

LONGHORN ARMY AMMUNITION PLANT KARNACK, TEXAS

ADMINISTRATIVE RECORD

Volume 19 of 19

2010

Bate Stamp Numbers

00098591 – 00099011

Prepared for

**Department of the Army
Longhorn Army Ammunition Plant**

1976 – 2010

***LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
ADMINISTRATIVE RECORD – CHRONOLOGICAL INDEX***

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2010

- A. Title: Letter - Concurrence to Record of Decision for LHAAP-50, Former Sump Water Tank, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas
 Author(s): TCEQ
 Recipient: USACE
 Date: October 4, 2010
 Bate Stamp: 00098591 – 00098591
- B. Title: Letter - Concurrence to Record of Decision for LHAAP-46, Plant 2 Area, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas
 Author(s): TCEQ
 Recipient: USACE
 Date: October 4, 2010
 Bate Stamp: 00098952 – 00098952
- C. Title: Letter - Concurrence to Record of Decision for LHAAP-35A(58), Shop Area, Group 4; Longhorn Army Ammunition Plant, Karnack, Texas
 Author(s): TCEQ
 Recipient: USACE
 Date: October 4, 2010
 Bate Stamp: 00098593 – 00098593
- D. Title: Meeting Minutes – Longhorn AAP Monthly Managers Meeting
 Author(s): Shaw Environmental, Inc., Houston, Texas
 Recipient: All Stakeholders
 Date: October 19, 2010
 Bate Stamp: 00098594 – 00098603
- E. Title: Meeting Minutes – LHAAP Restoration Advisory Board (RAB) Meeting
 Author(s): Shaw Environmental, Inc., Houston, Texas
 Recipient: All Stakeholders
 Date: October 19, 2010
 Bate Stamp: 00098604 – 00098629

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- F. Title: Public Meeting – Transcript for October 19, 2010 Public Meeting for LHAAP-16 Proposed Plan, Old Landfill, Longhorn Army Ammunition Plant, Karnack, Texas
Author(s): U.S. Army
Recipient: Public
Date: October 19, 2010
Bate Stamp: 00098630 – 00098700
- G. Title: Report – Final Record of Decision LHAAP-35A(58) Shops Area, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas
Author(s): Shaw Environmental, Inc., Houston, Texas
Recipient: Public
Date: October 25, 2010
Bate Stamp: 00098701 – 00098797
- H. Title: Report – Final Record of Decision LHAAP-46, Plant 2 Area, Group 4 Longhorn Army Ammunition Plant, Karnack, Texas
Author(s): Shaw Environmental, Inc., Houston, Texas
Recipient: Public
Date: October 25, 2010
Bate Stamp: 00098798 – 00098888
- I. Title: Report – Final Record of Decision LHAAP-50, Former Sump Water Tank, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas
Author(s): Shaw Environmental, Inc., Houston, Texas
Recipient: Public
Date: October 25, 2010
Bate Stamp: 00098889 – 00098008
- J. Title: Public Meeting – Proof of Publication from The Times, Shreveport, LA., for Final Records of Decision for Several Sites, November 1, 2010, Longhorn Army Ammunition Plant, Karnack, Texas
Author(s): Shaw Environmental, Inc., Houston, Texas
Recipient: Public
Date: October 31, 2010
Bate Stamp: 00098977 – 00098978

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KARNACK, TEXAS
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- K. Title: Public Meeting – Proof of Publication from Marshall News Messenger, Marshall, TX., for Final Records of Decision for Several Sites, November 3, 2010, Longhorn Army Ammunition Plant, Karnack, Texas
 Author(s): Shaw Environmental, Inc., Houston, Texas
 Recipient: Public
 Date: October 31, 2010
 Bate Stamp: 00098979 – 00098980
- L. Title: Meeting Minutes – Longhorn AAP Monthly Managers Meeting
 Author(s): Shaw Environmental, Inc., Houston, Texas
 Recipient: All Stakeholders
 Date: November 9, 2010
 Bate Stamp: 00098981 – 00098987
- M. Title: Letter – Concurrence to Decision Document for LHAAP-35A(58), Sumps, Longhorn Army Ammunition Plant, Karnack, Texas
 Author(s): TCEQ
 Recipient: USACE
 Date: December 15, 2010
 Bate Stamp: 00098988 – 00098988
- N. Title: Report – Final Decision Document for LHAAP-35/36 Sumps, Longhorn Army Ammunition Plant, Karnack, Texas
 Author(s): Shaw Environmental, Inc., Houston, Texas
 Recipient: All Stakeholders
 Date: December 21, 2010
 Bate Stamp: 00098989 – 00099011

Bryan W. Shaw, Ph.D., *Chairman*
Buddy Garcia, *Commissioner*
Carlos Rubinstein, *Commissioner*
Mark R. Vickery, P.G., *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

October 4, 2010

Mr. Thomas E. Lederle, Industrial Branch Chief
Assistant Chief of Staff for Installation Management
ATTN: DAIM-BD (Tom Lederle)
600 Army Pentagon
Washington, D.C. 20310-0600

Re: Record of Decision for LHAAP-50, Former Sump Water Tank, Group 4
Longhorn Army Ammunition Plant Superfund Site TX6213820529
Karnack, Harrison County, Texas

Dear Mr. Lederle:

The Texas Commission on Environmental Quality (TCEQ) received the final Record of Decision (ROD) for the LHAAP-50, Former Sump Water Tank, Group 4, at the Longhorn Army Ammunition Plant Superfund Site in Karnack, Texas on September 23, 2010. The TCEQ has completed the review of the above referenced document and concurs that the response action described in the ROD is the most appropriate remedy for LHAAP-50.

Sincerely,

A handwritten signature in blue ink, appearing to read "Mark R. Vickery", with a large, stylized flourish extending from the end.

Mark R. Vickery, P.G.
Executive Director

MV/FD/

cc: Mr. Sam Coleman, P.E., Director, Superfund Division, US Environmental
Protection Agency, Region 6

Bryan W. Shaw, Ph.D., *Chairman*
Buddy Garcia, *Commissioner*
Carlos Rubinstein, *Commissioner*
Mark R. Vickery, P.G., *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

October 4, 2010

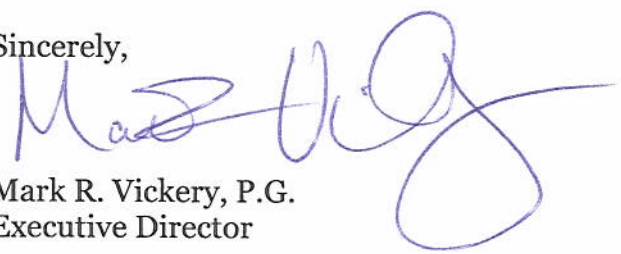
Mr. Thomas E. Lederle, Industrial Branch Chief
Assistant Chief of Staff for Installation Management
ATTN: DAIM-BD (Tom Lederle)
600 Army Pentagon
Washington, D.C. 20310-0600

Re: Record of Decision for LHAAP-46, Plant 2 Area, Group 4
Longhorn Army Ammunition Plant Superfund Site TX6213820529
Karnack, Harrison County, Texas

Dear Mr. Lederle:

The Texas Commission on Environmental Quality (TCEQ) received the final Record of Decision (ROD) for the LHAAP-46, Plant 2 Area, Group 4, at the Longhorn Army Ammunition Plant Superfund Site in Karnack, Texas on September 23, 2010. The TCEQ has completed the review of the above referenced document and concurs that the response action described in the ROD is the most appropriate remedy for LHAAP-46.

Sincerely,


Mark R. Vickery, P.G.
Executive Director

MV/FD/

cc: Mr. Sam Coleman, P.E., Director, Superfund Division, US Environmental Protection Agency, Region 6

Bryan W. Shaw, Ph.D., *Chairman*
Buddy Garcia, *Commissioner*
Carlos Rubinstein, *Commissioner*
Mark R. Vickery, P.G., *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

October 4, 2010

Mr. Thomas E. Lederle, Industrial Branch Chief
Assistant Chief of Staff for Installation Management
ATTN: DAIM-BD (Tom Lederle)
600 Army Pentagon
Washington, D.C. 20310-0600

Re: Record of Decision for LHAAP-35A(58), Shop Area, Group 4
Longhorn Army Ammunition Plant Superfund Site TX6213820529
Karnack, Harrison County, Texas

Dear Mr. Lederle:

The Texas Commission on Environmental Quality (TCEQ) received the final Record of Decision (ROD) for the LHAAP-35A(58), Shop Area, Group 4, at the Longhorn Army Ammunition Plant Superfund Site in Karnack, Texas on September 27, 2010. The TCEQ has completed the review of the above referenced document and concurs that the response action described in the ROD is the most appropriate remedy for LHAAP-35A(58).

Sincerely,

A handwritten signature in blue ink, appearing to read "Mark R. Vickery".

Mark R. Vickery, P.G.
Executive Director

MV/FD/

cc: Mr. Sam Coleman, P.E., Director, Superfund Division, US Environmental
Protection Agency, Region 6

LONGHORN ARMY AMMUNITION PLANT,**Karnack, Texas****MONTHLY MANAGERS' MEETING****AGENDA**

DATE: Tuesday, 19 October 2010
TIME: 1:00 p.m.
PLACE: Army Trailer, Longhorn or call in courtesy of Shaw: 866-797-9304/4155734

Welcome**RMZ****Action Items****Army**

- Provide update on document status for LHAAP-65.

Shaw

- Provide results for LHAAP-04 groundwater when available - completed

Defense Environmental Restoration Program (DERP) PBC Update**PS/SGW**

- Document Status/Environmental Sites (Table)
- Proposed Plans - Status
- Records of Decision - Status
- INF Pond liner repair - Status
- Groundwater Treatment Plant
- Marshall Public Library Administrative Record Switch to Electronic Status

DERP Total Environmental Restoration Contract Update**RMZ**

- LHAAP-37/67 – Status of RD
- Remaining TERC Recordations

MMRP Update**RMZ**

- Address EPA-TCEQ Responses to Perchlorate Memo
-

Other Issues**RMZ**

- Sump at Site 53
- Sitewide Schedule Review – Critical Documents
- IAP website to be provided
- Media Tour
- RAB Tour of GWTP and Sitewide

USFWS Update**RMZ/PB**

- Receipt of Documents for Review
- OPS and Proposed Remedies

Adjourn



Subject: **Final Minutes, Monthly Managers Meeting,
Longhorn Army Ammunition Plant (LHAAP)**

Location of Meeting: **Longhorn Army Ammunition Plant Trailer**

Date of Meeting: **October 19, 2010; 2:00 PM – 4:00 PM**

Meeting Participants:

BRAC:	Rose M. Zeiler
USACE-Tulsa:	Aaron Williams (phone), John Lambert (phone)
Shaw:	Praveen Srivastav, Susan Watson, Kay Everett
USEPA Region 6:	Steve Tzhone
TCEQ:	Fay Duke
USGS:	Kent Becher
USFWS:	Paul Bruckwicki, Barry Forsythe

Welcome

Rose M. Zeiler

Action Item Status:

Army

- Provide update on document status for LHAAP-65.--The evaluation report is currently in Army review.

Shaw

- Provide results for LHAAP-04 groundwater when available-completed.--The re-sample of the new well within the source areas was completed and results are expected in a week. The survey of the new wells is currently being conducted. Water levels have also been collected.

Defense Environmental Restoration Program (DERP) PBC Update

Praveen Srivastav

Document Status/Environmental Sites

Praveen Srivastav went over the document status/environmental sites table.

- LHAAP-02: TCEQ concurrence letter was received and the Final Decision Document was submitted. The existing well is dry. A new well will be installed and groundwater samples will be collected and analyzed for metals.
- LHAAP-03: Army comments were addressed and the document revised. The document is expected to go out to the TCEQ next week.
- LHAAP-04: The Draft Final Completion Report is in regulatory review. Steve indicated that the EPA had one comment. Additional explanation on sidewall sampling during the excavation was discussed. Susan Watson explained that when groundwater was encountered in the bottom of the excavation, they stopped digging deeper, and collected sidewall samples just above the groundwater. If the sample came back hot, they excavated more from that

sidewall. The excavation protocol was based on concentrations. They would step out, dig out, and resample until the samples came back clean. An example of this occurrence is on the south side the excavation. Kent Becher had a question about sampling technique and Susan explained that they did the soil removal in a “step-like” fashion. Fay Duke said that the completion report should clarify that if groundwater was encountered what was the next step. She stated that it should be explained in detail in the report. Steve Tzhone further asked and received clarification from Shaw that if groundwater was encountered then no further excavation occurred in that direction. Fay asked that manifests be scanned and included on a CD with the report. Praveen said that the path forward for LHAAP-04 is that a groundwater sample was collected last Thursday and those results were anticipated within a couple of weeks. Rose indicated that the schedule will be very tight to get to the ROD stage on schedule for FY 2011. LHAAP-18/24 and LHAAP-47 also run a risk of not meeting their schedules. Rose said that we can continue to collect data at these sites or stop and move forward. The FS has not been started on LHAAP-04 as Shaw is waiting on data to consider alternatives. Praveen said that the sampling data would be available to present to stakeholders next week. The site is now on an expedited path. Although it was suggested to break the site into two operable units (groundwater and soil) so that the FY11 schedule could be met for a soil ROD, Steve said he would prefer to keep them together; Rose agreed. Steve said that EPA is under new management and has a new federal facilities director that they will have to bring that under consideration – moving the LHAAP-04 ROD into FY12. He will go back and talk with them and see what their goals are. Steve said if the new director has the same momentum, then these sites will be pushed aggressively. There are currently 7 RODs slated for FY 2011 – moving LHAAP-04 out to FY12 would reduce that to 6.

- LHAAP-16: The public meeting for this site will be held tonight. The Draft ROD will be presented to Army before the comment period is over (before November 9, 2010).
- LHAAP-17: Rose indicated that the ROD is in review with BRAC legal.
- LHAAP-18/24: The RTCs for regulatory comments are in Army’s review.
- LHAAP-29: Army comments to the preliminary Draft Proposed Plan for LHAAP-29 is in progress.
- LHAAP-46: The RODs for 46, 50, and 58 are waiting on signature pages. The RODs were signed 9/30/10. Steve mentioned that the signature page for LHAAP-58 was not an original page and that they were tracking a FedEx package containing the original signature page. They would forward whenever they retrieved the necessary document. The preliminary Draft Remedial Design is in Army review.
- LHAAP-47: The feasibility study at LHAAP-47 can be sent out to Army this week and probably finalized in December. Shaw has spent a couple of months gathering data to support the FS revisions, and weekly teleconferences have been ongoing to present the data. Kent questioned the holding times of the samples and why there were high detection limits from some of the samples collected recently at LHAAP-47. Praveen said that the issue was that the lab diluted the sample because of turbidity and the protection of their equipment. It was emphasized that the sampling results reported were preliminary and not final. The samples were reanalyzed, meeting all holding times, with a lower detection limit. Praveen said he would have the specifics sent to Kent after engaging the Shaw project chemist.
- LHAAP-49: The Final ROD was submitted in September.
- LHAAP-50: The Draft RD is expected to go out at the end of this month.
- LHAAP-58: The Draft RD is expected to go out at the end of this month.
- LHAAP-35/36: The Final Decision Document is expected out by the end of the month.
- Pistol Range: The Final ROD was submitted in September.

Proposed Plans – Status

Various proposed plans are in different stages. See the above site discussions.

Records of Decision – Status

This was addressed above. Three RODs have been signed but have not been issued awaiting signature pages. Two other RODs were signed and submitted in September.

INF Pond Liner Repair – Status

Liner breaks and repair issues were discussed. The stakeholders will meet in the morning at 8:30AM to look at the liner.

Groundwater Treatment Plant

The plant is running normally and treating water 4 days a week. Shaw performed some maintenance work on the CatOx unit. There has been no release to the creek because of the dry conditions and the INF pond is filling up. Notification should be made when there is 2 feet of freeboard left. Then notification should be made at every ½ foot increase until it gets to 1-foot freeboard. It was asked if water from the creek can be pumped out onto the ground. Fay said that it can only be in an amount that doesn't create a surface water sheet flow. The discussion included the ability to sprinkle the water from the pond to other areas. Fay said that the sprinkling activity should not cause any ponding as well. Army indicated that they did not want it sprinkled on areas other than the original site it was pumped from, i.e. LHAAP-18/24 or LHAAP-16. Fay asked if any samples were collected from the pond. Shaw replied that usually the pond is not sampled because as the effluent is sampled before being discharged to the pond, unless there is an exceedance. Kent had some questions about the quarterly report and the injection system wells. Paul Bruckwicki indicated that he was not getting any treatment plant quarterly reports. He will begin receiving quarterly reports. It was also asked whether they are included in the Administrative Record. Groundwater treatment plant operations reports have never been included in the Administrative Record since they were not under the criteria of what is to be included in an administrative record. They are not "decision" based documents.

Marshall Public Library Administrative Record Switch to Electronic Status

The transfer of the hardcopies of the Administrative Record from the Marshall Public Library was discussed. FWS indicated an interest in taking the volumes.

Master Groundwater Sampling Schedule

Steve indicated that he would like to see a master sampling summary schedule. He said that everyone should agree on the structure and he understood that only LHAAP-12 is the only one in a true RD phase. He would like to see this schedule by December or preferably in November. It was asked how far in the schedule did the summary schedule show. Steve said that a 2-year look ahead should be sufficient. Fay mentioned she had not seen any data on LHAAP-12. The document is in Army review. Shaw will prepare and provide a template for the master schedule for performance and LTM sampling to the team.

DERP Total Environmental Restoration Contract Update*LHAAP-37/67 –Status of RD*

The RD is in Rose's review and should be available to regulators within the next couple of weeks.

Remaining TERC Recordations

Army received approval on the deed recordations and will need to file the documents at the courthouse.

MMRP Update

Address EPA- TCEQ Responses to Perchlorate Memo

The Army is currently working on this.

Other Issues

Sump at Site 53

The sump is near building 23T and is known as Sump 800 or 124. It is being addressed due to safety concerns and not an environmental issue.

Site-wide Schedule Review – Critical Documents

This document is routinely updated and presented to the RAB each time. Steve would like to have the submittal dates or end dates. John suggested that another column be added to the table to enable this data to be incorporated easily.

IAP Website to Be Provided

The IAP website link will be sent out shortly

Media Tour

Rose said that Army had received a request via email to conduct a media tour of the treatment plant and areas of Longhorn under current remedial activities. At her level, she does not have the authority to give permission for a tour for the media. The request is being processed through the Army's Office of Public Affairs – Community Outreach in Los Angeles. Mr. Ken Hawes is the point of contact and his office will determine whether media will be granted permission to film at Longhorn.

RAB Tour of GWTP and Sitewide

Rose suggested that the RAB may be interested in another tour of Longhorn, since we have more RAB members. She thought that sometime in January may be good.

Rose indicated that in tonight's RAB meeting that a new RAB charter will be drafted and that they needed a 2/3 majority vote for the new charter to be approved.

Paul indicated that road near the fire station still needed some repair. This was near the area of the excavation at LHAAP-04 conducted last year.

OPS and Proposed Remedies

Paul Bruckwicki and Steve Tzhone both stated their positions/concerns relative to this topic. [NOTE: A recommendation made by Paul and Steve subsequent to the meeting is that the intent of this section, *OPS and Proposed Remedies*, should be to document the identification of any USFWS issues that may potentially affect environmental restoration activities.]

Action Items

Shaw

- Include USFWS in the distribution of GWTP quarterly reports
- Provide further information on reanalysis of perchlorate samples from LHAAP-47 that had high detection limits of 12.5 µg/L.

- Prepare and provide a template for the master schedule for performance and LTM sampling

Meeting Adjourned

Next meeting is set for November 9, 2010 at 2 p.m. as a teleconference.

Location	Longhorn Army Ammunition Plant		
Date	19-Oct-2010	Time	2:00 PM

[illegible]



**Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
October 19, 2010**

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	Remarks
1	Final Decision Document, signed LHAAP-02	09/30/10	x	x						Submitted	
2	Draft Soil Removal Work Plan, LHAAP-03	7/15/10	x		Draft Final	10/30/10	x	x		Army comments received. RTC in preparation	
3	Draft Final Completion Report, LHAAP-04	05/24/10	x	x	Final	10/15/10	x	x		In regulatory review.	
4	Final Proposed Plan, LHAAP-16	09/14/10	x	x						Submitted	Public meeting scheduled for 10/19/10
5	Final Proposed Plan, LHAAP-17	5/21/10	x	x						Final submitted May 21, 2010	
6	Preliminary Draft Record of Decision, LHAAP-17	9/17/10	x		Draft	10/30/10				In Army's review	
7	Draft (Final) Feasibility Study, LHAAP-18/24	5/13/09	x	x	Draft Final	11/30/10	x	x		Received EPA and TCEQ comments on 8/5/10. Responses in progress	
8	(Preliminary) Draft Proposed Plan, LHAAP-29	5/21/10	x		Draft Proposed Plan	10/30/10	x	x	In progress	Received Army comments; RTC resolution in progress	



**Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
October 19, 2010**

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	Remarks
9	Final Record of Decision, LHAAP-46	09/30/10	x	x							
10	Draft Remedial Design, LHAAP-46	10/1/10	x							In Army review	
11	Draft (Final) Focused Feasibility Study, LHAAP-47	04/15/10	x	x	Revised Draft to Army	10/22/10	x		In progress	Field investigations completed. FS revisions in progress	
12	Final Record of Decision, LHAAP-49	9/23/10	x	x						Submitted	
13	Final Record of Decision, LHAAP-50	09/30/10	x	x							
14	Draft Remedial Design, LHAAP-50	10/30/10	x							In preparation	
15	Final Record of Decision, LHAAP-58	09/30/10	x	x							
16	Draft Remedial Design, LHAAP-58	10/30/10	x							In preparation	
17	Draft Final Decision Document, LHAAP-35/36	05/6/10	x	x	Final	10/30/10	x	x	In progress	Submitted proposed changes for TCEQ review	



**Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
October 19, 2010**

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	Remarks
18	Final Record of Decision, Pistol Range	9/23/10	x	x							



LONGHORN ARMY AMMUNITION PLANT
RESTORATION ADVISORY BOARD
Karnack, Texas
(479) 635-0110

October 11, 2010

Distribution (one copy each)

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LONGHORN ARMY AMMUNITION PLANT
RESTORATION ADVISORY BOARD
Karnack, Texas
(479) 635-0110

Dear LHAAP RAB Member,

The next Restoration Advisory Board (RAB) meeting will be held on Tuesday, October 19, 2010, from 5:30 to 6:45 p.m. at the Group Recreation Hall, Caddo Lake State Park, 245 Park Road #2, Karnack, Texas 75661. Following the RAB, there will be a Public Meeting for site LHAAP-16, a former landfill. We hope that you can attend both meetings. If you have any questions, please do not hesitate to contact me.

