4-Dichlorophenol	8270	330	µg/kg
			2,4-Dimethylphenol	8270	330	µg/kg
			2,4-Dinitrophenol	8270	1650	µg/kg
			2,4-Dinitrotoluene	8270	330	µg/kg
			2,6-Dinitrotoluene	8270	330	µg/kg
			2-Chloronaphthalene	8270	330	µg/kg
			2-Chlorophenol	8270	330	µg/kg
			2-Methylnaphthalene	8270	330	µg/kg
			2-Methylphenol	8270	330	µg/kg
			2-Nitroaniline	8270	1650	µg/kg
			2-Nitrophenol	8270	330	µg/kg
			3,3-Dichlorobenzidine	8270	650	µg/kg
			3-Nitroaniline	8270	1650	µg/kg
			4-Bromophenylphenylether	8270	330	µg/kg
			4-Chloro-3-methylphenol	8270	650	µg/kg
			4-Chloroaniline	8270	650	µg/kg
			4-Chlorophenylphenylether	8270	330	µg/kg
			4-Methylphenol	8270	330	µg/kg
			4-Nitroaniline	8270	1650	µg/kg
			4-Nitrophenol	8270	1650	µg/kg
			4,6-Dinitro-2-methylphenol	8270	1650	µg/kg
			Acenaphthene	8270	330	µg/kg
			Acenaphthylene	8270	330	µg/kg
			Anthracene	8270	330	µg/kg
			Benzo(a)anthracene	8270	330	µg/kg
			Benzo(a)pyrene	8270	330	µg/kg
			Benzo(b)fluoranthene	8270	330	µg/kg
			Benzo(g,h,i)perylene	8270	330	µg/kg
			Benzo(k)fluoranthene	8270	330	µg/kg
			Benzoic acid	8270	1650	µg/kg
			Benzyl alcohol	8270	650	µg/kg
			Butylbenzylphthalate	8270	330	µg/kg
			Chrysene	8270	330	µg/kg
			Dibenzo(a,h)anthracene	8270	330	µg/kg
			Dibenzofuran	8270	330	µg/kg
			Di-n-butylphthalate	8270	330	µg/kg
			Diethylphthalate	8270	330	µg/kg
			Dimethylphthalate	8270	330	µg/kg
			Fluoranthene	8270	330	µg/kg
			Fluorene	8270	330	µg/kg
			Hexachlorobenzene	8270	330	µg/kg
			Hexachlorobutadiene	8270	330	µg/kg

Table 11-2b
Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1993)

Investigated By /Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Soil - borings/surface soil				
			Hexachlorocyclopentadiene	8270	330	µg/kg
			Hexachloroethane	8270	330	µg/kg
			Indeno(1,2,3-c,d)pyrene	8270	330	µg/kg
			Isophorone	8270	330	µg/kg
			Naphthalene	8270	330	µg/kg
			Nitrobenzene	8270	330	µg/kg
			Pentachlorophenol	8270	1650	µg/kg
			Phenanthrene	8270	330	µg/kg
			Phenol	8270	330	µg/kg
			Pyrene	8270	330	µg/kg
			bis(2-Chloroethoxy)methane	8270	330	µg/kg
			bis(2-Chloroethyl)ether	8270	330	µg/kg
			bis(2-Chloroisopropyl)ether	8270	330	µg/kg
			bis(2-Ethylhexyl)phthalate	8270	330	µg/kg
			di-n-Octylphthalate	8270	330	µg/kg
			n-Nitrosodi-n-propylamine	8270	330	µg/kg
			n-Nitrosodiphenylamine	8270	330	µg/kg
			Explosives			
			HMX	8330	0.5	mg/kg
			RDX	8330	0.5	mg/kg
			1,3,5-TNB	8330	0.25	mg/kg
			1,3-DNB	8330	0.25	mg/kg
			Tetryl	8330	0.5	mg/kg
			Nitrobenzene	8330	0.26	mg/kg
			2,4,6-TNT	8330	0.25	mg/kg
			2,6-DNT	8330	0.25	mg/kg
			2,4-DNT	8330	0.25	mg/kg
			2-Nitrotoluene	8330	0.25	mg/kg
			4-Nitrotoluene	8330	0.25	mg/kg
			3-Nitrotoluene	8330	0.25	mg/kg
			Anions			
			Nitrate-Nitrite Nitrogen	353.3	0.1	mg/kg
			Chloride	9052	10	mg/kg
			Sulfate	9038	10 - 20	mg/kg

Note(s):

µg/kg - micrograms per kilogram

mg/kg - milligrams per kilogram

SVOC - semivolatile organic compound

VOC - volatile organic compound

18728

During the Phase 2 field investigation conducted by Sverdrup in 1994, four soil borings (27WW01 through 27WW04) were drilled in the vicinity of 27SB33 and completed as monitoring wells. Three surface soil samples (27SS21, 27SS22, and 27SS23) were collected from 0.0 to 0.5 feet using a stainless steel hand auger. The three surface soil samples were analyzed for chromium and mercury.

No explosives were detected in the Phase 2 soil samples. No volatiles or semivolatiles were tested. Results of the surface soil samples are given in Table 11-3 and results of the soil borings are given in Table 11-4.

Table 11-3
Site 27 - South Test Area
Sverdrup Surface Soil Analytical Summary (1994)

Parameter	Units	Sample 27SS21	Sample 27SS22	Sample 27SS23
		Sverdrup		
Chromium	mg/kg	10.6	7.8	5.6
Mercury	mg/kg	<DL	<DL	<DL

TCEQ GWP-Ind
10
0.2

Table 11-4
Site 27 - South Test Area
Sverdrup Soil Analytical Summary (1994)

Parameter	Units	Well 27WW01	Well 27WW02	Well 27WW03	Well 27WW04
Explosives	ug/kg	<DL	<DL	<DL	<DL
Arsenic	mg/kg	2.5	5.2	3.2	3.4
Barium	mg/kg	1.05	86.1	23.8	72.8
Chromium	mg/kg	13.3	13.6	9	15.4
Lead	mg/kg	9	10	6.5	12.6
Nickel	mg/kg	8.4	8.3	5.2	18.6
Chloride	mg/kg	<DL	<DL	<DL	22.2
Nitrate/Nitrite	mg/kg	0.75	0.81	0.82	0.99
Sulfate	mg/kg	<DL	<DL	16.4	54.4

TCEQ GWP-Ind
1
200
10
1.5
2044

019729

Table 11-4 (continued)
Site 27 - South Test Area
Sverdrup Soil Analytical Summary (1994)

Parameter	Units	Well 27WW02		Well 27WW03			TCEQ GWP-Ind
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Explosives	µg/kg	<DL	<DL	<DL	<DL	<DL	
Arsenic	mg/kg	1.3	1.5	1.1	1.5	2.1	1
Barium	mg/kg	105	148	84.6	54.3	23	200
Chromium	mg/kg	6.9	9.6	8.2	8.5	7.1	0.2
Lead	mg/kg	6	7.1	6.7	5.4	4.9	1.5
Nickel	mg/kg	3.3	6.6	3.8	4.7	5.1	204.4
Chloride	mg/kg	49.8	<DL	<DL	22.6	30.4	
Nitrate/Nitrite	mg/kg	0.64	0.88	0.82	0.54	0.55	
Sulfate	mg/kg	41.5	<DL	<DL	26.3	26.7	

Table 11-4
Site 27 - South Test Area
Sverdrup Soil Analytical Summary (1994)

Parameter	Units	Well 27WW04			TCEQ GWP-Ind
		[illegible]	[illegible]	[illegible]10	
Explosives	µg/kg	<DL	<DL	<DL	
Arsenic	mg/kg	2.3	1.8	1.1	1
Barium	mg/kg	104	639	65.8	200
Chromium	mg/kg	6.2	9.8	6	10
Lead	mg/kg	7.7	6.1	4.5	1.5
Nickel	mg/kg	3.9	10	9.4	204.4
Chloride	mg/kg	<DL	6322	485	
Nitrate/Nitrite	mg/kg	1.6	1.9	2.6	
Sulfate	mg/kg	314	498	354	

Table 11-4b
Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1994)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
SVERDRUP	1994	Soil - surface	chromium	6010	NA	
			mercury	7470/7471	0.12	mg/kg
		Soil - monitoring well borings	***Metals***			
			Arsenic	7060	NA	
			Antimony	6010	1.1 - 1.3	mg/kg
			Barium	6010	NA	
			Cadmium	6010	0.56 - 0.63	mg/kg
			Chromium	6010	NA	
			Lead	7421	NA	
			Mercury	7470/7471	0.11 - 0.13	mg/kg
			Nickel	6010	NA	
			Selenium	7740	0.56 - 1.24	mg/kg
			Silver	6010	1.1 - 1.3	mg/kg
			Thallium	7841	0.55 - 1.2	mg/kg
			Explosives			
			1,3-DNB	8330	0.5 - 0.628	mg/kg
			RDX	8330	0.5 - 0.628	mg/kg
			1,3,5-TNB	8330	0.7 - 0.879	mg/kg
			2,4,6-TNT	8330	0.594 - 0.628	mg/kg
			2,4-DNT	8330	0.594 - 0.628	mg/kg
			2,6-DNT	8330	0.594 - 0.628	mg/kg
			HMX	8330	0.9 - 1.13	mg/kg
			Nitrobenzene	8330	0.6 - 0.754	mg/kg
			o-Nitrotoluene	8330	0.9 - 1.13	mg/kg
			3-Nitrotoluene	8330	0.9 - 1.13	mg/kg
			p-Nitrotoluene	8330	1.1 - 1.38	mg/kg
			Tetryl	8330	1.9 - 2.39	mg/kg
			2-Amino dinitrotoluene	8330	0.9 - 1.13	mg/kg
			4-Amino-2,6- dinitrotoluene	8330	1.1 - 1.38	mg/kg
			Anions			
			Nitrate-Nitrite-Nitrogen	353.3	NA	
			Chloride	9052	5.6 - 12.54	mg/kg
			Sulfate	9038	5.6 - 6.1	mg/kg

Note(s):
mg/kg - milligrams per kilogram
NA - Not available

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Table 11-5
Site 27 - South Test Area
Tulsa District Corps of Engineers (1996/97)
Surface Soil Analytical Summary

Parameter	Units	BASS27-01	BASS27-02	BASS27-03	BASS27-04	BASS27-05	BASS27-06	BASS27-07	BASS27-08	BASS27-09	TRRQ Guid?
Explosives	ug/kg	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	5,100
Aluminum	mg/kg	NT	10300	NT	5390	NT	4350	NT	8360	NT	10,200
Antimony	mg/kg	NT	<DL	NT	<DL	NT	<DL	NT	<DL	NT	
Arsenic	mg/kg	NT	13.1	NT	6.08	NT	11.6	NT	7.81	NT	1
Barium	mg/kg	NT	82.6	NT	123	NT	112	NT	69.5	NT	200
Beryllium	mg/kg	NT	1.16	NT	<DL	NT	<DL	NT	<DL	NT	0.4
Cadmium	mg/kg	NT	21	NT	8.54	NT	14.7	NT	9.03	NT	0.5
Calcium	mg/kg	NT	554	NT	392	NT	809	NT	787	NT	NA
Chromium	mg/kg	NT	30.9	NT	15.2	NT	36.3	NT	21.4	NT	10
Cobalt	mg/kg	NT	<DL	NT	<DL	NT	<DL	NT	<DL	NT	
Copper	mg/kg	NT	18.70	NT	6.94	NT	7.69	NT	5.65	NT	130
Iron	mg/kg	NT	70,000	NT	45,400	NT	23,200	NT	21,800	NT	NA
Lead	mg/kg	NT	17.0	NT	18.0	NT	15.0	NT	11.0	NT	1.5
Magnesium	mg/kg	NT	310	NT	187	NT	308	NT	635	NT	NA
Manganese	mg/kg	NT	204	NT	137	NT	223	NT	135	NT	1431
Mercury	mg/kg	NT	<DL	NT	<DL	NT	<DL	NT	<DL	NT	0.2
Nickel	mg/kg	NT	<DL	NT	2.41	NT	<DL	NT	<DL	NT	2044
Potassium	mg/kg	NT	302	NT	150	NT	235	NT	513	NT	NA
Selenium	mg/kg	NT	0.83	NT	0.71	NT	0.66	NT	<DL	NT	5
Silver	mg/kg	NT	<DL	NT	<DL	NT	<DL	NT	<DL	NT	
Strontium	mg/kg	NT	<DL	NT	<DL	NT	<DL	NT	16.8	NT	4132
Thallium	mg/kg	NT	<DL	NT	<DL	NT	<DL	NT	<DL	NT	
Vanadium	mg/kg	NT	72.4	NT	50.7	NT	25.6	NT	27.5	NT	72
Zinc	mg/kg	NT	41.3	NT	19.6	NT	19.6	NT	22.4	NT	3066

NT = Not tested.

Table 11-5b
Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1996/1997)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
USACE	Aug-96	Soil - Surface				
			Metals			
			Arsenic	7060	2.58 - 2.74	mg/kg
			Antimony	6010	10.3 - 10.9	mg/kg
			Barium	6010	2.06 - 2.19	mg/kg
			Cadmium	6010	2.06 - 2.19	mg/kg
			Chromium	6010	2.06 - 2.19	mg/kg
			Lead	7421	2	mg/kg
			Mercury	7471	0.124 - 0.131	mg/kg
			Nickel	6010	2.06 - 2.19	mg/kg
			Selenium	7740	0.52 - 0.55	mg/kg
			Silver	6010	2.10 - 10.3	mg/kg
			Thallium	6010	15.5 - 16.4	mg/kg
			Explosives			
			HMX	8330	0.9	mg/kg
			RDX	8330	0.5	mg/kg
			1,3,5-TNB	8330	0.7	mg/kg
			1,3-DNB	8330	0.5	mg/kg
			Tetryl	8330	1.9	mg/kg
			Nitrobenzene	8330	0.6	mg/kg
			2,4,6-TNT	8330	0.5	mg/kg
			2,6-DNT	8330	0.5	mg/kg
			2,4-DNT	8330	0.5	mg/kg
			2-Nitrotoluene	8330	0.9	mg/kg
			4-Nitrotoluene	8330	1.1	mg/kg
			3-Nitrotoluene	8330	0.9	mg/kg
			2-Am-DNT	8330	0.9	mg/kg
			4-Am-DNT	8330	1.1	mg/kg
USACE	Feb-97	Soil - Surface	***Metals***			
			Aluminum	6010	24.9 - 30.7	mg/kg
			Beryllium	6010	0.62 - 0.77	mg/kg
			Calcium	6010	62.2 - 76.8	mg/kg
			Cobalt	6010	2.49 - 3.07	mg/kg
			Copper	6010	1.24 - 1.54	mg/kg
			Iron	6010	12.4 - 15.4	mg/kg
			Potassium	6010	124 -154	mg/kg
			Magnesium	6010	12.4 - 15.4	mg/kg
			Manganese	6010	1.24 - 1.54	mg/kg
			Strontium	6010	12.4 - 15.4	mg/kg
			Vanadium	6010	2.49 - 3.07	mg/kg
			Zinc	6010	3.73 - 4.61	mg/kg

Note(s):

mg/kg - milligrams per kilogram

USACE - U.S. Army Corps of Engineers

018732

Table 11-6
Site 27 - South Test Area
Groundwater Analytical Summary
EPS (1982) and Ebasco (1993)

Parameter	Units	Well 131		Well 132		MCL	TCEQ GW-Ind
		11/82	3/93	11/82	3/93		
Volatiles	ug/l	<DL	<DL	NT	<DL		
Semivolatiles	ug/l	<DL	<DL	NT	<DL		
Di-n-butylphthalate	ug/l	52	<DL	NT	<DL		10,220
Ethylene glycol	ug/l	24	<DL	NT	<DL		204,400
Pesticides	ug/l	<DL	NT	NT	NT		
Explosives	ug/l	<DL	<DL	<DL	<DL		
Barium	mg/l	0.048	0.25	0.053	0.09	2	
Chromium	mg/l	<DL	<DL	0.015	<DL	0.1	
Lead	mg/l	<DL	<DL	0.016	<DL	0.015	
Nickel	mg/l	0.053	<DL	0.102	<DL		0.6447
Aluminum	mg/l	0.222	NT	0.232	NT		102.2
Cadmium	mg/l	0.001	<DL	0.009	<DL	0.005	
Strontium	mg/l	1.34	NT	2.64	NT		61.32
Thallium	mg/l	0.08	<DL	0.1	<DL	0.002	
Chloride	mg/l	27850	306	10330	1700		
Fluoride	mg/l	1	NT	1	NT		
Nitrate/Nitrite	mg/l	<DL	<DL	<DL	0.01		
Sulfate	mg/l	216.6	121	337	780		

NT = Not tested.

Table 11-6b
Groundwater Analytical Methods and Detection Limits
South Test Area LHAAP-001-R
1982 and 1993

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EPS	1982	groundwater -wells		EPS Method		
			Metals			
			Aluminum	1M	10	µg/L
			Arsenic	1B	6	µg/L
			Antimony	1B	10.2	µg/L
			Barium	1B	11.4	µg/L
			Beryllium	1M	10	µg/L
			Cadmium	1B	0.28	µg/L
			Chromium	1B	6.64	µg/L
			Copper	1M	23.9	µg/L
			Lead	1B	7.49	µg/L
			Manganese	1M	12.1	µg/L
			Mercury	1D	1.3	µg/L
			Nickel	1M	30	µg/L
			Selenium	1B	6	µg/L
			Silver	1M	10	µg/L
			Strontium	1M	25	µg/L
			Thallium	1M	50	µg/L
			Zinc	1M	27.1	µg/L
			Organics			
			Benzene	2J	1	µg/L
			Chloroform	2J	1	µg/L
			Trichloroethene	2J	1	µg/L
			Trichloroethane	NA	NA	
			Trichlororomethane	NA	NA	
			Pentachlorophenol	1X	2	µg/L
			o-chlorophenol	1X	0.7	µg/L
			2,4-dichlorophenol	1X	1	µg/L
			Pentane	NA	NA	
			Di-N-Butyl-phthalate	1Z	2	µg/L
			Dibutylphthalate	NA	NA	
			Dichloromethane	NA	NA	
			Diethylphthalate	1Z	2	µg/L
			Nitrobenzene	1Z	1	µg/L
			1,1-bicyclohexyl	NA	NA	
			Glycine,N-acetyl-Ntrifluoroacetyl)methylester	NA	NA	
			2-(1,1-dimethylethoxyl)-ethanol	NA	NA	
			1-bromo-2-methoxy-cyclopentane	NA	NA	
EPS	1982	groundwater -wells	***Explosives***			
			1,3-dinitrobenzene	7V	1.68	µg/L
			2,4,6-trinitrotoluene	7V	1.46	µg/L
			1,3,5-trinitrobenzene	7V	1.08	µg/L
			2,4 dinitrotoluene	7V	0.89	µg/L
			2,6-dinitrotoluene	7V	1.2	µg/L
			Nitrobenzene	7V	0.76	µg/L
			Pesticides/PCBs			
			p,p-DDT	2F	0.05	µg/L
			Dieldrin	2F	0.09	µg/L
			Alpha-BHC	2F	0.09	µg/L
			Heptachlor	2F	0.05	µg/L
			Lindane	2F	0.09	µg/L
			Toxaphene	2F	4	µg/L
			PCB 1016	2F	0.6	µg/L
			PCB 1260	2F	1	µg/L

Table 11-6b
Groundwater Analytical Methods and Detection Limits
South Test Area LHAAP-001-R
1982 and 1993

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EPS	1982	groundwater -wells	***Anions***			
			Nitrate	2P	500	µg/L
			Nitrite	2P	250	µg/L
			Phosphate	2P	125	µg/L
			Sulfates	2P	580	µg/L
			Chloride	2P	500	µg/L
			Fluoride	2P	500	µg/L
			Chromate	2P	500	µg/L
			Thiocyanate	2P	500	µg/L
			Cyanide	2P	600	µg/L
EBASCO	1993	groundwater	***Metals***			
			Arsenic	7060	0.01	mg/L
			Antimony	6010	0.005	mg/L
			Barium	6010	0.01	mg/L
			Cadmium	6010	0.005	mg/L
			Chromium	6010	0.05	mg/L
			Lead	7421	0.005	mg/L
			Mercury	7470/7471	0.001	mg/L
			Nickel	6010	0.05	mg/L
			Selenium	7740	0.01	mg/L
			Silver	6010	0.01	mg/L
			Thallium	7841	0.002	mg/L
			VOCs			
			1,1,1-Trichloroethane	8240	5	µg/L
			1,1,2,2-Tetrachloroethane	8240	5	µg/L
			1,1,2-Trichloroethane	8240	5	µg/L
			1,1-Dichloroethane	8240	5	µg/L
			1,1-Dichloroethene	8240	5	µg/L
			1,2-Dichloroethane	8240	5	µg/L
			1,2-Dichloroethene	8240	5	µg/L
			1,2-Dichloropropane	8240	5	µg/L
			2-Butanone	8240	50	µg/L
			2-Chloroethylvinylether	8240	10	µg/L
			2-Hexanone	8240	50	µg/L
			4-Methyl-2-pentanone	8240	50	µg/L
			Acetone	8240	100	µg/L
			Benzene	8240	5	µg/L
			Bromodichloromethane	8240	5	µg/L
			Bromoform	8240	5	µg/L
			Bromomethane	8240	10	µg/L
			Carbon disulfide	8240	5	µg/L
			Carbon tetrachloride	8240	5	µg/L
			Chlorobenzene	8240	5	µg/L
			Chloroethane	8240	10	µg/L
			Chloroform	8240	5	µg/L
			Chloromethane	8240	10	µg/L
			Chlorodibromomethane	8240	5	µg/L
			Ethylbenzene	8240	5	µg/L
			Methylene chloride	8240	5	µg/L
			Styrene	8240	5	µg/L
			Tetrachloroethene	8240	5	µg/L
			Toluene	8240	5	µg/L
			Trichloroethene	8240	5	µg/L
			Vinyl acetate	8240	50	µg/L
			Vinyl chloride	8240	10	µg/L

Table 11-6b
Groundwater Analytical Methods and Detection Limits
South Test Area LHAAP-001-R
1982 and 1993

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	groundwater	***VOCs (continued)***			
			Xylenes	8240	5	µg/L
			cis-1,3-Dichloropropene	8240	5	µg/L
			trans-1,3-Dichloropropene	8240	5	µg/L
			SVOCs			
			1,2,4-Trichlorobenzene	8270	10	µg/L
			1,2-Dichlorobenzene	8270	10	µg/L
			1,3-Dichlorobenzene	8270	10	µg/L
			1,4-Dichlorobenzene	8270	10	µg/L
			2,4,5-Trichlorophenol	8270	50	µg/L
			2,4,6-Trichlorophenol	8270	10	µg/L
			2,4-Dichlorophenol	8270	10	µg/L
			2,4-Dimethylphenol	8270	10	µg/L
			2,4-Dinitrophenol	8270	50	µg/L
			2,4-Dinitrotoluene	8270	10	µg/L
			2,6-Dinitrotoluene	8270	10	µg/L
			2-Chloronaphthalene	8270	10	µg/L
			2-Chlorophenol	8270	10	µg/L
			2-Methylnaphthalene	8270	10	µg/L
			2-Methylphenol	8270	10	µg/L
			2-Nitroaniline	8270	50	µg/L
			2-Nitrophenol	8270	10	µg/L
			3,3-Dichlorobenzidine	8270	20	µg/L
			3-Nitroaniline	8270	50	µg/L
			4-Bromophenylphenylether	8270	10	µg/L
			4-Chloro-3-methylphenol	8270	20	µg/L
			4-Chloroaniline	8270	20	µg/L
			4-Chlorophenylphenylether	8270	10	µg/L
			4-Methylphenol	8270	10	µg/L
			4-Nitroaniline	8270	50	µg/L
			4-Nitrophenol	8270	50	µg/L
			4,6-Dinitro-2-methylphenol	8270	50	µg/L
			Acenaphthene	8270	10	µg/L
			Acenaphthylene	8270	10	µg/L
			Anthracene	8270	10	µg/L
			Benzo(a)anthracene	8270	10	µg/L
			Benzo(a)pyrene	8270	10	µg/L
			Benzo(b)fluoranthene	8270	10	µg/L
			Benzo(g,h,i)perylene	8270	10	µg/L
			Benzo(k)fluoranthene	8270	10	µg/L
			Benzoic acid	8270	50	µg/L
			Benzyl alcohol	8270	20	µg/L
			Butylbenzylphthalate	8270	10	µg/L
			Chrysene	8270	10	µg/L
			Dibenzo(a,h)anthracene	8270	10	µg/L
			Dibenzofuran	8270	10	µg/L
			Di-n-butylphthalate	8270	10	µg/L
			Diethylphthalate	8270	10	µg/L
			Dimethylphthalate	8270	10	µg/L
			Fluoranthene	8270	10	µg/L
			Fluorene	8270	10	µg/L
			Hexachlorobenzene	8270	10	µg/L
			Hexachlorobutadiene	8270	10	µg/L
			Hexachlorocyclopentadiene	8270	10	µg/L
			Hexachloroethane	8270	10	µg/L
			Indeno(1,2,3-c,d)pyrene	8270	10	µg/L