Shaw Environmental, Inc. (Shaw) is the contractor supporting the U.S. Army environmental restoration activities at the Longhorn Army Ammunition Plant (LHAAP), and will be coordinating the RAB meeting. A tentative agenda for the meeting is attached.

Regards,

Dr. Rose Zeiler
Department of the Army
Longhorn Army Ammunition Plant
Box 220
Ratcliff, Arkansas 72951



LONGHORN ARMY AMMUNITION PLANT
 RESTORATION ADVISORY BOARD
 Karnack, Texas
 (479) 635-0110

AGENDA

DATE: Tuesday, October 19, 2010
TIME: 5:30 – 6:45 PM
PLACE: Group Recreation Hall, Caddo Lake State Park, Karnack, Texas

- 05:30** Welcome {RMZ & PF}
- 05:35** Open items {RMZ}
 New Members
 Charter Revision
 Election of Co-Chair
 Perimeter Wells Sampling Results
- 05:55** Defense Environmental Restoration Program (DERP) Performance Based
 Contract (PBC) Update {Shaw}
 - Documents Status/ Environmental Sites
 - Groundwater Treatment Plant (GWTP) Update
 - LHAAP-04, LHAAP-17, LHAAP-47, and LHAAP-50 Field Work
 - Perimeter Well/Surface Water Sampling Update
 - Fact Sheet Site LHAAP-16
- 06:15** DERP Total Environmental Restoration Contract Update {RMZ}
 - LHAAP-35B(37) and LHAAP-67 RD
- 06:20** Military Munitions Response Program (MMRP) On-Hold {USACE}
- 06:25** Other Environmental Restoration Issues/Concerns {RMZ}
 - Construction Debris Landfill
 2011 IAP Web Address
- 06:30** ECOP VI
- 06:35** **LHAAP Environmental Restoration History (PB)**
- 06:45** Adjourn {RMZ}



Subject: Draft Final Minutes, Quarterly Restoration Advisory Board (RAB) Meeting, Longhorn Army Ammunition Plant (LHAAP)

Location of Meeting: Caddo Lake State Park – Group Recreation Hall, Karnack, Texas

Date of Meeting: October 19, 2010, 5:30 – 06:30 PM

Meeting Participants:

LHAAP/BRAC Rose M. Zeiler

Shaw Environmental: Praveen Srivastav, Kay Everett, Susan Watson

TCEQ: Fay Duke

USEPA Region 6: Steve Tzhone, Barry Forsythe

USFWS: Mark Williams

USGS: Kent Becher

RAB: **Present:** Paul Fortune, Ken Burkhalter, Robert Cargill, Charles Dixon, Lee Guice, Judith Johnson, Richard LeTourneau, Nigel Shivers, Judy Vandeventer, Tom Walker, E.V. Wilson, Carol Fortune
Absent: Ted Kurz, Jim Lambright, and Pickens Winters

Community: Jeff Thompson, George Rice, Dawn Orsak

An agenda for the RAB meeting was distributed prior to the meeting.

Welcome – Rose Zeiler and Paul Fortune

The meeting was called to order.

Open Items – Rose Zeiler

New Members

RAB members in attendance were introduced. Those in attendance were Paul Fortune, Ken Burkhalter, Robert Cargill, Charles Dixon, Lee Guice, Judith Johnson, Richard LeTourneau,

Nigel Shivers, Judy Vandeventer, Tom Walker, and E.V. Wilson. RAB members absent from the meeting are Ted Kurz, Jim Lambright, and Pickens Winters.

Charter Revision

Paul fortune asked that we allow more time for review of the charter instead of voting for approval at the meeting. It was granted. The differences of a public meeting and RAB meeting were discussed; and, when asked prior to the beginning of tonight's RAB meeting, some of the RAB members indicated they were in favor of breaking between the two meetings and possibly having them on separate nights.

RAB members also expressed interested in having more historical information on the sites under consideration for actions. Steve said that a history of the site and how the contamination got there would be helpful in assisting new RAB members get up to date quickly.

Election of Co-Chair

It was noted that election of the RAB Community Co-Chair was overdue. With the new members now seated, the election will take place soon.

Perimeter Wells Sampling Results

Sampling results were provided as handouts. More information will be provided later in the meeting.

Defense Environmental Restoration Program (DERP) Performance Based Contract (PBC) Update–Shaw

Document Status/Environmental Sites

Praveen Srivastav distributed copies of the document status table and discussed each site.

- Praveen indicated that the LHAAP-02 is a no further action site and that there is no soil contamination; however, groundwater would be monitored. The final decision document has been issued after receiving state concurrence. Praveen explained that the site is a former parking lot within LHAAP-58, and soil samples were collected in the ditches surrounding the parking lot for metals.
- A soil removal work plan for LHAAP-03 is in Army review. Praveen indicated that LHAAP-03 was a former waste storage pad for a drum of waste paint. It is also located within LHAAP-58.
- The Draft Final Completion Report for LHAAP-04 is in regulatory review. This site is across from the Fire Station and was a former wastewater treatment area. Rose said that excavation activities for removal of contaminated perchlorate soil were going on during the Refuge opening last fall. Groundwater concerns are still being addressed, and two more groundwater monitoring wells were installed at this site.
- The Final Proposed Plan for LHAAP-16 was submitted in September. Hard copies and electronic copies of the Proposed Plan and FS are available. The Public Meeting for LHAAP-16 will be held tonight after the RAB meeting has concluded.
- Public comments to the Proposed Plan for LHAAP-17 are being addressed and will be submitted soon. The draft Record of Decision is in preparation. LHAAP-17 was a burning ground where waste materials were taken and burned. There is contamination in the soil and groundwater.

- Regulatory comments have been received on the Draft Final FS for LHAAP-18/24. Comment responses are in preparation. Historical operations indicated that wastes were brought here for disposal from other areas of the installation. An interim remedy to keep water from migrating was implemented at this site: the current extraction system and groundwater treatment plant.
- The FS has been finalized for LHAAP-29. This site was the TNT manufacturing area which consisted of 5 to 6 production lines. Additional Army comments have been received on the Draft Proposed Plan for LHAAP-29 and addressed. The preliminary Draft Proposed Plan is in Army review.
- The Final ROD for LHAAP-46 was signed on September 23 and 30, 2010 and submitted on October 25, 2010.
- The draft Remedial Design (RD) for LHAAP-46, Plant 2 Area, is in Army review.
- The Draft Final FS for LHAAP-47 is being revised. As required by regulators, field investigations were recently completed and new data will be incorporated into the FS.
- The Final ROD for LHAAP-49 was signed on August 23 and September 7, 2010 and submitted on September 23, 2010. LHAAP-49 was used as an acid storage facility. It is the site where the huge concrete saddles remain, which is where the storage tanks used to be.
- The Final ROD for LHAAP-50 was signed on September 23 and 30, 2010 and submitted on October 25, 2010. LHAAP-50 was a wastewater storage facility. Contamination is in the soil and groundwater. The draft RD is in preparation.
- The Final ROD for LHAAP-58 was signed on September 29 and 30, 2010 and submitted October 25, 2010. LHAAP-58 was the maintenance complex for the installation.
- Proposed changes were submitted to TCEQ for their review of the Draft Final Decision Document for LHAAP-35/36. This site contains several sumps across LHAAP.
- The Final ROD for the Pistol Range was signed on August 18 and September 7, 2010 and submitted September 23, 2010.

Groundwater Treatment Plant (GWTP) Update

The GWTP has been operating normally since the last update. Some maintenance on the plant has been occurring.

Some questions were asked about how the treatment plant worked. Basically groundwater is extracted from monitoring wells and the water is treated. The treated water is then discharged into the creek, reinjected, or discharged to the INF pond. A process diagram was presented to better illustrate the process. Discharge into the creek is determined on the amount of flow in the creek. Discharging unto the INF pond is a last resort measure. Treated water has been diverted to the INF pond lately because there has been no flow in the creek. Treated water is sampled on a regular basis and is analyzed for chemicals of concern.

LHAAP-04, LHAAP-17, LHAAP-47, and LHAAP-50 Field Work

These sites were discussed during the document status presentation and the schedule is as shown on the handout. Field work at LHAAP-47 and LHAAP-04 has been completed. Soil samples collected at LHAAP-17 and 50 has been completed. Paul Fortune asked how many wells are located at the site across from the Fire Station and what the contaminant was. There

are four directly across from the Fire Station, two of which were recently installed, and the contaminant is perchlorate.

Perimeter Well/Surface Water Sampling Update

Sampling results for the perimeter background wells samples were available by hand out. Praveen briefly discussed the results. Creek samples are usually collected every quarter; however, due to the extremely dry conditions this quarter, no samples were collected since the creeks were dry.

Fact Sheet Site LHAAP-16

Some discussion regarding contamination at the landfill ensued. A question was posed regarding the possibility of groundwater rising up into the landfill underneath that would compromise the groundwater. Historically, some borings were installed before the cap was placed. It was asked if the landfill had a liner. It is suspected there is no bottom liner based on the age of the landfill and operating practices for landfills for that time period. Some questions on tetrachloroethene (TCE) were discussed. Rose indicated that TCE is a difficult contaminant to remediate based on its physical and chemical properties. Some natural attenuation is occurring at the site because daughter products can be observed in some samples.

DERP Total Environmental Restoration Contract (TERC) Update – Rose Zeiler LHAAP-35B(37) and LHAAP-67

The Remedial Design for sites LHAAP-37 and -67 is in preparation.

Military Munitions Response Program (MMRP) Update – USACE

No ROD is available yet and the issuance of the ROD for the MMRP sites has been pushed out to another year because of other schedules. LUCs are currently in affect and signs are posted.

Other Environmental Restoration Issues/Concerns

Construction Debris Landfill

This is a 7-acre landfill, also known as Site 19, and contains transite, concrete, building demolition debris, etc. It was capped and has undergone an investigation for releases to the environment. The investigation determined there was no environmental release from site 19. The landfill cap has been inspected, approved, and restoration of native grasses is being established. The closure report has been finalized. It is not an NPL site.

2011 IAP Web Address

This website address will be provided when it becomes available. The public will be able to download the IAP or print it.

ECOP VI

Nothing new was discussed.

LHAAP Environmental Restoration History

Rose indicated that a tour of the land still under Army jurisdiction was conducted last year and she offered to conduct the tour again, since we have new RAB members. She is considering having it in December or January.

Dawn Orsak introduced herself and explained that Caddo Lake Institute (CLI), of which she is the administrator, was granted a TAG (technical assistance grant) from the EPA. With this TAG, CLI has retained the services of a technical specialist to review documents and interpret reports on their behalf. Dawn also mentioned that CLI is designing a website and asked what the community would like to see on it. They expect to put links to documents and other valuable information on it.

Paul Fortune asked about the mercury sampling at LHAAP-49 and he mentioned the brief history about the sampling itself. Kent Becher with the USGS and Barry Forsythe sampled the area on September 14, 2010 and sent the samples in for analysis. They expect the results in about a month.

The next RAB meeting is scheduled for January 25, 2011 at 6:30 p.m. Some expressed interested in meeting at the former location at the Karnack Community Center

Adjourn

October Meeting Attachments and Handouts:

- *Status of Technical Documents PBC*
- *Meeting Agenda*
- *Fact Sheet for LHAAP-16*
- *Perimeter Well/Surface Water (Creek) sample location maps and tables*



Shaw Environmental, Inc.

Longhorn Army Ammunition Plant Restoration Advisory Board Meeting



Location	Caddo Lake State Park--Group Recreation Hall		
Date	19-Oct-2010	5:30 PM	page 1 of __

Please sign in the space provided or add your name and address on next page if your name does not appear below.

ATTENDEES

Name (printed)	Signature	Organization	Phone	E-mail
RAB Members				
Paul Fortune	<i>Paul Fortune</i>	RAB Co-Chair		plfortune@hotmail.com
Ken Burkhalter	<i>Ken Burkhalter</i>	RAB Board Member	318-268-3409	kburkhalter@shreve.net
Robert Cargill	<i>Robert Cargill</i>	RAB Board Member	903-237-8845	robertcargill@gmail.com
Charles Dixon	<i>Charles Dixon</i>	RAB Board Member	978-9737	crdixon1@charter.net
Carol Fortune		RAB Board Member		cafortune@hotmail.com
Lee Guice	<i>Lee Guice</i>	RAB Board Member		guiceengr@aol.com
Judith Johnson	<i>Judith Johnson</i>	RAB Board Member		judithjohnson@webtv.net
Ted Kurz		RAB Board Member		tk7108@gmail.com
Jim Lambright		RAB Board Member		lakepair@yahoo.com
Richard LeTourneau	<i>Richard LeTourneau</i>	RAB Board Member	903-668-1043	richardoi@aol.com
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E. V. Wilson	<i>E. V. Wilson</i>	RAB Board Member		evw1@valornet.com
Pickens Winters		RAB Board Member		NA
Longhorn Team Members and Community				
Rose M. Zeiler	<i>Rose M. Zeiler</i>	Longhorn AAP	(479) 635-0110	rose.zeiler@us.army.mil
Andrew Maly		USAEC	(210) 428-9131	adnrew.maly@us.army.mil
Aaron Williams		USACE, Tulsa	(918) 669-4915	aaron.k.williams@usace.army.mil
John Lambert		USACE, Tulsa	(918) 669-4992	john.r.lambert@SWT03.usace.army.mil
Steve Tzhone	<i>Steve Tzhone</i>	USEPA, Dallas	(214) 665-8409	tzhone.stephen@epa.gov
Raji Josiam		USEPA, Dallas	(214) 665-8529	josiam.raji@epa.gov
Fay Duke	<i>Fay Duke</i>	TCEQ, Austin	(512) 239-2443	fduke@tceq.state.tx.us
Dale Vodak		TCEQ	(903) 535-5147	dvodak@tceq.state.tx.us
Paul Bruckwicki		USFSW	(903) 679-4536	paul_bruckwicki@fws.gov
Barry Forsythe	<i>Barry Forsythe</i>	USFSW	(214) 665-8467	forsythe.barry@epa.gov
Mark Williams	<i>Mark Williams</i>	USFSW	(903) 679-9144	mark_williams@fws.gov
Praveen Srivastav	<i>Praveen Srivastav</i>	SHAW	(281) 531-3188	praveen.srivastav@shawgrp.com
Kay Everett	<i>Kay Everett</i>	SHAW	(281) 531-3121	kay.everett@shawgrp.com
Susan Watson	<i>Susan Watson</i>	SHAW	(281) 531-3107	susan.watson@shawgrp.com
Kent Behr	<i>Kent Behr</i>	USGS	(817) 253-0356	kdbehr@usgs.gov

Longhorn Army Ammunition Plant Restoration Advisory Board Meeting

[illegible]



**Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
October 19, 2010**

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	Remarks
1	Final Decision Document, signed LHAAP-02	09/30/10	x	x						Submitted	
2	Draft Soil Removal Work Plan, LHAAP-03	7/15/10	x		Draft Final	10/30/10	x	x		Army comments received. RTC in preparation	
3	Draft Final Completion Report, LHAAP-04	05/24/10	x	x	Final	10/15/10	x	x		In regulatory review.	
4	Final Proposed Plan, LHAAP-16	09/14/10	x	x						Submitted	Public meeting scheduled for 10/19/10
5	Final Proposed Plan, LHAAP-17	5/21/10	x	x						Final submitted May 21, 2010	
6	Preliminary Draft Record of Decision, LHAAP-17	9/17/10	x		Draft	10/30/10				In Army's review	
7	Draft (Final) Feasibility Study, LHAAP-18/24	5/13/09	x	x	Draft Final	11/30/10	x	x		Received EPA and TCEQ comments on 8/5/10. Responses in progress	
8	(Preliminary) Draft Proposed Plan, LHAAP-29	5/21/10	x		Draft Proposed Plan	10/30/10	x	x	In progress	Received Army comments; RTC resolution in progress	



**Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
October 19, 2010**

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	Remarks
9	Final Record of Decision, LHAAP-46	09/30/10	x	x							
10	Draft Remedial Design, LHAAP-46	10/1/10	x							In Army review	
11	Draft (Final) Focused Feasibility Study, LHAAP-47	04/15/10	x	x	Revised Draft to Army	10/22/10	x		In progress	Field investigations completed. FS revisions in progress	
12	Final Record of Decision, LHAAP-49	9/23/10	x	x						Submitted	
13	Final Record of Decision, LHAAP-50	09/30/10	x	x							
14	Draft Remedial Design, LHAAP-50	10/30/10	x							In preparation	
15	Final Record of Decision, LHAAP-58	09/30/10	x	x							
16	Draft Remedial Design, LHAAP-58	10/30/10	x							In preparation	
17	Draft Final Decision Document, LHAAP-35/36	05/6/10	x	x	Final	10/30/10	x	x	In progress	Submitted proposed changes for TCEQ review	



**Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
October 19, 2010**

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	Remarks
18	Final Record of Decision, Pistol Range	9/23/10	x	x							

LHAAP-16 Old Landfill

PROPOSED REMEDY: Cap Maintenance, Land Use Controls, In Situ Enhanced Bioremediation, Passive Biobarriers, and Monitored Natural Attenuation

Site History

LHAAP-16 is a capped landfill located in the south-central portion of the Longhorn Army Ammunition Plant (LHAAP). The site encompasses approximately 20 acres, of which approximately 13 acres are covered by the landfill cap. The landfill was established in 1940s and was used for disposal of solid and industrial wastes until the 1980s when disposal activities were terminated. The Army and the USEPA signed a Record of Decision (ROD) in 1995 approving an interim remedial action which included the construction of a multilayer landfill cap that was completed in 1998. In 1996 and 1997, a groundwater extraction system was installed by the Army to prevent the groundwater plume from migrating to Harrison Bayou.

Site Characteristics

Harrison Bayou runs along the northeastern edge of LHAAP-16. Much of the site is relatively flat, though land becomes steeper near Harrison Bayou. Surface drainage from LHAAP-16 flows mostly through small gullies and ditches to Harrison Bayou which discharges into Caddo Lake to the northeast of the site. The subsurface at the site is composed of medium plastic sandy silt, fine sands, and clay. The clay layers tend to separate the groundwater into shallow, intermediate, upper deep, and deep zones. The groundwater flow direction is northeast toward Harrison Bayou in the shallow, intermediate and deep zones, while flow direction is southeast toward Harrison Bayou in the upper deep groundwater zone. Groundwater flow between the landfill and Harrison Bayou is also influenced by the presence of an extraction well system.



Human Health Risk Assessment

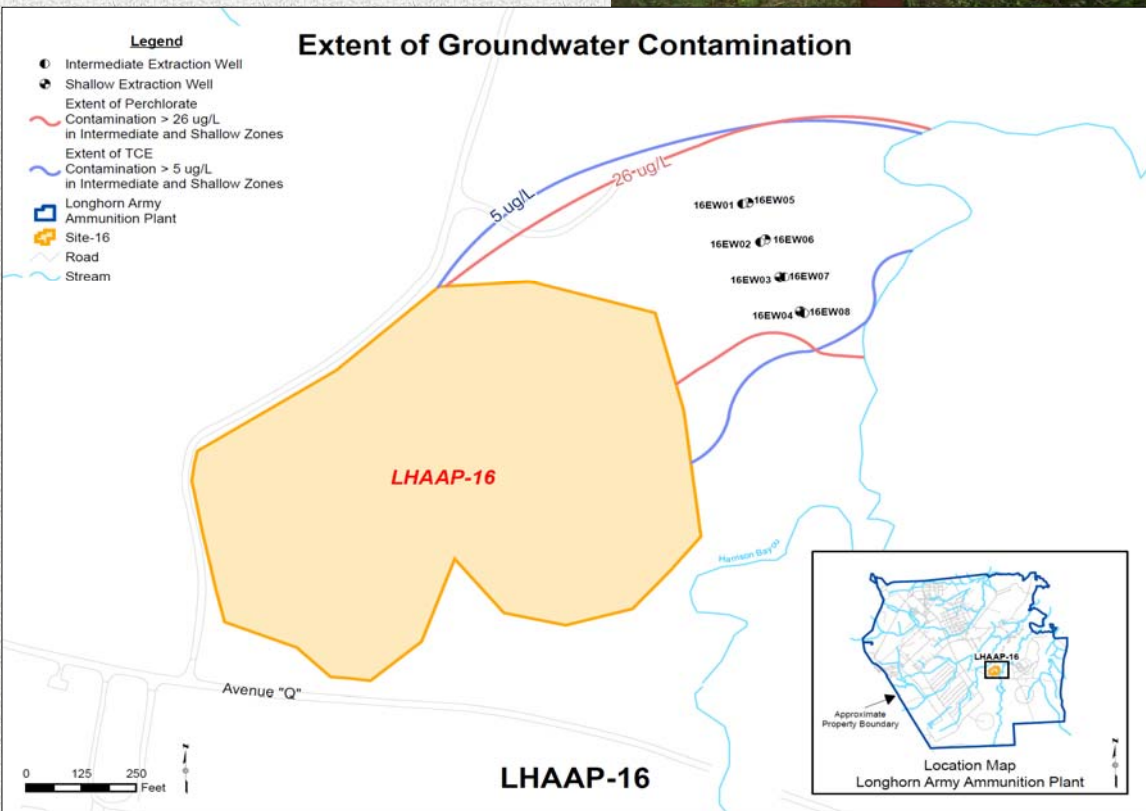
The Baseline Human Health Risk Assessment (BHHRA) was conducted for LHAAP-16 to determine current and future effects of contaminants on human health. The exposure pathways evaluated for the hypothetical future maintenance worker were based on exposure to the site environmental media (soil, groundwater, Harrison Bayou surface water and sediment) under an industrial scenario. Based on the BHHRA, it was concluded that groundwater posed an unacceptable cancer risk and non-cancer hazard to the hypothetical future maintenance worker.

Ecological Risk Assessment

The Baseline Ecological Risk Assessment (BERA) was conducted for LHAAP-16 to evaluate potential hazards to ecological resources. It was determined that no action was needed at LHAAP-16 to protect ecological resources.

Chemicals of Concern

The BHHRA identified chemicals of concern (COCs) in groundwater that may require remediation. The COCs were trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride (VC) and perchlorate in the shallow and intermediate groundwater. The upper deep groundwater zone and the deep zone show no groundwater contamination.



Remedial Action Objectives

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

- Protection of human health and the environment by preventing exposure to landfill contents.
- Protection of human health and environment by reducing leaching and migration of landfill hazardous substances into the groundwater.
- Protection of human health by preventing human exposure to groundwater contaminated with COCs.
- Protection of human health and the environment by preventing groundwater contaminated with COCs from migrating into nearby surface water.
- Return groundwater in the shallow and intermediate zones to its potential beneficial use as drinking water, wherever practicable, within a reasonable time period given the particular site circumstances.

Remedial Alternatives

- Alternative 1: Maintenance of existing landfill cap and no further action for landfill waste and groundwater- Estimated cost \$630,000
- Alternative 2: Maintenance of existing landfill cap, enhanced groundwater extraction and land use controls (LUCs)- Estimated cost \$9,820,000
- Alternative 3a: Maintenance of existing landfill cap, monitored natural attenuation (MNA) of groundwater and LUCs- Estimated cost \$2,710,000
- Alternative 3b: Maintenance of existing landfill cap, extraction of highly contaminated groundwater, MNA and LUCs- Estimated cost \$3,430,000
- Alternative 4: Maintenance of existing landfill cap, passive groundwater treatment and LUCs- Estimated cost \$4,560,000
- Alternative 5a: Removal of highly contaminated landfill waste, passive groundwater treatment, off-site disposal and LUCs- Estimated cost \$13,070,000
- Alternative 5b: Complete landfill removal, passive groundwater treatment, off-site disposal and LUCs- Estimated cost \$115,610,000
- Alternative 6: In situ treatment of landfill sources, MNA and LUCs- Estimated cost \$6,400,000

Alternative 7: Cap Maintenance, LUCs, in situ enhanced bioremediation, passive biobarriers and MNA- Estimated cost \$1,980,000

The alternatives were evaluated based on effectiveness, implementability, and cost. The no further action alternative provides a comparative baseline, but does not meet the objectives. Alternatives 2 through 7 will provide actions to limit exposure to landfill contents and contaminated groundwater through the use of LUCs until contamination is reduced to cleanup levels. The LUCs will protect the landfill cap, prevent human exposure to landfill waste and residual groundwater and ensure no withdrawal or use of groundwater beneath the site for anything other than environmental monitoring and testing. Alternatives 2 to 7 would reduce groundwater contamination to the cleanup levels through maintenance of existing landfill cap, groundwater extraction, MNA (passive remedial action that relies on natural biological, chemical, and physical processes), extraction of hot spots in groundwater, permeable reactive barrier, excavation of hot spot areas in the landfill, complete removal of landfill waste, in situ treatment of landfill hot spots, and in situ bioremediation.

Proposed Remedy: Alternative 7

Alternative 7 is the recommended remedial alternative for LHAAP-16 and is consistent with the intended future use of the site as a wildlife refuge. The proposed remedy involves maintenance of landfill cap, enhanced in situ bioremediation in the most contaminated portion of groundwater, and installation of passive biobarriers in groundwater for additional protection of Harrison Bayou. Following the reduction in concentrations by in situ bioremediation and passive biobarriers, natural attenuation will further reduce concentrations of COCs in groundwater. Based on preliminary natural attenuation evaluation, groundwater cleanup levels are expected to be met in 280 years. MNA will be evaluated after two years of quarterly monitoring and if proper conditions of natural attenuation are not established, additional in situ bioremediation will be performed. The timeframe will be re-evaluated after additional sampling is conducted following shut down of extraction system and implementation of in situ bioremediation and passive biobarriers. Alternative 7 will satisfy the RAOs through groundwater use restriction LUCs, which restrict use to only environmental monitoring and testing and thus ensure the protection of human health by preventing human exposure to the groundwater until the proposed remedy reduces the contamination to cleanup levels.

Perchlorate Results for Creek Sampling
Longhorn Army Ammunition Plant, Karnack, Texas

Creek Sample ID	Aug 2007	Dec 2007	Mar 2008	Jun 2008	Sep 2008	Dec 2008	May 2009	July 2009	Aug 2009	Sep 2009	Dec 2009	Mar 2010	Jun 2010	Sep 2010
GPW-1	0.5U	10.7	27	0.5U	0.5U	0.22U	16	4U	Not Sampled	1.2U	3.7	1.3J	0.6U	dry
GPW-3	0.5U	7.48	21.9	9.42	1.1	0.22U	8.9	4U	Not Sampled	0.6U	2.8	1.8J	0.6U	dry
HBW-1	122	0.5U	0.5U	0.5U	0.5U	0.22U	0.55U	4U	Not Sampled	1.5U	0.275U	1.5U	0.6U	dry
HBW-7	1.02	0.5U	0.5U	0.5U	0.5U	0.22U	0.55U	4U	24*	1.2U	0.275U	1.5U	0.6U	dry
HBW-10	0.5U	0.5U	0.5U	0.5U	0.5U	0.22U	0.55U	4U	Not Sampled	1.5U	0.275U	1.2U	0.6U	dry

NOTES:

all units in micrograms/liter (µg/L)

U undetected

J approximate value present below normal reporting limit

GP is Goose Prairie Creek

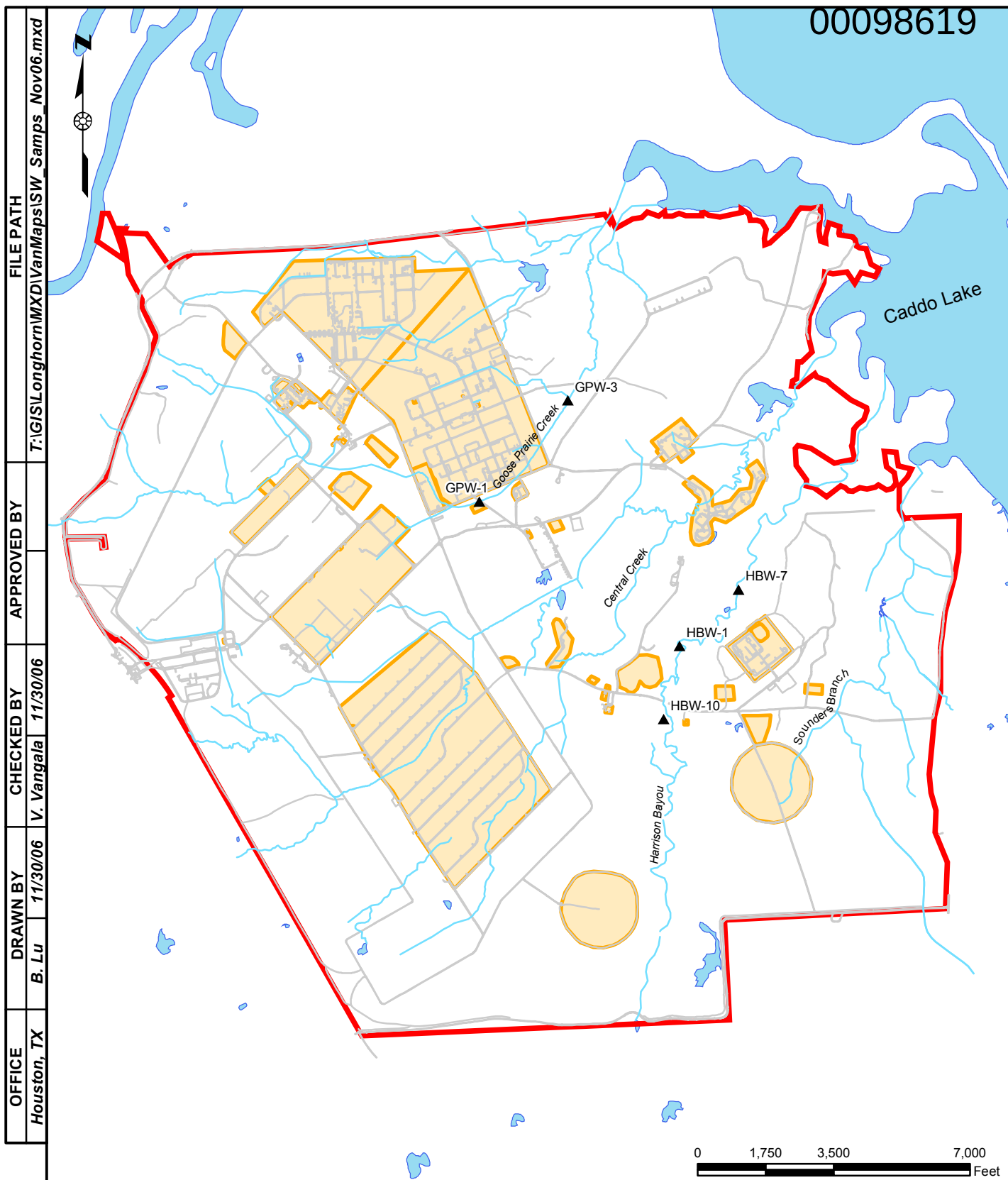
HB is Harrison Bayou

W is surface water

* Special sample taken during GWTP shutdown

September conditions: All creek sampling points were dry in September.

00098619



OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Lu	V. Vangala		T:\GIS\Longhorn\MXD\VanMaps\SW_Samps_Nov06.mxd

Plot Date: 11/06

Legend

- ▲ Surface Water Sampling Location
- Stream
- Road
- Site
- Lake



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

FIGURE 1
SURFACE WATER SAMPLING LOCATION
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

**Perchlorate Results for Perimeter Well Sampling
Longhorn Army Ammunition Plant, Karnack, Texas**

Well ID	Sep 2006	May 2007	Aug 2007	Dec 2007	Mar 2008	Sep 2008	May 2009	Sep 2009	Mar 2010	Sep 2010
LHPMW108	10 U		0.5U			2.5 U		1.2U		3.0U
LHPMW110	10 U		10U			5.0 U		6.0U		dry
LHPMW111	4 U		0.5U			0.5 U		0.30U		dry
LHPMW112	5 U		3U			2.0 U		0.30U		3.0U
LHPMW133	1.08	1 U	1.09	0.5 U	0.5 U	0.5 U	0.47 J	0.32J	0.30U	0.32J
LHPMW134	0.708 J	1 U	0.949 J	0.5 U	0.5 U	0.829 J	0.40 J	0.30U	0.30U	0.45J

NOTES:

all units in µg/L

µg/L micrograms/liter

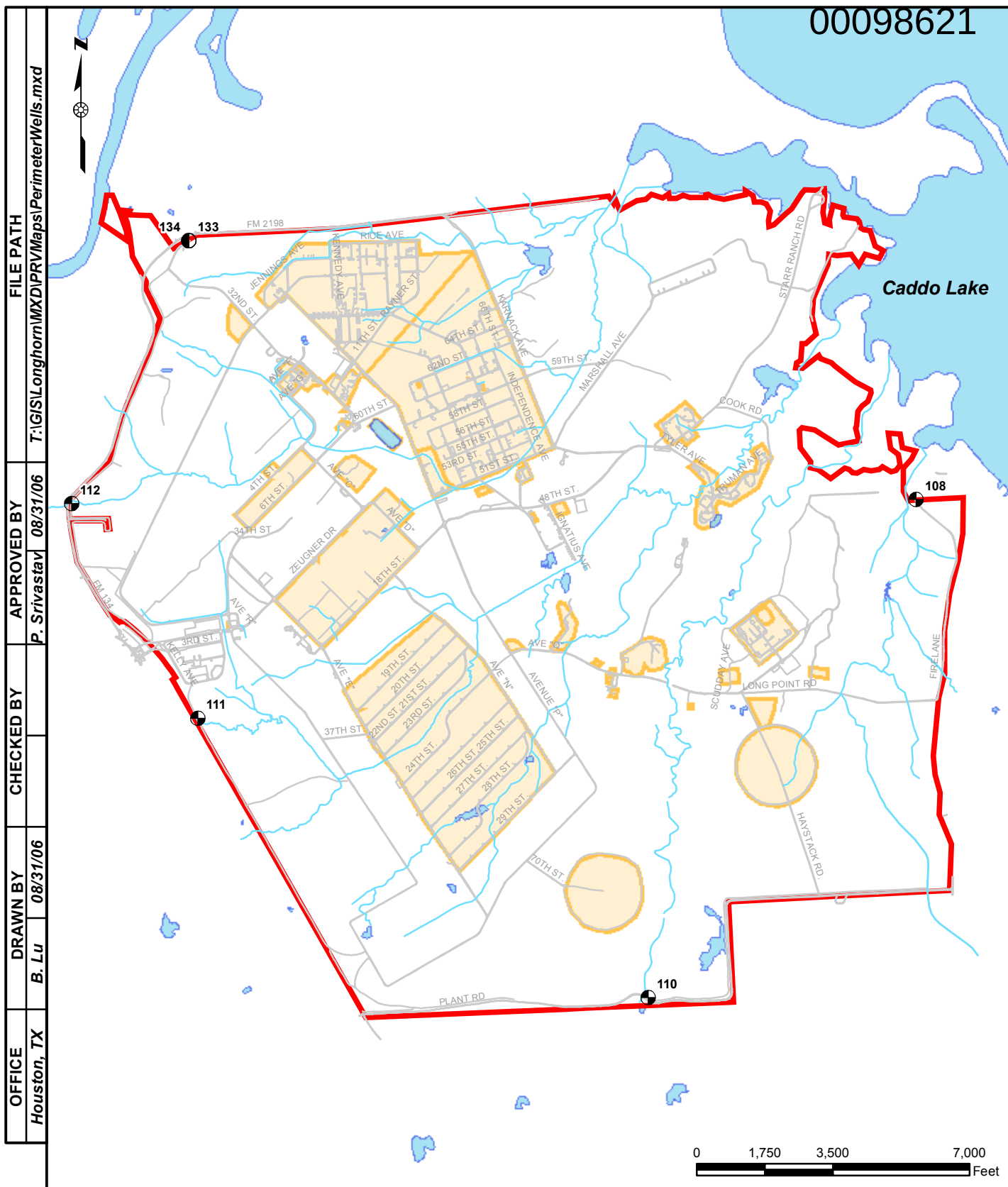
U undetected

J Present below normal reporting limit but greater than or equal to the MDL and the concentration is an approximate value.

L Result biased low.

MDL method detection limit

00098621



OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Lu	08/31/06	P. Srivastav	08/31/06
T:\GIS\Longhorn\MXD\IPRV\Maps\PerimeterWells.mxd				

Legend

-  Shallow Perimeter Well
-  Intermediate Perimeter Well
-  Stream
-  Road
-  Site
-  Lake/Pond
-  LHAAP Approximate Boundary



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

FIGURE 1

PERIMETER WELL LOCATION MAP

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Plot Date: 08/06

LHAAP-16 Old Landfill Longhorn Army Ammunition Plant

Ongoing Operations

RAB Meeting

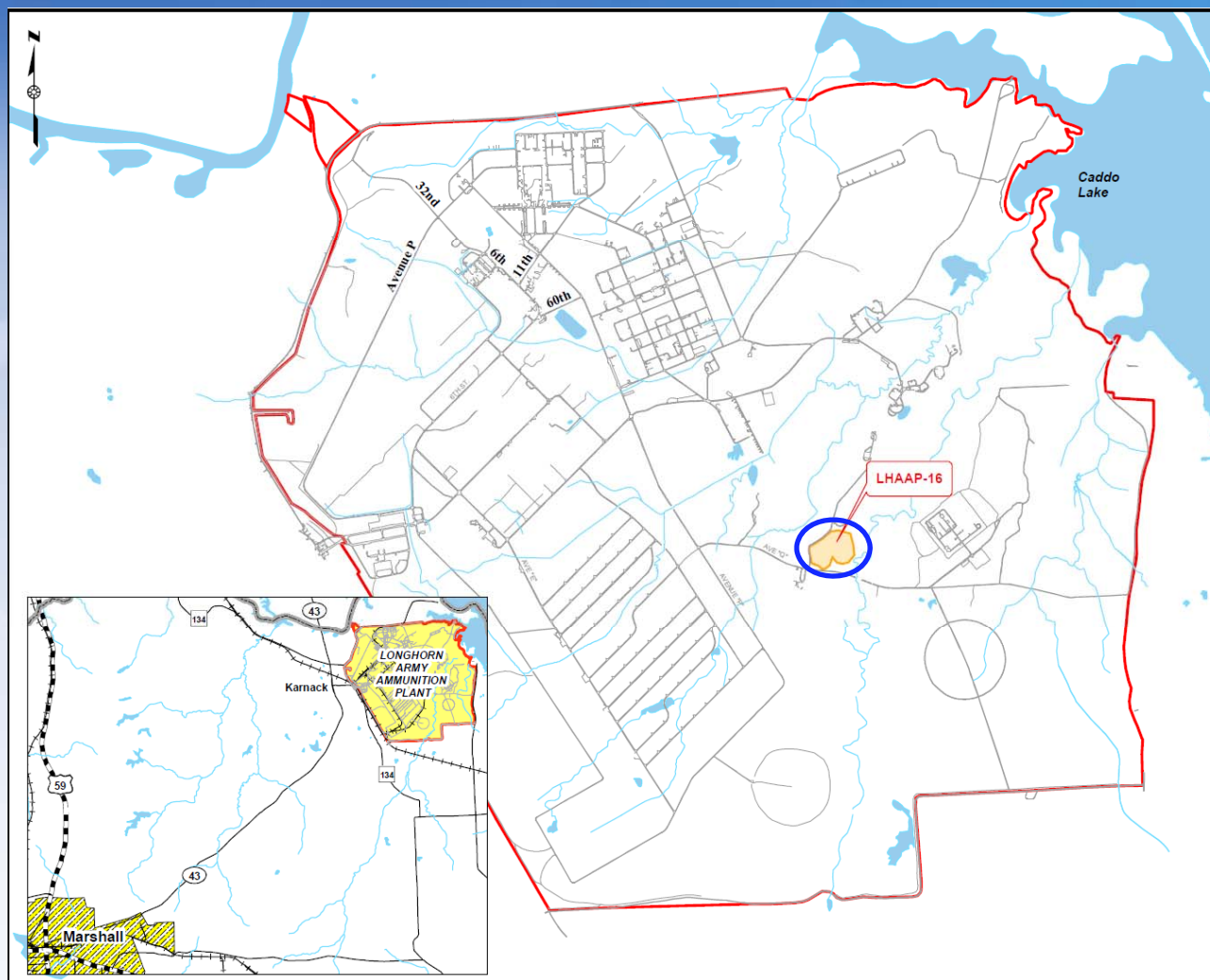
October 19, 2010

5:30 p.m.

Caddo Lake State Park

Karnack, Texas

LHAAP-16 Site Location



In south-central portion of LHAAP and is approximately 20 acres

LHAAP-16 Site Background

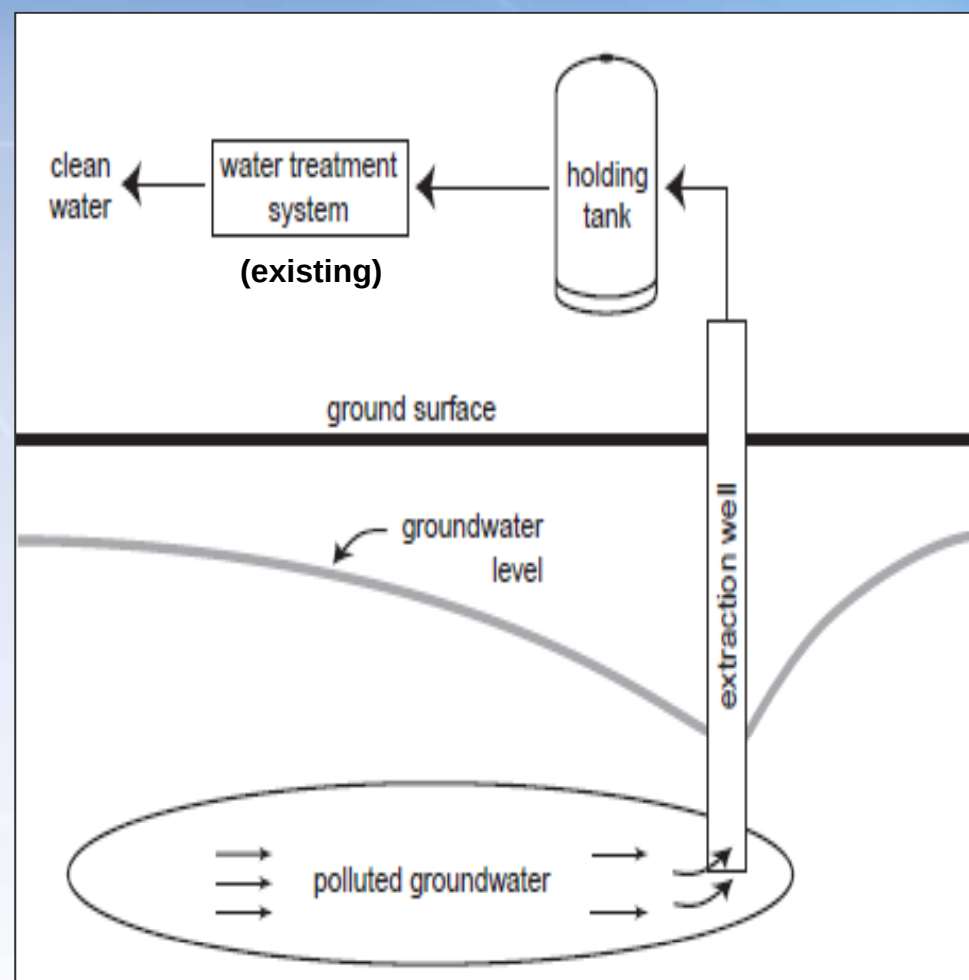
- Used as a landfill between 1940s and 1980s for the disposal of solid and industrial wastes
- In 1995, the Army and USEPA signed a Record of Decision (ROD) approving an interim remedial action to mitigate risks posed by the buried waste at the site
- From 1996 to 1998, a 13-acre multilayer cap was constructed as a component of the remedy. The cap has been maintained since that time.