Table 11-6b
Groundwater Analytical Methods and Detection Limits
South Test Area LHAAP-001-R
1982 and 1993

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	groundwater	***SVOCs (continued)***			
			Isophorone	8270	10	µg/L
			Naphthalene	8270	10	µg/L
			Nitrobenzene	8270	10	µg/L
			Pentachlorophenol	8270	50	µg/L
			Phenanthrene	8270	10	µg/L
			Phenol	8270	10	µg/L
			Pyrene	8270	10	µg/L
			bis(2-Chloroethoxy)methane	8270	10	µg/L
			bis(2-Chloroethyl)ether	8270	10	µg/L
			bis(2-Chloroisopropyl)ether	8270	10	µg/L
			bis(2-Ethylhexyl)phthalate	8270	10	µg/L
			di-n-Octylphthalate	8270	10	µg/L
			n-Nitrosodi-n-propylamine	8270	10	µg/L
			n-Nitrosodiphenylamine	8270	10	µg/L
			Explosives			
			HMX	8330	0.1	µg/L
			RDX	8330	0.1	µg/L
			1,3,5-TNB	8330	0.1	µg/L
			1,3-DNB	8330	0.1	µg/L
			Tetryl	8330	0.1	µg/L
			Nitrobenzene	8330	0.1	µg/L
			2,4,6-TNT	8330	0.1	µg/L
			2,6-DNT	8330	0.1	µg/L
			2,4-DNT	8330	0.1	µg/L
			2-Nitrotoluene	8330	0.1	µg/L
			4-Nitrotoluene	8330	0.1	µg/L
			3-Nitrotoluene	8330	0.1	µg/L
			Anions			
			Nitrate-Nitrite Nitrogen	353.3	0.01	mg/L
			Direct Total Phenol	9065	0.1	mg/L
			Chloride	9252	1	mg/L
			Sulfate	9038	1 - 30	mg/L
			TOC	9060	1	mg/L

Note(s):
µg/L - micrograms per liter
mg/L - milligrams per liter
NA - not available
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
TOC - total organic carbon
VOC - volatile organic compound

018733

Table 11-7
Site 27 - South Test Area
Groundwater Analytical Summary - Sverdrup Wells (1994)

Parameters	Units	Well 27WW01	Well 27WW02	Well 27WW03	Well 27WW04	MCL	TCEQ GW-Ind
Semivolatiles	ug/l	<DL	<DL	<DL	<DL		
Explosives	ug/l	<DL	<DL	<DL	<DL		
Arsenic	mg/l	0.006	<DL	<DL	<DL	0.01	
Barium	mg/l	0.097	0.046	0.017	0.05	2	
Chromium	mg/l	0.053	0.026	0.01	0.025	0.1	
Nickel	mg/l	0.13	0.23	0.12	0.37		2.044
Chloride	mg/l	2340	3700	2.7	2200		
Nitrate/Nitrite	mg/l	0.06	0.08	1.17	0.24		
Sulfate	mg/l	1250	1800	2.4	1700		

Phase 1 groundwater investigations consisted of collecting groundwater grab samples from the 10 soil borings drilled. The purpose of collecting groundwater grab samples was to obtain preliminary field screening data of potential groundwater contaminants. The most significant findings from the analysis of groundwater grab samples was the detection of nitrobenzene (6.58 ug/l) and RDX (18.4 ug/l) in the sample from 27GG33, located in the cratered hillocks west of the test pad. Sample 27GG38 contained elevated nitrate at 3.31 mg/l and 27GG37 contained elevated sulfate, chloride, and nitrate. A data table summarizing the results of all groundwater grab samples is shown in Appendix D.

Based on the explosives found in grab sample 27GG33, four monitoring wells, 27WW01 through 27WW04, were installed during the Phase 2 field investigation at the locations shown on Figure 11-1. Well 27WW01 was installed approximately 10 feet from 27SB33, and wells 27WW02 and 27WW03 were installed to the east of the boring. Well 27WW04 was installed downgradient of the other three wells. The maximum screen length used was 10 ft.

The wells were purged a minimum of five well volumes and sampled once field parameters stabilized. No explosives or semivolatiles were found. Volatiles were not tested. Nickel, nitrate, and chloride were detected at elevated levels in most of the samples. Results of these analyses are given in Table 11-7.

Table 11-7b
Groundwater Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1994)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
SVERDRUP	1994	groundwater-wells	***Metals***			
			Arsenic	7060	0.005	mg/L
			Antimony	6010	0.01	mg/L
			Barium	6010	0.02	mg/L
			Cadmium	6010	0.01	mg/L
			Chromium	6010	0.02	mg/L
			Lead	7421	0.02 - 0.1	mg/L
			Mercury	7470/7471	0.0002	mg/L
			Nickel	6010	NA	
			Selenium	7740	0.005 - 0.02	mg/L
			Silver	6010	0.02	mg/L
			Thallium	7841	0.05	mg/L
			SVOCs			
			NA	NA	NA	
			Explosives			
			1,3-DNB	8330	0.2 - 0.3	µg/L
			RDX	8330	0.6 - 0.9	µg/L
			1,3,5-TNB	8330	0.5 - 0.75	µg/L
			2,4,6-TNT	8330	0.7 - 1.05	µg/L
			2,4-DNT	8330	0.5 - 0.75	µg/L
			2,6-DNT	8330	0.5 - 0.75	µg/L
			HMX	8330	0.4 - 0.6	µg/L
			Nitrobenzene	8330	0.6 - 0.9	µg/L
			o-Nitrotoluene	8330	0.4	µg/L
			3-Nitrotoluene	8330	0.4 - 0.6	µg/L
			p-Nitrotoluene	8330	0.4	µg/L
			Tetryl	8330	0.4 - 0.6	µg/L
			2-Amino dinitrotoluene	8330	0.5 - 0.75	µg/L
			4-Amino-2,6- dinitrotoluene	8330	0.6 - 0.9	µg/L
			Anions			
			Nitrate	353.3	NA	
			Chloride	9056/325.3	NA	
			Sulfate	9056/375.4	NA	

Note(s):
µg/L - micrograms per liter
mg/L - milligrams per liter
NA - not available

11.1.3 Surface Water and Sediment Investigations

Four sediment and 4 surface water samples were collected during the Phase 1 remedial investigation. No explosives or volatiles were found in the sediment samples. Two of the sediments contained di-n-butylphthalate. Most samples contained low levels of metals and anions. Lead was detected in surface water sample 27SW03 at 0.015 mg/l. Barium, chloride, nitrate, and sulfate were found in low levels in these samples. No volatiles, semivolatiles, or explosives were found. Results are given in Tables 11-8 and 11-9.

No surface water or sediment samples were collected during the Phase 2 field investigation.

Table 11-8
Site 27 - South Test Area
Sediment Analytical Summary (1993)

Parameters	Units	Sample 27SD02	Sample 27SD01	Sample 27SD04	Sample 27SD03
Volatiles	ug/kg	<DL	<DL	<DL	<DL
Semi-volatiles	ug/kg	<DL	<DL	<DL	<DL
Di-n-butylphthalate	ug/kg	<DL	2170	<DL	1760
Explosives	ug/kg	<DL	<DL	<DL	<DL
Arsenic	mg/kg	1.1	0.9	1.1	0.7
Barium	mg/kg	91.8	43.5	254	39
Chromium	mg/kg	4.6	1.9	5.2	2.4
Lead	mg/kg	9	8	5	4
Mercury	mg/kg	0.03	<DL	<DL	<DL
Nickel	mg/kg	6	3	3.9	2.8
Selenium	mg/kg	<DL	0.2	<DL	<DL
Chloride	mg/kg	44	<DL	<DL	<DL
Nitrate/Nitrite	mg/kg	2.26	2.17	<DL	2.36
Sulfate	mg/kg	40	40	50	30
pH	pH	6.3	5.2	5.6	6.4
Conductivity	umhos/cm	170	51	197	123

Table 11-8b
Sediment Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1993)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Sediment	***Metals***			
			Arsenic	7060	0.1	mg/kg
			Antimony	6010	1	mg/kg
			Barium	6010	1	mg/kg
			Cadmium	6010	1	mg/kg
			Chromium	6010	1	mg/kg
			Lead	7421	1	mg/kg
			Mercury	7470/7471	0.01	mg/kg
			Nickel	6010	1	mg/kg
			Selenium	7740	0.1	mg/kg
			Silver	6010	1	mg/kg
			Thallium	7841	0.2	mg/kg
			VOCs			
			1,1,1-Trichloroethane	8240	5	µg/kg
			1,1,2,2-Tetrachloroethane	8240	5	µg/kg
			1,1,2-Trichloroethane	8240	5	µg/kg
			1,1-Dichloroethane	8240	5	µg/kg
			1,1-Dichloroethene	8240	5	µg/kg
			1,2-Dichloroethane	8240	5	µg/kg
			1,2-Dichloroethene	8240	5	µg/kg
			1,2-Dichloropropane	8240	5	µg/kg
			2-Butanone	8240	50	µg/kg
			2-Chloroethylvinylether	8240	10	µg/kg
			2-Hexanone	8240	50	µg/kg
			4-Methyl-2-pentanone	8240	50	µg/kg
			Acetone	8240	100	µg/kg
			Benzene	8240	5	µg/kg
			Bromodichloromethane	8240	5	µg/kg
			Bromoform	8240	5	µg/kg
			Bromomethane	8240	10	µg/kg
			Carbon disulfide	8240	5	µg/kg
			Carbon tetrachloride	8240	5	µg/kg
			Chlorobenzene	8240	5	µg/kg
			Chloroethane	8240	10	µg/kg
			Chloroform	8240	5	µg/kg
			Chloromethane	8240	10	µg/kg
			Chlorodibromomethane	8240	5	µg/kg
			Ethylbenzene	8240	5	µg/kg
			Methylene chloride	8240	5	µg/kg
			Styrene	8240	5	µg/kg
			Tetrachloroethene	8240	5	µg/kg
			Toluene	8240	5	µg/kg
			Trichloroethene	8240	5	µg/kg
			Vinyl acetate	8240	50	µg/kg
			Vinyl chloride	8240	10	µg/kg
			Xylenes	8240	5	µg/kg
			cis-1,3-Dichloropropene	8240	5	µg/kg
			trans-1,3-Dichloropropene	8240	5	µg/kg

Table 11-8b
Sediment Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1993)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Sediment	***SVOCs***			
			1,2,4-Trichlorobenzene	8270	330	µg/kg
			1,2-Dichlorobenzene	8270	330	µg/kg
			1,3-Dichlorobenzene	8270	330	µg/kg
			1,4-Dichlorobenzene	8270	330	µg/kg
			2,4,5-Trichlorophenol	8270	1650	µg/kg
			2,4,6-Trichlorophenol	8270	330	µg/kg
			2,4-Dichlorophenol	8270	330	µg/kg
			2,4-Dimethylphenol	8270	330	µg/kg
			2,4-Dinitrophenol	8270	1650	µg/kg
			2,4-Dinitrotoluene	8270	330	µg/kg
			2,6-Dinitrotoluene	8270	330	µg/kg
			2-Chloronaphthalene	8270	330	µg/kg
			2-Chlorophenol	8270	330	µg/kg
			2-Methylnaphthalene	8270	330	µg/kg
			2-Methylphenol	8270	330	µg/kg
			2-Nitroaniline	8270	1650	µg/kg
			2-Nitrophenol	8270	330	µg/kg
			3,3-Dichlorobenzidine	8270	650	µg/kg
			3-Nitroaniline	8270	1650	µg/kg
			4-Bromophenylphenylether	8270	330	µg/kg
			4-Chloro-3-methylphenol	8270	650	µg/kg
			4-Chloroaniline	8270	650	µg/kg
			4-Chlorophenylphenylether	8270	330	µg/kg
			4-Methylphenol	8270	330	µg/kg
			4-Nitroaniline	8270	1650	µg/kg
			4-Nitrophenol	8270	1650	µg/kg
			4,6-Dinitro-2-methylphenol	8270	1650	µg/kg
			Acenaphthene	8270	330	µg/kg
			Acenaphthylene	8270	330	µg/kg
			Anthracene	8270	330	µg/kg
			Benzo(a)anthracene	8270	330	µg/kg
			Benzo(a)pyrene	8270	330	µg/kg
			Benzo(b)fluoranthene	8270	330	µg/kg
			Benzo(g,h,i)perylene	8270	330	µg/kg
			Benzo(k)fluoranthene	8270	330	µg/kg
			Benzoic acid	8270	1650	µg/kg
			Benzyl alcohol	8270	650	µg/kg
			Butylbenzylphthalate	8270	330	µg/kg
			Chrysene	8270	330	µg/kg
			Dibenzo(a,h)anthracene	8270	330	µg/kg
			Dibenzofuran	8270	330	µg/kg
			Di-n-butylphthalate	8270	330	µg/kg
			Diethylphthalate	8270	330	µg/kg
			Dimethylphthalate	8270	330	µg/kg
			Fluoranthene	8270	330	µg/kg
			Fluorene	8270	330	µg/kg
			Hexachlorobenzene	8270	330	µg/kg
			Hexachlorobutadiene	8270	330	µg/kg

Table 11-8b
Sediment Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1993)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Sediment	***SVOCs (continued)***			
			Hexachlorocyclopentadiene	8270	330	µg/kg
			Hexachloroethane	8270	330	µg/kg
			Indeno(1,2,3-c,d)pyrene	8270	330	µg/kg
			Isophorone	8270	330	µg/kg
			Naphthalene	8270	330	µg/kg
			Nitrobenzene	8270	330	µg/kg
			Pentachlorophenol	8270	1650	µg/kg
			Phenanthrene	8270	330	µg/kg
			Phenol	8270	330	µg/kg
			Pyrene	8270	330	µg/kg
			bis(2-Chloroethoxy)methane	8270	330	µg/kg
			bis(2-Chloroethyl)ether	8270	330	µg/kg
			bis(2-Chloroisopropyl)ether	8270	330	µg/kg
			bis(2-Ethylhexyl)phthalate	8270	330	µg/kg
			di-n-Octylphthalate	8270	330	µg/kg
			n-Nitrosodi-n-propylamine	8270	330	µg/kg
			n-Nitrosodiphenylamine	8270	330	µg/kg
			Explosives	8330		
			HMX	8330	0.5	mg/kg
			RDX	8330	0.5	mg/kg
			1,3,5-TNB	8330	0.25	mg/kg
			1,3-DNB	8330	0.25	mg/kg
			Tetryl	8330	0.5	mg/kg
			Nitrobenzene	8330	0.26	mg/kg
			2,4,6-TNT	8330	0.25	mg/kg
			2,6-DNT	8330	0.25	mg/kg
			2,4-DNT	8330	0.25	mg/kg
			2-Nitrotoluene	8330	0.25	mg/kg
			4-Nitrotoluene	8330	0.25	mg/kg
			3-Nitrotoluene	8330	0.25	mg/kg
			Anions			
			Nitrate-Nitrite Nitrogen	353.3	0.1	mg/kg
			Chloride	9052	10	mg/kg
			Sulfate	9038	10	mg/kg

Note(s):

µg/kg - micrograms per kilogram

mg/kg - milligrams per kilogram

SVOC - semivolatile organic compound

VOC - volatile organic compound

018735

Table 11-9
Site 27 - South Test Area
Surface Water Analytical Summary (1993)

Parameter	Units	Sample 27SW02	Sample 27SW03	Sample 27SW04	Sample 27SW05
Volatiles	ug/l	<DL	<DL	<DL	<DL
Semi-volatiles	ug/l	<DL	<DL	<DL	<DL
Explosives	ug/l	<DL	<DL	<DL	<DL
Barium	mg/l	0.11	0.29	0.11	0.12
Lead	mg/l	<DL	0.015	<DL	<DL
Chloride	mg/l	27.5	15.1	48.7	30.1
Nitrate/Nitrite	mg/l	0.29	0.33	0.28	0.2
Sulfate	mg/l	40	40	50	30

MCL
2
0.015

11.2 NATURE AND EXTENT OF CONTAMINATION

11.2.1 Explosives

During the Phase 1 Remedial Investigation, explosives were detected only in groundwater grab sample 27GG33. As a result, four new wells were installed in the vicinity of boring 27SB33 to further evaluate the potential for explosives contamination in the area. No explosives were detected in any of the soil or groundwater samples collected from the four new wells. The explosives found in the 1982 work by EPS have not been found in any other surface or subsurface soil samples. The presence of explosives, the most likely contaminant at the site, is not confirmed.

11.2.2 Volatile and Semivolatile Organics

No volatiles were found in any soil or water sample. With the exception of the one sample of ethylene glycol, only low concentrations of phthalates were found. These are common plasticizers and are more likely to be indicators of laboratory contamination than site contamination, especially at these concentrations. There is no indication of volatiles or semivolatiles at the site.

Table 11-9b
Surface Water Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1993)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Surface water	***Metals***			
			Arsenic	7060	0.01	mg/L
			Antimony	6010	0.005	mg/L
			Barium	6010	0.01	mg/L
			Cadmium	6010	0.005	mg/L
			Chromium	6010	0.05	mg/L
			Lead	7421	0.005	mg/L
			Mercury	7470/7471	0.001	mg/L
			Nickel	6010	0.05	mg/L
			Selenium	7740	0.01	mg/L
			Silver	6010	0.01	mg/L
			Thallium	7841	0.002	mg/L
			VOCs			
			1,1,1-Trichloroethane	8240	5	µg/L
			1,1,2,2-Tetrachloroethane	8240	5	µg/L
			1,1,2-Trichloroethane	8240	5	µg/L
			1,1-Dichloroethane	8240	5	µg/L
			1,1-Dichloroethene	8240	5	µg/L
			1,2-Dichloroethane	8240	5	µg/L
			1,2-Dichloroethene	8240	5	µg/L
			1,2-Dichloropropane	8240	5	µg/L
			2-Butanone	8240	50	µg/L
			2-Chloroethylvinylether	8240	10	µg/L
			2-Hexanone	8240	50	µg/L
			4-Methyl-2-pentanone	8240	50	µg/L
			Acetone	8240	100	µg/L
			Benzene	8240	5	µg/L
			Bromodichloromethane	8240	5	µg/L
			Bromoform	8240	5	µg/L
			Bromomethane	8240	10	µg/L
			Carbon disulfide	8240	5	µg/L
			Carbon tetrachloride	8240	5	µg/L
			Chlorobenzene	8240	5	µg/L
			Chloroethane	8240	10	µg/L
			Chloroform	8240	5	µg/L
			Chloromethane	8240	10	µg/L
			Chlorodibromomethane	8240	5	µg/L
			Ethylbenzene	8240	5	µg/L
			Methylene chloride	8240	5	µg/L
			Styrene	8240	5	µg/L
			Tetrachloroethene	8240	5	µg/L
			Toluene	8240	5	µg/L
			Trichloroethene	8240	5	µg/L
			Vinyl acetate	8240	50	µg/L
			Vinyl chloride	8240	10	µg/L
			Xylenes	8240	5	µg/L
			cis-1,3-Dichloropropene	8240	5	µg/L
			trans-1,3-Dichloropropene	8240	5	µg/L

Table 11-9b
Surface Water Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1993)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Surface water	***SVOCs***			
			1,2,4-Trichlorobenzene	8270	10	µg/L
			1,2-Dichlorobenzene	8270	10	µg/L
			1,3-Dichlorobenzene	8270	10	µg/L
			1,4-Dichlorobenzene	8270	10	µg/L
			2,4,5-Trichlorophenol	8270	50	µg/L
			2,4,6-Trichlorophenol	8270	10	µg/L
			2,4-Dichlorophenol	8270	10	µg/L
			2,4-Dimethylphenol	8270	10	µg/L
			2,4-Dinitrophenol	8270	50	µg/L
			2,4-Dinitrotoluene	8270	10	µg/L
			2,6-Dinitrotoluene	8270	10	µg/L
			2-Chloronaphthalene	8270	10	µg/L
			2-Chlorophenol	8270	10	µg/L
			2-Methylnaphthalene	8270	10	µg/L
			2-Methylphenol	8270	10	µg/L
			2-Nitroaniline	8270	50	µg/L
			2-Nitrophenol	8270	10	µg/L
			3,3-Dichlorobenzidine	8270	20	µg/L
			3-Nitroaniline	8270	50	µg/L
			4-Bromophenylphenylether	8270	10	µg/L
			4-Chloro-3-methylphenol	8270	20	µg/L
			4-Chloroaniline	8270	20	µg/L
			4-Chlorophenylphenylether	8270	10	µg/L
			4-Methylphenol	8270	10	µg/L
			4-Nitroaniline	8270	50	µg/L
			4-Nitrophenol	8270	50	µg/L
			4,6-Dinitro-2-methylphenol	8270	50	µg/L
			Acenaphthene	8270	10	µg/L
			Acenaphthylene	8270	10	µg/L
			Anthracene	8270	10	µg/L
			Benzo(a)anthracene	8270	10	µg/L
			Benzo(a)pyrene	8270	10	µg/L
			Benzo(b)fluoranthene	8270	10	µg/L
			Benzo(g,h,i)perylene	8270	10	µg/L
			Benzo(k)fluoranthene	8270	10	µg/L
			Benzoic acid	8270	50	µg/L
			Benzyl alcohol	8270	20	µg/L
			Butylbenzylphthalate	8270	10	µg/L
			Chrysene	8270	10	µg/L
			Dibenzo(a,h)anthracene	8270	10	µg/L
			Dibenzofuran	8270	10	µg/L
			Di-n-butylphthalate	8270	10	µg/L
			Diethylphthalate	8270	10	µg/L
			Dimethylphthalate	8270	10	µg/L
			Fluoranthene	8270	10	µg/L
			Fluorene	8270	10	µg/L
			Hexachlorobenzene	8270	10	µg/L
			Hexachlorobutadiene	8270	10	µg/L

Table 11-9b
Surface Water Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(1993)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Surface water	***SVOCs (continued)***			
			Hexachlorocyclopentadiene	8270	10	µg/L
			Hexachloroethane	8270	10	µg/L
			Indeno(1,2,3-c,d)pyrene	8270	10	µg/L
			Isophorone	8270	10	µg/L
			Naphthalene	8270	10	µg/L
			Nitrobenzene	8270	10	µg/L
			Pentachlorophenol	8270	50	µg/L
			Phenanthrene	8270	10	µg/L
			Phenol	8270	10	µg/L
			Pyrene	8270	10	µg/L
			bis(2-Chloroethoxy)methane	8270	10	µg/L
			bis(2-Chloroethyl)ether	8270	10	µg/L
			bis(2-Chloroisopropyl)ether	8270	10	µg/L
			bis(2-Ethylhexyl)phthalate	8270	10	µg/L
			di-n-Octylphthalate	8270	10	µg/L
			n-Nitrosodi-n-propylamine	8270	10	µg/L
			n-Nitrosodiphenylamine	8270	10	µg/L
			Explosives			
			HMX	8330	0.1	µg/L
			RDX	8330	0.1	µg/L
			1,3,5-TNB	8330	0.1	µg/L
			1,3-DNB	8330	0.1	µg/L
			Tetryl	8330	0.1	µg/L
			Nitrobenzene	8330	0.1	µg/L
			2,4,6-TNT	8330	0.1	µg/L
			2,6-DNT	8330	0.1	µg/L
			2,4-DNT	8330	0.1	µg/L
			2-Nitrotoluene	8330	0.1	µg/L
			4-Nitrotoluene	8330	0.1	µg/L
			3-Nitrotoluene	8330	0.1	µg/L
			Anions			
			Nitrate-Nitrite Nitrogen	353.3	0.01	mg/L
			Chloride	9052	1	mg/L
			Sulfate	9038	1	mg/L

Note(s):
µg/L - micrograms per liter
mg/L - milligrams per liter
SVOC - semivolatile organic compound
VOC - volatile organic compound

1.6.11 Site 27 (Southeast Test Area)

Soil samples were collected at Site 27 in May and October 2000, and the analytical results are provided in Table 1-17. Groundwater samples were collected from four of the six monitoring wells at Site 27 during the April/May 2000 sampling event; from all six wells during the August/September/October 2000 sampling event; and from three monitoring wells in the January/February 2001 sampling event. Analytical results for the groundwater samples are presented in Table 1-18.