LHAAP-16 Groundwater

- Prior to capping the landfill, rainwater seeped into the landfill wastes and contaminated the groundwater
- In 1996 and 1997, the Army voluntary installed a groundwater extraction system to prevent groundwater plume from migrating to Harrison Bayou.
- The groundwater extraction system is still being operated. Extracted water is treated at the onsite groundwater treatment plant.

Extraction and Treatment

- Pumps used to pull polluted groundwater to surface
- Water passes into holding tank and then to a treatment system where the chemicals are removed
- The clean treated water is then discharged back into Harrison Bayou or injected into the ground at LHAAP-18/24



Groundwater Chemicals of Concern

Shallow and Intermediate Groundwater:

- Trichloroethene (TCE)
- Cis-1,2-dichloroethene
- Vinyl Chloride
- Perchlorate



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**A Public Meeting to discuss the
proposed final remedy for
LHAAP-16 is scheduled to follow
this RAB Meeting**

Revisions to transcript for LHAAP-16 Public Meeting October 19, 2010			
Page:	Line:	From:	To:
2	5	places	faces
2	23	Super Fun	Superfund
3	2	record of decision	Record of Decision
3	2	remedial design	Remedial Design
3	3	Remedial action	Remedial Action
3	3	remedial action-operations	Remedial Action Operations
3	3	long term	Long Term
3	4	monitoring	Monitoring
3	5	operating properly and successfully	Operating Properly and Successfully
3	7	national priority list	National Priority List
3	13	proposed	Proposed
3	14	plan	Plan
3	14	record	Record
3	15	decision	Decision
3	15	proposed plan	Proposed Plan
3	16	proposed plan	Proposed Plan
3	18	proposed plan	Proposed Plan
3	19	proposed plan	Proposed Plan
3	20	feasibility study	Feasibility Study
3	20	preferred	Preferred
3	21	alternative	Alternative
3	24	proposed plan	Proposed Plan
4	2	record of decision	Record of Decision
4	15	record of decision	Record of Decision
5	23	hazard index	Hazard Index
5	24	hazard	Index
5	25	hazard	Index
6	7	fish and wildlife	Fish and Wildlife
6	9	conservational (unintelligible)	congressional MOA (unintelligible)
6	10	JUDY:	JUDY VANDEVENTER:
6	17	other	others
6	20	JUDY:	JUDY VANDEVENTER:
6	23	JUDY:	JUDY VANDEVENTER:
7	5	nonresolution	nonresidential
7	6	JUDY:	JUDY VANDEVENTER:
7	7	MR. TZHOE:	MR. TZHONE:
9	2	MR. TZHOE:	MR. TZHONE:
9	19	So an action	So no action
12	12	barrels	pairs
12	14	intermedial	intermediate
12	16	1824	18/24
14	24	(unintelligible)	zero valent iron
14	25	ominous	harmless

Revisions to transcript for LHAAP-16 Public Meeting October 19, 2010			
Page:	Line:	From:	To:
15	1	bibarriers	biobarriers
15	3	provide nutrients.	provide nutrients and carbon source.
15	4	(unintelligible)	eat
15	7	Some of the chemicals may be	Some of the chemicals that are in the
15	12	(unintelligible)	groundwater may be
15	17	Mr. TZHOE:	that degrades
16	9	medial	MR. TZHONE:
16	11	a capsulation	remedial
16	13	A capsulation	encapsulation
17	9	Omni	Encapsulation
17	15	slab	Army
18	8	hand	slap
18	14	army	land
19	13	JUDY:	Army
20	17	PAUL:	JUDY VANDEVENTER:
21	1	MR. TZHOE:	PAUL FORTUNE:
21	11	comparison	MR. TZHONE:
21	23	present work	comparing
22	9	contaminate levels.	present worth
22	10	why	contaminant levels.
22	12	protectives.	what
22	20	contaminates	protective.
23	11	army	contaminants
23	15	proposed plan	Army
23	16	alternative	Proposed Plan
23	17	preferred alternative	Alternative
24	1	contaminates	Preferred Alternative
24	2	contaminates	contaminants
24	14	plant	contaminants
25	8	MR. RICE: You're going...	plan
25	11	contaminates	MR. RICE: Praveen, I have a question on
26	6	...we'd like to. We're trying...	MNA evaluation. You're going...
26	20	MR. TZHOE:	contaminants
28	5	remedy	...we'd like to. Overall, we're trying...
28	11	which are low.	MR. TZHONE:
28	19	...(unintelligible) That's...	MNA
28	22	71 in the shallow	which should be low.
28	23	possible (unintelligible)	...(unintelligible) that's...
29	4	downgrading	Certainly into the shallow
29	15	downgrade	possibly going into intermediate.
30	15	...which would enhance...	downgradient
30	16	cleaning	downgradient
			...which was enhanced...
			cleanup

Revisions to transcript for LHAAP-16 Public Meeting October 19, 2010			
Page:	Line:	From:	To:
31	11	...if you would address in the...	...if you would address it in the...
31	20	JUDY:	JUDY VANDEVENTER:
32	1	...degradation is.	...degradation is. Then you can project it.
32	6	JUDY:	JUDY VANDEVENTER:
32	12	JUDY:	JUDY VANDEVENTER:
32	15	Faye	Fay
32	25	Faye	Fay
33	1	FAYE:	FAY:
33	2	PC	TCE
33	20	NCL	MCL
33	22	FAYE:	FAY:
34	6	MR. TZHOE:	MR. TZHONE:
34	7	Faye	Fay
34	8	FAYE:	FAY:
34	11	MR. TZHOE:	MR. TZHONE:
35	11	JUDY:	JUDY VANDEVENTER:
35	24	JUDY:	JUDY VANDEVENTER:
36	7	inspector general	Inspector General
37	16	contaminate	contaminant
38	3	contaminate	contamination
39	20	DPD	DPT
40	12	MR. TZHOE:	MR. TZHONE:
41	12	congress	Congress
42	1	MR. TZHOE:	MR. TZHONE:
42	11	FAYE:	FAY:
42	18	PAUL:	MAN:
42	22	MAN:	PAUL FORTUNE:
43	1	PAUL:	PAUL FORTUNE:
43	8	(unintelligible). It's not...	DNAPL that you're looking at, it's not...
43	10	PAUL:	PAUL FORTUNE:
43	13	MR. TZHOE:	MR. TZHONE:
43	15	PAUL:	PAUL FORTUNE:
43	19	PAUL:	PAUL FORTUNE:
44	6	MR. TZHOE:	MR. TZHONE:
45	5	landfill	landfills
45	5	...removal of the waste.	...removal of the waste and disposing of it.
46	9	inspector general	Inspector General
46	18	army	Army
46	19	super fun	Superfund
47	14	MR. TZHOE:	MR. TZHONE:
47	16	army	Army
47	16	fishery and wildlife	Fish and Wildlife
47	18	army	Army
47	21	army	Army
47	23	MR. TZHOE:	MR. TZHONE:
47	24	army	Army

Revisions to transcript for LHAAP-16 Public Meeting October 19, 2010			
Page:	Line:	From:	To:
48	1	alternative	Alternative
48	3	alternative	Alternative
48	7	army	Army
48	8	fishery and wildlife	Fish and Wildlife
48	9	alternative	Alternative
48	12	army	Army
48	21	PAUL:	PAUL FORTUNE:
48	23	proposal plan	Proposed Plan
48	25	proposal plan	Proposed Plan
49	7	MR. TZHOE:	MR. TZHONE:
50	3	MR. TZHOE:	MR. TZHONE:
50	9	...to the members.	...to the RAB members.

1
2
3
4
5
6 PUBLIC MEETING

7 PROPOSED PLAN
8
9

10 LHAAP-16 OLD LANDFILL
11 LONGHORN ARMY AMMUNITION PLANT
12

13 October 19, 2010

14 7:00 p.m.

15 Caddo Lake State Park

16 Karnack, Texas
17
18
19

20 ORIGINAL
21
22
23

24 Reported by:
25 Tamela Jo Bodden
Certified Court Reporter

1 MR. SRIVASTAV: So the site is site
2 LHAAP-16 Old Landfill. We talked about this site in
3 quite detail, especially the history and things like
4 that, so I'm going to skip over that information. I
5 don't see any new places that have joined since we
6 finished up the last portion.

7 Okay, why are we here? We're here to present an
8 overview of the proposed plan for the environmental
9 clean up at site 16. We are also here to answer any
10 questions about the plan and to receive your comments
11 on the plan. If you have questions during the
12 presentation, and we do encourage that, so if at any
13 point you have a question, please feel free to ask.
14 But we do ask that you please state your name.

15 We have a court reporter who is going to record
16 your questions and our answers. And you'll also have
17 an opportunity to send follow-up questions via e-mail
18 or through written letter.

19 What is the process? This is an outline of what
20 we call a CERCLA process. This is the overall process
21 that controls how we address the sites at this
22 particular installation. CERCLA program is also called
23 the Super Fund Program in more popular terms. We
24 started with a PA/SI, or a preliminary assessment site
25 investigation, PA/SI over here. And next phase is an

1 RI/FS, or remedial investigation feasibility study.
2 Then there's a record of decision, remedial design,
3 Remedial action, remedial action-operations/long term
4 monitoring, and site closure. And somewhere in between
5 is an operating properly and successfully stage.

6 These are some of the dates that Longhorn was
7 placed on this national priority list in August of
8 1990. The RI/FS phase, you can see the full form here,
9 I'm just using this for the purpose of my presentation.
10 This phase was completed between 1992 and 2009. So
11 even as of last year, we're still collecting samples
12 and so on and so forth.

13 Where we are right now is we are at the proposed
14 plan stage. So between the RI/FS and the record of
15 decision is the proposed plan stage. So we have a
16 final propose plan right now, and this, the public
17 meeting, a comment period. So that's where we are.

18 What is the proposed plan? The purpose of the
19 proposed plan is to present information that's in the
20 feasibility study and as well as present the preferred
21 alternative, give you information on how that
22 alternative measures up with respect to other
23 alternatives.

24 Why is a proposed plan important? It gives us the
25 basis for the selected or final remedy for the site.

1 The remedy is documented in the next document which is
2 called the record of decision, which will be then
3 followed by remedial actions which implement that final
4 remedy for the site.

5 Site 16, we talked about this earlier. Site 16 is
6 over here at the base.

7 Let me know if I'm going too fast. Please feel
8 free to stop me with questions.

9 This is some of the information. How did we get
10 here? A lot of the historical information I talked
11 about earlier that the landfill was used between the
12 '40s, 1940s and 1980s, for disposal. Rain water seeped
13 through the landfill waste and contaminated the
14 groundwater.

15 In 1995 there was a record of decision for an
16 interim remedy at the site. Then between 1996 and 1998
17 a cap was constructed. And then also a groundwater
18 extraction system was installed within the same time
19 frame between '96 and '97 to prevent the plume from
20 migrating to Harrison Bayou.

21 So what investigations were conducted at the site?
22 They were conducted by several contractors which
23 included the Corps of Engineers themselves did some
24 work. And they hired contractors like Shaw. And there
25 were multiple contractors who conducted investigations,

1 and those investigations included collection of soil
2 and sediment samples which were approximately 120
3 samples. A fairly large number. Groundwater samples,
4 approximately 270.

5 The next step in what we call the remedial
6 investigation process is performance of risk
7 assessment. Basically this slide goes through what is
8 a risk assessment. Give you some basic information.
9 Risk assessment, it uses the data that we talked about
10 earlier, soil and groundwater data. Evaluate potential
11 risks to receptors, and these are the likely receptors
12 that are expected at the site. It calculates the risk
13 to the human health and the environment outside the
14 acceptable range. It evaluates the risk, and then it
15 gives you the conclusion as whether or not the risk is
16 acceptable.

17 This gives us the range of what is acceptable.
18 The cancer is considered acceptable if it's between
19 1×10 to the power of -6 to 1×10 to the power of -4 .
20 This here is like 1 in a 1,000,000 receptor may get
21 cancer. To 1 in 10,000.

22 Then there's a noncancer risk, or noncancer
23 hazard, which is measured as a hazard index. And it's
24 considered an acceptable if the value of this hazard
25 index is more than one. If it's less than 1, it's

1 acceptable; if it's over 1, it's unacceptable.

2 Exposure depends on current and future land use
3 and groundwater scenarios. The use scenario at
4 Longhorn Army Ammunition Plant is
5 industrial/recreational. This is based on the fact
6 that the property, or the site, as they get cleaned up
7 they're being transferred to fish and wildlife, and
8 this area is going to be a national wildlife refuge as
9 per a conservational (unintelligible).

10 JUDY: I see it says
11 industrial/recreational. Why does it say that if it's
12 supposed to be a national wildlife refuge? Why does it
13 say industrial?

14 MR. SRIVASTAV: Of the scenarios that are
15 available in the guidelines for EPA, there are
16 residential use, there is industrial use, and there are
17 some other. So industrial use was the closest.

18 MS. ZEILER: Oh, you want to make sure
19 we're not talking about industry coming in.

20 JUDY: That's exactly right.

21 MS. ZEILER: It's a risk level. So it's
22 not like there's somebody living there.

23 JUDY: So it's not like we're -- say just
24 in case some industry wants to --

25 MS. ZEILER: Recreational

1 (unintelligible) risk production, which is what we are
2 at and (unintelligible) risk reduction rule.

3 Recreational exposure is the same as the industrial
4 level of exposure. Has to do with the number of hours
5 you're exposed, like nonresolution.

6 JUDY: I just wanted to clarify that.

7 MR. TZHOE: For risk, how we calculate
8 risk, we have a residential scenario, we have a
9 commercial scenario, and we have an industrial
10 scenario. And the most stringent one is usually
11 residential, and commercial and then industrial.

12 Now, for Longhorn, which is anticipated and is a
13 wildlife refuge, we use basically the industrial one
14 because that's the most applicable out of those three..
15 So that's why the industrial.

16 MR. SRIVASTAV: This pretty much has to
17 do with, what's the duration of exposure for somebody
18 who's at the site. So for an industrial worker who is
19 going to be at the site during only certain hours a day
20 and then they go home. So that's how it's calculated
21 which is the same as whether it's a wildlife refuge
22 manager versus an industrial worker who's at a
23 industrial facility.

24 So what is the conclusion of the risk assessment?
25 Is there human health risk at site 16? The answer is

1 yes. This risk assessment was performed in 2002, and
2 it concluded that the groundwater at the site posed an
3 unacceptable cancer risk and a noncancer hazard. So
4 there are chemicals in the groundwater which pose both
5 cancer and noncancer risks to a hypothetical future
6 maintenance worker.

7 So what this risk is saying is not necessarily
8 that somebody is going to do that kind of activity
9 here. It's a hypothetical situation, in case somebody
10 were to do, what would be the risk that that person
11 would have.

12 WOMAN: But that risk is exposure,
13 thermal exposure?

14 MR. SRIVASTAV: In terms of exposure
15 pathways, there are several pathways. For example, a
16 person could be exposed to contaminants in the soil by
17 thermal just like (unintelligible) could be ingestion,
18 accidental ingestion, for example. It could be
19 inhalation depending on what kind of contamination. It
20 could be water.

21 So all that is considered in the exposure path
22 scenario. It gets pretty involved, the calculations.
23 But that's what ultimately came out of the risk
24 assessment for the site, it is unacceptable.

25 The media that were considered were soil,

1 groundwater, surface water, and sediments.

2 MR. TZHOE: So what that means is the
3 other ones are okay, but it's the groundwater exposure
4 to the industrial worker that's not acceptable.

5 MR. SRIVASTAV: So we evaluated soil,
6 groundwater, surface water, and sediment; but
7 groundwater is the one that showed unacceptable risk.
8 If you remember the soil and the contaminated risk to
9 all (unintelligible) up by landfill so there is no
10 exposure to that under the current conditions.

11 Ecological risk. Is there ecological risk at site
12 16? The answer is no. We conducted a base wide
13 ecological risk assessment which evaluated different
14 scenarios for the animals that are expected to be at
15 the site based on the range, how far they go from the
16 places they inhabit. We found that there's no risk at
17 site 16, ecological risk. Which kind of goes hand in
18 hand because there's no contamination in the soil that
19 is of concern. So an action is required for ecological
20 risk at site 16.

21 Now that we know that there's a risk or hazard
22 from the contaminants in the groundwater, the next step
23 is to set up some remedial action objectives. So we
24 know we need to do remedial action here. We need to
25 treat this groundwater. We need to bring it back to

1 where it's no longer a risk or hazard to human health.
2 So these are, these bullets show what the objectives
3 are for this site. Those are:

4 Protection of the human health and the environment
5 by preventing exposure to the landfill contents. So we
6 discussed earlier that there was disposal of material
7 that was of hazardous nature in this landfill, so we
8 need to protect human health so nobody gets in contact
9 with it. So that's one objective.

10 Protection of the human health and the environment
11 by reducing leaching and migration of landfill
12 hazardous substances into the groundwater. So that's
13 one. So we want to make sure that -- isolate that as
14 much as possible, those hazardous materials that are in
15 the landfill.

16 Protection of the human health by preventing human
17 exposure to the groundwater contaminated with chemicals
18 of concern. So we know currently the ground is
19 contaminated. We need to make sure nobody drinks that
20 water or uses it in some other fashion.

21 Protection of the human health and the environment
22 by preventing groundwater contaminated with COCs,
23 contaminant of concern, from migrating into the nearby
24 surface water, and that's Harrison Bayou. We know that
25 the water from Harrison Bayou flows into Caddo Lake

1 which is a drinking water source for several
2 communities in this area, especially in Louisiana. So
3 we need to protect the creek.

4 Then we also need to return the groundwater in the
5 shallow and intermediate zones to its potential
6 beneficial use as drinking water wherever practicable
7 within a reasonable time given for particular site
8 characteristics. So what that means is the state of
9 Texas requires or assumes that all the waters of the
10 state are potential drinking water sources. So then
11 there's an expectation both on EPA's behalf on EPA's
12 part and TCEQ that all bodies that have been affected,
13 groundwater bodies be returned at some point to their
14 beneficial use.

15 So these are the five objectives that are the
16 basis of the remedies that are evaluated; formulated,
17 evaluated, and then one of them is selected.

18 The next step is what are the cleanup levels?
19 What are we shooting for here? What do we need to
20 achieve?

21 These cleanup levels are concentrations for
22 individual chemicals in the soil and the groundwater,
23 specifically groundwater in this case, above which some
24 remediation or control measures are required, their
25 established remedial action objectives and address

1 potential risk. And we talked about the objectives
2 earlier.

3 Chemicals of concern. We have trichloroethene,
4 Cis-1,2-DCE, vinyl chloride, and perchlorate.

5 We also talked about this figure landfill here.
6 These show the extent of the perchlorate and the TCE.
7 The red line shows perchlorate plume, so it's found
8 over here in the north and the south. And then also
9 the blue line is TCE. That plume is also bound.

10 What's the ongoing remedy at the site? I
11 mentioned that there are extraction wells at the site
12 and there are 4 barrels. There are 4 in the shallow
13 zone and with the shallow wells are deeper wells in the
14 intermedial zone that extract the groundwater.

15 That groundwater is then transported by pipes to
16 this treatment plant at site 1824. Here is a picture
17 of the treatment plant.

18 The remedy also includes maintenance of the
19 landfill cap. So the landfill was constructed to
20 prevent exposure to the landfill waste to prevent the
21 leaking of the waste into the groundwater. So that
22 landfill is being maintained. We discussed earlier in
23 quite a bit of detail what that maintenance requires.
24 And then the groundwater is then being extracted and
25 treated at the treatment plant.

1 So those are the components that are going on
2 right now. They've been going on since the late '90s.

3 I'll skip over this one. Shows a schematic of
4 what happens with the extraction of the groundwater.

5 How are alternatives developed? The alternatives
6 are developed by combining various technologies to
7 mitigate risk in all media. In this case those media
8 are landfill waste and the groundwater.

9 We evaluated several technologies, and these are
10 listed here:

11 Maintenance of the existing landfill cap.

12 Excavation and off-site disposal of the highly
13 contaminated area of the landfill waste.

14 Complete removal.

15 And we compare these to see, okay, what would
16 happen if we actually were to excavate the waste.
17 That's kind of the other end point of how to deal with
18 the waste. This is highly contaminated. And then the
19 other option would be to completely removal -- the
20 complete removal and off-site disposal of the
21 (unintelligible) and entire landfill.

22 The fourth one is land use control for protection
23 and maintenance of the existing landfill cap.

24 For groundwater we looked at, ex situ treatment.
25 Ex situ refers to the fact that if you were to pump the

1 water out, it's out of the ground, and any treatment we
2 do at the surface is called ex situ. We looked at
3 enhanced groundwater extraction. We already have
4 extraction going on. Can that be enhanced in some way.