PERCHLORATE

Table 1-17 Summary of Soil Sample Results at Site 27

Sample Location	Date Collected	Result (µg/kg)	RL (µg/kg)	MDL (µg/kg)	Start Depth (feet)	End Depth (feet)
27SB01	5/30/2000	28.9	5.44	5.44	0	0.5
	5/30/2000	<5.54 U	5.54	5.54	1	2
27SB02	10/4/2000	<23 U	23	9.5	0	0.5
	10/4/2000	<22 U	22	9.3	1	2
27SB03	10/4/2000	<22 U	22	9.3	0	0.5
	10/4/2000	<23 U	23	9.6	1	2
27SB04	10/4/2000	<22 U	22	9	0	0.5
	10/4/2000	<21 U	21	8.9	1	2
27SB05	10/4/2000	<21 U	21	8.9	0	0.5
	10/4/2000	<21 U	21	8.9	1	2
27SB06	10/4/2000	<22 U	22	9.1	0	0.5
	10/4/2000	<22 U	22	9.2	1	2
27SB07	10/4/2000	<22 U	22	9.3	0	0.5
	10/4/2000	<22 U	22	9.1	1	2
27SB08	10/4/2000	<24 U	24	9.9	0	0.5
	10/4/2000	<24 U	24	9.8	1	2
27SB09	10/4/2000	<22 U	22	9.1	0	0.5
	10/4/2000	<23 U	23	9.5	1	2
27SB10	10/4/2000	<23 U	23	9.6	0	0.5
	10/4/2000	<23 U	23	9.6	1	2
27SB11	10/4/2000	<24 U	24	9.8	0	0.5
	10/4/2000	<24 U	24	9.8	1	2
27SB12	10/4/2000	<23 U	23	9.5	0	0.5
	10/4/2000	<23 U	23	9.7	1	2
27SB13	10/4/2000	<22 U	22	9.1	0	0.5
	10/4/2000	<22 U	22	9	1	2

TCEQ GWP-Ind 7,200

NO MCL

µg/kg = micrograms per kilogram
MDL = method detection limit
RL = reporting limit
U = not detected

Table 1-18 Summary of Groundwater Sample Results at Site 27

Sample Location	April-May 2000 Event (µg/L)	Aug/Sept/Oct 2000 Event (µg/L)	Jan - Feb 2001 Event (µg/L)
131	<1 U	<4 U	<0.71 U
132	<1 U	<8 U	NS
27WW01	**52.6**	<16 U	<3.6 U
27WW02	NS	<16 U	NS
27WW03	NS	<16 U	NS
27WW04	**16.4**	<16 U	<2.8 U

Bold values exceed 4 µg/L
< = Indicates the result was less than the corresponding reporting limit.
µg/L = micrograms per liter
NS = not sampled
U = not detected

~~1.6.12 Site 29 (TNT Production Area)~~

Soil samples were collected at Site 29 in May 2000. The analytical results for the soil samples are contained in Table 1-19. Groundwater samples were collected from five monitoring wells at Site 27 during the April/May 2000 sampling event; from all 16 wells during the August/September/October 2000 sampling event; and from nine monitoring wells in the January/February 2001 sampling event. The analytical results for the groundwater samples are presented in Table 1-20.

Table 1-19 Summary of Soil Sample Results at Site 29

Sample Location	Date Collected	Result (µg/kg)	Reporting Limit (µg/kg)	Method Detection Limit (µg/kg)	Start Depth (feet)	End Depth (feet)
29SB77	5/31/2000	34.8	6.08	6.08	0	0.5
	5/31/2000	24.5	5.95	5.95	1	2
29SB78	5/31/2000	115 J	6.31	6.31	0	0.5
	5/31/2000	57.6	6.36	6.36	1	2

µg/kg = micrograms per kilogram
J = estimated value

Table 1-18b
Groundwater and Soil Analytical Methods and Detection Limits
South Test Area LHAAP-001-R
(2000/2001)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
STEP	2000/2001	soil - borings	perchlorate	HPLC/300.1	5.54 - 24	µg/kg
		groundwater - wells	perchlorate	HPLC/300.1	1 - 16	µg/L

Note(s):
µg/kg - micrograms per kilogram
µg/L - micrograms per liter

Table 2. Results of metals analysis in mg/kg dry weight for soil/sediment samples collected from 200 sites at Caddo Lake National Wildlife Refuge in 2003 (Note - dl is the analytical detection limit and bdl is below the analytical detection limit).

Analyte	Site 50	Site 51	Site 52	Site 53	Site 54	Site 55	Site 56	Site 57	Site 58
Aluminum	3030.00	5295.00	3378.00	1674.00	8474.00	3143.00	4050.00	3435.00	3560.00
dl	10.5	10.6	10.8	10.7	10.8	10.8	10.8	10.9	10.8
Arsenic	1.30	1.65	2.11	1.08	2.12	0.92	1.83	1.03	1.18
dl	0.52	0.53	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Barium	132.00	117.00	38.00	71.20	216.00	66.50	149.00	38.40	81.10
dl	1.05	1.06	1.08	1.07	1.08	1.08	1.08	1.09	1.08
Beryllium	0.35	0.56	0.29	0.37	1.07	0.35	0.50	0.26	0.33
dl	0.21	0.21	0.22	0.21	0.22	0.22	0.22	0.22	0.22
Boron	2.40	3.19	bdl	bdl	bdl	bdl	2.64	bdl	bdl
dl	2.10	2.12	2.15	2.14	2.15	2.16	2.16	2.17	2.15
Cadmium	bdl	bdl	bdl	bdl	0.38	bdl	bdl	bdl	bdl
dl	0.26	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Chromium	4.97	7.28	14.60	6.26	9.33	4.73	8.06	5.75	6.10
dl	1.05	1.06	1.08	1.07	1.08	1.08	1.08	1.09	1.08
Copper	2.08	2.67	1.48	1.75	6.95	1.39	3.45	1.50	1.59
dl	0.52	0.53	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Iron	3345.00	5537.00	7285.00	2760.00	11,863.00	3615.00	4643.00	5395.00	4872.00
dl	10.5	10.6	10.8	10.7	10.8	10.8	10.8	10.9	10.8
Lead	11.00	11.60	7.84	11.90	14.30	9.10	12.10	7.16	7.87
dl	2.10	2.12	2.15	2.14	2.15	2.16	2.16	2.17	2.15
Magnesium	300.00	311.00	199.00	117.00	1820.00	224.00	291.00	250.00	225.00
dl	10.5	10.6	10.8	10.7	10.8	10.8	10.8	10.9	10.8
Manganese	1021.00	599.00	214.00	485.00	1086.00	48.80	787.00	261.00	315.00
dl	1.05	1.06	1.08	1.07	1.08	1.08	1.08	1.09	1.08
Mercury	0.047	0.031	bdl	0.039	0.043	0.028	0.029	0.040	0.027
dl	0.024	0.024	0.026	0.015	0.025	0.021	0.019	0.020	0.018
Molybdenum	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	1.05	1.06	1.08	1.07	1.08	1.08	1.08	1.09	1.08
Nickel	4.29	4.47	2.87	2.22	13.90	2.63	4.60	2.29	2.48
dl	1.05	1.06	1.08	1.07	1.08	1.08	1.08	1.09	1.08
Selenium	bdl	bdl	bdl	0.62	bdl	bdl	bdl	bdl	bdl
dl	0.52	0.53	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Silver	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.20	0.19
Strontium	12.70	8.87	4.64	4.54	44.90	4.13	15.00	6.69	3.01
dl	0.52	0.53	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Vanadium	10.80	12.40	15.30	9.66	12.20	9.36	12.10	9.68	9.16
dl	0.52	0.53	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Zinc	13.10	10.10	8.29	7.33	45.40	8.23	16.70	10.20	9.78
dl	5.21	5.30	5.38	5.36	5.38	5.40	5.40	5.43	5.38

Table 2 (continued). Results of metals analysis in mg/kg dry weight for soil/sediment samples collected from 200 sites at Caddo Lake National Wildlife Refuge in 2003 (Note - dl is the analytical detection limit; and bdl is below the analytical detection limit).

Analyte	Site 59	Site 60	Site 61	Site 62	Site 63	Site 64	Site 65	Site 66	Site 67
Aluminum	6379.00	17,400.00	2647.00	3336.00	4301.00	10,272.00	9531.00	10,429.00	3290.00
dl	10.60	10.40	10.80	10.80	10.80	10.40	10.80	10.60	11.10
Arsenic	2.86	4.24	0.85	1.67	2.63	1.73	2.44	4.02	2.71
dl	0.53	0.52	0.54	0.54	0.54	0.52	0.54	0.53	0.55
Barium	135.00	316.00	71.20	129.00	102.00	180.00	404.00	142.00	55.90
dl	1.06	1.04	1.08	1.08	1.08	1.04	1.08	1.06	1.11
Beryllium	0.78	1.68	0.32	0.50	0.92	0.88	0.62	0.91	0.51
dl	0.21	0.21	0.22	0.22	0.22	0.21	0.22	0.21	0.22
Boron	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	2.13	2.08	2.15	2.17	2.15	2.08	2.17	2.13	2.21
Cadmium	0.30	bdl	bdl	bdl	bdl	bdl	0.32	bdl	bdl
dl	0.27	0.26	0.27	0.27	0.27	0.26	0.27	0.27	0.28
Chromium	7.78	18.30	3.56	5.13	6.24	14.20	11.70	13.70	9.48
dl	1.06	1.04	1.08	1.08	1.08	1.04	1.08	1.06	1.11
Copper	4.70	8.79	2.31	4.39	3.85	9.56	7.26	6.83	4.37
dl	0.53	0.52	0.54	0.54	0.54	0.52	0.54	0.53	0.55
Iron	9953.00	21,940.00	3031.00	4067.00	7165.00	9308.00	14,940.00	13,729.00	7996.00
dl	10.60	10.40	10.80	10.80	10.80	10.40	10.80	10.60	11.10
Lead	17.00	22.00	6.02	10.30	12.90	16.70	20.00	11.70	7.59
dl	2.13	2.08	2.15	2.17	2.15	2.08	2.17	2.13	2.21
Magnesium	800.00	1596.00	411.00	531.00	445.00	874.00	1424.00	1347.00	771.00
dl	10.60	10.40	10.80	10.80	10.80	10.40	10.80	10.60	11.10
Manganese	1003.00	1812.00	294.00	903.00	793.00	472.00	2400.00	814.00	123.00
dl	1.06	1.04	1.08	1.08	1.08	1.04	1.08	1.06	1.11
Mercury	0.058	0.070	0.041	0.039	0.042	0.047	0.065	0.037	bdl
dl	0.025	0.025	0.018	0.021	0.019	0.019	0.019	0.020	0.016
Molybdenum	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	1.06	1.04	1.08	1.08	1.08	1.04	1.08	1.06	1.11
Nickel	8.04	24.30	3.66	5.24	5.86	12.10	23.20	6.03	1.98
dl	1.06	1.04	1.08	1.08	1.08	1.04	1.08	1.06	1.11
Selenium	bdl	0.62	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	0.53	0.52	0.54	0.54	0.54	0.52	0.54	0.53	0.55
Silver	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	0.19	0.19	0.19	0.20	0.19	0.19	0.20	0.19	0.20
Strontium	22.90	34.30	14.60	13.50	22.20	29.80	52.40	30.60	22.10
dl	0.53	0.52	0.54	0.54	0.54	0.52	0.54	0.53	0.55
Vanadium	15.00	26.70	6.11	7.08	12.90	19.10	20.70	18.40	12.10
dl	0.53	0.52	0.54	0.54	0.54	0.52	0.54	0.53	0.55
Zinc	25.80	31.60	12.40	13.40	11.30	33.50	48.20	44.20	20.40
dl	5.32	5.19	5.38	5.42	5.38	5.19	5.42	5.32	5.54

Table 2 (continued). Results of metals analysis in mg/kg dry weight for soil/sediment samples collected from 200 sites at Caddo Lake National Wildlife Refuge in 2003 (Note - dl is the analytical detection limit; and bdl is below the analytical detection limit).

Analyte	Site 194	Site 195	Site 196	Site 197	Site 198	Site 199	Site 200	Site 201	Site 202
Aluminum	3617.00	4296.00	4396.00	6144.00	9552.00	4643.00	8892.00	5649.00	2937.00
dl	10.20	10.40	10.00	10.30	10.20	10.00	10.40	10.30	10.00
Arsenic	1.13	1.47	3.87	2.17	1.04	2.71	0.60	1.71	0.86
dl	0.51	0.52	0.50	0.52	0.51	0.50	0.52	0.52	0.50
Barium	109.00	108.00	198.00	164.00	55.40	47.70	26.60	263.00	46.90
dl	0.21	0.21	0.20	0.21	0.21	0.20	0.21	0.21	0.20
Beryllium	0.56	0.37	0.84	1.15	0.66	1.01	0.31	0.48	bdl
dl	0.21	0.21	0.20	0.21	0.21	0.20	0.21	0.21	0.20
Boron	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	2.05	2.08	2.01	2.07	2.05	2.00	2.08	2.06	2.00
Cadmium	bdl	bdl	0.27	bdl	bdl	0.44	bdl	bdl	bdl
dl	0.26	0.26	0.25	0.26	0.26	0.25	0.26	0.26	0.25
Chromium	5.87	9.35	14.00	10.10	11.50	9.84	10.40	11.80	4.93
dl	1.02	1.04	1.00	1.03	1.02	1.00	1.04	1.03	1.00
Copper	1.18	1.68	2.23	2.36	4.00	1.98	1.77	13.80	1.16
dl	0.51	0.52	0.50	0.52	0.51	0.50	0.52	0.52	0.50
Iron	4343.00	4604.00	11,640.00	7135.00	6771.00	8798.00	2735.00	3991.00	2493.00
dl	10.20	10.40	10.00	10.30	10.20	10.00	10.40	10.30	10.00
Lead	17.00	12.20	13.80	14.10	21.60	20.10	12.60	11.40	10.90
dl	2.05	2.08	2.01	2.07	2.05	2.00	2.08	2.06	2.00
Magnesium	341.00	343.00	384.00	501.00	514.00	269.00	232.00	515.00	185.00
dl	10.20	10.40	10.00	10.30	10.20	10.00	10.40	10.30	10.00
Manganese	1198.00	924.00	2285.00	3160.00	398.00	417.00	17.80	69.10	870.00
dl	1.02	1.04	1.00	1.03	1.02	1.00	1.04	1.03	1.00
Mercury	0.055	0.054	0.055	0.077	0.061	0.038	0.043	0.031	0.045
dl	0.023	0.023	0.020	0.022	0.022	0.021	0.020	0.021	0.020
Molybdenum	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	1.02	1.04	1.00	1.03	1.02	1.00	1.04	1.03	1.00
Nickel	5.35	5.52	7.34	11.10	4.98	4.59	2.07	4.79	2.24
dl	1.02	1.04	1.00	1.03	1.02	1.00	1.04	1.03	1.00
Selenium	bdl	bdl	bdl	0.33	bdl	0.65	bdl	bdl	bdl
dl	0.51	0.52	0.50	0.52	0.51	0.50	0.52	0.52	0.50
Silver	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	0.18	0.19	0.18	0.19	0.18	0.18	0.19	0.19	0.18
Strontium	11.30	12.60	36.70	12.20	14.40	6.36	12.60	17.00	5.81
dl	0.51	0.52	0.50	0.52	0.51	0.50	0.52	0.52	0.50
Vanadium	11.30	12.20	24.30	16.30	19.20	23.00	6.88	9.50	8.36
dl	0.51	0.52	0.50	0.52	0.51	0.50	0.52	0.52	0.50
Zinc	12.90	18.80	28.20	21.80	21.60	17.10	17.30	80.30	6.63
dl	5.12	5.19	5.02	5.17	5.12	5.00	5.19	5.15	5.00

Table 2b
Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(2003)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil				
			Metals			
			Aluminum	Texas A & M University Method Codes 001, 004, 006	10.3 - 10.8	mg/kg
			Arsenic	Texas A & M University Method Codes 001, 004, 007	0.52 - 0.54	mg/kg
			Barium	Texas A & M University Method Codes 001, 004, 006	0.21 - 1.08	mg/kg
			Beryllium	Texas A & M University Method Codes 001, 004, 006	0.21 - 0.22	mg/kg
			Boron	Texas A & M University Method Codes 001, 004, 006	2.06 - 2.16	mg/kg
			Cadmium	Texas A & M University Method Codes 001, 004, 006	0.26 - 0.27	mg/kg
			Chromium	Texas A & M University Method Codes 001, 004, 006	1.03 - 1.08	mg/kg
			Copper	Texas A & M University Method Codes 001, 004, 006	0.52 - 0.54	mg/kg
			Iron	Texas A & M University Method Codes 001, 004, 006	10.3 - 10.8	mg/kg
			Lead	Texas A & M University Method Codes 001, 004, 006	2.06 - 2.16	mg/kg
			Magnesium	Texas A & M University Method Codes 001, 004, 006	10.3 - 10.8	mg/kg
			Manganese	Texas A & M University Method Codes 001, 004, 006	1.03 - 1.08	mg/kg
			Mercury	Texas A & M University Method Codes 001, 004, 008	0.018 - 0.021	mg/kg
			Molybdenum	Texas A & M University Method Codes 001, 004, 006	1.03 - 1.08	mg/kg
			Nickel	Texas A & M University Method Codes 001, 004, 006	1.03 - 1.08	mg/kg
			Selenium	Texas A & M University Method Codes 001, 004, 007	0.52 - 0.54	mg/kg
			Silver	Texas A & M University Method Codes 001, 004, 039	0.19	mg/kg
			Strontium	Texas A & M University Method Codes 001, 004, 006	0.52 - 0.54	mg/kg
			Vanadium	Texas A & M University Method Codes 001, 004, 006	0.52 - 0.54	mg/kg
			Zinc	Texas A & M University Method Codes 001, 004, 006	5.15 - 5.40	mg/kg
			SVOCs			
			1,2,4-Trichlorobenzene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			1,2-Dichlorobenzene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			1,3-Dichlorobenzene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			1,4-Dichlorobenzene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg

Table 2b
Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(2003)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil				
			1-Chloronaphthalene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			1-Naphthylamine	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2,3,4,6-Tetrachlorophenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2,4,5-Trichlorophenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2,4,6-Trichlorophenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2,4-Dichlorophenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2,4-Dimethylphenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2,4-Dinitrophenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2,4-Dinitrotoluene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2,6-Dichlorophenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2,6-Dinitrotoluene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2-Chloronaphthalene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2-Chlorophenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2-Methylphenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2-Naphthylamine	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2-Nitroaniline	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2-Nitrophenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2-Picoline	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			2-Methylnaphthalene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			3,3-Dichlorobenzidine	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			3-Methylcholanthrene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			3-Nitroaniline	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			4,6-Dinitro-2-methylphenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			4-Aminobiphenyl	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			4-Bromophenylphenylether	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg

Table 2b
Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(2003)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil				
			4-Chloro-3-methylphenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			4-Chloroaniline	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			4-Chlorophenylphenylether	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			4-Methylphenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			4-Nitrophenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			7,12-	Texas A & M University Method	0.0315-0.0416	mg/kg
			Acentophenone	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Aniline	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Benzidine	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Benzo(a)anthracene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Benzoic acid	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Benzyl alcohol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			bis(2-Chloroethoxy)methane	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			bis(2-Chloroethyl)ether	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			bis(2-Ethylhexyl)phthalate	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			bis(2-Chloroisopropyl)ether	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Butylbenzylphthalate	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Carbazole	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Di-n-butylphthalate	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Di-n-Octylphthalate	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Dibenzo(a,h)anthracene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Diben(a,j)acridine	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Dibenzofuran	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Diethylphthalate	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Dimethylphthalate	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Diphenylamine	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg

Table 2b
Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(2003)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil				
			Ethyl methanesulfonate	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Hexachlorobutadiene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Hexachlorocyclopentadiene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Hexachloroethane	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Isophorone	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Methyl methanesulfonate	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			N-nitroso-di-n-propylamine	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			N-nitrosopiperidine	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Nitrobenzene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Pentachlorobenzene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Pentachloronitrobenzene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Pentachlorophenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Phenacetin	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Phenol	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Pronamide	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			A,a-dimethylphenylamine	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Acenaphthalene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Acenaphthene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Anthracene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Benzo(a)pyrene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Benzo(b)fluoranthene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Benzo(g,h,i)perylene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Benzo(k)fluoranthene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Chrysene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Fluoranthene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg

Table 2b
Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(2003)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil				
			Fluorene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Indeno(1,2,3-c,d)pyrene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			n-Nitrosodiphenylamine	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Naphthalene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			p-Dimethylaminoazobenzene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Phenanthrene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
			Pyrene	Texas A & M University Method Code 031	0.0315-0.0416	mg/kg
				Texas A & M University Method Code 031		
			Pesticides/PCBs			
			1,2,3,4-tetrachlorobenzene	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			1,2,4,5-tetrachlorobenzene	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Aldrin	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Hexachlorobenzene	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Heptachlor	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Alpha BHC	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Alpha chlordane	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Beta BHC	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			cis-nonachlor	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			delta-BHC	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Dieldrin	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Endosulfan II	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Endrin	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			gamma-BHC (Lindane)	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			gamma chlordane	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Heptachlor epoxide	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Mirex	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg

Table 2b
Soil Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(2003)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil				
			o,p-DDD	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			o,p-DDE	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			o,p-DDT	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			oxychlordane	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			p,p-DDD	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			p,p-DDE	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			p,p-DDT	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Pentachloro-anisole	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Toxaphene	Texas A & M University Method Code 031	0.000315 - 0.00208	mg/kg
			Trans-nonachlor	Texas A & M University Method Code 031	0.000315 - 0.000416	mg/kg
			Total PCBs	Texas A & M University Method Code 031	0.000315 - 0.00208	mg/kg
			Perchlorate	EPA Method 314.0 Modified	8	µg/kg

Note(s):
µg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
PCB - polychlorinated biphenyls
SVOC - semivolatile oranic compound
VOC - volatile organic compound

Table 4A-1. Chemicals Detected in Soils[1]
Site 27 Addendum, Longhorn Army Ammunition Plant

Chemical	Frequency of Detection	Sample Quantitation Limits	Range of Detected Concentrations	Background Range[2]
Metals (mg/Kg)				
Arsenic	4/4	--	6.08-13.1	2.3-29.7
Barium	4/4	--	69.5-123	35.1-287
Cadmium	4/4	--	8.54-21.0	1.25
Chromium	4/4	--	15.2-36.3	3.2-22.8
Nickel	1/4	2.06-2.11	2.41	1.5-6.3
Lead	4/4	--	11-18	2.6-17.4
Selenium	3/4	0.52	0.66-0.83	0.5
Aluminum	4/4	--	4,350-10,300	1,270-20,700
Beryllium	1/4	0.62-0.66	1.16	NA[3]
Calcium	4/4	--	392-809	124-1,090
Copper	4/4	--	5.65-18.7	0.88-6.7
Iron	4/4	--	21,800-70,000	2,450-31,000
Potassium	4/4	--	150-513	133-481
Magnesium	4/4	--	187-635	68.4-474
Manganese	4/4	--	135-223	10.9-2,330
Strontium	1/4	12.5-15.4	16.8	2.3-13.3
Vanadium	4/4	--	25.6-72.4	NA[3]
Zinc	4/4	--	19.6-41.3	3.4-16.2

[1] 0 to 6-inch depth.
[2] Range of detected concentrations in surface (0-0.5 feet) soils from Final Soil Background Concentration Report, Longhorn Army Ammunition Plant, (USACE 1995b).
[3] Not available.