5 In situ treatment refers to any kind of treatment
6 that is happening down below in the surface of the
7 water without taking it out to the surface. We looked
8 at enhanced bioremediation in most contaminated
9 groundwater areas. Looked at something called
10 permeable reactive barrier, which contain a combination
11 of gravel and organic media.

12 You can think of them as permeable curtains which
13 are built into the ground. When we are looking at the
14 groundwater flowing toward the creek we build these
15 things across the groundwater flow. So as the
16 groundwater is flowing through these permeable
17 curtains, it gets treated because these curtains are
18 trenches. They're filled with material or agents that
19 actually treat that chemical as they go through it.

20 Passive biobarriers. These are also trenches or
21 curtains that are built into the subsurface. But here
22 the emphasis is on biological treatment as opposed to
23 here it's more chemical. There are agents like
24 (unintelligible) which treats something like TCE or
25 trichloroethene and dumps it into a ominous product.

1 In the passive bibarriers, the emphasis is more on
2 biological taking advantage of some naturally occurring
3 bacteria which provide nutrients. They can actually
4 (unintelligible) these chemicals.

5 We also looked at soil vapor extraction in the
6 highly contaminated area of the landfill waste. That
7 involves extraction. Some of the chemicals may be
8 rising up into the soil as they vaporize. We can
9 extract that by installing wells, the zone above the
10 ground.

11 We also looked at monitored natural attenuation.
12 This is just a natural process of (unintelligible)
13 chemicals by under natural conditions. We just monitor
14 the progress of the natural digression.

15 Again, land use controls for restriction of the
16 groundwater use and protection of the cap.

17 MR. TZHOE: Does anyone have any
18 questions about any of those technologies that we
19 looked at?

20 MAN: Are those the only technologies
21 that were considered?

22 MR. SRIVASTAV: Those are the only ones
23 we considered, yes.

24 MR. GUICE: I noticed that you didn't
25 have anything dealing with metals. Is that not a

1 problem here?

2 MR. SRIVASTAV: There are some metals
3 that are COCs, that are contaminants of concern. But
4 we believe those are related -- they're not distinct
5 plumes, they're more either an artifact of sampling or
6 an artifact of some wells that are stainless steel. So
7 I think there's a few wells that show elevated chromium
8 and nickel, and the plan is to address them during the
9 medial design phase by installing PVC wells and
10 addressing it.

11 MR. GUICE: Has a capsulation been
12 considered?

13 MR. SRIVASTAV: A capsulation of?

14 MR. GUICE: The entire (unintelligible)..

15 MR. SRIVASTAV: No, it's not considered
16 practical of the subsurface conditions.

17 MR. GUICE: How about in situ
18 capsulation. Dig it up and put it in a concrete
19 container.

20 MR. SRIVASTAV: The landfill contents? I
21 think we did evaluate that, and that will show up in
22 one of the alternatives. So we're not going to -- I
23 don't think we have the time, or is it really necessary
24 during this presentation to go through in detail all
25 the alternatives. They are discussed in the proposed

1 plan. They are discussed in the feasibility study. So
2 if you are interested --

3 MR. GUICE: I'm just looking at
4 alternative 5b and comparing the cost of that to in
5 situ encapsulation. That's more money than I make in
6 two years, maybe even three.

7 MR. SRIVASTAV: That's what it comes down
8 to. Alternative 1 is no action. But that doesn't mean
9 that Omni or Shaw will not maintain the landfill cap.
10 The landfill cap will still be maintained but there is
11 no other action.

12 Alternative 2, maintenance of the existing
13 landfill cap and enhanced groundwater extraction. So
14 here the extraction will go on here and we're going to
15 enhance it in some way, and then you also need to slab
16 land use controls to protect the landfill or any access
17 to it.

18 Alternative 3a, maintenance of landfill cap and
19 MNA. I would like to also mention that a lot of these
20 alternatives, there was a feasibility study that was
21 done by Jacobs in January, I would like to say back in
22 like 2003 or 2004. And they actually evaluated a lot
23 of these alternatives. What we did was we tagged on to
24 that and we said, okay, none of these look like will
25 work, let's evaluate a different alternative. So we

1 looked at alternative 7. That's what we developed as
2 we think is what's needed for the site.

3 3b has maintenance of existing landfill cap, hot
4 spot extraction. Hot spot just means that there are
5 some areas that are a lot more contaminated, the
6 concentrations are higher than other areas. We could
7 extract the groundwater from there. And the remaining
8 plume would have MNA and hand use controls.

9 Maintenance of landfill cap, passive groundwater
10 treatment, and this would be more in situ treatment,
11 land use controls.

12 Landfill hot spot removal. This is where we
13 actually get into the landfill. We have to destroy the
14 cap that's already there that the army has spent
15 millions of dollars installing. And then we go after
16 -- first of all you need to know where the hot spots
17 are and then you go after it. But this one would not
18 remove the entire contents.

19 MR. RICE: What's the difference between
20 the hot spot removal in 5a and the hot spot extraction
21 in 3b?

22 MR. SRIVASTAV: I think this is referring
23 to the groundwater, hot spot extraction. You're
24 talking about this here, 5a? That's for the landfill
25 contents. Taking out highly contaminated parts of the

1 landfill waste after you peel off the cover.

2 And that 5b is removing all the contents and
3 dispose of off-site and then in situ treatment,
4 off-site disposal LUCs. You can look at this why or
5 not practical or preferred. One of the problems in
6 removing some of this landfill waste is that hazard you
7 actually face in removing the contents. There could be
8 some highly contaminated waste. You're exposing the
9 public as you take it out, transport it across public
10 roads. So that also is considered as one of the
11 evaluations criteria.

12 Then landfill source in situ treatment --

13 JUDY: If that's not practical to do, why
14 would be any of the hot spots? If they were the real
15 hot spots, they would be just as serious a threat as
16 the complete removal, wouldn't it?

17 MR. SRIVASTAV: You're absolutely right.
18 If you were to read the evaluation, they probably sound
19 about the same.

20 Alternative 6 is just treating the source in situ,
21 which by means the waste remains where it is but to
22 treat it in some way. And that's extremely difficult.

23 Alternative 7 is a mixture of what you saw up
24 here; alternative 2, maintenance of the existing
25 landfill cap. Keep the things as they are. The waste

1 stays in place but we have land use controls to protect
2 the integrity of the cap to prevent anybody accessing
3 the cap. Also land use controls to prevent access to
4 the groundwater for the duration that it's not cleaned
5 up yet. In situ enhanced by bioremediation as you'll
6 see later on. That goes hand in hand with passive
7 biobarriers, so it's a combination of treating hot
8 spots in the groundwater with bio, and then also
9 building biobarriers, which are these permeable
10 curtains I talked about. And injecting
11 (unintelligible) to the ground.

12 Then that will be followed with monitored natural
13 attenuation after we knock down the really high
14 concentrations. It's expected that monitored natural
15 attenuation will take over in the long run to clean up
16 the site.

17 PAUL: On alternative 2, this here is an
18 example, it's about \$9 million. How long does that
19 maintenance go for, for that million dollars?

20 MR. SRIVASTAV: That must be a 30 year, I
21 think, 30 years of operation.

22 PAUL: Is that the same for all those
23 maintenance, even the one on the alternative 6?

24 MR. SRIVASTAV: It carries the
25 assumptions all the way through.

1 MR. TZHOE: To clarify, if you're talking
2 about actual maintenance, Paul, that's going to go on
3 forever that landfill is there, as long as that
4 landfill is there. But for cost estimation purposes,
5 we do it for 30 years for all of them.

6 MR. SRIVASTAV: This is just a -- you
7 asked the question earlier about estimation, so this is
8 just some information on how we develop these
9 estimates. They're based on the feasibility levels
10 scoping, and they intend to aid in making project
11 evaluations. And then comparison some alternatives.
12 They're not super accurate. They're not based on any
13 cost that we go out and get from subcontractors. But
14 since they're all done in the same way, they're a good
15 way to compare alternatives.

16 The capital and operating cost are estimated for
17 30 years, and they are designed just the way they're
18 done. They may have an accuracy from minus 30 to plus
19 50 percent. This is not just Shaw, this is how the
20 process works. They're not meant to be that
21 inaccurate, we don't intentionally make them
22 inaccurate, but that's the range.

23 Then we also look at the present work for each
24 alternative using a discount rate. And what that
25 really means is if you -- you know, we're not going to

1 spend all the money today, some of the money may be
2 spent ten years later. So what you have to invest
3 today at a rate that will get to that money at that
4 point. That's the present worth.

5 These are the criteria, how the alternatives are
6 evaluated. We look at the overall protection of the
7 human health and the environment. Compliance with the
8 applicable or relevant appropriate requirements. An
9 example would be maximum contaminate levels. This is
10 why the state and the EPA expect the Army and Shaw to
11 clean up too. Those are the goals that are considered
12 protectives.

13 We look at the long term effectiveness and
14 permanence. How permanent is this remedy? What's the
15 long term effectiveness? Is it only going to be
16 effective for one year, or is it going to be effective
17 many years down the road?

18 How effective is this particular alternative in
19 reduction of toxicity, mobility and the volume of the
20 contaminates.

21 Short term effectiveness. This is where the
22 protection of the workers come in. If you start
23 excavating and removing hazardous waste it can -- you
24 know, it's probably a permanent solution, but it also
25 would create some short term effects.

1 How implementable is something? Is it something
2 that's completely out of this world? How practical is
3 this particular technology. Cost plays a factor in
4 this. Agency acceptance of the proposed remedy. The
5 regulators get to review this. They give us their
6 comments. We address their comments. We make changes
7 as necessary.

8 Finally is the community acceptance of the
9 proposed remedy. That's what today's meeting is all
10 about. You get to review them. You get to comment on
11 it. And we work with the army and the regulators to
12 address your comments.

13 So all the alternatives were evaluated using those
14 nine criteria. Like I said earlier, all that
15 information is available in the proposed plan. The
16 outcome of the evaluation is that alternative 7 is our
17 preferred alternative because it meets the remedial
18 action objective that is I went to earlier. It
19 protects the human health and environment because we
20 have land use controls in place. It's a widely used
21 technology, readily implementable. It's
22 bioremediation, enhance bioremediation. They're
23 established technologies and they're very, very
24 effective.

25 It will give us long term effectiveness once we

1 use the contaminates in groundwater. We don't expect
2 those contaminates will be permanently used and
3 concentrated. It is cost effective for EPA's
4 preference for treatment.

5 So how does alternative 7 attain remedial action
6 objectives? It may seem like I'm saying the same thing
7 over and over. What it does is it prevents the
8 exposure by maintenance of the cap. We treat the
9 groundwater which releases the concentrations and the
10 migration to the Harrison Bayou.

11 So will in situ bioremediation of the contaminated
12 areas. We're getting more detail on what this remedy
13 is about. And I'll show you a couple of maps to show
14 where we plant to do all this at the site.

15 This in situ bioremediation includes passive
16 biobarriers and downgradient portion of the
17 contaminated plume to prevent migration to Harrison
18 Bayou. There will be another passive biobarrier at the
19 edge of the landfill to contain any potential migration
20 of COCs from the land. We talked about earlier while
21 there's likely to be contamination right underneath the
22 landfill, so slowly it may migrate out and contaminate
23 areas that we are already cleaning. So to prevent
24 that, we will build another biobarrier along the edge
25 of the landfill, and I'll show you a map later on.

1 At some point we hope to shut down the extraction
2 system. Once the concentrations go down below a
3 certain level. Or enough that we think that MNA will
4 work. MNA will be evaluated after two years of
5 quarterly monitoring. If it's not effective after two
6 years, we may have to do a contingency remedy which
7 means further treatment of certain areas.

8 MR. RICE: You're going to do this
9 evaluation shortly after you conducted a remedial
10 measure. How are you going to differentiate between
11 reduction in contaminates that are due to the remedial
12 measures and reductions that are due to natural
13 attenuation?

14 MR. SRIVASTAV: Remember we're trying to
15 enhance the natural attenuation. There are portions of
16 the plume the natural attenuation is already up to it.
17 Here we are trying to treat those highly contaminated
18 areas and reduce those levels down. So, yeah, there
19 will be a time when the amendments are still there and
20 they're reducing concentrations. But we should be able
21 to see the effect in the plume that the bioremediation
22 has become more effective than it used to be.

23 MR. RICE: I don't understand that, but I
24 don't want to take up any more time.

25 MS. ZEILER: Aren't there different areas

1 of the plume that you expect to see are not impacted or
2 some areas of the plume that aren't directly impacted
3 by the remedies?

4 MR. SRIVASTAV: That's what I'm saying,
5 there are areas we are already seeing degradation, but
6 not to the extent we'd like to. We're trying to
7 establish this by distribution of the amendments, the
8 carbon source and the bacteria. So if we see that
9 regime has been established, that's the purpose. We're
10 trying to change the underlying condition. So at that
11 point what used to be becomes kind of irrelevant
12 because we have changed the conditions. And we hope
13 that will sustain for the long haul.

14 MR. RICE: I still don't understand how
15 you can differentiate between the two. Maybe that's
16 something we'll just have to work out later and
17 discuss. I don't want to take up all the time
18 discussing this point.

19 MR. SRIVASTAV: Okay.

20 MR. TZHOE: Anyone have any questions on
21 any of the components of the proposed remedy? I know
22 George brought up a point about how one component be
23 evaluated. You know, all this goes through an
24 evaluation process. Every five years EPA is going to
25 evaluate that all the components are still progressing

1 as planned, and that's the five year review.

2 We already have some upon monitored data right now
3 and we're going to keep on collecting monitoring data
4 as these components get put in place.

5 Some of the biobarriers, if you guys have a fish
6 tank, you can imagine that's like a filter you run the
7 water through. And it goes through this biobarrier and
8 water comes out. So that's what a biobarrier is.

9 Enhanced treatment, biotreatment, I guess,
10 Praveen, if you want to show the next slide. So if
11 there's any questions about any of these components,
12 feel free to ask.

13 MR. SRIVASTAV: Conceptually this shows
14 areas where we might have chemicals. You can think of
15 this as the soil. There are some microbes. There are
16 some chemicals. Eventually those microbes will start
17 eating up into the contaminate, and eventually the
18 contaminate is degraded into byproducts that are not
19 harmful.

20 What's a passive biobarrier? This is a cross
21 section of the ground surface. We build a, by
22 injecting these chemicals, amendments into the ground,
23 we build this kind of permeable trench, or a curtain.
24 As the polluted groundwater goes through it, it's
25 cleaned up at the other end. The concentrations are

1 lowered. These amendments include injection of
2 emulsified oil and bioaugmentation which is a culture
3 of microbes that feed on the oil, but at the same time
4 they also feed on -- they destroy the chemicals.

5 Another concept of what happens in remedy, the
6 degradation is (unintelligible) because of
7 biodegradation, absorption, volatilization, chemical,
8 dispersion and dilution. All those are factors of
9 monitored natural attenuation. The success depends on
10 favorable conditions which include level of dissolved
11 oxygen, which are low. It should be a reducing
12 condition than pH and some other factors.

13 This is a proposed remedy. If you remember the
14 plume was going kind of like this, so what we are
15 proposing is to put a -- starting at this end --

16 MS. ZEILER: That's the edge going north.

17 MR. SRIVASTAV: That's the edge of the
18 landfill. Build a biobarrier. The groundwater will
19 all (unintelligible) That's based on the groundwater
20 data they've collected for several years.

21 MS. ZEILER: How deep is the biobarrier?

22 MR. SRIVASTAV: 71 in the shallow and
23 possible (unintelligible). I don't remember the exact
24 depth.

25 MS. ZEILER: So the point would be is

1 water flowing through that barrier?

2 MR. SRIVASTAV: Exactly. So any
3 contaminated groundwater that's coming from under and
4 carrying contamination, the downgrading location will
5 be treated by this passive biobarrier. Then we will
6 build another biobarrier to the point of discharge into
7 the Harrison Bayou. So any contamination that escapes
8 is going to get treated by this. So eventually you
9 should have clean water flowing into the Harrison
10 Bayou.

11 We also have these injection points. Where we
12 will inject more of the same stuff, emulsified oil and
13 some bacteria. This extraction system will continue to
14 operate. And what that will do is, some of this oil
15 will get carried in the downgrade direction. Some of
16 it will get pulled by these extraction wells. So this
17 whole area, which is also the more contaminated area of
18 this plume, will get treated by these amendments.

19 So overall and partly to answer George's question,
20 Mr. Rice's question, is that after we are done with all
21 of this, this entire area should have a pretty good
22 distribution of carbon source and bacteria which will
23 enhance natural attenuation.

24 Does that now answer your question?

25 MR. RICE: I guess maybe we're talking

1 about definition of terms because we were talking about
2 natural attenuation, now we're talking about enhanced
3 natural attenuation.

4 MR. SRIVASTAV: I realized that after I
5 said that it's enhanced natural attenuation.

6 MR. RICE: I guess a concern I have with
7 that is if you're going to estimate time of cleanup
8 based on an enhanced natural attenuation, eventually
9 that enhancement will dissipate, and then we'll go back
10 to some other rate that is purely natural and not
11 enhanced.

12 MR. SRIVASTAV: What we're expecting is
13 by that time, we will have knocked down, the
14 concentrations down to levels which should not, that
15 MNA which ^{was} ~~would~~ enhance at one point, but once it gets
16 back to natural conditions, it should take the cleaning ^{up}
17 of the site in a certain number of years.

18 MS. ZEILER: But we will know because we
19 will be monitoring and we will be doing the five year
20 reviews of the effectiveness.

21 GEORGE: I guess measuring the effects of
22 the unenhanced natural attenuation after the effects of
23 bioremediation dissipate, that will occur at some point
24 in the future which you don't know right now.

25 MS. ZEILER: Not right now, but I thought

42:50

43:17

43:

43:49

1 we had some areas of the plume where we didn't think
2 were going to be enhanced by this. We were going to
3 have MNA in those areas or am I totally off base? I
4 might be thinking of another site in the area. But
5 your concern is that we're not really seeing what MNA
6 is doing? After the enhancement is through and then,
7 you know.

8 GEORGE: This is the point I'm going to
9 address in my written comments, so I don't want to take
10 up all the time in reading it and talking about it at
11 this point. But I'd appreciate it if you would address
12 in the written comments.

13 MR. SRIVASTAV: This remedy for the
14 landfill is maintenance of the cap and land use
15 controls.

16 Estimated time to achieve cleanup levels. Based
17 on the natural attenuation, and this is without the
18 bio, will be 280 years. But that's the time we're
19 trying to cut by doing more active remediation.

20 JUDY: What kind of time frame are you
21 talking about if it's not 280 years?

22 MR. SRIVASTAV: We don't know that yet.
23 Like I said, the time frame will be reevaluated after
24 we perform additional sampling. We have done the bio.
25 We go another round of samples, see what the rate of

1 degradation is.

2 JUDY: So we're really in an unknown time
3 frame, this 30-year cost could be extrapolated to a
4 number of times to come out.

5 MS. ZEILER: Most certainly it will be.

6 JUDY: And the other thing that I
7 remembered y'all saying was that at some point the laws
8 require you to get the potential -- within a reasonable
9 time, get it back to drinking water standards. Did I
10 hear that?

11 MS. ZEILER: Right.

12 JUDY: Well, 280 years is not reasonable
13 to get it back to drinking water.

14 MS. ZEILER: Here's where I'm going to
15 Faye to give you the analogy. This is not something
16 that can be done easily. In fact, it's rarely done
17 where we restore to drinking water standard with this
18 contaminant. It's just a fact of life.

19 So when we talk about years it's going to be done,
20 we're talking in, this is what calculations show us.
21 And I started talking about that earlier. Dr. Cherry,
22 John Cherry, who has written and studied extensively
23 throughout, he told me he's never seen a site that's
24 cleaned up to drinking water standard in our lifetimes.
25 I'm going to ask Faye to give you the analogy she uses.

1 FAYE: It's an analogy. She is not
2 actually talking about PC in groundwater. She is
3 actually talking about in the landfill. We may have
4 the dense aqueous phase, literally very concentrated
5 sources. And so once it spills into the ground, think
6 of it as a Rit dye or something like oil poured into a
7 sponge. Then you just pour water. You can't squeeze
8 it, you just have to pour water and let it run. That
9 sponge is going to hold onto that oil.

10 That's like the soil holding onto that product.
11 It's slowly leaching that oil that was absorbed in the
12 sponge slowly into your water. Even if we pump it, you
13 can't squeeze the soil, I mean squeeze the sponge. So
14 you're just pouring water.

15 So it's going to take a long time to get that oil
16 completely out of the sponge, and sometimes it's
17 impossible really in soil. I mean, you should know
18 that.

19 MS. ZEILER: We get really, really close
20 to that NCL, but at some point that curve's going to
21 flatten out, and it's going to take a very long time.

22 FAYE: And the in situ treatment would be
23 something like you're pouring detergent or something
24 into that sponge, help to break up oil and the water as
25 it flushes out faster and you can treat it and extract

1 it. So usually when I try to kind of explain
2 contaminants in groundwater, once it gets into the
3 groundwater, it's very difficult to clean it up. It
4 really is. It is hard to get it out of that soil
5 particles.

6 MR. TZHOE: And, Judy, let me just add to
7 what Faye said.

8 FAYE: But can I finish, because I don't
9 think we answered Judy's question. She wants to know
10 about the reasonable time frame. Go ahead.

11 MR. TZHOE: That's what I was going to
12 try to address. Judy, 280 years is a long time. From
13 EPA's perspective, 280 years is reasonable here because
14 we're looking at several different things.

15 A) It's not a residential area. It's not even a
16 commercial area. It's not even an industrial area.
17 It's a wildlife refuge. So that's one.

18 2) We have those different exposure pathways. Out
19 of all of them, only the groundwater one is affected,
20 and no one here is on that groundwater. Everyone is on
21 city water and there's outside city water sources.