Table 3
Soil Analytical Medthods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(CAPE 2006)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
CAPE	2006	Soil	MC (explosives), WP	SW-846 Method 7580	0.519 - 0.535	µg/kg

Note(s):
µg/kg - micrograms per kilogram
MC - munitions constituents
WP - white phosphorus

Table A - 1
USEPA Region 6 Confirmation Sampling
Groundwater Analytical Results Summary
South Test Area/Bomb Test Area, LHAAP-001-R
October 2009

			Location Code	MW-131	MW-132	27WW01	27WW02	27WW03	27WW04
			Sample No.	GW-131-05	GW-132-06	GW-27WW-01-01	GW-27WW-02-02	GW-27WW-03-03	GW-27WW-04-04
			Sample Date	23-Oct-09	23-Oct-09	22-Oct-09	22-Oct-09	23-Oct-09	22-Oct-09
Parameter	Units	MCL	TCEQ GW-Ind	Result	Result	Result	Result	Result	Result
Metals									
Aluminum	mg/L		102.2	0.157	0.0048 J	<0.050	0.118B	6.56	0.0136 J,B
Antimony	mg/L	0.006		<0.001	<0.001	<0.001	0.000134 J	<0.001	<0.001
Arsenic	mg/L	0.01		0.0017	0.0024	0.00164	0.00157	0.00208	0.00149
Barium	mg/L	2		0.118	0.0522	0.0233	0.0203	0.0337	0.0268
Beryllium	mg/L	0.004		0.0000860 J	0.0000840 J	0.0000440 J	0.00454	0.0251	0.000340 J
Cadmium	mg/L	0.005		0.000116 J	0.0000460 J	0.00191	0.00114	0.00336	0.000327 J
Calcium	mg/L			214	28	476	400	384	398
Chromium	mg/L	0.1		0.00119	0.000481 J	0.00692	0.122	0.0161	0.0285
Cobalt	mg/L		6.132	0.0229	0.014	0.0566	0.134	0.73	0.213
Copper	mg/L	1.3		0.00144 B	0.00205 B	0.00296	0.0045	0.00463 B	0.00352
Iron	mg/L			2.48 B	1.430 B	0.650B	0.507B	0.0842B	0.759B
Lead	mg/L	0.015		0.000212 J	0.0000670 J	0.000014 J,B	0.0000960 J,B	0.0012	0.00013 J, B
Magnesium	mg/L			106	157	318	314	308	325
Manganese	mg/L		14.3	0.00378	0.482	7.5	2.17	24.8	9.01
Nickel	mg/L		2.044	0.0312	0.0187	0.167 B	0.288B	0.291	0.301 B
Potassium	mg/L			1.510J	2.58 J	8.52 J	4.86 J	9.59 J	1.59 J
Selenium	mg/L	0.05		0.00436	0.00558	0.00542	0.00503	0.00287	0.00363
Silver	mg/L		0.511	0.000012 J, B	<0.001	<0.001	<0.001	0.000289 J, B	<0.001
Sodium	mg/L			406	1140	1060	1040	1350	981
Thallium	mg/L	0.002		0.0000140 J	0.0000230 J	0.0000490 J	0.000232 J	0.000188 J	0.0000780 J
Vanadium	mg/L			0.00155 B	0.00236B	0.000222 J	<0.001	0.000662 J, B	0.000746 J
Zinc	mg/L		30.66	0.001UB	0.0081 J,B	0.0377	0.165	0.141 B	0.0855
Perchlorate	µg/L		72	<5.0 G	2.6B*, G	<5.0 G	3.2 B*, G	76 Q	<5.0G

Table A - 1
USEPA Region 6 Confirmation Sampling
Groundwater Analytical Results Summary
South Test Area/Bomb Test Area, LHAAP-001-R
October 2009

			Location Code	MW-131	MW-132	27WW01	27WW02	27WW03	27WW04
			Sample No.	GW-131-05	GW-132-06	GW-27WW-01-01	GW-27WW-02-02	GW-27WW-03-03	GW-27WW-04-04
			Sample Date	23-Oct-09	23-Oct-09	22-Oct-09	22-Oct-09	23-Oct-09	22-Oct-09
Parameter	Units	MCL	TCEQ GW-Ind	Result	Result	Result	Result	Result	Result
Explosives									
HMX	µg/L		5110	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
RDX	µg/L		26	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,3,5- TNB	µg/L		3066	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,3-DNB	µg/L		10.22	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Tetryl	µg/L		1022	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Nitrobenzene	µg/L		51.1	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
2,4,6- TNT	µg/L		51.1	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
4-ADNT	µg/L		17.03	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
2-ADNT	µg/L		17.03	<0.20	<0.20	<0.20	<0.20	<0.20	0.14J
2,6-DNT	µg/L		0.42	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
2,4-DNT	µg/L		0.42	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
2-Nitrotoluene	µg/L		1022	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
4-Nitrotoluene	µg/L		1022	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
3-Nitrotoluene	µg/L		1022	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40

Notes and Abbreviations:

Bolded and shaded - Level above the MCL or TCEQ GW-Ind value

B - analyte was detected in the associated method blank

B* - estimated results; result is less than the reporting limit of 5 µg/L

G - elevated reporting limit; the reporting limit is elevated due to matrix interference

GW-Ind - groundwater MSC for industrial use

J - estimated results detected above the method detection limit but below the reporting limit

MCL - maximum contaminant level

ug/L - micrograms per liter

mg/L - milligrams per liter

Q - elevated reporting limit; the reporting limit is elevated due to high analyte levels

Table A-1b
Groundwater Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(2009)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
USEPA	October 2009	Groundwater - wells	***Metals***			
			Aluminum	6020	50	µg/L
			Antimony	6020	1	µg/L
			Arsenic	6020	1	µg/L
			Barium	6020	1	µg/L
			Beryllium	6020	1	µg/L
			Cadmium	6020	1	µg/L
			Calcium	6020	20000 - 40000	µg/L
			Chromium	6020	1	µg/L
			Cobalt	6020	1	µg/L
			Copper	6020	1	µg/L
			Iron	6020	50	µg/L
			Lead	6020	1	µg/L
			Magnesium	6020	20000 - 40000	µg/L
			Manganese	6020	100	µg/L
			Nickel	6020	1	µg/L
			Potassium	6020	20000 - 40000	µg/L
			Selenium	6020	1	µg/L
			Sodium	6020	20000 - 40000	µg/L
			Thallium	6020	1	µg/L
			Vanadium	6020	1	µg/L
			Zinc	6020	10	µg/L
			Explosives			
			HMX	8330	0.4	µg/L
			RDX	8330	0.2	µg/L
			1,3,5-TNB	8330	1	µg/L
			1,3-DNB	8330	0.4	µg/L
			Tetryl	8330	0.2	µg/L
			Nitrobenzene	8330	0.4	µg/L
			2,4,6-TNT	8330	0.4	µg/L
			4-ADNT	8330	0.2	µg/L
			2-ADNT	8330	0.2	µg/L
			2,6-DNT	8330	0.2	µg/L
			2,4-DNT	8330	0.4	µg/L
			2-Nitrotoluene	8330	0.4	µg/L
			4-Nitrotoluene	8330	1	µg/L
			3-Nitrotoluene	8330	0.4	µg/L
			Perchlorate	EPA Method	5	µg/L

Note(s):

µg/L - micrograms per liter

USEPA - U.S. Environmental Protection Agency

Table A - 2
U.S. Army Confirmation Split Sampling
Groundwater Analytical Results Summary
South Test Area/Bomb Test Area, LHAAP-001-R
October 2009

			Location Code	MW-131		MW-132		27WW01		27WW02		27WW03		27WW04	
			Sample No.	GW-131-05-091023		GW-132-06-091023		GW-27WW-01-01-091022		GW-27WW-02-02-091022		GW-27WW-03-03-091023		GW-27WW-04-04-091022	
			Sample Date	23-Oct-09		23-Oct-09		22-Oct-09		22-Oct-09		23-Oct-09		22-Oct-09	
Parameter	Units	MCL	TCEQ GW-Ind	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Metals															
Aluminum	mg/L		102.2	0.138		0.0107	J B	0.018	U	0.156		7.32		0.0207	J B
Antimony	mg/L	0.006		0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U	0.0005	U
Arsenic	mg/L	0.01		0.00147	J B	0.00266	J B	0.00328	J B	0.00401	J B	0.00347	J B	0.0023	J B
Barium	mg/L	2		0.113		0.0477		0.0235		0.0209		0.0367		0.0249	
Beryllium	mg/L	0.004		0.0003	U	0.0003	U	0.0003	U	0.00381		0.0194		0.000448	J
Cadmium	mg/L	0.005		0.0006	U	0.0006	U	0.00178	J	0.00105	J	0.00319		0.0006	U
Calcium	mg/L			201		252		433		385		390		359	
Chromium	mg/L	0.1		0.00196	J B	0.00147	J B	0.00572	J B	0.119		0.0231		0.0209	
Cobalt	mg/L		6.132	0.0203		0.0127		0.0572		0.174		1.17		0.212	
Copper	mg/L	1.3		0.00208	J	0.0005	U	0.00221	J	0.00385	J	0.0108		0.003	J
Iron	mg/L			2.17		1.36		0.833		0.658		0.29	J B	0.767	
Lead	mg/L	0.015		0.00041	J	0.0004	U	0.000542	J	0.000446	J	0.00173	J	0.0004	J
Magnesium	mg/L			109		148		302		326		359		302	
Manganese	mg/L		14.3	3.95		0.511		7.44		2.92		27.9		8.71	
Nickel	mg/L		2.044	0.0298		0.0164		0.175		0.396		0.49		0.318	
Potassium	mg/L			1.38		1.59		7.06		3.96		7.3		1.23	
Selenium	mg/L	0.05		0.0025	U	0.0025	U	0.0025	U	0.00293	J	0.00692		0.0025	U
Silver	mg/L		0.511	0.0007	U	0.0007	U	0.0007	U	0.0007	U	0.0007	U	0.0007	U
Sodium	mg/L			403		1030		971		1050		1630		880	
Thallium	mg/L	0.002		0.0008	U	0.0008	U	0.0008	U	0.0008	U	0.0013	J	0.0008	U
Zinc	mg/L		30.66	0.00569	J B	0.00598	J B	0.0435		0.226		0.254		0.0936	

Table A - 2
U.S. Army Confirmation Split Sampling
Groundwater Analytical Results Summary
South Test Area/Bomb Test Area, LHAAP-001-R
October 2009

			Location Code	MW-131		MW-132		27WW01		27WW02		27WW03		27WW04	
			Sample No.	GW-131-05-091023		GW-132-06-091023		GW-27WW-01-01-091022		GW-27WW-02-02-091022		GW-27WW-03-03-091023		GW-27WW-04-04-091022	
			Sample Date	23-Oct-09		23-Oct-09		22-Oct-09		22-Oct-09		23-Oct-09		22-Oct-09	
Parameter	Units	MCL	TCEQ GW-Ind	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Explosives															
1,3,5-Trinitrobenzene	µg/L		3066	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
1,3-Dinitrobenzene	µg/L		10.22	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
2,4,6-Trinitrotoluene	µg/L		51.1	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
2,4-Dinitrotoluene	µg/L		0.42	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
2,6-Dinitrotoluene	µg/L		0.42	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
2-Amino-4,6-dinitrotoluene	µg/L		17.03	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
2-Nitrotoluene	µg/L		1022	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
3-Nitrotoluene	µg/L		1022	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
4-Amino-2,6-dinitrotoluene	µg/L		17.03	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
4-Nitrotoluene	µg/L		1022	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
HMX	µg/L		5110	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
Nitrobenzene	µg/L		51.1	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
RDX	µg/L		26	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
Tetryl	µg/L		1022	0.12	U	0.1	U	0.14	U	0.18	U	0.14	U	0.18	U
Perchlorate	µg/L		72	0.062	U	0.062	U	0.062	U	3.4		50		0.062	U

Notes and Abbreviations:

Bolded and shaded - level above the MCL or TCEQ GW-Ind value

B - analyte was detected in associated method blank

GW-Ind - groundwater MSC for industrial use

J - estimated results detected above the method detection limit but below the reporting limit

MCL - maximum contaminant level

mg/L - milligrams per liter

ug/L - micrograms per liter

U - Not detected. The method detection limit is provided.

Table A-2b
Groundwater Analytical Methods and Detection Limits
South Test Area/Bomb Test Area, LHAAP-001-R
(2009)

Investigated By/ Sampling Event	Date	Medium	Analytical Parameters	Analytical Method	Detection Limits	Units
US Army	October 2009	Groundwater - wells	***Metals***			
			Aluminum	6020	0.01 - 1.0	mg/L
			Antimony	6020	0.005	mg/L
			Arsenic	6020	0.005	mg/L
			Barium	6020	0.005	mg/L
			Beryllium	6020	0.002	mg/L
			Cadmium	6020	0.002	mg/L
			Calcium	6020	5 - 50	mg/L
			Chromium	6020	0.005	mg/L
			Cobalt	6020	0.005	mg/L
			Copper	6020	0.005	mg/L
			Iron	6020	0.2	mg/L
			Lead	6020	0.005	mg/L
			Magnesium	6020	0.2 - 20	mg/L
			Manganese	6020	0.005 - 0.5	mg/L
			Nickel	6020	0.005 - 0.1	mg/L
			Potassium	6020	0.2	mg/L
			Selenium	6020	0.005	mg/L
			Silver	6020	0.005	mg/L
			Sodium	6020	0.2 - 20	mg/L
			Thallium	6020	0.002	mg/L
			Zinc	6020	0.005	mg/L
			Explosives			
			HMX	8330	0.000330 - 0.000594	mg/L
			RDX	8330	0.000330 - 0.000594	mg/L
			1,3,5-TNB	8330	0.000330 - 0.000594	mg/L
			1,3-DNB	8330	0.000330 - 0.000594	mg/L
			Tetryl	8330	0.000330 - 0.000594	mg/L
			Nitrobenzene	8330	0.000330 - 0.000594	mg/L
			2,4,6-TNT	8330	0.000330 - 0.000594	mg/L
			4-ADNT	8330	0.000330 - 0.000594	mg/L
			2-ADNT	8330	0.000330 - 0.000594	mg/L
			2,6-DNT	8330	0.000330 - 0.000594	mg/L
			2,4-DNT	8330	0.000330 - 0.000594	mg/L
			2-Nitrotoluene	8330	0.000330 - 0.000594	mg/L
			4-Nitrotoluene	8330	0.000330 - 0.000594	mg/L
			3-Nitrotoluene	8330	0.000330 - 0.000594	mg/L
			Perchlorate	EPA Method 314.0	0.2	µg/L

Note(s):
µg/L - micrograms per liter
mg/L - milligrams per liter

Appendix B

LHAAP-003-R Data Summary Tables

APPENDIX B
LHAAP-003-R

Page No.	Table No.	Reference
B-1 B-2	Table 10-1 Table 10-1b	Environmental Protection Systems, Inc (EPS) 1984, *Longhorn Army Ammunition Plant Contamination Survey,* June.
B-3 B-6	Table 10-2 Table 10-2b	Ebasco Services, Inc (Ebasco), 1993, *Sampling and Data Results Report, Site LH27, Remedial Investigation, Longhorn Army Ammunition Plant,* Volume VI, March.
B-5 B-9	Table 10-3 Table 10-3b	Sverdrup Environmental, Inc (SVERDRUP), 1994, *Sampling and Data Results Report: Laboratory Report, Remedial Investigation Sites II, I, XX, 27, Longhorn Army Ammunition Plant, Karnack, Texas*, Volume I, November.
B-10	Table 10-4	U.S. Army Corps of Engineers (USACE), Tulsa District, 1997, *Remedial Investigation Report, Group 1 Sites (Sites 11, 1, XX, 27), Longhorn Army Ammunition Plant, Karnack, Texas*, Volume I, May.
B-11	Table 10-4b	U.S. Army Corps of Engineers (USACE), Southwestern Division Laboratory, 1996, *Results of Chemical Analyses of Soil Samples, Signal Test Area (XX), Longhorn Army Ammunition Plant,* November. U.S. Army Corps of Engineers (USACE), Southwestern Division Laboratory, 1997, *Results of Chemical Analyses of Soil Samples, SignalTest Area (XX), Longhorn Army Ammunition Plant,* March.
B-18 B-19 B-23 B-24 B-27	Table 10-5 Table 10-5b Table 10-6 Table 10-6b Table 10-7	Environmental Protection Systems, Inc (EPS) 1984, *Longhorn Army Ammunition Plant Contamination Survey,* June. Ebasco Services, Inc (Ebasco), 1993, *Sampling and Data Results Report, Site LH27, Remedial Investigation, Longhorn Army Ammunition Plant,* Volume VI, March.
B-28	Table B-3	Sverdrup Environmental, Inc (SVERDRUP), 1994, *Sampling and Data Results Report: Laboratory Report, Remedial Investigation Sites II, I, XX, 27, Longhorn Army Ammunition Plant, Karnack, Texas*, Volume I, November.
B-31	Table 10-7b	Ebasco Services, Inc (Ebasco), 1993, *Sampling and Data Results Report, Site LH27, Remedial Investigation, Longhorn Army Ammunition Plant,* Volume VI, March.
B-34 B-35	Table 1-32 Table 1-32b	Solution to Environmental Problems (STEP), 2005, *Plant-wide Perchlorate Investigation, Longhorn Army Ammunition Plant, Karnack, Texas*, April.

APPENDIX B (*continued*)
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Page No.	Table No.	Reference
B-36 B-38	Table 2 Table 2b	U.S. Fish and Wildlife Service (USFWS), 2003, *Contaminant Investigation of Northern, Central, and Eastern Portions of Caddo Lake National Wildlife Refuge, Texas*, November.
B-44	Table 5A-1	U.S. Army Corps of Engineers (USACE), Tulsa District, 1997, *Remedial Investigation Report, Group 1 Sites (Sites 11, 1, XX, 27), Longhorn Army Ammunition Plant, Karnack, Texas*, Volume II, May.
B-45	Table 3	CAPE, 2007, *Engineering Evaluation/Cost Analysis, Longhorn Army Ammunition Plant, Karnack, Texas*, Final, October.
B-46	Table B-1	Groundwater Analytical Results Summary Table provided by the USEPA from the October 2009 Groundwater Confirmation Sampling.
B-48	Table B-1b	Booz Allen Hamilton Inc., 2009, *Analytical Report, Longhorn Army Ammunition Plant*, November.
B-49	Table B-2	Groundwater Analytical Results Summary Table from the October 2009 Groundwater Confirmation Sampling by the U.S. Army
B-51	Table B-2b	ALS Laboratory Group USA, 2009, *Analytical Report, Longhorn Army Ammunition Plant*, November

interval in boring XXSB01. Neither acetone nor any other volatile organic compounds were reported. Analytical results from XXSB01 are shown in Table 10-3.

In August 1996, the Tulsa District Corps of Engineers collected surface soil samples from two locations in support of the risk analysis to be performed at this site. Both samples were analyzed for volatile organic compounds and 11 metals (arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, antimony, and thallium). In February 1997, surface soil samples were taken at the same two locations. Samples from both locations were analyzed for semi-volatile organic compounds and pesticides/PCBs. A sample from RASSXX-02 was also analyzed for 12 metals (aluminum, beryllium, calcium, cobalt, copper, iron, potassium, magnesium, manganese, strontium, vanadium and zinc). Analytical results from surface soil samples collected by the Tulsa District Corps of Engineers are presented in Table 10-4.

No explosives, pesticides, volatile organics or semivolatile organic compounds were detected. Elevated concentrations of arsenic and chromium were detected.

Table 10-1
Site XX - Ground Signal Test Area
EPS Surface Soil Analytical Summary (1982)

Parameter	Units	Sample Number/Interval			TCEQ GW-Ind µg/kg
		<0.01	>0.02	>0.03	
		0.00-0.01	0.01-0.02	0.02-0.03	
Explosives	ug/kg	<DL	<DL	<DL	5,100,000
Nitrate	ug/kg	8.0	7.41	<DL	
Sulfate	ug/kg	61.93	28.83	41.04	
Chloride	ug/kg	5.0	<DL	<DL	
Fluoride	ug/kg	6.0	6.0	<DL	
Aluminum	ug/kg	1128.6	1105.5	3.6	10,229,000
Barium	ug/kg	227.8	165.8	61.0	208,000
Chromium	ug/kg	8.4	9.2	9.4	10,000
Lead	ug/kg	27.6	26.5	26.6	1500
Manganese	ug/kg	742	499.5	140.8	1,431,000
Strontium	ug/kg	9.4	11.8	3.9	6,132,000
Copper	ug/kg	3.3	2.7	2.0	130,000
Zinc	ug/kg	6.3	10.1	11.1	3066,000
Nickel	ug/kg	4.0	5.0	4.0	204,000

Table 10-1b
Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1982)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EPS	1982	Soil	***Metals***	EPS Method		
			Aluminum	1N	0.36	µg/g
			Arsenic	1J	0.3	µg/g
			Antimony	1J	0.76	µg/g
			Barium	1J	0.99	µg/g
			Beryllium	1N	0.5	µg/g
			Cadmium	1N	0.5	µg/g
			Chromium	1N	0.6	µg/g
			Copper	1N	0.5	µg/g
			Lead	1J	0.89	µg/g
			Manganese	1N	0.25	µg/g
			Mercury	2D	2.7	µg/g
			Nickel	1N	0.5	µg/g
			Selenium	1J	0.5	µg/g
			Silver	1N	0.5	µg/g
			Strontium	1N	0.5	µg/g
			Thallium	1N	3	µg/g
			Zinc	1N	0.5	µg/g
			Explosives			
			1,3-dinitrobenzene	7W	0.5	µg/g
			2,4,6-trinitrotoluene	7W	0.73	µg/g
			1,3,5-trinitrobenzene	7W	0.71	µg/g
			2,4 dinitrotoluene	7W	0.5	µg/g
			2,6-dinitrotoluene	7W	0.61	µg/g
			Nitrobenzene	7W	1.15	µg/g
			Anions			
			Nitrates	7U	5	µg/g
			Nitrites	7U	5	µg/g
			Sulfates	7U	25	µg/g
			Chloride	7U	7	µg/g
			Fluoride	7U	5	µg/g
			Chromate	7U	5	µg/g
			Thiocyanate	7U	10	µg/g
			Cyanide	7U	5	µg/g

Note(s):
µg/g - micrograms per gram

019710

Table 10-2
Site XX- Ground Signal Test Area
Ebasco Subsurface Soil Analytical Summary (1993)

Parameter	Units	Boring XX9316		Boring XX9316				TCEQ GWP-Ind
		0.0-2.0	5.0-7.0	0.0-3.0	3.0-7.0	9.0-14.0	16.0-18.0	
Volatiles	ug/kg	<DL	<DL	<DL	<DL	<DL	<DL	
Semivolatiles	ug/kg	<DL	<DL	<DL	<DL	<DL	<DL	
Di-n-butyl phthalate	ug/kg	517B	428B	674B	649B	753B	1310B	1,000,000
Explosives	ug/kg	<DL	<DL	<DL	<DL	<DL	<DL	5100
Arsenic	mg/kg	3	2	4	5	2.1	2	1
Barium	mg/kg	44	42	20.2	54.3	31.8	32.5	200
Chromium	mg/kg	4.9	<DL	6.3	8.6	8.8	14.8	10
Lead	mg/kg	6	4	6	11	7	9	1.5
Mercury	mg/kg	<DL	<DL	0.03	<DL	0.06	<DL	0.2
Nickel	mg/kg	2.8	2.4	2.1	11.1	13.3	27.8	2044
Selenium	mg/kg	0.3	<DL	0.2	0.2	<DL	1.2	5
Thallium	mg/kg	<DL	<DL	<DL	0.2	<DL	0.2	
Nitrate/Nitrite	mg/kg	0.9	6.72	5.33	2.81	<DL	5.82	
Sulfate	mg/kg	990	5700	4500	5300	4600	4100	
pH	pH	5.7	6.8	5.7	6.4	5.9	5.9	
Conductivity	umhos/cm	44	70	38	59	27	920	

018711

Table 10-2 (con't)
Site XX- Ground Signal Test Area
Ebasco Subsurface Soil Analytical Summary (1993)

Parameter	Units	Boring XXSD1 0.0-2.0	Boring XXSD2 0.0-2.0	Boring XXSD3 0.0-2.0	Boring XXSD4 0.0-2.0	Boring XXSD5 7.5-8.0
Volatiles	ug/kg	<DL	<DL	<DL	<DL	<DL
TCE	ug/kg	<DL	42	<DL	<DL	<DL
Acetone	ug/kg	<DL	<DL	<DL	<DL	10300
Semivolatiles	ug/kg	<DL	<DL	<DL	<DL	<DL
Di-n- butyl phthalate	ug/kg	1820B	1850B	<DL	1810B	1830B
Explosives	ug/kg	<DL	<DL	<DL	<DL	<DL
Arsenic	mg/kg	5	2	3	3	6
Barium	mg/kg	66.7	100	28.2	37.6	26.6
Chromium	mg/kg	13.5	9.3	12.9	11.4	14.2
Lead	mg/kg	7	5	6	5	5
Mercury	mg/kg	<DL	0.06	0.03	0.03	0.04
Nickel	mg/kg	4.5	10.1	2.8	5.9	21.3
Selenium	mg/kg	0.1	<DL	0.3	0.1	<DL
Chloride	mg/kg	<DL	<DL	<DL	<DL	310
Nitrate/Nitrite	mg/kg	<DL	8.75	0.56	<DL	5.74
Sulfate	mg/kg	820	5100	150	4900	820
pH	pH	6.1	6.7	7.9	5.9	5.4
Conductivity	umhos/cm	33	50	71	195	1520

TCEQ GW Protective

500
9.2 x 10^6

1,000,000

5100
1
200
10
1.5
0.2
204
5

018712

Table 10-2 (con't)
Site XX- Ground Signal Test Area
Ebasco Subsurface Soil Analytical Summary (1993)

Parameter	Units	Boring XXSB20		Boring XXSB21		TCEQ GW P-Ind
		0.0-2.0	2.5-5.0	0.0-2.0	2.5-5.0	
Volatiles	ug/kg	<DL	<DL	<DL	<DL	
Semivolatiles	ug/kg	<DL	<DL	<DL	<DL	
Di-n-butylphthalate	ug/kg	2080B	2790B	2270B	2390B	1,000,000
Explosives	ug/kg	<DL	<DL	<DL	<DL	5,100
Arsenic	mg/kg	4	2	1	1.9	1
Barium	mg/kg	57.2	52.4	48.5	48.8	200
Chromium	mg/kg	15.9	9.9	5.9	7.2	10
Lead	mg/kg	4	5	5	6	1.5
Nickel	mg/kg	5.8	4.4	4.1	4.1	204.4
Selenium	mg/kg	0.1	<DL	<DL	<DL	5
Nitrate/Nitrite	mg/kg	1.5	1	1.1	1	
Sulfate	mg/kg	3800	4400	500	400	
pH	pH	5.9	5.4	5.9	5.7	
Conductivity	umhos/cm	195	1520	36	29	