22 So these are some of the factors that EPA looks at
23 when we determine what is reasonable, what is a
24 reasonable time frame. Now, you saw all of those
25 alternatives. If this was a residential property,

1 people are going to build on it, people are using that
2 groundwater for drinking water, my recommendation would
3 be that 115 million billion in one, get that done
4 immediately.

5 But since this is a different type of land use
6 scenario where we're not talking about the soil, we're
7 not talking about other contamination, we're talking
8 about groundwater that nobody is using even though all
9 of us have to restore it, that feeds into a little bit
10 more leeway under reasonable time frame.

11 JUDY: I guess I see the alternative
12 y'all have come up with based on 30 year cost. And
13 it's like it's a bottomless pit of money that's going
14 to have to be spent. So if you just did it right up
15 front and took care of all that then --

16 MS. ZEILER: But we couldn't. Judy, the
17 fact is, even if we went in there and excavated that
18 whole landfill, we still have a release to groundwater,
19 and we have secondary sources that are present, and we
20 can't get them.

21 So it's like, okay, what is the best way? What is
22 the most reasonable way to spend the money to get
23 there? I wish it were as simple as that.

24 JUDY: Well, it looks like we've tried to
25 make it look like it's the least expensive thing when I

1 really think it's going to be a much more expensive
2 thing than we're --

3 MS. ZEILER: That's why we do three. And
4 actually when we're talking about that, that's
5 something we try to keep in mind. We have certain
6 criteria to select remedies, and part of our report to
7 the inspector general and how much money we spend in
8 our budget.

9 But in reality you're right. Some remedies, we're
10 looking for -- you've got to keep calculating where we
11 have to keep coming back and doing the monitoring,
12 doing the monitoring. We try to look at that.

13 Because you're right, over time it's costly. If
14 there's a way to do it up front where we're going to
15 minimize those costs and justify when you try to do it.

16 MR. RICE: I'd like to make some comment
17 on this particular topic. I have some written comments
18 that I'm in the process of preparing, and I'll submit
19 those before November 8. But I think probably some of
20 the most significant comments I have, have to do with
21 the issue of what is a reasonable time frame of
22 cleanup. I don't think that you're presenting a
23 reasonable time frame for a number of reasons.

24 First of all, when we're talking about many
25 decades out, or even one or two centuries, we have no

1 idea what's going to happen.

2 MS. ZEILER: What technology.

3 MR. RICE: No, what's going to happen at
4 the site. We cannot say that people won't be living
5 there. We can't say that people won't be using the
6 ground water. So that addresses this very long time
7 period that you're proposing.

8 Another related issue has to do with the landfill
9 as a continuing source of contamination. There's a cap
10 on it now, and it's probably reduced the amount of
11 contamination that it produces. But I haven't seen any
12 information that indicates that it has stopped
13 contaminating groundwater. I think until we get that
14 information, a prudent and probably correct assumption
15 is that the landfill is continuing to contaminate
16 groundwater. And until that contaminate source is
17 removed, you'll never clean up groundwater.

18 So what I think you ought to incorporate in your
19 plan are, first of all, more aggressive measures to
20 clean up groundwater, more aggressive than you have in
21 your current alternative to reduce that amount of time.
22 I realize that's difficult, but you could do more.

23 And I also think you should reconsider some of the
24 alternatives that you rejected, like those alternatives
25 for treating the landfill or completely removing the

1 landfill or removal of hot spots or a vapor extraction
2 program to reduce the amount of time that the landfill
3 will continue to act as a source of contaminate.

4 In particular I think you ought to, no matter what
5 you do, you ought to remove any of the waste that are
6 subject to being submerged below the water.

7 MS. ZEILER: Right. And I agree that a
8 continuing source is a big problem. It's not something
9 we're saying doesn't exist. We're not saying that, not
10 acknowledging that possibility. Certainly we will
11 respond to your comment and consider it.

12 And I think, though I want to point out, that our
13 biobarrier around the landfill is what's supposed to
14 fix that. If we have to keep coming back to that, then
15 that's what we have to do. We're not ignoring the fact
16 it's coming up.

17 And I understand what you're saying. Why not go
18 in and get rid of the source right there. It might be
19 a higher upfront cost, but the long term pay off is
20 better. I understand.

21 KEN: Do you consider doing some
22 injection into the landfill site with these microbes
23 and stuff to get right to the source of the thing? If
24 this is going to work out as a barrier, why can't you
25 go in and make some injection sites?

1 MS. ZEILER: I'm going to let Praveen
2 answer that. Part of it I'm going to answer first is
3 knowing where the source and where to inject. And then
4 compromising the --

5 KEN: If you don't know where to inject,
6 then you're not going to know where the hot spots are.
7 The only alternative is to either dig the whole thing
8 up because unless you do some kind of injection
9 sampling, you don't even have an idea where the hot
10 spots are.

11 I'm thinking why don't you just take the whole 20
12 acres and inject these microbes all over. If they work
13 that well that you can make a barrier out of them, why
14 don't you go ahead and --

15 MS. ZEILER: I'm not sure they work on
16 landfills; is that right? I'm not sure.

17 MR. SRIVASTAV: We also don't know what's
18 in the landfill. There is always a concern if there's
19 something we don't want to drill through. For example,
20 if you're starting DPD or drilling a well, if there is
21 a container of something, it may actually make things
22 worse. There is that concern. Then you basically
23 destroy the landfill cap.

24 MR. DIXON: I've got a comment on that.
25 We remediated phenol, Lone Star Steel. And when the

1 waste was fairly low, the bacteria was very effective.
2 But that carboxylic acid is very toxic to any kind of
3 bacteria. So if you actually hit those hot spots, you
4 could kill all your bacteria if you hit a high enough
5 concentration. They need to be on the weaker
6 concentrations. That could be a problem too if you
7 were actually getting into the center of the hot spot.
8 It could just kill all the bacteria if it's like
9 phenol.

10 MS. ZEILER: Did you say Loan Star?

11 MR. DIXON: Yeah, Lone Star Steel.

12 MR. TZHOE: Definitely if anybody has any
13 comments, any written or verbal ones. George did bring
14 up a very good point, and that is; what is reasonable?
15 I can tell you what EPA, before I came on board the
16 project manager before me selected a remedy at landfill
17 12, site 12. And they had different components in the
18 landfill and that one was 230 something years. All
19 these remedies after we go through the nine criteria
20 including community acceptance, they also add into what
21 is reasonable. So George is correct.

22 I don't know right now. I can't guarantee right
23 now this will forever be a wildlife refuge. People --
24 it won't turn into a residential, city water will stop
25 and people will actually use that as drinking water. I

1 can't guarantee that. But I can tell you the
2 information I have right now, the EPA has right now, is
3 that this is going to remain a wildlife refuge. Nobody
4 is using that water source as a drinking water source
5 and it's available drinking water source. And that
6 these factors leading to the more of the leeway to the
7 time frame. That's some of the things that we
8 discussed when we evaluate the alternatives.

9 MS. ZEILER: One of the things is that
10 how dependable are those components that we can use. I
11 think entering this into the refuge system really will
12 take an act of congress to remove it. Or it would go
13 through the refuge exchange system. Is that right,
14 Mark? I'm pretty sure that's how this land stays.

15 So it's not like somebody here locally can say,
16 we're going to do something. You can't do that. But
17 your comment is good. We don't know what's going to
18 happen in 50 years or how precious groundwater might be
19 here or whether it has to be used as a source.

20 But if the trappings of our society are still in
21 effect, then we'll know that we have reported in the
22 county those restrictions, and we'll have shown exactly
23 where it is and what the issues are and who can use it
24 and what the risks are. So we'll be able to come back
25 and address it if we need to.

1 MR. TZHOE: So basically if it ever
2 changes, if it ever changes out of fishing and
3 wildlife, if it ever becomes a residential development,
4 if city water ever stops and that gets used, we would
5 immediately stop this remedy that we're proposing and
6 sharing with everybody and get another one of the more
7 active ones. So right now we're progressing along with
8 the scenario as we understand it. That's anticipated
9 for the future. If that ever changes, then we will
10 come back and change the remedy.

11 FAYE: And to ensure that the remedy stay
12 protective, EPA does at a minimum a five year review of
13 the remedy to evaluate and see if it's still protective
14 of human health and the environment.

15 If it's viewed -- if conditions change and the
16 remedy is viewed as not being productive, EPA has every
17 authority to mandate a new remedy.

18 PAUL: I think the Egyptians thought they
19 would never ever excavate their mummies and put them on
20 display either. That 280 years fits into a similar
21 time frame.

22 MAN: What would you get for \$116 million
23 when you talk about complete extraction?

24 MS. ZEILER: Total removal of the
25 landfill.

1 MAN: Total removal of the landfill and
2 all of the contaminated substances as well? So for
3 \$116 million what do you get? What are you talking
4 away for \$116 million?

5 MR. SRIVASTAV: The entire, whatever is
6 under the landfill. It would be a lot more.

7 MS. ZEILER: But remember that any
8 (unintelligible). It's not necessarily going to stay
9 there.

10 PAUL: So that's cost prohibitive. But
11 there was one remedy that was mentioned where it was
12 removal of hot spots, am I correct?

13 MR. TZHOE: Can we put the different
14 alternatives back up there.

15 PAUL: So \$13 million, that may not be a
16 bad bang for your buck there. Can you explain where
17 the hot spots are. How do you find them?

18 MR. SRIVASTAV: I don't know.

19 PAUL: You have a price tag on it though.

20 MR. SRIVASTAV: That's the same question.
21 We're trying not to punch holes all over this landfill
22 so we don't destroy the landfill cap which is doing a
23 pretty good job. You don't punch holes all over. You
24 may risk puncturing a drum or something that was
25 installed, that was put in there. You may end up

1 making things worse than what they are now. That's the
2 risk. So we don't know where the hot spots are. We
3 have no idea.

4 MR. GUICE: Was that a previous study?
5 That's a previous study.

6 MR. TZHOE: And that one probably is also
7 based on an estimated volume calculated with off site
8 disposal.

9 MR. SRIVASTAV: The cost is based on, you
10 know the areas approximately where the cap is. I think
11 there was a map that shows how big the landfill itself
12 was. The cap is bigger than the landfill. Of course,
13 we have to assume how deep it might have been based on
14 some data they probably came across. That's how you
15 calculated the volume. Assuming the entire thing or 80
16 percent of it is hazardous waste. That's how we come
17 with that. But again, it's just an estimate.

18 MR. RICE: Praveen, I understand your
19 concern about possibly making things worse and
20 puncturing the ground. But if there are drums of
21 solvent, say, in the landfill, given the long time
22 period that we're talking about here, you wouldn't
23 expect those drums to last anyway. At some point the
24 drums are going to disappear and whatever is in them
25 would go where it's going to go.

1 MR. SRIVASTAV: Yeah, that's quite
2 possible. But all I'm pointing out are the risks that
3 may happen. Again, we shouldn't forget that a landfill
4 cap is a presumptive remedy for a lot of the DOD sites
5 at the landfill, not the removal of the waste.

6 That's the scenario that the Department of the
7 Army was working on at that point. And our remedy
8 protects that remedy, and plus takes it further to
9 protect the surface water and when you get what's in
10 the groundwater. So I think we're meeting objectives
11 of protection of human health.

12 Yeah, you can do a lot more, but it all comes down
13 to what's practical and what's cost effective.

14 MR. LETOURNEAU: As I understand it,
15 alternative 7 is the option that you've chosen. And as
16 I understand it, the cost for that option is 1,980,000
17 over 30 years; is that correct?

18 MR. SRIVASTAV: Yes.

19 MR. LETOURNEAU: Additional cost after 30
20 years, assuming that this could go to 280, who pays the
21 additional cost after 30 years? That's my question.

22 MS. ZEILER: The Army. The same as the
23 one paying the first 30. Each subsequent 30. Which is
24 actually we the taxpayers.

25 MR. LETOURNEAU: In other words, that's a

1 continuing rolling over factor?

2 MS. ZEILER: Right. And that's kind of
3 the bad thing. We can't see the total long term cost.
4 But on some of the others, we'll see an up front cost,
5 and there's not any long term. It's just a way to look
6 at the data. And plus it's based on -- or to compare
7 alternatives. And it has to be that because that's the
8 30 year liability that the government requires,
9 inspector general requires us, and our liability for 30
10 years so that we can report that.

11 MR. LETOURNEAU: So on any of these
12 alternatives, had they been chosen and after 30 years
13 there's still a problem, regardless of whether there's
14 a land transfer in the next future years, then the Army
15 has -- this is always an agreement that they'll
16 continue to fund this in perpetuity?

17 MS. ZEILER: Right. And I will add that
18 the army goes through phases of trying to get through
19 sites. This is a super fun site that's taken a long
20 time, and we really want to get our remedies in place.

21 We also understand that at some point in the
22 future, not here but all army sites, we may want to go
23 back in and look at optimizing our long term costs.
24 Our environmental sites go in phases. I don't know,
25 probably EPA is the same way. We try to get through

1 certain phases. Our first is the RI/FS stage, and we
2 signed to get remedy in place. We've gotten a remedy
3 in place. And we hope that it's good and long term.

4 If 30 years from now, I think your question is
5 about 30 years, if we see that we're not getting
6 anywhere, and even if our five year -- we may come back
7 and try to optimize at some point, optimize what our
8 long term costs are. We're never forbidden from coming
9 back and doing that.

10 We have the option of coming back and working with
11 our regulators. We might say, we're not getting
12 anywhere. We probably will be identified in five year
13 review.

14 MR. TZHOE: The army is always liable and
15 retains the responsibility for these sites. Whether
16 the army and fishery and wildlife work out a transfer
17 arrangement or whatever happens as far as the refuge
18 goes, as far as these remedy components, the army will
19 always be responsible for implementing them and funding
20 for them.

21 MR. LETOURNEAU: But would the army only
22 be responsible for implementing alternative 7?

23 MR. TZHOE: This is what the army will be
24 responsible for. Right now TCQ and EPA and the army,
25 we agree on -- in our negotiations back and forth we

1 finally agree on alternative 7, and we're proposing it
2 to the public and we're soliciting public comment.

3 Let's just say after public comment, alternative 7
4 gets implemented and we do that five year review like I
5 talked about before. Let's say by year 15, whether
6 it's me or another EPA person, we look at all the
7 information with the state and with the army and
8 fishery and wildlife and we say, you know what,
9 alternative 7, we thought 15 years ago it would work;
10 but now it's not working. We're going to put in
11 another alternative or add to it.

12 Well, the army is still liable and retains the
13 responsibility for that. The Army always retains that
14 responsibility for making sure all those remedial
15 objectives, you know the ones that protect human
16 health, prevent migration of surface water, restore
17 back up to drinking water levels, they're responsible
18 for all that to be met.

19 MR. LETOURNEAU: I just wanted to make it
20 clear our understanding on our own part.

21 PAUL: I would just like to ask George if
22 you have an opinion on this proposal.

23 MR. RICE: I reviewed the proposal plan
24 and a number of the associated documents that support
25 the proposal plan. I don't think that this alternative

1 is adequate. I think that more ought to be done to
2 reduce the length of time that will be required to
3 clean the site up.

4 MR. SRIVASTAV: Remember 280 years is
5 without treatment, and that time will be reduced after
6 we treat the groundwater.

7 MR. TZHOE: Those comments are valid.
8 Like I said, this is one item that the EPA wrestles
9 with; what is reasonable for this scenario? What is
10 reasonable for a wildlife refuge? What is reasonable
11 where it's not residential? What is reasonable where
12 there is contaminated groundwater but no other
13 exposures? What is reasonable where everybody is on
14 safe drinking city water and drinking water? So what
15 is reasonable?

16 So comments like, if George submits comments like,
17 I really think ten years is reasonable, that's
18 something that we could take back and work with EPA
19 headquarters and say, hey, EPA headquarters, nationwide
20 what do you mean by reasonable? Our site teams with
21 the public have some comment that we think this is
22 reasonable, but is this in line with what you guys are
23 seeing overall?

24 MS. ZEILER: But the reality of the
25 answer is, if we were to ask somebody like ten years,

1 we need a technical impracticability because it would be
2 technically impractical to do.

3 MR. TZHOE: Praveen, can you go over how
4 the comments should be submitted and sent.

5 MR. SRIVASTAV: Yes. How do you comment?
6 I guess one is this forum; questions and answers are
7 being recorded. You can also, forms are available in
8 the proposed plan itself. I guess copies were sent out
9 to the members. Also the Marshall Public Library,
10 those are the hours. You can go visit and look at the
11 proposed plan and other information, supporting
12 information. You can send your written comments to
13 Rose. Her address is on there. It's also in the
14 proposed plan in the fact sheet. And you can also mail
15 them. The address is on the screen.

16 The comment period runs through November 8. The
17 transcript will be posted in the admin record. The
18 comments will be summarized and addressed as part of
19 the record.

20 I'm done with the presentation.

21 MS. ZEILER: We're concluding the
22 meeting. Mark and I are going to take transfer
23 questions. If there are no other comments or questions
24 to be made, then this meeting comes to an end. Thank
25 you.

C E R T I F I C A T E

STATE OF LOUISIANA:

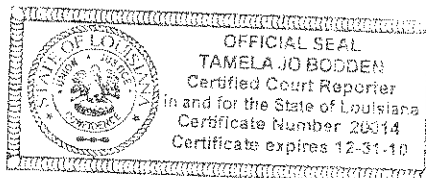
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I, Tamela Jo Bodden, RPR, CCR, CSR, do hereby certify that the said meeting was held at the time and place set forth herein, and consists of the foregoing 51 pages; that the meeting was reported by me and thereafter transcribed to the best of my ability under my supervision and is a true and correct record of the proceedings had at said meeting.

I further certify that I am not of counsel or related to or employed by any of the parties to this cause or in any way interested in the event thereof.

Dated this 14th day of November, 2010.



TAMELA JO BODDEN, RPR, CCR, CSR
Registered Professional Reporter, 8710
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Date: October 25, 2010

Project No.: 117591

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 Record of Decision, LHAAP-58, Shops Area, Group 4,
Longhorn Army Ammunition Plant

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

For: Review ☐ As Requested ☐ Approval ☐ Corrections ☐ Submittal ☐ Other ☒ X

<i>Item No:</i>	<i>No. of Copies</i>	<i>Date:</i>	<i>Document Title</i>
1	2	September 2010	Final Record of Decision, LHAAP-58, Shops Area, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas

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

Sincerely:

Praveen Srivastav
Project Manager

CC: Distribution List:

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Mr. A. Maly – USAEC (electronic only)

Ms. Rose Zeiler – BRAC-LHAAP

Mr. S. Tzhone – EPA Region 6 (2)

Ms. F. Duke – TCEQ, Austin (2)

Mr. D. Vodak – TCEQ, Tyler

Mr. P. Bruckwicki – U.S. Fish and Wildlife Service



DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
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RATCLIFF, AR 72951

October 25, 2010

DAIM-ODB-LO

Mr. Stephen Tzhone
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Superfund Division (6SF-AT)
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Final Record of Decision, LHAAP-35A(58), Shops Area, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2010

Dear Mr. Tzhone,

The above-referenced document is being transmitted to you for your records. The document has been prepared by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility.

The point of contact for this action is the undersigned. I ask that Praveen Srivastav, 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,

A handwritten signature in cursive script, reading "Rose M. Zeiler", is positioned above the typed name.

Rose M. Zeiler, Ph.D.
Longhorn AAP Site Manager

Copies furnished:

F. Duke, TCEQ, Austin, TX
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DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
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October 25, 2010

DAIM-ODB-LO

Ms. Fay Duke (MC-136)
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Remediation Division
Texas Commission on Environmental Quality
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Austin, TX 78753

Re: Final Record of Decision, LHAAP-35A(58), Shops Area, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2010
SUP 126

Dear Ms. Duke,

The above-referenced document is being transmitted to you for your records. The document has been prepared by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility.

The point of contact for this action is the undersigned. I ask that Praveen Srivastav, 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,

A handwritten signature in black ink, reading "Rose M. Zeiler", is positioned below the "Sincerely," text.

Rose M. Zeiler, Ph.D.
Longhorn AAP Site Manager

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S. Tzhone, USEPA Region 6, Dallas, TX
D. Vodak, TCEQ, Tyler, TX
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J. Lambert, USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
A. Maly, USAEC, TX
P. Srivastav, Shaw, Houston, TX (for project files)

FINAL
RECORD OF DECISION
LHAAP-35A(58), SHOPS AREA, GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



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

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

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

September 2010

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Appendix A	Public Meeting Newspaper and Media Notices

Glossary of Terms

Located at the end of this ROD

Acronyms and Abbreviations

µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
AT123D	Analytical Transient One-, Two-, and Three-Dimensional Simulation of Waste Transport in the Aquifer System
BERA	baseline ecological risk assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COC	chemical of concern
COEC	chemical of ecological concern
COPC	chemical of potential concern
CSM	conceptual site model
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
ECOP	environmental condition of property
EPC	exposure point concentration
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FR	Federal Register
FS	feasibility study
ft ²	square feet
GW-Ind	TCEQ groundwater medium-specific concentration for industrial use
GW-Res	TCEQ groundwater medium-specific concentration for residential use
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
Jacobs	Jacobs Engineering Group
LHAAP	Longhorn Army Ammunition Plant
LTM	long-term monitoring
LUC	land use control
MCL	maximum contaminant level
mg/kg-day	milligrams per kilogram per day
MNA	monitored natural attenuation

Acronyms and Abbreviations (continued)

MOA	memorandum of agreement
MSC	medium-specific concentration
MSL	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RDX	1,3,5-Trinitroperhydro-1,3,5-triazine
RFA	RCRA Facility Assessment
RfD	reference dose
RI	remedial investigation
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SF	slope factor
Shaw	Shaw Environmental, Inc.
STEP	Solutions to Environmental Problems, Inc.
SVOC	semivolatile organic compound
TAC	Texas Administrative Code
TCA	trichloroethane
TCDD	tetrachlorodibenzo-p-dioxin
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TNT	trinitrotoluene
U.S. Army	U.S. Department of the Army
USACE	U.S. Army Corps of Engineers
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USC	U.S. Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VC	vinyl chloride
VOC	volatile organic compound

1.0 The Declaration

1.1 Site Name and Location

LHAAP-35A(58), Shops Area, Group 4

Longhorn Army Ammunition Plant
Karnack, Texas

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

1.2 Statement of Basis and Purpose

This decision document presents the selected remedy for LHAAP-35A(58), Shops Area, located at the Longhorn Army Ammunition Plant (LHAAP) in Karnack, Texas. The remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Code of Federal Regulations (CFR) Title 40 §300.

The remedy selection was based on the Administrative Record for the site, including the remedial investigation (RI) (Jacobs Engineering Group, Inc. [Jacobs], 2002), baseline human health risk assessment (BHHRA) report (Jacobs, 2003), installation-wide baseline ecological risk assessment (BERA) report (Shaw Environmental, Inc. [Shaw], 2007a), feasibility study (FS) (Shaw, 2009), Proposed Plan (U.S. Department of the Army [U.S. Army], 2010), and other related documents contained in the Administrative Record for LHAAP-35A(58).

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

1.3 Assessment of the Site

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

1.4 Description of the Selected Remedy

The final selected remedy for LHAAP-35A(58) protects human health and the environment by preventing human exposure to groundwater contaminated with chlorinated solvents

(tetrachloroethene [PCE], trichloroethene [TCE], cis-1,2-dichloroethene [DCE], trans-1,2-DCE, 1,1-DCE, vinyl chloride [VC], 1,1,2-trichloroethane [TCA], 1,1-dichloroethane [DCA], and chloroethane) and preventing groundwater contaminated with chlorinated solvents from migrating into nearby surface water. No principal threat source material has been identified at LHAAP-35A(58). Two separate plumes were identified at LHAAP-35A(58): the eastern plume and the western plume. The remedy components are summarized below for the two plumes.

Eastern Plume

- In situ bioremediation will be implemented in a target area where the highest concentrations of contaminants were detected. It is anticipated that the treatment will enhance biodegradation in portions of the plume outside the treated area.
- Monitored natural attenuation (MNA) will follow in situ bioremediation treatment and reduce contaminants to cleanup levels. Monitoring will be quarterly in Years 1 and 2, and semiannual in Years 3 through 5. In subsequent years, monitoring will be annual until the next five-year review. Monitoring will continue every 5 years until cleanup levels are achieved.
- Land use control (LUC) in the impacted area will ensure the protection of human health by restricting the use of groundwater to environmental monitoring and testing. The LUC will remain in place until the cleanup levels are met.

Western Plume

- MNA will be implemented to verify that the TCE plume is stable and will not migrate to nearby surface water at levels that may present an unacceptable risk to human health and the environment. MNA will return groundwater to its potential beneficial use, wherever practicable. Performance objectives will be evaluated after 2 years of MNA. During those 2 years, monitoring will be quarterly. If MNA is found to be ineffective, a contingency remedy to enhance MNA will be implemented. If MNA is found to be effective, it will be continued, and long-term monitoring (LTM) will be semiannual for 3 years. In subsequent years, LTM will be annual until the next five-year review. The monitoring and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue every 5 years until cleanup levels are achieved.
- LUC in the impacted area will ensure the protection of human health by restricting the use of groundwater to environmental monitoring and testing. The LUC will remain in place until the cleanup levels are met.

Based on a preliminary natural attenuation evaluation and groundwater modeling, cleanup levels are expected to be met through natural attenuation in approximately 200 years in the western plume. The cleanup times for natural attenuation for the eastern plume will be evaluated after in situ bioremediation, but the cleanup times are anticipated to be similar to the western plume. Estimated cleanup times based on first order kinetics are presented in the natural attenuation evaluation in the FS, Appendix A (Shaw, 2009). For the western plume, the estimated cleanup

time is 135 years for 1,1-DCE, and then an additional 70 years for its daughter product VC. Considering the lithologic variability, particularly the lateral and vertical change from sand to clay, the time to achieve cleanup levels may vary. In the course of the remedy, the additional monitoring results will allow more accurate time estimates.

The groundwater flow rates are within the normal range for the formation material at the site. Based on the groundwater flow rate and the distance to surface water, no adverse impact is expected to the surface water during the time it would take natural attenuation to reduce contaminant concentrations to cleanup levels.

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

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

The management strategy at LHAAP is to approach each site separately to address human health issues and to approach the sites by sub-area to address ecological risk. Thus, the implementation of this remedy at LHAAP-35A(58) is independent of any other remedial action at LHAAP to address human health issues. To address ecological risk, LHAAP-35A(58) was grouped with several other sites as part of the Industrial Sub-Area. No chemicals exceeded ecological

thresholds of concern in the Industrial Sub-Area, thus, no action is needed at LHAAP-35A(58) to address ecological risk (Shaw, 2007a).

1.5 Statutory Determinations

For the eastern plume, the selected remedy does satisfy the statutory preference for treatment as a principle element of the remedy. For the western plume, the selected remedy does not satisfy the statutory preference. Although the final selected remedy for the western plume is not intended to address the statutory preference for treatment to the maximum extent practicable, the final selected remedy offers, within a reasonable time frame and at a lower cost, a similar level of protection to human health and the environment than those remedy alternatives which satisfy the preference for treatment. In addition, no source materials constituting principle threats will be addressed within the scope of this action. In addition, the remedy offers long-term effectiveness through the implementation of LUC, which would minimize the potential risk posed by the contaminated groundwater. Further, evaluation of MNA including routine monitoring of the attenuation until cleanup levels are met would document the effectiveness of the selected remedy. The selected remedy is easily and immediately implementable and has a moderate cost compared to the other alternatives considered for LHAAP-35A(58) with the exception of Alternative 1 (No Action).

The selected remedy of MNA for the western plume would reduce the toxicity, mobility, or volume of contaminants in the groundwater through a passive remedial action. The selected remedy of in situ bioremediation and MNA for the eastern plume would reduce the toxicity, mobility, or volume of contaminants in the groundwater through active remediation. There is no known principal threat material or contaminant source in the LHAAP-35A(58) groundwater.

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

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record for this site.

- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater as identified in the baseline risk assessment and ROD (**Section 2.6**).
- Potential land and groundwater use that will be available at the sites as a result of the selected remedy (**Section 2.6**).
- Chemicals of concern (COCs) and their concentrations (**Section 2.7**).
- Baseline risk represented by the COCs (**Section 2.7**).
- Cleanup levels established for COCs and the basis for these levels (**Sections 2.7.3 and 2.8**).
- Absence of source materials constituting principle threats that need to be addressed at this site (**Section 2.11**).
- Key factor(s) that led to selecting the remedy (**Section 2.12**).
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (**Section 2.12**).

1.7 Authorizing Signatures

As the lead agency, the United States Army issues this ROD for LHAAP-35A(58) which documents the final selected remedy. The undersigned is the appropriate approval authority for this decision.

Thomas E. Lederle 29 Sep 2010
(Name) (Date)

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

The United States Environmental Protection Agency approves the selected remedy as provided in the ROD for LHAAP-35A(58).

Samuel Coleman 9-30-10
(Name) (Date)

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

2.0 *Decision Summary*

2.1 *Site Name, Location, and Description*

LHAAP-35A(58), Shops Area

Longhorn Army Ammunition Plant
Karnack, Texas

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

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

Source of Cleanup Money: U.S. Army, Department of Defense
Site Type: Industrial Facility

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

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

LHAAP-35A(58), also known as the Shops Area, is located in the north-central portion of LHAAP. LHAAP-35A(58) is an industrial area (former maintenance complex which included the Shops Area) that provided a wide range of support services. Early investigations for LHAAP-35A(58) covered a larger area that included additional areas to the south. The current boundary covers approximately 11 acres. Located within the boundaries of LHAAP-35A(58) are other sites including LHAAP-02, vacuum truck overnight parking; LHAAP-03, Paint Shop Building 722 (waste collection); LHAAP-60, pesticide storage buildings; LHAAP-68, mobile

storage tank parking; and LHAAP-69, service station underground storage tanks. **Figure 2-2** shows both the historic and current site boundaries.

2.2 *Site History and Enforcement Activities*

2.2.1 *History of Site Activities*

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

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

LHAAP-35A(58), the Shops Area was established in 1942 as part of the installation's initial construction. Plant-operated laundry, automotive, woodworking, metalworking, painting, refrigeration, and electrical shops served the needs of the overall facility. The site was active throughout LHAAP's mission and became inactive in 1996-1997, along with the entire installation.

2.2.2 *History of Investigative Activities*

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

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

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

Several investigations to determine the nature and extent of contamination in the soil, groundwater, surface water, and sediments at LHAAP-35A(58) were conducted and are listed below. Samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, explosive compounds, perchlorate, pesticides, polychlorinated biphenyls (PCBs), dioxins/furans, total petroleum hydrocarbons, and/or polycyclic aromatic hydrocarbons, depending on the focus of the investigation. For some of the earlier investigations, LHAAP sites were organized into groups, and LHAAP-35A(58) was included in Group 4. The group designation was de-emphasized as the complexities of the individual sites became greater. The following summarizes the investigations at LHAAP-35A(58).

- **Multi-phase investigation of Group 4 sites:** Between 1992 and 2001 numerous investigations were conducted in a phased approach by Jacobs, U.S. Army Corps of Engineers (USACE), and BCM Engineers, Inc. Activities included installation of 24 monitoring wells and analysis of groundwater, surface water, sump contents, soil, and sediment samples. The results are documented in the RI for Group 4 sites (Jacobs, 2002). **Figures 2-3** and **2-4** show the soil and groundwater sample locations, respectively, at LHAAP-35A(58).
- **Plant-wide perchlorate investigation:** The investigation was conducted by Solutions to Environmental Problems, Inc. (STEP) in 2000 through 2002 (STEP, 2005). Groundwater samples were collected from five wells.
- **Baseline Human Health Risk Assessment:** The BHHRA (Jacobs, 2003) used data from the investigations conducted through 2001 including the plant-wide perchlorate investigation results up to that time. The report concluded that the soil at LHAAP-35A(58) required no action because the associated carcinogenic risk and non-carcinogenic hazard were acceptable. Groundwater was found to pose unacceptable carcinogenic risk and non-carcinogenic hazard.
- **Environmental Site Assessment:** Media investigated in 2003 included soil and groundwater (Plexus Scientific Corporation, 2005).
- **Baseline Ecological Risk Assessment:** The BERA (Shaw, 2007a) determined that LHAAP-35A(58), as a part of the Industrial Sub-Area, did not have chemicals of

ecological concern (COECs). The evaluation was based on environmental investigations from 1993 to 2006.

- **Data gaps:** Additional investigations were conducted by Shaw in 2004 after the BHHRA was finalized to further delineate the extent of groundwater contamination identified during previous sampling events. The results of the 2004 investigation were presented in the *Data Gaps Investigation* (Shaw, 2007b).
- **Sumps report:** The 146 sumps/waste rack sumps across LHAAP were grouped together and were designated as LHAAP-35/36. Five of these sumps/waste rack sumps were located on LHAAP-35A(58). All sumps were removed from the site in the mid-1990s, and it was determined that no further action is necessary for sump-related soil (Shaw, 2008).
- **Feasibility Study:** The FS (Shaw, 2009) was based on the available results from previous investigations. In addition, it included the natural attenuation evaluation based on sampling results from 2008 and before.

2.2.3 History of CERCLA Enforcement Activities

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

The FS for LHAAP-35A(58) (Shaw, 2009) was issued in December 2009, and the Proposed Plan (U.S. Army, 2010) was issued in January 2010. This ROD follows that Proposed Plan and precedes the more detailed RD.

2.3 Community Participation

The U.S. Army, USEPA, TCEQ and the LHAAP Restoration Advisory Board (RAB) have provided public outreach to the surrounding community concerning LHAAP-35A(58) and other environmental sites at LHAAP. The outreach program has included fact sheets, media interviews, site visits, invitations to attend quarterly RAB and regulatory review meetings, and public meetings consistent with its public participation responsibilities under Sections 113(k)(2)(B), 117(a), and 121(f)(1)(G) of CERCLA.

The Final Proposed Plan (U.S. Army, 2010) for the selection of the remedy for LHAAP 35A(58) was released to the Administrative Record and made available to the public for review and comment on January 25, 2010. A media release was sent to radio stations KTBS, KSLA and KETK on January 18, 2010. The initial notice of availability of the Proposed Plan and other related documents in the Administrative Record file was published in both *The Shreveport Times*

and the *Marshall News Messenger* on both January 17 and 24, 2010. An extension to the public review period was requested. A notice for the 30-day extension and a second public meeting was published in *The Shreveport Times* on February 22 and 28, 2010, and in the *Marshall News Messenger* on February 21 and 28, 2010. The newspaper and media notices for the meetings are provided in **Appendix A**. The public comment period for the Proposed Plan began on January 25, 2010 and ended March 25, 2010. Public meetings were held on January 26, 2010 in an open forum style with informal comments, questions, and discussions, and on March 9, 2010 with a more formal format and a court reporter. The transcript for the meeting on March 9, 2010 is part of the Administrative Record. The significant comments (oral or written) are addressed in the Responsiveness Summary, which is included in this ROD as **Section 3.0**.

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

Location: Marshall Public Library
300 S. Alamo
Marshall, Texas, 75670

Business Hours: Monday – Thursday 10:00 a.m. – 8:00 p.m.
Friday – Saturday 10:00 a.m. – 5:00 p.m.

2.4 Scope and Role of Response Action

The recommended action at LHAAP-35A(58) will prevent potential risks associated with exposure to contaminated groundwater. Although groundwater at Longhorn is not currently being used as drinking water, nor may it be used in the future based on its reasonably anticipated use as a national wildlife refuge, when establishing the remedial action objectives (RAOs) for this response action, the U.S. Army has considered the NCP's expectation to return usable groundwaters to their potential beneficial uses wherever practicable and has also considered the State of Texas designation of all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 TAC 335.563(h)(1). The U.S. Army intends to return the contaminated shallow groundwater zone at LHAAP-35A(58) to its potential beneficial uses, which for the purposes of this ROD is considered to be attainment of the Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C). If an MCL is not available for a chemical, the promulgated TCEQ groundwater medium-specific concentration (MSC) for industrial use (GW-Ind) will be used. If a return to potential beneficial uses is not practicable, the NCP expectation is to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction.

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

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

2.5 *Site Characteristics*

This section of the ROD presents a brief comprehensive overview of the LHAAP-35A(58) site characteristics with respect to the conceptual site model (CSM), physical site features, known or suspected sources of contamination, types of contamination, and affected media. Known or potential routes of contaminant migration are also discussed. Detailed information about the site characteristics can be found in the RI (Jacobs, 2002).

2.5.1 *Conceptual Site Model*

Figure 2-5 illustrates the overall CSM for LHAAP-35A(58) and presents the potential pathways that are being considered for remediation. Pathways that are likely to be incomplete or have negligible impact are not being considered for remediation.

The sources of contamination at LHAAP-35A(58) were most likely spills resulting from the variety of support services that occurred in the area. Sampling of and near the sumps does not indicate them as likely sources of contamination. The spills would result in minor soil contamination that would migrate, depending on the contaminants, through overland flow via surface runoff or through leaching to the groundwater. Overland flow does not currently appear to be contributing to a migration of contaminants, as the ditch surface water did not contain any VOCs, SVOCs, explosives, pesticides, or PCBs. Likewise, the sediment data do not show detections of VOCs, SVOCs, explosives, or pesticides. Some metals were detected in the surface water and sediment at low concentrations that naturally occur.

The other migration pathway, leaching of contaminants to groundwater, is a likely pathway. Although there appears to be no residual soil contamination (no VOCs detected in subsurface soils), VOCs are present in the groundwater. Chlorinated compounds were initially detected in two shallow groundwater wells, LHSMW05 and LHSMW07, separated by approximately 750 feet with differing relative amounts of the contaminants. The shallow well LHSMW06, located between the two contaminated wells, had low concentrations of VOCs with no MCL exceedances; however, TCE, cis-1,2-DCE, and VC were detected in the 2007 sampling round. Two isolated areas of contamination, one centered around LHSMW07, and the other centered around LHSMW05 with its edge approximately at LHSMW04, are present at LHAAP-35A(58).

These two areas are referred to as the eastern and western plumes. An intermediate and a deep well are located immediately adjacent to LHSMW05. An intermediate well is located adjacent to LHSMW07. Contaminants are not found in these wells, suggesting that downward migration has not occurred.

Well LHSMW05, located in the eastern plume, has elevated levels of only TCE and PCE. The maximum concentrations for PCE and TCE in this well are 5,100 and 230 micrograms per liter ($\mu\text{g/L}$), respectively. Both of these concentrations were above the MCL. In February 2007, PCE at 6.4 $\mu\text{g/L}$ was detected for the first time in LHSMW04, approximately 300 feet east of LHSMW05. In 2008, both PCE and TCE were detected in LHSMW04 at concentrations above their MCLs.

LHSMW07, located in the western plume, is near the sampled drainage ditch which flows to Goose Prairie Creek. Another well, 35AWW04, located downgradient from LHSMW07, is closer to Goose Prairie Creek and historically had low levels of VOCs present. VOCs were not detected in well 35AWW04 during the 2004 sampling round. The maximum contaminant concentration detected in LHSMW07 was 576 $\mu\text{g/L}$ of 1,1-DCE in 2008, which is greater than the drinking water MCL. Other VOCs were detected in this well with concentrations of TCE and VC also exceeding their MCLs. A new well, 35AWW06, was installed downgradient of LHSMW07 in 2008. The 1,1-DCE concentration was 57.6 $\mu\text{g/L}$ in this well and the TCE and VC are below their MCLs, but PCE is above its MCL at 7.29 $\mu\text{g/L}$. The nearest downgradient surface water sampling location in Goose Prairie Creek is GPSCW08 (approximately 1,750 feet to the south). No contaminants were detected at this location during the 2004 or earlier sampling events (Jacobs, 2002).

There is little potential for the COCs present in shallow groundwater at LHAAP-35A(58) to adversely impact Goose Prairie Creek. This is based on modeling calculations of the fate and transport of the contaminants, and on the groundwater elevation and the topography. The modeling calculations are further discussed in **Section 2.5.5**. Based on the groundwater elevation and the topography, it is unlikely that the groundwater near LHSMW07 will migrate up to the surface water tributary to Goose Prairie Creek. The nearest creek staff location is approximately 1,000 feet downstream from LHAAP-35A(58) in Goose Prairie Creek. At this location, the creek bottom is approximately 203 feet above mean sea level (MSL). It is expected that the creek bottom elevations near LHAAP-35A(58) would be higher than the 203 feet MSL since the tributary near LHAAP-35A(58) is not deep and the surface elevation is approximately 219 feet MSL. The groundwater elevation on the western side of LHAAP-35A(58) near the creek tributaries is approximately 200 feet MSL. Thus, the groundwater from LHAAP-35A(58) is below the creek bottom and would not flow into the surface water at this location.

2.5.2 Overview of the Site

The current site boundary of LHAAP-35A(58) comprises approximately 11 acres in the north-central portion of LHAAP. In November 2006, USACE evaluated different boundaries for LHAAP-35A(58) that were found in various documents to include the Shops Area and the grounds of a power plant known as the 200 Area. It was recommended that LHAAP-35A(58) should include only the Shops Area and should not include the 200 Area (USACE, 2006). The historic and current site boundaries are shown on **Figure 2-2**.

The surface features are a mixture of asphalt-paved roads, parking area, and wooded and grassy vegetation-covered areas. The topography in this area is relatively flat with the surface drainage flowing into tributaries of Goose Prairie Creek. Runoff from the site enters Caddo Lake via Goose Prairie Creek. LHAAP-35A(58) has no known areas of archaeological or historical importance.

2.5.3 Geology and Hydrogeology

Groundwater is present in shallow, intermediate, and deep zones at LHAAP-35A(58). The shallow, intermediate, and deep zones are encountered at 10 to 25 feet below ground surface (bgs), 60 to 71 feet bgs, and 126 to 140 bgs, respectively. Data gathered from the monitoring wells installed at the site indicated that the groundwater flows radially from near the central southwestern part of the site with an east flow on the eastern side of the site and a south/southeast flow on the western side of the site, as shown in **Figure 2-6**.

For the shallow groundwater zone, hydraulic conductivity values ranged from a minimum value of 3.5×10^{-5} centimeters per second (cm/sec) in the southeast portion of the site to a maximum value of 1.4×10^{-3} cm/sec northwest of the site. The hydraulic conductivity value for the deep groundwater zone is 1.3×10^{-3} cm/sec (Jacobs, 2002).

The soil at LHAAP-35A(58) consists of clays and silty clays with thin lenses of sand. The sand lenses are approximately 3 to 5 feet thick. The depth to the sand lenses varies across the site. A cross-section of the site is shown in **Figure 2-7**.

2.5.4 Sampling Strategy

Several sampling events were conducted at LHAAP-35A(58) from 1992 to 2008, as outlined in **Section 2.2.2** on site investigations. In the early investigations, soil samples were collected from throughout the site to determine the areas of contamination. Subsequent investigations focused on the areas where contamination was found, performing additional soil, groundwater, and sediment sampling and installing monitoring wells to delineate the contamination. Samples were analyzed for various analytes including VOCs, SVOCs, metals, explosives, perchlorate, pesticides, and dioxins/furans. In the area of the contaminant plume, groundwater samples were

also analyzed for indicators of conditions that promote natural attenuation (biodegradation), such as sulfide, methane, and chloride.