Table 10-3
Site XX - Ground Signal Test Area
Sverdrup Subsurface Soil Analytical Summary (1994)

Parameter	Units	Boring XXSB01			TCEQ GW P-Ind
		0-2	2-4	8-10	
Volatiles	ug/kg	<DL	<DL	<DL	
Methylene chloride	ug/kg	18	<DL	<DL	38,000

Table 10-2b
Soil Sampling Analytical Methods and Detections Limits
Gound Signal Test Area, LHAAP-003-R
(1993)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Soil - borings	***Metals***			
			Arsenic	7060	1	mg/kg
			Antimony	6010	1	mg/kg
			Barium	6010	1	mg/kg
			Cadmium	6010	1	mg/kg
			Chromium	6010	1	mg/kg
			Lead	7421	1	mg/kg
			Mercury	7470/7471	0.01	mg/kg
			Nickel	6010	1	mg/kg
			Selenium	7740	0.1	mg/kg
			Silver	6010	1	mg/kg
			Thallium	7841	0.2	mg/kg
			VOCs			
			1,1,1-Trichloroethane	8240	5	µg/kg
			1,1,2,2-Tetrachloroethane	8240	5	µg/kg
			1,1,2-Trichloroethane	8240	5	µg/kg
			1,1-Dichloroethane	8240	5	µg/kg
			1,1-Dichloroethene	8240	5	µg/kg
			1,2-Dichloroethane	8240	5	µg/kg
			1,2-Dichloroethene	8240	5	µg/kg
			1,2-Dichloropropane	8240	5	µg/kg
			2-Butanone	8240	50	µg/kg
			2-Chloroethylvinylether	8240	10	µg/kg
			2-Hexanone	8240	50	µg/kg
			4-Methyl-2-pentanone	8240	50	µg/kg
			Acetone	8240	100	µg/kg
			Benzene	8240	5	µg/kg
			Bromodichloromethane	8240	5	µg/kg
			Bromoform	8240	5	µg/kg
			Bromomethane	8240	10	µg/kg
			Carbon disulfide	8240	5	µg/kg
			Carbon tetrachloride	8240	5	µg/kg
			Chlorobenzene	8240	5	µg/kg
			Chloroethane	8240	10	µg/kg
			Chloroform	8240	5	µg/kg
			Chloromethane	8240	10	µg/kg
			Chlorodibromomethane	8240	5	µg/kg
			Ethylbenzene	8240	5	µg/kg
			Methylene chloride	8240	5	µg/kg
			Styrene	8240	5	µg/kg
			Tetrachloroethene	8240	5	µg/kg
			Toluene	8240	5	µg/kg
			Trichloroethene	8240	5	µg/kg
			Vinyl acetate	8240	50	µg/kg
			Vinyl chloride	8240	10	µg/kg
			Xylenes	8240	5	µg/kg
			cis-1,3-Dichloropropene	8240	5	µg/kg
			trans-1,3-Dichloropropene	8240	5	µg/kg

Table 10-2b
Soil Sampling Analytical Methods and Detections Limits
Gound Signal Test Area, LHAAP-003-R
(1993)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Soil - borings	***SVOCs***			
			1,2,4-Trichlorobenzene	8270	330	µg/kg
			1,2-Dichlorobenzene	8270	330	µg/kg
			1,3-Dichlorobenzene	8270	330	µg/kg
			1,4-Dichlorobenzene	8270	330	µg/kg
			2,4,5-Trichlorophenol	8270	1650	µg/kg
			2,4,6-Trichlorophenol	8270	330	µg/kg
			2,4-Dichlorophenol	8270	330	µg/kg
			2,4-Dimethylphenol	8270	330	µg/kg
			2,4-Dinitrophenol	8270	1650	µg/kg
			2,4-Dinitrotoluene	8270	330	µg/kg
			2,6-Dinitrotoluene	8270	330	µg/kg
			2-Chloronaphthalene	8270	330	µg/kg
			2-Chlorophenol	8270	330	µg/kg
			2-Methylnaphthalene	8270	330	µg/kg
			2-Methylphenol	8270	330	µg/kg
			2-Nitroaniline	8270	1650	µg/kg
			2-Nitrophenol	8270	330	µg/kg
			3,3-Dichlorobenzidine	8270	650	µg/kg
			3-Nitroaniline	8270	1650	µg/kg
			4-Bromophenylphenylether	8270	330	µg/kg
			4-Chloro-3-methylphenol	8270	650	µg/kg
			4-Chloroaniline	8270	650	µg/kg
			4-Chlorophenylphenylether	8270	330	µg/kg
			4-Methylphenol	8270	330	µg/kg
			4-Nitroaniline	8270	1650	µg/kg
			4-Nitrophenol	8270	1650	µg/kg
			4,6-Dinitro-2-methylphenol	8270	1650	µg/kg
			Acenaphthene	8270	330	µg/kg
			Acenaphthylene	8270	330	µg/kg
			Anthracene	8270	330	µg/kg
			Benzo(a)anthracene	8270	330	µg/kg
			Benzo(a)pyrene	8270	330	µg/kg
			Benzo(b)fluoranthene	8270	330	µg/kg
			Benzo(g,h,i)perylene	8270	330	µg/kg
			Benzo(k)fluoranthene	8270	330	µg/kg
			Benzoic acid	8270	1650	µg/kg
			Benzyl alcohol	8270	650	µg/kg
			Butylbenzylphthalate	8270	330	µg/kg
			Chrysene	8270	330	µg/kg
			Dibenzo(a,h)anthracene	8270	330	µg/kg
			Dibenzofuran	8270	330	µg/kg
			Di-n-butylphthalate	8270	330	µg/kg
			Diethylphthalate	8270	330	µg/kg
			Dimethylphthalate	8270	330	µg/kg
			Fluoranthene	8270	330	µg/kg
			Fluorene	8270	330	µg/kg
			Hexachlorobenzene	8270	330	µg/kg
			Hexachlorobutadiene	8270	330	µg/kg

Table 10-2b
Soil Sampling Analytical Methods and Detections Limits
Gound Signal Test Area, LHAAP-003-R
(1993)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Soil - borings	***SVOCs (continued)***			
			Hexachlorocyclopentadiene	8270	330	µg/kg
			Hexachloroethane	8270	330	µg/kg
			Indeno(1,2,3-c,d)pyrene	8270	330	µg/kg
			Isophorone	8270	330	µg/kg
			Naphthalene	8270	330	µg/kg
			Nitrobenzene	8270	330	µg/kg
			Pentachlorophenol	8270	1650	µg/kg
			Phenanthrene	8270	330	µg/kg
			Phenol	8270	330	µg/kg
			Pyrene	8270	330	µg/kg
			bis(2-Chloroethoxy)methane	8270	330	µg/kg
			bis(2-Chloroethyl)ether	8270	330	µg/kg
			bis(2-Chloroisopropyl)ether	8270	330	µg/kg
			bis(2-Ethylhexyl)phthalate	8270	330	µg/kg
			di-n-Octylphthalate	8270	330	µg/kg
			n-Nitrosodi-n-propylamine	8270	330	µg/kg
			n-Nitrosodiphenylamine	8270	330	µg/kg
			Explosives			
			HMX	8330	0.5	mg/kg
			RDX	8330	0.5	mg/kg
			1,3,5-TNB	8330	0.25	mg/kg
			1,3-DNB	8330	0.25	mg/kg
			Tetryl	8330	0.5	mg/kg
			Nitrobenzene	8330	0.26	mg/kg
			2,4,6-TNT	8330	0.25	mg/kg
			2,6-DNT	8330	0.25	mg/kg
			2,4-DNT	8330	0.25	mg/kg
			2-Nitrotoluene	8330	0.25	mg/kg
			4-Nitrotoluene	8330	0.25	mg/kg
			3-Nitrotoluene	8330	0.25	mg/kg
			Anions			
			Nitrate-Nitrite Nitrogen	353.3	0.01-0.05	mg/kg
			Sulfate	9038	50-300	mg/kg
			Chloride	9052	+	mg/kg

Note(s):
µg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
SVOC - semivolatile organic compound
VOC - volatile organic compound

Table 10-3b
Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(SVERDRUP 1994)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
SVERDRUP	1994	Soil - boring	*VOCs*			
			1,1,1-Trichloroethane	8240	6	µg/kg
			1,1,2,2-Tetrachloroethane	8240	6	µg/kg
			1,1,2-Trichloroethane	8240	6	µg/kg
			1,1-Dichloroethane	8240	6	µg/kg
			1,1-Dichloroethene	8240	6	µg/kg
			1,2-Dichloroethane	8240	6	µg/kg
			1,2-Dichloropropane	8240	6	µg/kg
			1,2,3-Trichloropropane	8240	12	µg/kg
			1,4-Dichloro-2-butene	8240	12	µg/kg
			2-Butanone	8240	12	µg/kg
			Ethene (2 chloroethoxyl)-	8240	12	µg/kg
			2-Hexanone	8240	12	µg/kg
			4-Methyl-2-pentanone	8240	12	µg/kg
			Acetone	8240	12	µg/kg
			Acrolein	8240	60	µg/kg
			Acrylonitrile	8240	60	µg/kg
			Benzene	8240	6	µg/kg
			Bromodichloromethane	8240	6	µg/kg
			Bromoform	8240	6	µg/kg
			Bromomethane	8240	12	µg/kg
			Carbon disulfide	8240	6	µg/kg
			Carbon tetrachloride	8240	6	µg/kg
			Chlorobenzene	8240	6	µg/kg
			Chloroethane	8240	12	µg/kg
			Chloroform	8240	6	µg/kg
			Chloromethane	8240	12	µg/kg
			cis-1,3-Dichloropropene	8240	6	µg/kg
			Dibromomethane	8240	6	µg/kg
			Dibromochloromethane	8240	6	µg/kg
			Dichlorodifluoromethane	8240	6	µg/kg
			Ethylbenzene	8240	6	µg/kg
			Ethyl methacrylate	8240	6	µg/kg
			Iodomethane	8240	12	µg/kg
			Methylene chloride	8240	12	µg/kg
			Styrene	8240	6	µg/kg
			Tetrachloroethene	8240	6	µg/kg
			Toluene	8240	6	µg/kg
			Total Xylenes	8240	6	µg/kg
			1,2-Dichloroethylene	8240	6	µg/kg
			trans-1,3-Dichloropropene	8240	6	µg/kg
			Trichloroethene	8240	6	µg/kg
			Trichlorofluoromethane	8240	6	µg/kg
			Vinyl acetate	8240	12	µg/kg
			Vinyl chloride	8240	12	µg/kg

Note(s):
µg/kg - micrograms per kilogram
VOC - volatile organic compound

11713

Table 10-4
Site XX - Ground Signal Test Area
Tulsa District Corps of Engineers (1996/97)
Surface Soil Analytical Summary

Parameter	Units	[illegible]	[illegible]
Explosives	ug/kg	<DL	<DL
Pesticides	mg/kg	<DL	<DL
Volatile Organics	ug/kg	<DL	<DL
Semivolatiles	mg/kg	<DL	<DL
Aluminum	mg/kg	4670	8050
Antimony	mg/kg	<DL	<DL
Arsenic	mg/kg	32.8	4.33
Barium	mg/kg	88.1	92.2
Beryllium	mg/kg	<DL	<DL
Cadmium	mg/kg	3.63	5.42
Calcium	mg/kg	332	621
Chromium	mg/kg	28.9	14.3
Cobalt	mg/kg	3.21	<DL
Copper	mg/kg	3.70	6.21
Iron	mg/kg	6,970	13,500
Lead	mg/kg	11.0	9
Magnesium	mg/kg	243	826
Manganese	mg/kg	567	37.8
Mercury	mg/kg	<DL	<DL
Nickel	mg/kg	10.6	15
Potassium	mg/kg	281	484
Selenium	mg/kg	<DL	<DL
Silver	mg/kg	<DL	<DL
Strontium	mg/kg	<DL	18.9
Thallium	mg/kg	<DL	<DL
Vanadium	mg/kg	20.6	24.3
Zinc	mg/kg	9.17	17.6

TCEQ .GVIP.tmd
10,220
1
200
0.4
0.5
NA
10
130
NA
1.5
NA
1431
0.2
204
NA
5
613 ?
7.2
3060

Table 10-4b
USACE Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1996/1997)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USACE	1996/97	Soil - surface	***Metals***			
			Arsenic	7060	0.596 - 58.7[a]	mg/kg
			Antimony	6010	1.1 - 1.2	mg/kg
			Barium	6010	2.22 - 2.38	mg/kg
			Cadmium	6010	2.22 - 2.38	mg/kg
			Chromium	6010	2.22 - 2.38	mg/kg
			Lead	7421	2	mg/kg
			Mercury	7471	0.133 - 0.143	mg/kg
			Nickel	6010	2.22 - 2.38	mg/kg
			Selenium	7740	0.55 -0.60	mg/kg
			Silver	6010	2.22 - 2.38	mg/kg
			Thallium	6010	0.6	mg/kg
			Explosives			
			HMX	8330	0.9	mg/kg
			RDX	8330	0.5	mg/kg
			1,3,5-TNB	8330	0.7	mg/kg
			1,3-DNB	8330	0.5	mg/kg
			Tetryl	8330	1.9	mg/kg
			Nitrobenzene	8330	0.6	mg/kg
			2,4,6-TNT	8330	0.5	mg/kg
			2,6-DNT	8330	0.5	mg/kg
			2,4-DNT	8330	0.5	mg/kg
			2-Nitrotoluene	8330	0.9	mg/kg
			4-Nitrotoluene	8330	1.1	mg/kg
			3-Nitrotoluene	8330	0.9	mg/kg
			2-Am-DNT	8330	0.9	mg/kg
			4-Am-DNT	8330	1.1	mg/kg
			VOCs			
			1,1,1-Trichloroethane	8260	5.54 -5.96	µg/kg
			1,1,2,2-Tetrachloroethane	8260	5.54 -5.96	µg/kg
			1,1,2-Trichloroethane	8260	5.54 -5.96	µg/kg
			1,1-Dichloroethane	8260	5.54 -5.96	µg/kg
			1,1-Dichloroethene	8260	5.54 -5.96	µg/kg
			1,2-Dichloroethane	8260	5.54 -5.96	µg/kg
			1,2-Dichloropropane	8260	5.54 -5.96	µg/kg
			2-Butanone	8260	111 - 119	µg/kg
			2-Chloroethylvinylether	8260	11.1 - 11.9	µg/kg
			2-Hexanone	8260	55.4 - 59.6	µg/kg
			4-Methyl-2-pentanone	8260	111 - 119	µg/kg
			Acetone	8260	22.2 - 23.8	µg/kg
			Acrylonitrile	8260	5.54 -5.96	µg/kg

Table 10-4b
USACE Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1996/1997)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USACE	1996/97	Soil - surface	*VOCs (continued)*			
			Benzene	8260	5.54 -5.96	µg/kg
			Bromobenzene	8260	5.54 -5.96	µg/kg
			Bromochloromethane	8260	5.54 -5.96	µg/kg
			Bromodichloromethane	8260	5.54 -5.96	µg/kg
			Bromoform	8260	5.54 -5.96	µg/kg
			Bromomethane	8260	5.54 -5.96	µg/kg
			Carbon disulfide	8260	5.54 -5.96	µg/kg
			Carbon tetrachloride	8260	5.54 -5.96	µg/kg
			Chlorobenzene	8260	5.54 -5.96	µg/kg
			Chloroethane	8260	5.54 -5.96	µg/kg
			Chloroform	8260	5.54 -5.96	µg/kg
			2-Chlorotoluene	8260	5.54 -5.96	µg/kg
			3-Chlorotoluene	8260	5.54 -5.96	µg/kg
			Chloromethane	8260	5.54 -5.96	µg/kg
			Dibromochloromethane	8260	5.54 -5.96	µg/kg
			1,2-Dibromo-3-chloropropane	8260	27.7 - 29.8	µg/kg
			1,2-Dibromoethane	8260	5.54 -5.96	µg/kg
			1,2-Dichlorobenzene	8260	5.54 -5.96	µg/kg
			1,3-Dichlorobenzene	8260	5.54 -5.96	µg/kg
			1,4-Dichlorobenzene	8260	5.54 -5.96	µg/kg
			trans-1,4-Dichloro-2-butene	8260	111 - 119	µg/kg
			2,2-Dichloropropane	8260	5.54 -5.96	µg/kg
			1,1-Dichloropropene	8260	5.54 -5.96	µg/kg
			1,3-Dichloropropane	8260	5.54 -5.96	µg/kg
			cis-1,2-Dichloroethene	8260	5.54 -5.96	µg/kg
			trans-1,2-Dichloroethene	8260	5.54 -5.96	µg/kg
			Dibromomethane		5.54 -5.96	µg/kg
			Ethylbenzene	8260	5.54 -5.96	µg/kg
			Iodomethane	8260	5.54 -5.96	µg/kg
			Methylene chloride	8260	5.54 -5.96	µg/kg
			Styrene	8260	5.54 -5.96	µg/kg
			1,1,1,2-Tetrachloroethane	8260	5.54 -5.96	µg/kg
			Tetrachloroethene	8260	5.54 -5.96	µg/kg
			Toluene	8260	5.54 -5.96	µg/kg
			1,2,3-Trichlorobenzene	8260	5.54 -5.96	µg/kg
			1,2,4-Trichlorobenzene	8260	5.54 -5.96	µg/kg
			Trichloroethene	8260	5.54 -5.96	µg/kg
			Trichlorofluoromethane	8260	5.54 -5.96	µg/kg
			1,2,3-Trichloropropane	8260	5.54 -5.96	µg/kg
			1,3,5-Trimethylbenzene	8260	5.54 -5.96	µg/kg

Table 10-4b
USACE Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1996/1997)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USACE	1996/97	Soil - surface	***VOCs (continued)***			
			1,2,4-Trimethylbenzene	8260	5.54 -5.96	µg/kg
			Vinyl acetate	8260	55.4 - 59.6	µg/kg
			Vinyl chloride	8260	2.22 - 2.38	µg/kg
			m,p-Xylenes	8260	5.54 -5.96	µg/kg
			o-Xylenes	8260	5.54 -5.96	µg/kg
			cis-1,3-Dichloropropene	8260	5.54 -5.96	µg/kg
			trans-1,3-Dichloropropene	8260	5.54 -5.96	µg/kg
USACE	February 1997	Soil	***Metals***			
			Aluminum	6010	26.5 - 27.9	mg/kg
			Beryllium	6010	0.66 - 0.70	mg/kg
			Calcium	6010	66.1 - 69.7	mg/kg
			Cobalt	6010	2.65 - 2.79	mg/kg
			Copper	6010	1.32 - 1.39	mg/kg
			Iron	6010	13.2 - 13.9	mg/kg
			Magnesium	6010	13.2 - 13.9	mg/kg
			Manganese	6010	1.32 - 1.39	mg/kg
			Potassium	6010	132 - 139	mg/kg
			Strontium	6010	13.2 - 13.9	mg/kg
			Vanadium	6010	2.65 - 2.79	mg/kg
			Zinc	6010	3.97 - 4.18	mg/kg
			VOCs			
			1,1,1-Trichloroethane	8260	6.78	µg/kg
			1,1,2,2-Tetrachloroethane	8260	6.78	µg/kg
			1,1,2-Trichloroethane	8260	6.78	µg/kg
			1,1-Dichloroethane	8260	6.78	µg/kg
			1,1-Dichloroethene	8260	6.78	µg/kg
			1,2-Dichloroethane	8260	6.78	µg/kg
			1,2-Dichloropropane	8260	6.78	µg/kg
			2-Butanone	8260	136	µg/kg
			2-Chloroethylvinylether	8260	13.6	µg/kg
			2-Hexanone	8260	67.8	µg/kg
			4-Methyl-2-pentanone	8260	136	µg/kg
			Acetone	8260	27.1	µg/kg
			Acrylonitrile	8260	6.78	µg/kg
			Benzene	8260	6.78	µg/kg
			Bromobenzene	8260	6.78	µg/kg
			Bromochloromethane	8260	6.78	µg/kg
			Bromodichloromethane	8260	6.78	µg/kg
			Bromoform	8260	6.78	µg/kg
			Bromomethane	8260	6.78	µg/kg

Table 10-4b
USACE Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1996/1997)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USACE	February 1997	Soil	*VOCs (continued)*			
			Carbon disulfide	8260	6.78	µg/kg
			Carbon tetrachloride	8260	6.78	µg/kg
			Chlorobenzene	8260	6.78	µg/kg
			Chloroethane	8260	6.78	µg/kg
			Chloroform	8260	6.78	µg/kg
			2-Chlorotoluene	8260	6.78	µg/kg
			3-Chlorotoluene	8260	6.78	µg/kg
			Chloromethane	8260	6.78	µg/kg
			Dibromochloromethane	8260	6.78	µg/kg
			1,2-Dibromo-3-chloropropane	8260	33.9	µg/kg
			1,2-Dibromoethane	8260	6.78	µg/kg
			1,2-Dichlorobenzene	8260	6.78	µg/kg
			1,3-Dichlorobenzene	8260	6.78	µg/kg
			1,4-Dichlorobenzene	8260	6.78	µg/kg
			trans-1,4-Dichloro-2-butene	8260	136	µg/kg
			2,2-Dichloropropane	8260	6.78	µg/kg
			1,1-Dichloropropene	8260	6.78	µg/kg
			1,3-Dichloropropane	8260	6.78	µg/kg
			cis-1,2-Dichloroethene	8260	6.78	µg/kg
			trans-1,2-Dichloroethene	8260	6.78	µg/kg
			Dibromomethane		6.78	µg/kg
			Ethylbenzene	8260	6.78	µg/kg
			Iodomethane	8260	6.78	µg/kg
			Methylene chloride	8260	6.78	µg/kg
			Styrene	8260	6.78	µg/kg
			1,1,1,2-Tetrachloroethane	8260	6.78	µg/kg
			Tetrachloroethene	8260	6.78	µg/kg
			Toluene	8260	6.78	µg/kg
			1,2,3-Trichlorobenzene	8260	6.78	µg/kg
			1,2,4-Trichlorobenzene	8260	6.78	µg/kg
			Trichloroethene	8260	6.78	µg/kg
			Trichlorofluoromethane	8260	6.78	µg/kg
			1,2,3-Trichloropropane	8260	6.78	µg/kg
			1,3,5-Trimethylbenzene	8260	6.78	µg/kg
			1,2,4-Trimethylbenzene	8260	6.78	µg/kg
			Vinyl acetate	8260	67.8	µg/kg
			Vinyl chloride	8260	6.78	µg/kg
			m,p-Xylenes	8260	6.78	µg/kg
			o-Xylenes	8260	6.78	µg/kg
			cis-1,3-Dichloropropene	8260	6.78	µg/kg
			trans-1,3-Dichloropropene	8260	6.78	µg/kg

Table 10-4b
USACE Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1996/1997)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USACE	February 1997	Soil	***SVOCs***			
			1,2,4-Trichlorobenzene	8270	0.437 - 0.460	mg/kg
			1,2-Dichlorobenzene	8270	0.437 - 0.460	mg/kg
			1,3-Dichlorobenzene	8270	0.437 - 0.460	mg/kg
			1,4-Dichlorobenzene	8270	0.437 - 0.460	mg/kg
			2,3,4,6-Tetrachlorophenol	8270	0.437 - 0.460	mg/kg
			2,4,5-Trichlorophenol	8270	2.18 - 2.30	mg/kg
			2,4,6-Trichlorophenol	8270	0.437 - 0.460	mg/kg
			2,4-Dichlorophenol	8270	0.437 - 0.460	mg/kg
			2,4-Dimethylphenol	8270	0.437 - 0.460	mg/kg
			2,4-Dinitrophenol	8270	2.18 - 2.30	mg/kg
			2,4-Dinitrotoluene	8270	0.437 - 0.460	mg/kg
			2,6-Dinitrotoluene	8270	0.437 - 0.460	mg/kg
			2-Chloronaphthalene	8270	0.437 - 0.460	mg/kg
			2-Chlorophenol	8270	0.437 - 0.460	mg/kg
			2-Methylphenol	8270	0.437 - 0.460	mg/kg
			2-Nitroaniline	8270	2.18 - 2.30	mg/kg
			2-Nitrophenol	8270	0.437 - 0.460	mg/kg
			2-Methylnaphthalene	8270	0.437 - 0.460	mg/kg
			3,3-Dichlorobenzidine	8270	0.437 - 0.460	mg/kg
			3-Methylcholanthrene	8270	0.437 - 0.460	mg/kg
			3-Nitroaniline	8270	2.18 - 2.30	mg/kg
			4,6-Dinitro-2-methylphenol	8270	2.18 - 2.30	mg/kg
			4-Bromophenylphenylether	8270	0.437 - 0.460	mg/kg
			4-Chloro-3-methylphenol	8270	0.860 - 0.907	mg/kg
			4-Chloroaniline	8270	0.437 - 0.460	mg/kg
			4-Chlorophenylphenylether	8270	0.437 - 0.460	mg/kg
			4-Methylphenol	8270	0.437 - 0.460	mg/kg
			4-Nitroaniline	8270	2.18 - 2.30	mg/kg
			4-Nitrophenol	8270	1.06 - 1.12	mg/kg
			Benzo(a)anthracene	8270	0.437 - 0.460	mg/kg
			Benzoic acid	8270	1.06 - 1.12	mg/kg
			Benzyl alcohol	8270	0.860 - 0.907	mg/kg
			bis(2-Chloroethoxy)methane	8270	0.437 - 0.460	mg/kg
			bis(2-Chloroethyl)ether	8270	0.437 - 0.460	mg/kg
			bis(2-Ethylhexyl)phthalate	8270	0.437 - 0.460	mg/kg
			bis(2-Chloroisopropyl)ether	8270	0.437 - 0.460	mg/kg
			Butylbenzylphthalate	8270	0.437 - 0.460	mg/kg
			Carbazole	8270	0.437 - 0.460	mg/kg
			Di-n-butylphthalate	8270	0.437 - 0.460	mg/kg
			Di-n-Octylphthalate	8270	0.437 - 0.460	mg/kg

Table 10-4b
USACE Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1996/1997)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USACE	February 1997	Soil	***SVOCs (continued)***			
			Dibenzo(a,h)anthracene	8270	0.437 - 0.460	mg/kg
			Dibenzofuran	8270	0.437 - 0.460	mg/kg
			Diethylphthalate	8270	0.437 - 0.460	mg/kg
			Dimethylphthalate	8270	0.437 - 0.460	mg/kg
			Ethyl methanesulfonate	8270	0.437 - 0.460	mg/kg
			Hexachlorobenzene	8270	0.437 - 0.460	
			Hexachlorobutadiene	8270	0.437 - 0.460	mg/kg
			Hexachlorocyclopentadiene	8270	0.437 - 0.460	mg/kg
			Hexachloroethane	8270	0.437 - 0.460	mg/kg
			Isophorone	8270	0.437 - 0.460	mg/kg
			N-nitroso-di-n-propylamine	8270	0.437 - 0.460	mg/kg
			Nitrobenzene	8270	0.437 - 0.460	mg/kg
			Pentachlorobenzene	8270	0.437 - 0.460	mg/kg
			Pentachlorophenol	8270	2.18 - 2.24	mg/kg
			Phenol	8270	0.437 - 0.460	mg/kg
			Acenaphthalene	8270	0.437 - 0.460	mg/kg
			Acenaphthene	8270	0.437 - 0.460	mg/kg
			Anthracene	8270	0.437 - 0.460	mg/kg
			Benzo(a)pyrene	8270	0.437 - 0.460	mg/kg
			Benzo(b)fluoranthene	8270	0.437 - 0.460	mg/kg
			Benzo(g,h,i)perylene	8270	0.437 - 0.460	mg/kg
			Benzo(k)fluoranthene	8270	0.437 - 0.460	mg/kg
			Chrysene	8270	0.437 - 0.460	mg/kg
			Fluoranthene	8270	0.437 - 0.460	mg/kg
			Fluorene	8270	0.437 - 0.460	mg/kg
			Indeno(1,2,3-c,d)pyrene	8270	0.437 - 0.460	mg/kg
			n-Nitrosodiphenylamine	8270	0.437 - 0.460	mg/kg
			Naphthalene	8270	0.437 - 0.460	mg/kg
			Phenanthrene	8270	0.437 - 0.460	mg/kg
			Pyrene	8270	0.437 - 0.460	mg/kg
			Pesticides			
			Aldrin	3540/8081	5	µg/kg
			Heptachlor	3540/8081	5	µg/kg
			Alpha BHC	3540/8081	5	µg/kg
			Chlordane	3540/8081	5	µg/kg
			Beta BHC	3540/8081	10	µg/kg
			delta-BHC	3540/8081	5	µg/kg
			Dieldrin	3540/8081	10	µg/kg
			Alpha Endosulfan	3540/8081	5	µg/kg
			Beta Endosulfan	3540/8081	10	µg/kg

Table 10-4b
USACE Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1996/1997)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USACE	February 1997	Soil	***Pesticides (continued)***			
			Endosulfan Sulfate	3540/8081	10	µg/kg
			Endrin	3540/8081	10	µg/kg
			Endrin Aldehyde	3540/8081	10	µg/kg
			gamma-BHC	3540/8081	5	µg/kg
			Heptachlor epoxide	3540/8081	5	µg/kg
			4,4--DDD	3540/8081	10	µg/kg
			4,4--DDE	3540/8081	10	µg/kg
			4,4--DDT	3540/8081	10	µg/kg
			Toxaphene	3540/8081	75	µg/kg
			Methoxylchlor	3540/8081	20	mg/kg
			PCBs			
			Aroclor 1016	8080	0.132 - 0.139	mg/kg
			Aroclor 1221	8080	0.132 - 0.139	mg/kg
			Aroclor 1232	8080	0.132 - 0.139	mg/kg
			Aroclor 1242	8080	0.132 - 0.139	mg/kg
			Aroclor 1248	8080	0.132 - 0.139	mg/kg
			Aroclor 1254	8080	0.132 - 0.139	mg/kg
			Aroclor 1260	8080	0.132 - 0.139	mg/kg

Note(s):

[a] - dilution factor of 100

µg/kg - micrograms per kilogram

mg/kg - milligrams per kilogram

PCB - polychlorinated biphenyl

SVOC - semivolatile organic compound

USACE - U.S. Army Corps of Engineers

VOC - volatile organic compound

#18715

Table 10-5
Site XX - Ground Signal Test Area
Groundwater Analytical Summary (1982 and 1983)

Parameter	Units	Well MW-127		Well MW-128		MCL	TEQ GW-Inf
		1982	March 1993	1982	March 1993		
Volatiles	ug/l	<DL*	<DL*	<DL	<DL		
Semivolatiles	ug/l	<DL*	<DL*	<DL	<DL		
Explosives	ug/l	<DL	<DL	<DL	<DL		
Aluminum	mg/l	0.037	<DL	0.353	<DL		102.2
Barium	mg/l	0.046	0.11	0.0515	<DL	2	
Cadmium	mg/l	0.01	<DL	0.005	<DL	0.005	
Chromium	mg/l	0.012	<DL	<DL	<DL	0.1	
Lead	mg/l	<DL	0.011	<DL	0.011	0.015	
Manganese	mg/l	1.86	<DL	1.086	<DL		14.308
Nickel	mg/l	0.157	0.05	0.082	<DL		2.044
Strontium	mg/l	3.36	<DL	4.12	<DL		61.32
Thallium	mg/l	0.14	<DL	0.11	<DL	0.002	
Sulfate	mg/l	1622	1200	559	330		
Chloride	mg/l	832	527	1000	873		
Fluoride	mg/l	1	<DL	<DL	<DL		

* This table erroneously shows well MW-127 as being sampled for VOCs and SVOCs when according to the EPS 1982 Report text, the well was not sampled.

Table 10-5b
Groundwater Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
1982 and 1993

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EPS	1982	Groundwater -wells	***Metals***			
			Aluminum	1M	10	µg/L
			Arsenic	1B	6	µg/L
			Antimony	1B	10.2	µg/L
			Barium	1B	11.4	µg/L
			Beryllium	1M	10	µg/L
			Cadmium	1B	0.28	µg/L
			Chromium	1B	6.64	µg/L
			Copper	1M	23.9	µg/L
			Lead	1B	7.49	µg/L
			Manganese	1M	12.1	µg/L
			Mercury	1D	1.3	µg/L
			Nickel	1M	30	µg/L
			Selenium	1B	6	µg/L
			Silver	1M	10	µg/L
			Strontium	1M	25	µg/L
			Thallium	1M	50	µg/L
			Zinc	1M	27.1	µg/L
			Organics			
			Benzene	2J	1	µg/L
			Chloroform	2J	1	µg/L
			Trichloroethylene	2J	1	µg/L
			Pentachlorophenol	1X	2	µg/L
			o-chlorophenol	1X	0.7	µg/L
			2,4-dichlorophenol	1X	1	µg/L
			Tetrahydrofuran	NA	NA	
			Dibutylphthalate	NA	NA	
			Dichloromethane	NA	NA	
			Diethylphthalate	1Z	2	µg/L
			Nitrobenzene	1Z	1	µg/L
			2-(1,1-dimethylethoxyl)-ethanol	NA	NA	
			Explosives			
			1,3-dinitrobenzene	7V	1.68	µg/L
			2,4,6-trinitrotoluene	7V	1.46	µg/L
			1,3,5-trinitrobenzene	7V	1.08	µg/L
			2,4 dinitrotoluene	7V	0.89	µg/L
			2,6-dinitrotoluene	7V	1.2	µg/L
			Nitrobenzene	7V	0.76	µg/L
			Anions			
			Nitrate	2P	500	µg/L
			Nitrite	2P	250	µg/L
			Phosphate	2P	125	µg/L
			Sulfates	2P	580	µg/L
			Chloride	2P	500	µg/L
			Fluoride	2P	500	µg/L
			Chromate	2P	500	µg/L
			Thiocyanate	2P	500	µg/L
			Cyanide	2P	600	µg/L

Table 10-5b
Groundwater Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
1982 and 1993

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Groundwater	***Metals***			
			Arsenic	7060	0.01	mg/L
			Antimony	6010	0.005	mg/L
			Barium	6010	0.01	mg/L
			Cadmium	6010	0.005	mg/L
			Chromium	6010	0.05	mg/L
			Lead	7421	0.005	mg/L
			Mercury	7470/7471	0.001	mg/L
			Nickel	6010	0.05	mg/L
			Selenium	7740	0.01	mg/L
			Silver	6010	0.01	mg/L
			Thallium	7841	0.002	mg/L
			VOCs			
			1,1,1-Trichloroethane	8240	5	µg/L
			1,1,2,2-Tetrachloroethane	8240	5	µg/L
			1,1,2-Trichloroethane	8240	5	µg/L
			1,1-Dichloroethane	8240	5	µg/L
			1,1-Dichloroethene	8240	5	µg/L
			1,2-Dichloroethane	8240	5	µg/L
			1,2-Dichloroethene	8240	5	µg/L
			1,2-Dichloropropane	8240	5	µg/L
			2-Butanone	8240	50	µg/L
			2-Chloroethylvinylether	8240	10	µg/L
			2-Hexanone	8240	50	µg/L
			4-Methyl-2-pentanone	8240	50	µg/L
			Acetone	8240	100	µg/L
			Benzene	8240	5	µg/L
			Bromodichloromethane	8240	5	µg/L
			Bromoform	8240	5	µg/L
			Bromomethane	8240	10	µg/L
			Carbon disulfide	8240	5	µg/L
			Carbon tetrachloride	8240	5	µg/L
			Chlorobenzene	8240	5	µg/L
			Chloroethane	8240	10	µg/L
			Chloroform	8240	5	µg/L
			Chloromethane	8240	10	µg/L
			Chlorodibromomethane	8240	5	µg/L
			Ethylbenzene	8240	5	µg/L
			Methylene chloride	8240	5	µg/L
			Styrene	8240	5	µg/L
			Tetrachloroethene	8240	5	µg/L
			Toluene	8240	5	µg/L
			Trichloroethene	8240	5	µg/L
			Vinyl acetate	8240	50	µg/L
			Vinyl chloride	8240	10	µg/L
			Xylenes	8240	5	µg/L
			cis-1,3-Dichloropropene	8240	5	µg/L
			trans-1,3-Dichloropropene	8240	5	µg/L

Table 10-5b
Groundwater Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
1982 and 1993

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Groundwater	***SVOCs***			
			1,2,4-Trichlorobenzene	8270	10	µg/L
			1,2-Dichlorobenzene	8270	10	µg/L
			1,3-Dichlorobenzene	8270	10	µg/L
			1,4-Dichlorobenzene	8270	10	µg/L
			2,4,5-Trichlorophenol	8270	50	µg/L
			2,4,6-Trichlorophenol	8270	10	µg/L
			2,4-Dichlorophenol	8270	10	µg/L
			2,4-Dimethylphenol	8270	10	µg/L
			2,4-Dinitrophenol	8270	50	µg/L
			2,4-Dinitrotoluene	8270	10	µg/L
			2,6-Dinitrotoluene	8270	10	µg/L
			2-Chloronaphthalene	8270	10	µg/L
			2-Chlorophenol	8270	10	µg/L
			2-Methylnaphthalene	8270	10	µg/L
			2-Methylphenol	8270	10	µg/L
			2-Nitroaniline	8270	50	µg/L
			2-Nitrophenol	8270	10	µg/L
			3,3-Dichlorobenzidine	8270	20	µg/L
			3-Nitroaniline	8270	50	µg/L
			4-Bromophenylphenylether	8270	10	µg/L
			4-Chloro-3-methylphenol	8270	20	µg/L
			4-Chloroaniline	8270	20	µg/L
			4-Chlorophenylphenylether	8270	10	µg/L
			4-Methylphenol	8270	10	µg/L
			4-Nitroaniline	8270	50	µg/L
			4-Nitrophenol	8270	50	µg/L
			4,6-Dinitro-2-methylphenol	8270	50	µg/L
			Acenaphthene	8270	10	µg/L
			Acenaphthylene	8270	10	µg/L
			Anthracene	8270	10	µg/L
			Benzo(a)anthracene	8270	10	µg/L
			Benzo(a)pyrene	8270	10	µg/L
			Benzo(b)fluoranthene	8270	10	µg/L
			Benzo(g,h,i)perylene	8270	10	µg/L
			Benzo(k)fluoranthene	8270	10	µg/L
			Benzoic acid	8270	50	µg/L
			Benzyl alcohol	8270	20	µg/L
			Butylbenzylphthalate	8270	10	µg/L
			Chrysene	8270	10	µg/L
			Dibenzo(a,h)anthracene	8270	10	µg/L
			Dibenzofuran	8270	10	µg/L
			Di-n-butylphthalate	8270	10	µg/L
			Diethylphthalate	8270	10	µg/L
			Dimethylphthalate	8270	10	µg/L
			Fluoranthene	8270	10	µg/L
			Fluorene	8270	10	µg/L
			Hexachlorobenzene	8270	10	µg/L

Table 10-5b
Groundwater Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
1982 and 1993

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Groundwater	***SVOCs (continued)***			
			Hexachlorobutadiene	8270	10	µg/L
			Hexachlorocyclopentadiene	8270	10	µg/L
			Hexachloroethane	8270	10	µg/L
			Indeno(1,2,3-c,d)pyrene	8270	10	µg/L
			Isophorone	8270	10	µg/L
			Naphthalene	8270	10	µg/L
			Nitrobenzene	8270	10	µg/L
			Pentachlorophenol	8270	50	µg/L
			Phenanthrene	8270	10	µg/L
			Phenol	8270	10	µg/L
			Pyrene	8270	10	µg/L
			bis(2-Chloroethoxy)methane	8270	10	µg/L
			bis(2-Chloroethyl)ether	8270	10	µg/L
			bis(2-Chloroisopropyl)ether	8270	10	µg/L
			bis(2-Ethylhexyl)phthalate	8270	10	µg/L
			di-n-Octylphthalate	8270	10	µg/L
			n-Nitrosodi-n-propylamine	8270	10	µg/L
			n-Nitrosodiphenylamine	8270	10	µg/L
			Explosives			
			HMX	8330	0.1	µg/L
			RDX	8330	0.1	µg/L
			1,3,5-TNB	8330	0.1	µg/L
			1,3-DNB	8330	0.1	µg/L
			Tetryl	8330	0.1	µg/L
			Nitrobenzene	8330	0.1	µg/L
			2,4,6-TNT	8330	0.1	µg/L
			2,6-DNT	8330	0.1	µg/L
			2,4-DNT	8330	0.1	µg/L
			2-Nitrotoluene	8330	0.1	µg/L
			4-Nitrotoluene	8330	0.1	µg/L
			3-Nitrotoluene	8330	0.1	µg/L
			Anions			
			Nitrate-Nitrite Nitrogen	353.3	0.01-0.2	mg/L
			Chloride	9052	1	mg/L
			Sulfate	9038	1-30	mg/L
			Total Phenols Direct	9065	0.1	mg/L
			Total Organic Carbon	9060	1	mg/L
			Total Organic Halogens	9020	5	mg/L

Note(s):
µg/L - micrograms per liter
mg/L - milligrams per liter
NA - not available
VOC - volatile organic compound
SVOC - semivolatile organic compound

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Table 10-6
Site XX - Ground Signal Test Area
Sediment Analytical Summary (1993)

Parameter	Units	SD-014	SD-15	SD-16	SD-17	SD-18	SD-19	SD-20	TLEQ GWP-Ind
Volatiles	ug/kg	<DL	<DL	<DL	<DL	<DL	<DL	<DL	
Semivolatiles	ug/kg	<DL	<DL	<DL	<DL	<DL	<DL	<DL	
Bis(2-ethylhexyl)phthalate	ug/kg	369	<DL	<DL	443	434	<DL	421	600
Di-n-butylphthalate	ug/kg	<DL	<DL	<DL	669	554	<DL	<DL	1,000,000
Explosives	ug/kg	<DL	<DL	<DL	<DL	<DL	<DL	<DL	5100
Arsenic	mg/kg	2.4	1	1.9	1.8	2	3.5	0.9	1
Barium	mg/kg	126	29.8	64.1	23.3	48.4	27.5	39.6	200
Chromium	mg/kg	5.5	4.1	9.8	3.5	5.8	<DL	4.4	10
Lead	mg/kg	9	5	7	4	6	8	6	1.5
Mercury	mg/kg	0.03	0.03	0.03	0.01	0.01	0.01	0.03	0.2
Nickel	mg/kg	14.7	3.7	5.1	2.6	3.1	3.1	4	2044
Selenium	mg/kg	0.3	0.1	0.4	0.1	0.2	0.3	0.1	5
Chloride	mg/kg	<DL	44	<DL	<DL	<DL	<DL	44	
Sulfate	mg/kg	30	40	230	30	30	30	40	
pH	pH	7.3	5.6	6	5.7	5.8	6.3	5.8	
Conductivity	umhos/cm	115	88	37	25	53	62	98	

Table 10-6b
Sediment Sampling Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1993)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Sediment	***Metals***			
			Arsenic	7060	0.5	mg/kg
			Antimony	6010	1	mg/kg
			Barium	6010	1	mg/kg
			Cadmium	6010	1	mg/kg
			Chromium	6010	1	mg/kg
			Lead	7421	1	mg/kg
			Mercury	7470/7471	0.01	mg/kg
			Nickel	6010	1	mg/kg
			Selenium	7740	0.1	mg/kg
			Silver	6010	1	mg/kg
			Thallium	7841	0.2	mg/kg
			VOCs			
			1,1,1-Trichloroethane	8240	5	µg/kg
			1,1,2,2-Tetrachloroethane	8240	5	µg/kg
			1,1,2-Trichloroethane	8240	5	µg/kg
			1,1-Dichloroethane	8240	5	µg/kg
			1,1-Dichloroethene	8240	5	µg/kg
			1,2-Dichloroethane	8240	5	µg/kg
			1,2-Dichloroethene	8240	5	µg/kg
			1,2-Dichloropropane	8240	5	µg/kg
			2-Butanone	8240	50	µg/kg
			2-Chloroethylvinylether	8240	10	µg/kg
			2-Hexanone	8240	50	µg/kg
			4-Methyl-2-pentanone	8240	50	µg/kg
			Acetone	8240	100	µg/kg
			Benzene	8240	5	µg/kg
			Bromodichloromethane	8240	5	µg/kg
			Bromoform	8240	5	µg/kg
			Bromomethane	8240	10	µg/kg
			Carbon disulfide	8240	5	µg/kg
			Carbon tetrachloride	8240	5	µg/kg
			Chlorobenzene	8240	5	µg/kg
			Chloroethane	8240	10	µg/kg
			Chloroform	8240	5	µg/kg
			Chloromethane	8240	10	µg/kg
			Chlorodibromomethane	8240	5	µg/kg
			Ethylbenzene	8240	5	µg/kg
			Methylene chloride	8240	5	µg/kg
			Styrene	8240	5	µg/kg
			Tetrachloroethene	8240	5	µg/kg
			Toluene	8240	5	µg/kg
			Trichloroethene	8240	5	µg/kg
			Vinyl acetate	8240	50	µg/kg
			Vinyl chloride	8240	10	µg/kg
			Xylenes	8240	5	µg/kg
			cis-1,3-Dichloropropene	8240	5	µg/kg
			trans-1,3-Dichloropropene	8240	5	µg/kg

Table 10-6b
Sediment Sampling Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1993)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Sediment	***SVOCs***			
			1,2,4-Trichlorobenzene	8270	330	µg/kg
			1,2-Dichlorobenzene	8270	330	µg/kg
			1,3-Dichlorobenzene	8270	330	µg/kg
			1,4-Dichlorobenzene	8270	330	µg/kg
			2,4,5-Trichlorophenol	8270	1650	µg/kg
			2,4,6-Trichlorophenol	8270	330	µg/kg
			2,4-Dichlorophenol	8270	330	µg/kg
			2,4-Dimethylphenol	8270	330	µg/kg
			2,4-Dinitrophenol	8270	1650	µg/kg
			2,4-Dinitrotoluene	8270	330	µg/kg
			2,6-Dinitrotoluene	8270	330	µg/kg
			2-Chloronaphthalene	8270	330	µg/kg
			2-Chlorophenol	8270	330	µg/kg
			2-Methylnaphthalene	8270	330	µg/kg
			2-Methylphenol	8270	330	µg/kg
			2-Nitroaniline	8270	1650	µg/kg
			2-Nitrophenol	8270	330	µg/kg
			3,3-Dichlorobenzidine	8270	650	µg/kg
			3-Nitroaniline	8270	1650	µg/kg
			4-Bromophenylphenylether	8270	330	µg/kg
			4-Chloro-3-methylphenol	8270	650	µg/kg
			4-Chloroaniline	8270	650	µg/kg
			4-Chlorophenylphenylether	8270	330	µg/kg
			4-Methylphenol	8270	330	µg/kg
			4-Nitroaniline	8270	1650	µg/kg
			4-Nitrophenol	8270	1650	µg/kg
			4,6-Dinitro-2-methylphenol	8270	1650	µg/kg
			Acenaphthene	8270	330	µg/kg
			Acenaphthylene	8270	330	µg/kg
			Anthracene	8270	330	µg/kg
			Benzo(a)anthracene	8270	330	µg/kg
			Benzo(a)pyrene	8270	330	µg/kg
			Benzo(b)fluoranthene	8270	330	µg/kg
			Benzo(g,h,i)perylene	8270	330	µg/kg
			Benzo(k)fluoranthene	8270	330	µg/kg
			Benzoic acid	8270	1650	µg/kg
			Benzyl alcohol	8270	650	µg/kg
			Butylbenzylphthalate	8270	330	µg/kg
			Chrysene	8270	330	µg/kg
			Dibenzo(a,h)anthracene	8270	330	µg/kg
			Dibenzofuran	8270	330	µg/kg
			Di-n-butylphthalate	8270	330	µg/kg
			Diethylphthalate	8270	330	µg/kg
			Dimethylphthalate	8270	330	µg/kg
			Fluoranthene	8270	330	µg/kg
			Fluorene	8270	330	µg/kg
			Hexachlorobenzene	8270	330	µg/kg

Table 10-6b
Sediment Sampling Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1993)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Sediment	***SVOCs (continued)***			
			Hexachlorobutadiene	8270	330	µg/kg
			Hexachlorocyclopentadiene	8270	330	µg/kg
			Hexachloroethane	8270	330	µg/kg
			Indeno(1,2,3-c,d)pyrene	8270	330	µg/kg
			Isophorone	8270	330	µg/kg
			Naphthalene	8270	330	µg/kg
			Nitrobenzene	8270	330	µg/kg
			Pentachlorophenol	8270	1650	µg/kg
			Phenanthrene	8270	330	µg/kg
			Phenol	8270	330	µg/kg
			Pyrene	8270	330	µg/kg
			bis(2-Chloroethoxy)methane	8270	330	µg/kg
			bis(2-Chloroethyl)ether	8270	330	µg/kg
			bis(2-Chloroisopropyl)ether	8270	330	µg/kg
			bis(2-Ethylhexyl)phthalate	8270	330	µg/kg
			di-n-Octylphthalate	8270	330	µg/kg
			n-Nitrosodi-n-propylamine	8270	330	µg/kg
			n-Nitrosodiphenylamine	8270	330	µg/kg
			Explosives			
			HMX	8330	0.5	mg/kg
			RDX	8330	0.5	mg/kg
			1,3,5-TNB	8330	0.25	mg/kg
			1,3-DNB	8330	0.25	mg/kg
			Tetryl	8330	0.5	mg/kg
			Nitrobenzene	8330	0.26	mg/kg
			2,4,6-TNT	8330	0.25	mg/kg
			2,6-DNT	8330	0.25	mg/kg
			2,4-DNT	8330	0.25	mg/kg
			2-Nitrotoluene	8330	0.25	mg/kg
			4-Nitrotoluene	8330	0.25	mg/kg
			3-Nitrotoluene	8330	0.25	mg/kg
			Anions			
			Nitrate-Nitrite Nitrogen	353.3	0.1	mg/kg
			Chloride	9052	10	mg/kg
			Sulfate	9038	10-50	mg/kg

Note(s):

µg/kg - micrograms per kilogram

mg/kg - milligrams per kilogram

VOC - volatile organic compound

SVOC - semivolatile organic compound

Table 10-7
Site XX - Ground Signal Test Area
Surface Water Analytical Summary (1993)

Parameter	Units	SW [illegible]	SW [illegible]	SW [illegible]	SW [illegible]	SW [illegible]	SW [illegible]	SW [illegible]
Volatiles	ug/l	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Semivolatiles	ug/l	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Explosives	ug/l	<DL	<DL	<DL	<DL	<DL	<DL	<DL
Barium	mg/l	0.11	0.13	0.07	0.06	0.23	0.43	0.09
Lead	mg/l	<DL	<DL	<DL	<DL	<DL	0.006	0.011
Chloride	mg/l	28.4	31.0	2.6	2.6	2.6	2.6	9.7
Nitrate/Nitrite	mg/l	0.04	<DL	0.30	0.09	<DL	<DL	<DL
Sulfate	mg/l	32	29	2.0	5.0	<DL	<DL	4.0

10.2 NATURE AND EXTENT OF CONTAMINATION

10.2.1 Explosives

No explosives were detected in any sample collected at Site XX from any sample medium.

10.2.2 Volatile and Semivolatile Organics

Acetone was detected in two samples at Site XX. It was detected at a concentration of 10,300 ug/kg in a subsurface soil sample obtained from the 2.5 to 5.0-ft sampling interval in soil boring XXSB19, and at a concentration of 17 ug/l in groundwater grab sample XXGG01 from the soil boring adjacent to XXSB19. The water sample was accompanied by a contaminated travel blank. The blank contained acetone at 17 ug/l and indicated a problem in sampling or shipping. The acetone at these locations was thoroughly investigated by soil boring XXSB01 and 5 soil gas samples, all of which were clean. This sample of acetone must represent either a sampling or a laboratory problem. TCE was present in one isolated subsurface soil sample collected from the 5-7 ft sampling interval in soil boring XXSB17 on the eastern portion of the site and methylene chloride was detected at a concentration of 18 ug/kg in one subsurface soil sample collected between a depth of 0-2 ft in soil boring XXSB01. The only semivolatiles found were di-n-butyl phthalate and bis(2-ethylhexyl)phthalate. These common plasticizers were either qualified with a B (found in the method blanks) or were found in very low concentrations. No contamination by volatile or semivolatile organics is demonstrated.

Table B-3
Groundwater Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(SVERDRUP 1994)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
SVERDRUP	1994	Groundwater - grab from boring	*VOCs*			
			1,1,1-Trichloroethane	8240	5	µg/L
			1,1,2,2-Tetrachloroethane	8240	5	µg/L
			1,1,2-Trichloroethane	8240	5	µg/L
			1,1-Dichloroethane	8240	5	µg/L
			1,1-Dichloroethene	8240	5	µg/L
			1,2-Dichloroethane	8240	5	µg/L
			1,2-Dichloropropane	8240	5	µg/L
			1,2,3-Trichloropropane	8240	5	µg/L
			1,4,Dichloro-2-butene	8240	10	µg/L
			2-Butanone	8240	10	µg/L
			Ethene (2 chloroethoxyl)-	8240	10	µg/L
			2-Hexanone	8240	10	µg/L
			4-Methyl-2-pentanone	8240	10	µg/L
			Acetone	8240	100	µg/L
			Acrolein	8240	50	µg/L
			Acrylonitrile	8240	50	µg/L
			Benzene	8240	5	µg/L
			Bromodichloromethane	8240	5	µg/L
			Bromoform	8240	5	µg/L
			Bromomethane	8240	10	µg/L
			Carbon disulfide	8240	5	µg/L
			Carbon tetrachloride	8240	5	µg/L
			Chlorobenzene	8240	5	µg/L
			Chloroethane	8240	10	µg/L
			Chloroform	8240	5	µg/L
			Chloromethane	8240	10	µg/L
			cis-1,3-Dichloropropene	8240	5	µg/L
			Dibromomethane	8240	5	µg/L
			Dibromochloromethane	8240	5	µg/L
			Dichlorodifluoromethane	8240	5	µg/L
			Ethylbenzene	8240	5	µg/L
			Ethyl methacrylate	8240	5	µg/L
			Iodomethane	8240	10	µg/L
			Methylene chloride	8240	10	µg/L
			Styrene	8240	5	µg/L
			Tetrachloroethene	8240	5	µg/L
			Toluene	8240	5	µg/L
			Total Xylenes	8240	5	µg/L
			1,2-Dichloroethylene	8240	5	µg/L
			trans-1,3-Dichloropropene	8240	5	µg/L
			Trichloroethene	8240	5	µg/L
			Trichlorofluoromethane	8240	5	µg/L
			Vinyl acetate	8240	10	µg/L
			Vinyl chloride	8240	10	µg/L
			SVOCs			
			1-Chloronaphthalene	8270	10	µg/L
			1,2,4-Trichlorobenzene	8270	10	µg/L
			1,2-Dichlorobenzene	8270	10	µg/L
			1,2-Diphenylhydrazine	8270	50	µg/L
			1,3-Dichlorobenzene	8270	10	µg/L
			1,4-Dichlorobenzene	8270	10	µg/L
			2,4,5-Trichlorophenol	8270	10	µg/L
			2,4,6-Trichlorophenol	8270	10	µg/L
			2,4-Dichlorophenol	8270	10	µg/L
			2,4-Dimethylphenol	8270	10	µg/L
			2,4-Dinitrophenol	8270	50	µg/L
			2,4-Dinitrotoluene	8270	10	µg/L
			2,6-Dinitrotoluene	8270	10	µg/L

Table B-3
Groundwater Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(SVERDRUP 1994)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
SVERDRUP	1994	Groundwater - grab from boring	***SVOCs (continued)***			
			2-Chloronaphthalene	8270	10	µg/L
			2-Chlorophenol	8270	10	µg/L
			2-Methylnaphthalene	8270	10	µg/L
			2-Methylphenol	8270	25	µg/L
			2-Nitroaniline	8270	50	µg/L
			2-Nitrophenol	8270	10	µg/L
			m-Cresol	8270	10	µg/L
			3-Nitroaniline	8270	25	µg/L
			4,6-Dinitro-o-cresol	8270	25	µg/L
			4-Bromophenylphenylether	8270	10	µg/L
			4-Chloroaniline	8270	10	µg/L
			4-Chlorophenylphenylether	8270	10	µg/L
			4-Chloro-3-methylphenol	8270	10	µg/L
			4-Methylphenol	8270	10	µg/L
			4-Nitroaniline	8270	25	µg/L
			4-Nitrophenol	8270	10	µg/L
			Acenaphthene	8270	10	µg/L
			Acenaphthylene	8270	10	µg/L
			Anthracene	8270	10	µg/L
			Benzoic acid	8270	10	µg/L
			Benzo(a)anthracene	8270	10	µg/L
			Benzo(a)pyrene	8270	10	µg/L
			Benzo(b)fluoranthene	8270	10	µg/L
			Benzo(g,h,i)perylene	8270	10	µg/L
			Benzo(k)fluoranthene	8270	10	µg/L
			Benzyl alcohol	8270	10	µg/L
			bis(2-Chloroethoxy)methane	8270	10	µg/L
			bis(2-Chloroethyl)ether	8270	10	µg/L
			bis(2-Chloroisopropyl)ether	8270	10	µg/L
			bis(2-Ethylhexyl)phthalate	8270	10	µg/L
			Butylbenzylphthalate	8270	10	µg/L
			Chrysene	8270	10	µg/L
			Dibenzofuran	8270	10	µg/L
			Dibenzo(a,h)anthracene	8270	10	µg/L
			Diethylphthalate	8270	10	µg/L
			Dimethylphthalate	8270	10	µg/L
			Di-n-butylphthalate	8270	10	µg/L
			di-n-Octylphthalate	8270	10	µg/L
			Diphenylamine	8270	20	µg/L
			Fluorene	8270	10	µg/L
			Fluoranthene	8270	10	µg/L
			Hexachlorobenzene	8270	10	µg/L
			Hexachlorobutadiene	8270	10	µg/L
			Hexachlorocyclopentadiene	8270	10	µg/L
			Hexachloroethane	8270	10	µg/L
			Indeno(1,2,3-c,d)pyrene	8270	10	µg/L
			Isophorone	8270	10	µg/L
			Naphthalene	8270	10	µg/L
			Nitrobenzene	8270	10	µg/L
			n-Nitrosodi-n-propylamine	8270	10	µg/L
			n-Nitrosodiphenylamine	8270	10	µg/L
			Pentachlorophenol	8270	25	µg/L
			Phenanthrene	8270	10	µg/L
			Phenol	8270	10	µg/L
			Pyrene	8270	10	µg/L
			Explosives			
			1,3-DNB	8330	0.2	µg/L
			RDX	8330	0.6	µg/L
			1,3,5-TNB	8330	0.5	µg/L
			2,4,6-TNT	8330	0.7	µg/L

Table B-3
Groundwater Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(SVERDRUP 1994)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
SVERDRUP	1994	Groundwater - grab from boring	*Explosives (continued)*			
			2,4-DNT	8330	0.5	µg/L
			2,6-DNT	8330	0.5	µg/L
			HMX	8330	0.6	µg/L
			Nitrobenzene	8330	0.6	µg/L
			o-Nitrotoluene	8330	0.6	µg/L
			3-Nitrotoluene	8330	0.4	µg/L
			p-Nitrotoluene	8330	0.4	µg/L
			Tetryl	8330	0.4	µg/L
			2-Amino dinitrotoluene	8330	0.5	µg/L
			4-Amino-2,6- dinitrotoluene	8330	0.6	µg/L

Note(s):
µg/L - micrograms per liter
SVOC - semivolatile organic compound
VOC - volatile organic compound

Table 10-7b
Surface Water Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1993)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Surface Water	***Metals***			
			Arsenic	7060	0.01	mg/L
			Antimony	6010	0.005	mg/L
			Barium	6010	0.01	mg/L
			Cadmium	6010	0.005	mg/L
			Chromium	6010	0.05	mg/L
			Lead	7421	0.005	mg/L
			Mercury	7470/7471	0.001	mg/L
			Nickel	6010	0.05	mg/L
			Selenium	7740	0.05	mg/L
			Silver	6010	0.01	mg/L
			Thallium	7841	0.01	mg/L
			VOCs			
			1,1,1-Trichloroethane	8240	5	µg/L
			1,1,2,2-Tetrachloroethane	8240	5	µg/L
			1,1,2-Trichloroethane	8240	5	µg/L
			1,1-Dichloroethane	8240	5	µg/L
			1,1-Dichloroethene	8240	5	µg/L
			1,2-Dichloroethane	8240	5	µg/L
			1,2-Dichloroethene	8240	5	µg/L
			1,2-Dichloropropane	8240	5	µg/L
			2-Butanone	8240	50	µg/L
			2-Chloroethylvinylether	8240	10	µg/L
			2-Hexanone	8240	50	µg/L
			4-Methyl-2-pentanone	8240	50	µg/L
			Acetone	8240	100	µg/L
			Benzene	8240	5	µg/L
			Bromodichloromethane	8240	5	µg/L
			Bromoform	8240	5	µg/L
			Bromomethane	8240	10	µg/L
			Carbon disulfide	8240	5	µg/L
			Carbon tetrachloride	8240	5	µg/L
			Chlorobenzene	8240	5	µg/L
			Chloroethane	8240	10	µg/L
			Chloroform	8240	5	µg/L
			Chloromethane	8240	10	µg/L
			Chlorodibromomethane	8240	5	µg/L
			Ethylbenzene	8240	5	µg/L
			Methylene chloride	8240	5	µg/L
			Styrene	8240	5	µg/L
			Tetrachloroethene	8240	5	µg/L
			Toluene	8240	5	µg/L
			Trichloroethene	8240	5	µg/L
			Vinyl acetate	8240	50	µg/L
			Vinyl chloride	8240	10	µg/L
			Xylenes	8240	5	µg/L
			cis-1,3-Dichloropropene	8240	5	µg/L
			trans-1,3-Dichloropropene	8240	5	µg/L

Table 10-7b
Surface Water Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1993)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Surface Water	***SVOCs***			
			1,2,4-Trichlorobenzene	8270	10-12.5	µg/L
			1,2-Dichlorobenzene	8270	10-12.5	µg/L
			1,3-Dichlorobenzene	8270	10-12.5	µg/L
			1,4-Dichlorobenzene	8270	10-12.5	µg/L
			2,4,5-Trichlorophenol	8270	50-62.5	µg/L
			2,4,6-Trichlorophenol	8270	10-12.5	µg/L
			2,4-Dichlorophenol	8270	10-12.5	µg/L
			2,4-Dimethylphenol	8270	10-12.5	µg/L
			2,4-Dinitrophenol	8270	50-62.5	µg/L
			2,4-Dinitrotoluene	8270	10-12.5	µg/L
			2,6-Dinitrotoluene	8270	10-12.5	µg/L
			2-Chloronaphthalene	8270	10-12.5	µg/L
			2-Chlorophenol	8270	10-12.5	µg/L
			2-Methylnaphthalene	8270	10-12.5	µg/L
			2-Methylphenol	8270	10-12.5	µg/L
			2-Nitroaniline	8270	50-62.5	µg/L
			2-Nitrophenol	8270	10-12.5	µg/L
			3,3-Dichlorobenzidine	8270	20-25	µg/L
			3-Nitroaniline	8270	50-62.5	µg/L
			4-Bromophenylphenylether	8270	10-12.5	µg/L
			4-Chloro-3-methylphenol	8270	20-25	µg/L
			4-Chloroaniline	8270	20-25	µg/L
			4-Chlorophenylphenylether	8270	10-12.5	µg/L
			4-Methylphenol	8270	10-12.5	µg/L
			4-Nitroaniline	8270	50-62.5	µg/L
			4-Nitrophenol	8270	50-62.5	µg/L
			4,6-Dinitro-2-methylphenol	8270	50-62.5	µg/L
			Acenaphthene	8270	10-12.5	µg/L
			Acenaphthylene	8270	10-12.5	µg/L
			Anthracene	8270	10-12.5	µg/L
			Benzo(a)anthracene	8270	10-12.5	µg/L
			Benzo(a)pyrene	8270	10-12.5	µg/L
			Benzo(b)fluoranthene	8270	10-12.5	µg/L
			Benzo(g,h,i)perylene	8270	10-12.5	µg/L
			Benzo(k)fluoranthene	8270	10-12.5	µg/L
			Benzoic acid	8270	50-62.5	µg/L
			Benzyl alcohol	8270	20-25	µg/L
			Butylbenzylphthalate	8270	10-12.5	µg/L
			Chrysene	8270	10-12.5	µg/L
			Dibenzo(a,h)anthracene	8270	10-12.5	µg/L
			Dibenzofuran	8270	10-12.5	µg/L
			Di-n-butylphthalate	8270	10-12.5	µg/L
			Diethylphthalate	8270	10-12.5	µg/L
			Dimethylphthalate	8270	10-12.5	µg/L
			Fluoranthene	8270	10-12.5	µg/L
			Fluorene	8270	10-12.5	µg/L
			Hexachlorobenzene	8270	10-12.5	µg/L

Table 10-7b
Surface Water Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(1993)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
EBASCO	1993	Surface Water	***SVOCs (continued)***			
			Hexachlorobutadiene	8270	10-12.5	µg/L
			Hexachlorocyclopentadiene	8270	10-12.5	µg/L
			Hexachloroethane	8270	10-12.5	µg/L
			Indeno(1,2,3-c,d)pyrene	8270	10-12.5	µg/L
			Isophorone	8270	10-12.5	µg/L
			Naphthalene	8270	10-12.5	µg/L
			Nitrobenzene	8270	10-12.5	µg/L
			Pentachlorophenol	8270	50-62.5	µg/L
			Phenanthrene	8270	10-12.5	µg/L
			Phenol	8270	10-12.5	µg/L
			Pyrene	8270	10-12.5	µg/L
			bis(2-Chloroethoxy)methane	8270	10-12.5	µg/L
			bis(2-Chloroethyl)ether	8270	10-12.5	µg/L
			bis(2-Chloroisopropyl)ether	8270	10-12.5	µg/L
			bis(2-Ethylhexyl)phthalate	8270	10-12.5	µg/L
			di-n-Octylphthalate	8270	10-12.5	µg/L
			n-Nitrosodi-n-propylamine	8270	10-12.5	µg/L
			n-Nitrosodiphenylamine	8270	10-12.5	µg/L
			Explosives			
			HMX	8330	0.1	µg/L
			RDX	8330	0.1	µg/L
			1,3,5-TNB	8330	0.1	µg/L
			1,3-DNB	8330	0.1	µg/L
			Tetryl	8330	0.1	µg/L
			Nitrobenzene	8330	0.1	µg/L
			2,4,6-TNT	8330	0.1	µg/L
			2,6-DNT	8330	0.1	µg/L
			2,4-DNT	8330	0.1	µg/L
			2-Nitrotoluene	8330	0.1	µg/L
			4-Nitrotoluene	8330	0.1	µg/L
			3-Nitrotoluene	8330	0.1	µg/L
			Anions			
			Nitrate-Nitrite Nitrogen	353.3	0.01	
			Chloride	9052	1	
			Sulfate	9038	1	

Note(s):
µg/L - micrograms per liter
mg/L - milligrams per liter
SVOC - semivolatile organic compound
VOC - volatile organic compound

1.6.21 Site 54 (Ground Signal Test Area)

Groundwater samples were collected from all three monitoring wells at Site 54 during the April/May and August/September/October 2000, and the January/February 2001 sampling events. Groundwater samples were also collected from three Geoprobe® points installed during June 2001. The analytical results for the groundwater samples are presented in Table 1-32.

PERCHLORATE TCEQ GW-Ind 72 ug/L

Table 1-32 Summary of Groundwater Sample Results at Site 54

Sample Location	April/May 2000 Event (µg/L)	August/Oct 2000 Event (µg/L)	Jan-Feb 2001 Event (µg/L)	April/May 2001 Event (µg/L)
127	26.8	<4 U	<1.7 U	NS
128	20.4	<8 U	<1.7 U	NS
18WW16	22.7	<8 U	8	NS
GPSAS54-01	NS	NS	NS	<4 U
GPSAS54-02	NS	NS	NS	<40 U
GPSAS54-03	NS	NS	NS	<40 U

NO MCL

Bold values exceed 4 µg/L
< = Indicates the result was less than the corresponding reporting limit.
µg/L = micrograms per liter
NS = not sampled
U = not detected

1.6.22 Site 67

Groundwater samples were collected from all four monitoring wells at Site 67 during the December 2000 sampling event. Perchlorate was not detected in any of the groundwater samples at concentrations greater than the reporting limit of 3 µg/L.

Table 1-32b
Groundwater Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(2000/2001)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
STEP	2000/2001	Groundwater - wells	Perchlorate	HPLC/300.1	1.7 -8	µg/L
		Groundwater - grab	Perchlorate	HPLC/300.1	4 - 40	µg/L

Note(s):
µg/L - micrograms per liter

Table 2 (continued). Results of metals analysis in mg/kg dry weight for soil/sediment samples collected from 200 sites at Caddo Lake National Wildlife Refuge in 2003 (Note - dl is the analytical detection limit; and bdl is below the analytical detection limit).

Analyte	Site 221	Site 222	Site 223	Site 224	Site 225	Site 226	Site 227	Site 228	Site 229
Aluminum	2268.00	6978.00	4333.00	7927.00	6885.00	17,010.00	17,790.00	8673.00	3291.00
dl	10.20	10.70	10.70	10.70	10.20	10.30	10.40	10.00	10.70
Arsenic	0.80	5.30	1.29	1.11	1.00	5.22	3.14	1.91	1.82
dl	0.51	0.54	0.54	0.54	0.51	0.53	0.52	0.50	0.53
Barium	37.60	1526.00	75.70	105.00	174.00	228.00	219.00	177.00	134.00
dl	0.20	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.21
Beryllium	0.24	1.00	0.39	1.38	0.43	1.73	1.46	1.19	0.61
dl	0.20	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.21
Boron	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	2.03	2.14	2.14	2.14	2.05	2.11	2.08	2.01	2.14
Cadmium	bdl	bdl	bdl	bdl	bdl	bdl	0.29	bdl	bdl
dl	0.25	0.27	0.27	0.27	0.26	0.26	0.26	0.25	0.27
Chromium	5.98	11.20	6.92	9.38	12.80	19.00	18.70	11.50	11.60
dl	1.02	1.07	1.07	1.07	1.02	1.05	1.04	1.00	1.07
Copper	0.98	7.31	1.81	5.10	12.20	9.86	22.10	5.17	2.43
dl	0.51	0.54	0.54	0.54	0.51	0.53	0.52	0.50	0.53
Iron	2645.00	14,850.00	3074.00	6048.00	4540.00	24,320.00	13,320.00	11,180.00	7092.00
dl	10.20	10.70	10.70	10.70	10.20	10.30	10.40	10.00	10.70
Lead	9.29	9.22	7.83	18.10	78.70	30.50	30.40	17.70	12.60
dl	2.03	2.14	2.14	2.14	2.05	2.11	2.08	2.01	2.14
Magnesium	119.00	2303.00	256.00	655.00	543.00	967.00	964.00	712.00	266.00
dl	10.20	10.70	10.70	10.70	10.20	10.30	10.40	10.00	10.70
Manganese	151.00	193.00	394.00	238.00	135.00	2351.00	1089.00	2820.00	969.00
dl	1.02	1.07	1.07	1.07	1.02	1.05	1.04	1.00	1.07
Mercury	bdl	0.042	0.025	0.038	0.15	0.12	0.12	0.093	0.037
dl	0.021	0.022	0.020	0.023	0.021	0.023	0.028	0.024	0.023
Molybdenum	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	1.02	1.07	1.07	1.07	1.02	1.05	1.04	1.00	1.07
Nickel	2.30	6.99	4.55	12.10	7.06	17.10	18.00	14.40	6.35
dl	1.02	1.07	1.07	1.07	1.02	1.05	1.04	1.00	1.07
Selenium	bdl	bdl	bdl	bdl	bdl	bdl	0.60	bdl	bdl
dl	0.51	0.54	0.54	0.54	0.51	0.53	0.52	0.50	0.53
Silver	bdl	bdl	bdl	bdl	0.68	bdl	0.23	bdl	bdl
dl	0.18	0.19	0.19	0.19	0.18	0.19	0.19	0.18	0.19
Strontium	1.73	26.10	7.12	19.30	16.40	23.20	29.30	22.20	13.20
dl	0.51	0.54	0.54	0.54	0.51	0.53	0.52	0.50	0.53
Vanadium	7.74	11.00	11.70	15.30	14.40	30.80	29.30	21.60	16.60
dl	0.51	0.54	0.54	0.54	0.51	0.53	0.52	0.50	0.53
Zinc	16.10	37.60	9.69	18.40	22.10	130.00	161.00	33.40	19.70
dl	5.08	5.36	5.36	5.36	5.12	5.26	5.19	5.02	5.34

Table 2 (continued). Results of metals analysis in mg/kg dry weight for soil/sediment samples collected from 200 sites at Caddo Lake National Wildlife Refuge in 2003 (Note - dl is the analytical detection limit; and bdl is below the analytical detection limit).

Analyte	Site 95	Site 96	Site 97	Site 98	Site 99	Site 100	Site 101	Site 102	Site 103
Aluminum	4487.00	1471.00	2296.00	4604.00	2199.00	6923.00	1983.00	3486.00	5140.00
dl	10.20	10.40	10.10	10.30	10.80	10.30	10.10	10.20	10.10
Arsenic	0.79	1.23	1.38	2.97	1.35	2.38	2.06	2.03	2.47
dl	0.51	0.52	0.51	0.52	0.54	0.52	0.51	0.51	0.51
Barium	33.50	33.90	35.10	170.00	35.60	89.80	89.10	71.90	112.00
dl	1.02	1.04	1.01	1.03	1.08	1.05	1.01	1.02	1.01
Beryllium	bdl	0.35	bdl	0.77	0.28	0.77	0.42	0.63	0.68
dl	0.20	0.21	0.20	0.21	0.22	0.21	0.20	0.20	0.20
Boron	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	2.03	2.08	2.03	2.07	2.15	2.09	2.02	2.04	2.02
Cadmium	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	0.25	0.26	0.25	0.26	0.27	0.26	0.25	0.26	0.25
Chromium	2.49	7.37	7.73	14.90	8.02	20.20	14.90	14.60	13.20
dl	1.02	1.04	1.01	1.03	1.08	1.05	1.01	1.02	1.01
Copper	0.83	1.40	0.96	3.23	0.86	3.12	1.65	1.55	2.25
dl	0.51	0.52	0.51	0.52	0.54	0.52	0.51	0.51	0.51
Iron	4861.00	3543.00	4139.00	11,919.00	4139.00	10,467.00	7116.00	6109.00	9267.00
dl	10.20	10.40	10.10	10.30	10.80	10.30	10.10	10.20	10.10
Lead	6.40	7.95	7.00	12.30	7.18	13.30	9.64	10.70	10.40
dl	2.03	2.08	2.03	2.07	2.15	2.09	2.02	2.04	2.02
Magnesium	121.00	106.00	144.00	326.00	131.00	360.00	189.00	223.00	274.00
dl	10.20	10.40	10.10	10.30	10.80	10.30	10.10	10.20	10.10
Manganese	577.00	543.00	268.00	721.00	346.00	715.00	477.00	641.00	532.00
dl	1.02	1.04	1.01	1.03	1.08	1.05	1.01	1.02	1.01
Mercury	0.019	0.023	0.020	0.044	0.018	0.028	0.025	0.028	0.028
dl	0.019	0.016	0.015	0.019	0.018	0.014	0.019	0.017	0.014
Molybdenum	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	1.47
dl	1.02	1.04	1.01	1.03	1.08	1.05	1.01	1.02	1.01
Nickel	1.93	2.62	2.09	6.17	2.53	5.91	3.84	4.41	3.82
dl	1.02	1.04	1.01	1.03	1.08	1.05	1.01	1.02	1.01
Selenium	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	0.51	0.52	0.51	0.52	0.54	0.52	0.51	0.51	0.51
Silver	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
dl	0.18	0.19	0.18	0.19	0.19	0.19	0.18	0.18	0.18
Strontium	5.76	3.91	3.34	12.00	3.39	7.79	7.89	6.73	8.41
dl	0.51	0.52	0.51	0.52	0.54	0.52	0.51	0.51	0.51
Vanadium	4.50	8.08	11.70	20.30	9.31	21.40	13.30	14.70	21.50
dl	0.51	0.52	0.51	0.52	0.54	0.52	0.51	0.51	0.51
Zinc	bdl	6.92	6.16	25.30	5.59	12.50	8.47	8.91	13.20
dl	5.08	5.21	5.07	5.17	5.38	5.23	5.05	5.10	5.05

Table 2b
Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(2003)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil	***Metals***			
			Aluminum	Texas A & M University Method Codes 001, 004, 006	10.20-10.70	mg/kg
			Arsenic	Texas A & M University Method Codes 001, 004, 007	0.51 - 0.54	mg/kg
			Barium	Texas A & M University Method Codes 001, 004, 006	0.21 - 1.02	mg/kg
			Beryllium	Texas A & M University Method Codes 001, 004, 006	0.20 - 0.21	mg/kg
			Boron	Texas A & M University Method Codes 001, 004, 006	2.03 - 2.14	mg/kg
			Cadmium	Texas A & M University Method Codes 001, 004, 006	0.25 - 0.27	mg/kg
			Chromium	Texas A & M University Method Codes 001, 004, 006	1.02 - 1.07	mg/kg
			Copper	Texas A & M University Method Codes 001, 004, 006	0.51 - 0.54	mg/kg
			Iron	Texas A & M University Method Codes 001, 004, 006	10.20-10.70	mg/kg
			Lead	Texas A & M University Method Codes 001, 004, 006	2.03 - 2.14	mg/kg
			Magnesium	Texas A & M University Method Codes 001, 004, 006	10.20 - 10.70	mg/kg
			Manganese	Texas A & M University Method Codes 001, 004, 006	1.02 - 1.07	mg/kg
			Mercury	Texas A & M University Method Codes 001, 004, 008	0.019 - 0.20	mg/kg
			Molybdenum	Texas A & M University Method Codes 001, 004, 006	1.02 - 1.07	mg/kg
			Nickel	Texas A & M University Method Codes 001, 004, 006	1.02 - 1.07	mg/kg
			Selenium	Texas A & M University Method Codes 001, 004, 007	0.51 - 0.54	mg/kg
			Silver	Texas A & M University Method Codes 001, 004, 039	0.18 - 0.19	mg/kg
			Strontium	Texas A & M University Method Codes 001, 004, 006	0.51 - 0.54	mg/kg
			Vanadium	Texas A & M University Method Codes 001, 004, 006	0.51 - 0.54	mg/kg
			Zinc	Texas A & M University Method Codes 001, 004, 006	5.08 - 5.36	mg/kg
			SVOCs			
			1,2,4-Trichlorobenzene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			1,2-Dichlorobenzene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			1,3-Dichlorobenzene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			1,4-Dichlorobenzene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg

Table 2b
Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(2003)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil	*SVOCs (continued)*			
			1-Chloronaphthalene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			1-Naphthylamine	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2,3,4,6-Tetrachlorophenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2,4,5-Trichlorophenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2,4,6-Trichlorophenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2,4-Dichlorophenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2,4-Dimethylphenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2,4-Dinitrophenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2,4-Dinitrotoluene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2,6-Dichlorophenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2,6-Dinitrotoluene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2-Chloronaphthalene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2-Chlorophenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2-Methylphenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2-Naphthylamine	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2-Nitroaniline	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2-Nitrophenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2-Picoline	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			2-Methylnaphthalene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			3,3-Dichlorobenzidine	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			3-Methylcholanthrene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			3-Nitroaniline	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			4,6-Dinitro-2-methylphenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			4-Aminobiphenyl	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			4-Bromophenylphenylether	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			4-Chloro-3-methylphenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg

Table 2b
Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(2003)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil	*SVOCs (continued)*			
			4-Chloroaniline	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			4-Chlorophenylphenylether	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			4-Methylphenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			4-Nitroaniline	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			4-Nitrophenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			7,12-dimethylbenz(a)anthracene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Acentophenone	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Aniline	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Benzidine	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Benzo(a)anthracene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Benzoic acid	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Benzyl alcohol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			bis(2-Chloroethoxy)methane	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			bis(2-Chloroethyl)ether	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			bis(2-Ethylhexyl)phthalate	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			bis(2-Chloroisopropyl)ether	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Butylbenzylphthalate	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Carbazole	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Di-n-butylphthalate	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Di-n-Octylphthalate	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Dibenzo(a,h)anthracene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Diben(a,j)acridine	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Dibenzofuran	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Diethylphthalate	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Dimethylphthalate	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg

Table 2b
Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(2003)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil	*SVOCs (continued)*			
			Diphenylamine	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Ethyl methanesulfonate	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Hexachlorobutadiene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Hexachlorocyclopentadiene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Hexachloroethane	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Isophorone	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Methyl methanesulfonate	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			N-nitroso-di-n-propylamine	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			N-nitrosopiperidine	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Nitrobenzene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Pentachlorobenzene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Pentachloronitrobenzene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Pentachlorophenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Phenacetin	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Phenol	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Pronamide	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			A,a-dimethylphenylamine	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Acenaphthalene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Acenaphthene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Anthracene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Benzo(a)pyrene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Benzo(b)fluoranthene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Benzo(g,h,i)perylene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Benzo(k)fluoranthene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Chrysene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Fluoranthene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg

Table 2b
Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(2003)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil	***SVOCs (continued)***			
			Fluorene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Indeno(1,2,3-c,d)pyrene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			n-Nitrosodiphenylamine	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Naphthalene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			p-Dimethylaminoazobenzene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Phenanthrene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Pyrene	Texas A & M University Method Code 031	0.0348-0.0374	mg/kg
			Pesticides/PCBs			
			1,2,3,4-tetrachlorobenzene	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			1,2,4,5-tetrachlorobenzene	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Aldrin	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Hexachlorobenzene	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Heptachlor	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Alpha BHC	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Alpha chlordane	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Beta BHC	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			cis-nonachlor	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			delta-BHC	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Dieldrin	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Endosulfan II	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Endrin	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			gamma-BHC	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			gamma chlordane	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Heptachlor epoxide	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Mirex	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg

Table 2b
Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(2003)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USFWS	2003	Soil	***Pesticides/PCBs (continued)***			
			o,p-DDD	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			o,p-DDE	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			o,p-DDT	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			oxychlordane	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			p,p-DDD	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			p,p-DDE	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			p,p-DDT	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Pentachloro-anisole	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Toxaphene	Texas A & M University Method Code 004	0.00171 - 0.00187	mg/kg
			Trans-nonachlor	Texas A & M University Method Code 004	0.000343 - 0.000373	mg/kg
			Total PCBs	Texas A & M University Method Code 004	0.00171 - 0.00187	mg/kg
			Perchlorate	EPA Method 314.0 Modified	8	µg/kg

Note(s):
µg/kg - micrograms per kilogram
EPA - U.S. Environmental Protection Agency
mg/kg - micrograms per kilogram
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
USFWS - U.S. Fish and Wildlife Service

Table 5A-1. Chemicals Detected in Soils[1]
Site XX Addendum, Longhorn Army Ammunition Plant

Chemical	Frequency of Detection[2]	Sample Quantitation Limits	Range of Detected Concentrations	Background Range[3]
Metals (mg/Kg)				
Arsenic	3/3	--	4.33-73.8	2.3-29.7
Barium	3/3	--	88.1-904	35.1-287
Cadmium	3/3	--	3.63-6.95	1.25
Chromium	3/3	--	12.3-28.9J	3.2-22.8
Lead	3/3	--	9-24.0	2.6-17.4
Nickel	3/3	--	10.6-43.0	1.5-6.3
Aluminum	3/3	--	2,690-8,050	1,270-20,700
Calcium	3/3	--	250-621	124-1,090
Cobalt	1/3	2.65-2.79	3.21	1.5-19.1
Copper	3/3	--	3.19-6.21	0.88-6.7
Iron	3/3	--	3,570-13,500	2,450-31,000
Potassium	3/3	--	142-484	133-481
Magnesium	3/3	--	162-826	68.4-474
Manganese	3/3	--	37.8-567	10.9-2,330
Strontium	1/3	13.6-13.9	18.9	2.3-13.3
Vanadium	3/3	--	10.8-24.3	NA[4]
Zinc	3/3	--	6.85-17.6	3.4-16.2

[1] 0 to 6-inch depth.
[2] Includes quality control duplicate sample.
[3] Range of detected concentrations in surface (0-0.5 feet) soils from Final Soil Background Concentration Report, Longhorn Army Ammunition Plant, (USACE 1995b).
[4] Not available.

Table 3
Soil Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(CAPE 2006)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
CAPE	2006	Soil	MC (explosives), WP	SW-846 Method 7580	0.519 - 0.535	µg/kg

Note(s):
µg/kg - micrograms per kilogram
MC - munitions constituents
WP - white phosphorus

Table B - 1
USEPA Region 6 Confirmation Sampling
Groundwater Analytical Results Summary
Ground Signal Test Area, LHAAP-003-R
October 2009

				Location Code	18WW-01-07	18WW-16-08	MW-127-09	MW-128-10
				Sample No.	GW-18WW-01-07	GW-18WW-16-08	GW-127-09	GW-128-10
				Sample Date	24-Oct-09	24-Oct-09	24-Oct-09	24-Oct-09
Parameter	Units	MCL	TCEQ GW-Ind		Result	Result	Result	Result
Metals								
Aluminum	mg/L		102.2		0.0116 J	0.273	0.151	0.00151 J
Antimony	mg/L	0.006			<0.001	0.000440 J	<0.001	<0.001
Arsenic	mg/L	0.01			0.001	0.00392	0.00238	0.00609
Barium	mg/L	2			0.588	0.134	0.02	0.0308
Beryllium	mg/L	0.004			0.0000150 J	0.0001 J	0.0000620 J	0.0000760 J
Cadmium	mg/L	0.005			0.000498 J	0.00253	0.0000870 J	0.0000170 J
Calcium	mg/L				10.3 J	176	158	116
Chromium	mg/L	0.1			0.0584	6.62	0.000962 J	0.0029
Cobalt	mg/L		6.132		0.00197	0.0208	0.0315	0.00205
Copper	mg/L	1.3			0.00339 B	0.106B	0.00220B	0.00105 B
Iron	mg/L				3.49 B	21.8 B	18 B	1.590 B
Lead	mg/L	0.015			0.000763 J	0.000360 J	0.000308 J	0.0000420 J
Magnesium	mg/L				5.41 J	120	95.7	73.5
Manganese	mg/L		14.3		0.15	0.252	1.88	1.41
Nickel	mg/L		2.044		0.306	1.27	0.0294	0.00809
Potassium	mg/L				2.33 J	3.93 J	3.75 J	5.04 J
Selenium	mg/L	0.05			0.000658 J	0.0147	0.00269	0.00275
Silver			0.511		0.00004 J, B	0.000235 J, B	<0.001	<0.001
Sodium	mg/L				205	556	397	704
Thallium	mg/L	0.002			<0.001	0.0000360 J	0.0000830 J	<0.001
Vanadium	mg/L		0.715		<0.001	<0.001	0.000864 J,B	0.00172 B
Zinc	mg/L		30.66		0.0703 B	0.0466 B	0.0286 B	0.00333 J,B
Perchlorate	µg/L		72		<1.0	4.6 B*, G	<5.0 G	<5.0 G

Table B - 1
USEPA Region 6 Confirmation Sampling
Groundwater Analytical Results Summary
Ground Signal Test Area, LHAAP-003-R
October 2009

			Location Code	18WW-01-07	18WW-16-08	MW-127-09	MW-128-10
			Sample No.	GW-18WW-01-07	GW-18WW-16-08	GW-127-09	GW-128-10
			Sample Date	24-Oct-09	24-Oct-09	24-Oct-09	24-Oct-09
Parameter	Units	MCL	TCEQ GW-Ind	Result	Result	Result	Result
Explosives							
HMX	µg/L		5110	<0.40	<0.40	<0.40	<0.40
RDX	µg/L		26	<0.20	<0.20	<0.20	<0.20
1,3,5-TNB	µg/L		3066	<1.0	<1.0	<1.0	<1.0
1,3-DNB	µg/L		10.22	<0.40	<0.40	<0.40	<0.40
Tetryl	µg/L		1022	<0.20	<0.20	<0.20	<0.20
Nitrobenzene	µg/L		51.1	<0.40	<0.40	<0.40	<0.40
2,4,6-TNT	µg/L		51.1	<0.40	<0.40	<0.40	<0.40
4-ADNT	µg/L		17.03	<0.20	<0.20	<0.20	<0.20
2-ADNT	µg/L		17.03	<0.20	<0.20	0.22 COL	0.30
2,6-DNT	µg/L		0.42	<0.20	<0.20	<0.20	<0.20
2,4-DNT	µg/L		0.42	<0.40	<0.40	<0.40	<0.40
2-Nitrotoluene	µg/L		1022	<0.40	<0.40	<0.40	<0.40
4-Nitrotoluene	µg/L		1022	<1.0	<1.0	<1.0	<1.0
3-Nitrotoluene	µg/L		1022	<0.40	<0.40	<0.40	0.24 J, COL

Notes and Abbreviations:

Bolded and shaded - level above the MCL or TCEQ GW-Ind value

B - analyte was detected in the associated method blank

B* - estimated results; result is less than the reporting limit of 5 µg/L

COL - more than 40% RPD between primary and confirmation detector results; the lower of the two results is reported

G - elevated reporting limit; the reporting limit is elevated due to matrix interference

GW-Ind - groundwater MSC for industrial use

J - estimated results detected above the method detection limit but below the reporting limit

MCL - maximum contaminant level

mg/L - milligrams per liter

ug/L - micrograms per liter

Q - elevated reporting limit; the reporting limit is elevated due to high analyte levels

Table B-1b
Groundwater Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(USEPA 2009)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
USEPA	October 2009	Groundwater - wells	***Metals***	6020		
			Aluminum	6020	50	µg/L
			Antimony	6020	1	µg/L
			Arsenic	6020	1	µg/L
			Barium	6020	1	µg/L
			Beryllium	6020	1	µg/L
			Cadmium	6020	1	µg/L
			Calcium	6020	20000 - 40000	µg/L
			Chromium	6020	1	µg/L
			Cobalt	6020	1	µg/L
			Copper	6020	1	µg/L
			Iron	6020	50	µg/L
			Lead	6020	1	µg/L
			Magnesium	6020	20000 - 40000	µg/L
			Manganese	6020	100	µg/L
			Nickel	6020	1	µg/L
			Potassium	6020	20000 - 40000	µg/L
			Selenium	6020	1	µg/L
			Sodium	6020	20000 - 40000	µg/L
			Thallium	6020	1	µg/L
			Vanadium	6020	1	µg/L
			Zinc	6020	10	µg/L
			Explosives			
			HMX	8330	0.4	µg/L
			RDX	8330	0.2	µg/L
			1,3,5-TNB	8330	1	µg/L
			1,3-DNB	8330	0.4	µg/L
			Tetryl	8330	0.2	µg/L
			Nitrobenzene	8330	0.4	µg/L
			2,4,6-TNT	8330	0.4	µg/L
			4-ADNT	8330	0.2	µg/L
			2-ADNT	8330	0.2	µg/L
			2,6-DNT	8330	0.2	µg/L
			2,4-DNT	8330	0.4	µg/L
			2-Nitrotoluene	8330	0.4	µg/L
			4-Nitrotoluene	8330	1	µg/L
			3-Nitrotoluene	8330	0.4	µg/L
			Perchlorate	EPA Method	5	µg/L

Note(s):
µg/L - micrograms per liter
USEPA - U.S. Environmental Protection Agency

Table B - 2
U.S. Army Confirmation Split Sampling
Groundwater Analytical Results Summary
Ground Signal Test Area, LHAAP-003-R
October 2009

			Location Code	18WW-01-07		18WW-16-08		MW-127-09		MW-128-10	
			Sample No.	GW-18WW-01-07-091024		GW-18WW-16-08-091024		GW-127-09-091024		GW-128-10-091024	
			Sample Date	24-Oct-09		24-Oct-09		24-Oct-09		24-Oct-09	
Parameter	Units	MCL	TCEQ GW-Ind	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Metals											
Aluminum	mg/L		102.2	0.0155	J B	2.04		0.194	J	0.00942	J B
Antimony	mg/L	0.006		0.0005	U	0.00335	J	0.0005	U	0.0005	U
Arsenic	mg/L	0.01		0.0009	U	0.019		0.00193	J	0.00304	J
Barium	mg/L	2		0.647		0.189		0.0242		0.0355	
Beryllium	mg/L	0.004		0.0003	U	0.000818	J	0.0003	U	0.0003	U
Cadmium	mg/L	0.005		0.0006	U	0.003986		0.0006	U	0.0006	U
Calcium	mg/L			9.86		169		149		123	
Chromium	mg/L	0.1		0.054		31.7		0.00166	J	0.00283	J B
Cobalt	mg/L		6.132	0.00202	J	0.043		0.0343		0.00105	J
Copper	mg/L	1.3		0.00234	J	1.06		0.00155	J	0.00136	J
Iron	mg/L			3.23		136		19.2		1.17	
Lead	mg/L	0.015		0.000702	J	0.00385	J	0.00058	J	0.000533	J
Magnesium	mg/L			5.7		114		98.6		75.2	
Manganese	mg/L		14.3	0.171		0.548		2.02		1.62	
Nickel	mg/L		2.044	0.338		1.89		0.0345		0.0058	
Potassium	mg/L			2.28		4.37		3.35		4.66	
Selenium	mg/L	0.05		0.0025	U	0.019		0.0025	U	0.0025	U
Silver				0.0007	U	0.0007	U	0.0007	U	0.0007	U
Sodium	mg/L			222		427		441		638	
Thallium	mg/L	0.002		0.0008	U	0.0012	J	0.0008	U	0.0008	U
Zinc	mg/L		30.66	0.0339		0.28		0.0344		0.00622	J B

Table B - 2
U.S. Army Confirmation Split Sampling
Groundwater Analytical Results Summary
Ground Signal Test Area, LHAAP-003-R
October 2009

			Location Code	18WW-01-07		18WW-16-08		MW-127-09		MW-128-10	
			Sample No.	GW-18WW-01-07-091024		GW-18WW-16-08-091024		GW-127-09-091024		GW-128-10-091024	
			Sample Date	24-Oct-09		24-Oct-09		24-Oct-09		24-Oct-09	
Parameter	Units	MCL	TCEQ GW-Ind	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Explosives											
1,3,5-Trinitrobenzene	µg/L		3066	0.12	U	0.1	U	0.22	U	0.12	U
1,3-Dinitrobenzene	µg/L		10.22	0.12	U	0.1	U	0.22	U	0.12	U
2,4,6-Trinitrotoluene	µg/L		51.1	0.12	U	0.1	U	0.22	U	0.12	U
2,4-Dinitrotoluene	µg/L		0.42	0.12	U	0.1	U	0.22	U	0.12	U
2,6-Dinitrotoluene	µg/L		0.42	0.12	U	0.1	U	0.22	U	0.12	U
2-Amino-4,6-dinitrotoluene	µg/L		17.03	0.12	U	0.1	U	0.22	U	0.12	U
2-Nitrotoluene	µg/L		1022	0.12	U	0.1	U	0.22	U	0.12	U
3-Nitrotoluene	µg/L		1022	0.12	U	0.1	U	0.22	U	0.12	U
4-Amino-2,6-dinitrotoluene	µg/L		17.03	0.12	U	0.1	U	0.22	U	0.12	U
4-Nitrotoluene	µg/L		1022	0.12	U	0.1	U	0.22	U	0.12	U
HMX	µg/L		5110	0.12	U	0.1	U	0.22	U	0.12	U
Nitrobenzene	µg/L		51.1	0.12	U	0.1	U	0.22	U	0.12	U
RDX	µg/L		26	0.12	U	0.1	U	0.22	U	0.12	U
Tetryl	µg/L		1022	0.12	U	0.1	U	0.22	U	0.12	U
Perchlorate	µg/L		72	0.062	U	5.4		0.062	U	0.062	U

Notes and Abbreviations:

Bolded and shaded - level above the MCL or TCEQ GW-Ind value

B - analyte was detected in associated method blank

GW-Ind - groundwater MSC for industrial use

J - estimated results detected above the method detection limit but below the reporting limit

MCL - maximum contaminant level

mg/L - milligrams per liter

ug/L - micrograms per liter

U - Not detected. The method detection limit is provided.

Table B-2b
Groundwater Analytical Methods and Detection Limits
Ground Signal Test Area, LHAAP-003-R
(2009)

Investigated By	Date	Medium Investigated	Analytical Parameters	Analytical Method	Detection Limits	Units
U.S. ARMY	October 2009	Groundwater - wells	***Metals***			
			Aluminum	6020	0.01 - 0.2	mg/L
			Antimony	6020	0.005	mg/L
			Arsenic	6020	0.005	mg/L
			Barium	6020	0.005	mg/L
			Beryllium	6020	0.002	mg/L
			Cadmium	6020	0.002	mg/L
			Calcium	6020	0.5	mg/L
			Chromium	6020	0.005 - 0.5	mg/L
			Cobalt	6020	0.005	mg/L
			Copper	6020	0.005	mg/L
			Iron	6020	0.2	mg/L
			Lead	6020	0.005	mg/L
			Magnesium	6020	0.2	mg/L
			Manganese	6020	0.005 - 0.25	mg/L
			Nickel	6020	0.005 - 0.1	mg/L
			Potassium	6020	0.2	mg/L
			Selenium	6020	0.005	mg/L
			Silver	6020	0.005	mg/L
			Sodium	6020	0.2 - 20	mg/L
			Thallium	6020	0.002	mg/L
			Zinc	6020	0.005	mg/L
			Explosives			
			HMX	8330	0.000330 - 0.000924	mg/L
			RDX	8330	0.000330 - 0.000924	mg/L
			1,3,5-TNB	8330	0.000330 - 0.000924	mg/L
			1,3-DNB	8330	0.000330 - 0.000924	mg/L
			Tetryl	8330	0.000330 - 0.000924	mg/L
			Nitrobenzene	8330	0.000330 - 0.000924	mg/L
			2,4,6-TNT	8330	0.000330 - 0.000924	mg/L
			4-ADNT	8330	0.000330 - 0.000924	mg/L
			2-ADNT	8330	0.000330 - 0.000924	mg/L
			2,6-DNT	8330	0.000330 - 0.000924	mg/L
			2,4-DNT	8330	0.000330 - 0.000924	mg/L
			2-Nitrotoluene	8330	0.000330 - 0.000924	mg/L
			4-Nitrotoluene	8330	0.000330 - 0.000924	mg/L
			3-Nitrotoluene	8330	0.000330 - 0.000924	mg/L
			Perchlorate	EPA Method 314.0	0.2	µg/L

Note(s):

µg/L - micrograms per liter

mg/L - milligrams per liter