2.5.5 *Nature and Extent of Contamination*

Based on the risk assessment and subsequent evaluations, it was determined that the COCs for the shallow groundwater at this site are PCE, TCE, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, VC, 1,1,2-TCA, 1,1-DCA, and chloroethene. The plume boundaries for PCE, TCE, and 1,1-DCE, as determined by their respective MCLs, are shown in **Figure 2-8**. The COCs are toxic and carcinogenic. No principal threat source material (such as dense non-aqueous phase liquid [DNAPL]) was identified or suspected to exist at LHAAP-35A(58).

The eastern plume has a lateral extent of approximately 270,000 square feet (ft²), and a vertical extent of approximately 5 feet. Assuming a total porosity of 0.3, the calculated volume of contaminated groundwater is 3.03 million gallons. The highest concentrations detected for PCE and TCE were 9,590 µg/L and 675 µg/L, respectively, from well 35AWW08, sampled in November 2008. The highest concentrations detected for 1,1-DCE and VC were 24 µg/L and 4.1 µg/L, respectively, from well 1004TW001, sampled in December 2003. Five shallow zone wells are within the eastern plume boundaries (35AWW08, 1004TW001, LHSMW04, LHSMW05, 03WW01), as well as one direct push data point (58DPT04).

The western plume has a lateral extent of approximately 180,000 ft², and a vertical extent of approximately 5 feet. Assuming a total porosity of 0.3, the calculated volume of contaminated groundwater is 2.02 million gallons. In the sampling results from November 2008, the highest concentrations detected for TCE, 1,1-DCE, and VC were 25 µg/L, 576 µg/L, and 14.4 µg/L, respectively, from well LHSMW07; the highest concentration detected for PCE was 7.19 µg/L from well 35AWW06. Three shallow zone wells are within the western plume boundaries: LHSMW07, 35AWW06, and 1004TW006.

Modeling calculations were completed to assess the potential for the COCs present in shallow groundwater at LHAAP-35A(58) to migrate toward and discharge to Goose Prairie Creek. The modeling concluded that contaminants present in the shallow groundwater at the site will not adversely impact Goose Prairie Creek surface water (Shaw, 2007c). The results were obtained by using the transport model Analytical Transient One-, Two-, and Three-Dimensional Simulation of Waste Transport in the Aquifer System (AT123D). AT123D assumes the aquifer to be homogeneous and isotropic. It accounted for advection, dispersion, adsorption, and chemical degradation. There are uncertainties in the use of modeling to estimate the impact of groundwater on surface water. Specifically, the absence of a downgradient well between the site and Goose Prairie Creek precluded the field verification of the model's results.

2.6 Current and Potential Future Land and Resource Uses

2.6.1 Current and Future Land Uses

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

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

The reasonably anticipated future use of LHAAP-35A(58) is as a national wildlife refuge. This anticipated future use is based on a Memorandum of Agreement (MOA) (U.S. Army, 2004) between the USFWS and the U.S. Army. That MOA documents the transfer process of the LHAAP acreage to USFWS to become the Caddo Lake National Wildlife Refuge. Presently the Caddo Lake National Wildlife Refuge occupies approximately 7,000 acres of the 8,416-acre former installation. In accordance with the National Wildlife Refuge System Administration Act of 1966 and its amendments (16 USC 668dd), the land will remain as a national wildlife refuge unless there is a change brought about by an act of Congress, or the land is part of an exchange authorized by the Secretary of the Interior.

2.6.2 Current and Future Surface Water Uses

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

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

2.6.3 *Current and Future Groundwater Uses*

Groundwater in the drinking water aquifer (250-430 feet bgs) near LHAAP is currently used as a drinking water source. The drinking water aquifer should not be confused with the deep zone groundwater described at LHAAP-35A(58), which is encountered at 126 to 140 bgs. There are five active water supply wells near LHAAP. One well is located in and owned by Caddo Lake State Park. The well is completed to a depth of 315 feet and has been in use since 1935. A second well owned by the Karnack Water Supply Corporation services the town of Karnack and is located approximately 2 miles southeast of town. This well is approximately 430 feet deep and has been in use since 1942. The Caddo Lake Water Supply Corporation has three wells located both north and northwest of LHAAP. These wells are identified as Caddo Lake Water Supply Corporation Wells 1, 2, and 3, and all are hydraulically upgradient of LHAAP (Jacobs, 2002). These wells are completed deeper than the deepest zone of contamination at LHAAP. Because of this and the large distance between these wells and LHAAP, water removal from these wells is not expected to affect groundwater flow at the site. In addition, there are several livestock and domestic wells located in the vicinity of LHAAP with depths averaging approximately 250 feet.

Three water supply wells are located within the boundary of LHAAP itself. One well is located at the Fire Station; the second well is located approximately 0.35 miles southwest of the Fire Station. The third well is located north of the USFWS administration building for the Caddo Lake National Wildlife Refuge, near the main entrance to LHAAP. The distances from these wells to LHAAP-35A(58) are approximately 0.39 mile, 0.57 mile, and 1.41 miles, respectively. All three water supply wells were completed at a depth much greater than the zone of contamination described at LHAAP-35A(58). Two additional wells previously supplied water to the installation, but these have been plugged and abandoned. None of these three wells are currently used for drinking water at LHAAP, although they may supply water for non-potable uses.

Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-35A(58) as a drinking water source, the State of Texas designates all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 TAC 335.563(h)(1). To be conservative, a hypothetical industrial use scenario was evaluated for risk. The future industrial scenario for LHAAP assumes limited use of groundwater as a drinking water source.

2.7 *Summary of Site Risks*

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

The site boundary used for the BHHRA was larger than the current limits of LHAAP-35A(58), and some of the maximum detected concentrations used as exposure point concentrations (EPCs) came from wells currently outside of LHAAP-35A(58) and have been incorporated into other areas that are being evaluated separately. The results of this change are further discussed in **Section 2.7.1.5**.

2.7.1 Summary of Human Health Risk Assessment

This section is based on the conclusions presented in the *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites* (Jacobs, 2003), in the *Data Gaps Investigations* (Shaw, 2007b), and in additional data collected in preparation of the *Final Feasibility Study, LHAAP-35A(58)* (Shaw, 2009). The risk assessment used data from the investigations conducted through 2001 including the plant-wide perchlorate investigation. Results from the later investigations did not change the overall outcome of the risk assessment. During the risk assessment, soil and groundwater data were used to calculate the aggregate risk, which was then compared to the USEPA target risk range of 1×10^{-4} to 1×10^{-6} for the excess lifetime carcinogenic risk and to a hazard index (HI) of 1 for non-carcinogenic hazards. If there is no unacceptable risk associated with a medium, and a cleanup level is not exceeded, then the medium is not identified in this ROD for remediation. The CSM that is associated with the risk assessment was introduced in **Section 2.5.1**, and is presented as **Figure 2-5**.

2.7.1.1 Identification of Chemicals of Potential Concern

The BHHRA identified chemicals of potential concern (COPCs) for LHAAP-35A(58) and evaluated the carcinogenic risk and non-carcinogenic hazard for each. **Table 2-1** summarizes the risk assessment data for the COPCs, including minimum and maximum detected concentrations, frequency of detection, and EPCs. Analytical results for various congeners of dioxins and furans are expressed as toxic equivalents of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). The EPCs for bis(2-ethylhexyl)phthalate, aluminum, perchlorate, and 1,3,5-Trinitroperhydro-1,3,5-triazine (RDX) became invalid for the risk assessment for LHAAP-35A(58) when the site boundary was redefined. For these chemicals, the EPCs had been based on wells (LHSMW01 and LHSMW03) that were associated with other sites outside the current LHAAP-35A(58) boundary. This is further discussed in **Section 2.7.1.5**.

2.7.1.2 Exposure Assessment

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

For soil, reasonable exposure pathways according to the CSM are: incidental ingestion of the surface soil (0 to 2 feet bgs), dermal contact with the surface soil, inhalation of particulates, and inhalation of VOCs from the soil (0 to 7 feet bgs). The BHHRA found VOC levels in the soil at

0 to 7 feet bgs to be non-detect; this exposure pathway did not add to carcinogenic risk or non-carcinogenic hazard. Therefore, it was not added to the summary tables in the ROD.

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

2.7.1.3 Toxicity Assessment

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

2.7.1.4 Risk Characterization

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

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

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

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

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ).

An $HQ < 1$ indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An $HI < 1$ indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. An $HI > 1$ indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

Non-carcinogenic $HQ = CDI/RfD$

Where: CDI = chronic daily intake
 RfD = reference dose

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

The carcinogenic risks for soil and groundwater are 2.1×10^{-5} and 1.6×10^{-2} , respectively (Jacobs, 2003). The hazard indices for soil and groundwater are 0.47 and 38, respectively. The carcinogenic risk and non-carcinogenic hazard are both acceptable for soil, and are both unacceptable for groundwater. Therefore, the remedial action focuses on the groundwater. The major contributors to both the carcinogenic risk and non-carcinogenic hazard of groundwater were PCE and 1,1-DCE.

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

2.7.1.5 *Evaluation of COPCs*

To further evaluate the occurrence of COPCs, a data gap investigation was conducted (Shaw, 2007b) and additional investigations were conducted when preparing the FS (Shaw, 2009). While these investigations did not change the overall outcome of the earlier BHHRA, they determined what COCs needed to be targeted by the remedial action, and accounted for the change in the site boundary since the time of the BHHRA. The historical and current site boundaries are shown in **Figure 2-2**. Chemicals that had high detections at a well that is no longer in the current boundary are noted in the discussion below. COPCs with high detections from wells that are no longer part of LHAAP-35A(58) were re-evaluated to determine if they should still be included as a COC for LHAAP-35A(58).

Table 2-6 lists the chemicals that have a HQ greater than 0.1 and **Table 2-7** lists chemicals that have a carcinogenic risk greater than 1×10^{-6} for the hypothetical maintenance worker. These tables also summarize the justifications for which of the COPCs should be classified as COCs. **Table 2-8** presents the outcome of the evaluation, which is the list of COCs that require remediation.

Volatile Organic Compounds

The maximum concentration of 1,1-DCE in groundwater (1,340 µg/L) was from LHSMW07 in 1996 and exceeded the MCL (7 µg/L). The most recent groundwater sample result, 576 µg/L from LHSMW07 in 2008, still exceeds the MCL. Thus, 1,1-DCE is considered a COC in the shallow groundwater zone at LHAAP-35A(58).

The maximum concentration of PCE in groundwater (9,590 µg/L) was from 35AWW08 and exceeded the MCL (5 µg/L). PCE is considered a COC in the shallow groundwater zone at LHAAP-35A(58).

The maximum concentration of VC in groundwater (10 µg/L) was from LHSMW07 in 1996 and exceeded the MCL (2 µg/L). The most recent groundwater samples from LHSMW07 in 2008 of 14.4 µg/L still exceed the MCL. Thus, VC is considered a COC in the shallow groundwater zone at LHAAP-35A(58). VC concentrations that exceed the MCL consistently occur with the 1,1-DCE concentrations that exceed the MCL, so no separate VC extent is shown on **Figure 2-8**.

The maximum concentration of TCE in groundwater (675 µg/L) was from 53AWW08 in 2008 and exceeded the MCL (5 µg/L). TCE is considered a COC in the shallow groundwater zone at LHAAP-35A(58).

The maximum concentration of 1,2-DCA in groundwater (3 µg/L) was from LHSMW07 in 1996 and is less than the MCL (5 µg/L). Thus, 1,2-DCA is not considered a COC at LHAAP-35A(58).

The maximum concentration of 1,1,2-TCA in groundwater (8 µg/L) was from LHSMW07 in 1996 and exceeded the MCL (5 µg/L). 1,1,2-TCA was detected at LHSMW07 in 2008 at a concentration of 1.92 µg/L. Even though the most recent groundwater sample was less than the MCL, 1,1,2-TCA is included as a COC at LHAAP-35A(58) for LTM.

Semivolatile Organic Compounds

The EPC used in risk assessment for bis(2-ethylhexyl)phthalate in groundwater (88 µg/L) was from LHSMW03 in 1994 and exceeded the MCL (6 µg/L). The well LHSMW03 is outside the LHAAP-35A(58) boundary, so the EPC based on that well is not valid. Bis(2-ethylhexyl)phthalate was detected in 2 of the 19 groundwater samples analyzed between 1994

and 2003. The results were all less than the MCL except for a 1998 estimated concentration of 12 µg/L at 35AWW02. That result was concluded to be anomalous (Jacobs, 2002). Bis(2-ethylhexyl)phthalate is also a common laboratory contaminant. Thus, bis(2-ethylhexyl)phthalate is not considered a COC at LHAAP-35A(58).

Metals

The risk assessment reported that the maximum concentration of manganese, 5,800 µg/L from LHSMW05 in 1994, is a contributor to the groundwater noncancer hazard (1.2) (Jacobs, 2003). This maximum manganese concentration is less than the LHAAP perimeter well groundwater background value (95% upper tolerance limit) of 7,820 µg/L (Shaw, 2007d). The most recent manganese sample from LHSMW05 in 1998 had a maximum concentration of 4,070 µg/L. This suggests that the maximum value from 1994 may have been in part due to suspended solids in the sample. Additionally, manganese from the new well 35AWW06 was 5,320 µg/L in November 2008, which is below the promulgated GW-Ind of 14,000 µg/L. Thus, manganese is not considered a COC for LHAAP-35A(58).

The maximum aluminum concentration in groundwater (98,200 µg/L), used as the EPC, was from LHSMW03 in 1994. The well LHSMW03 is outside the LHAAP-35A(58) boundary, so the EPC based on that well is not valid. The maximum aluminum concentration in groundwater (35,400 µg/L) at LHAAP-35A(58) was from LHSMW05 in 1994. In 1998, the aluminum concentration at LHSMW05 was 2,400 µg/L. This suggests that the fluctuations in maximum values from 1994 may be due to sampling methods used and may have been due to suspended solids in the sample. The maximum concentration of aluminum in the 1998 groundwater samples at LHAAP-35A(58) was 4,800 µg/L from 35AWW03, which was dry in 2008. The maximum aluminum concentration in 2008 was 2,610 µg/L at 35AWW07. This concentration is about 3% of the EPC used in the risk assessment. Thus, the HQ would be well below 1, and aluminum is not considered a COC at LHAAP-35A(58).

The maximum concentration of nickel in groundwater (1,100 µg/L), used as the EPC, was from LHSMW05 in 1996. Nickel was detected in 14 of the 16 groundwater samples analyzed between 1996 and 2003. In 1998, the nickel concentration at LHSMW05 was 240 µg/L. This is about 22% of the EPC concentration. It was noted that the two samples with the highest nickel concentrations (both at LHSMW05) also have the highest chromium concentrations. In 2008, the maximum nickel concentration (1,900 µg/L) was also associated with the highest chromium concentration. LHSMW05 and LHSMW04 were installed at the same time. That suggests that nickel and chromium detection are co-related. The wells are constructed of stainless steel, which contains both chromium and nickel. All steel alloys are susceptible to corrosion when in contact with groundwater. The localized nickel detections suggest that the elevated nickel concentrations may be related to well construction material, rather than from site-related

activities. Additionally, nickel is below the proposed cleanup goal of 2,000 µg/L based on the GW-Ind. Thus nickel is not considered a COC at LHAAP-35A(58).

The maximum concentration of thallium in groundwater (3.6 µg/L), used as the EPC, was from LHSMW07 in May 1998 and exceeded the MCL (2 µg/L). Thallium was detected in 5 of the 20 groundwater samples analyzed between 1994 and 2003. Thallium results from November 1998 have a maximum concentration of 1.8 µg/L (estimated value), and the most recent thallium result from November 2008 had a concentration of 0.000129J µg/L (estimated value). It appears that earlier samples contained more thallium than recent samples, indicating that thallium in the groundwater could be considered an artifact of turbid samples collected during historic sampling rounds. Thus, thallium is not considered a COC for LHAAP-35A(58).

The maximum concentration of strontium in groundwater (23,000 µg/L), used as the EPC, was from LHSMW07 in 1998. The strontium concentration at LHSMW07 from 2008 was almost the same at 23,300 µg/L. The maximum strontium concentration of 23,000 µg/L is well below the GW-Ind value of 61,000 µg/L. Thus, strontium is not considered a COC at LHAAP-35A(58).

Two detections of antimony in 1998 were above the MCL of 6 µg/L. The maximum concentration of antimony in groundwater (13 µg/L), used as the EPC, was from 35AWW03 in 1998. Metals were only analyzed for once at 35AWW03, and the well was dry in 2008. At 35AWW04, antimony was detected at 10 µg/L in September 1998. A second sample was collected and analyzed after the November 1998 sample, and antimony was not detected above 5 µg/L. This suggests that sampling methodology could have affected the result. The most recent detected result of 2.53 µg/L at 35AWW02 in 2008 was less than the MCL. Thus, antimony is not considered a COC for LHAAP-35A(58).

The maximum concentration of selenium in groundwater (65.8 µg/L), used as the EPC, was from LHSMW07 in 1996 and exceeded the MCL (50 µg/L), but had an HQ of only 0.13. The most recent selenium result at LHSMW07, from November 2008, had a detection of selenium at 90 µg/L. The HQ for 2008 selenium concentration using a ratio of HQ to EPC/maximum concentration would yield an HQ of 0.18 which is acceptable, and selenium is not considered a COC for the hypothetical future maintenance worker LHAAP-35A(58).

The maximum concentration of cobalt in groundwater (250 µg/L), used as the EPC, was from LHSMW05 in 1998. The highest concentrations of cobalt were isolated to LHSMW05. The maximum cobalt concentration of 250 µg/L is well below the GW-Ind value of 6,100 µg/L. Thus, cobalt is not considered a COC at LHAAP-35A(58).

Perchlorate and RDX

The maximum concentration of perchlorate in the groundwater (81 µg/L) used as the EPC was from LHSMW01 in 2001. Redefinition of the LHAAP-35A(58) boundary in 2006 put the well outside the current site boundary. Therefore, the EPC from LHSMW01 is not applicable to LHAAP-35A(58), and the well is being addressed under LHAAP-04. Perchlorate was not detected in the most recent 2007 samples collected from wells LHSMW04, LHSMW06, and LHSMW07 located at LHAAP-35A(58). Thus, perchlorate is not considered a COC at LHAAP-35A(58).

The maximum concentration of RDX in the groundwater (88.3 µg/L) from LHSMW03 in 1996 was used as an EPC in the 2003 risk assessment. A subsequent result in May 1998 was 1.3 UJ µg/L. Redefinition of the LHAAP-35A(58) boundary in 2006 resulted in well LHSMW03 lying outside the current site boundary. Because RDX was not detected in any other wells within LHAAP-35A(58), RDX is not considered a COC.

2.7.2 Summary of Ecological Risk Assessment

The ecological risk for LHAAP-35A(58) was addressed in the installation-wide BERA (Shaw, 2007a). The BERA provides a process that evaluates the likelihood that adverse ecological effects may occur, or are occurring, as a result of exposure to one or more stressors. A stressor is any physical, chemical, or biological entity that can induce an adverse ecological response. The BERA for LHAAP focuses only on chemical stressors.

Ecological risk does not exist unless:

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

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

LHAAP-35A(58) lies within the Industrial Sub-Area, and the BERA concluded that no chemicals exceeded ecological thresholds of concern in the Industrial Sub-Area (Shaw, 2007a). Thus, there are no COECs at LHAAP-35A(58). Therefore, no action is needed at LHAAP-35A(58) for the protection of ecological receptors.

2.7.3 *Basis of Action*

The remedial action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment. The conclusion reached by the FS investigation and subsequent investigations is that the COCs for groundwater at LHAAP-35A(58) are PCE, TCE, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, and VC. There are no COCs for soil. **Table 2-8** presents the cleanup levels for the COCs. The table includes cleanup levels for 1,1,2-TCA and its daughter products 1,1-DCA and chloroethane, even though they are not currently classified as COCs due to their low detections during recent sampling. However, 1,1,2-TCA and its daughter products will be included for inclusion as COCs for LTM as described in **Section 2.12.2** because the historical level of 1,1,2-TCA was a concern in the past.

A SDWA MCL has been determined for each of the COCs except for 1,1-DCA and chloroethene. For the chemicals with an MCL that has been determined, the MCL is used as the cleanup level. If no MCL exists, the GW-Ind is used as the cleanup level (TCEQ, 2006).

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

2.8 *Remedial Action Objectives*

The RAOs for LHAAP-35A(58), which address contamination associated with the media at the site and take into account the future uses of LHAAP streams, land, and groundwater are:

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

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

2.9 Description of Alternatives

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

2.9.1 Description of Remedy Components

Alternative 1 – No Action

As required by the NCP, the no action alternative provides a comparative baseline against which the action alternatives can be evaluated. Under this alternative, groundwater would be left “as is” without implementing any additional monitoring, containment, removal, treatment, or other mitigating actions. No actions would be implemented to reduce existing or potential future exposure to human receptors, although natural attenuation would be ongoing.

Estimated Capital Present Worth Cost: \$0

Estimated O&M Present Worth Cost: \$0

Cost Estimate Duration: --

Estimated Present Worth Cost: \$0

Alternative 2 – Monitored Natural Attenuation and Land Use Control

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

- MNA to return groundwater to its potential beneficial use, wherever practicable
- Performance objectives to evaluate the MNA remedy performance after two years
- LTM semiannually for three years, annually until the next five-year review, then once every five years to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen until cleanup levels are reached
- A contingency remedy to enhance MNA to reach the RAOs if MNA is found to be ineffective
- LUC to restrict access to the contaminated groundwater until the cleanup levels are reached

Estimated Capital Present Worth Cost: \$60,500

Estimated O&M Present Worth Cost: \$432,300

Cost Estimate Duration: 30 years

Estimated Present Worth Cost: \$492,800

Alternative 3 – In Situ Bioremediation, Short Term LUC and LTM

The major components of this alternative include the following:

- In situ bioremediation in a target area that has the highest contaminant concentrations at each of the two plumes
- MNA with LTM to reduce groundwater contamination to cleanup levels
- LUC until the cleanup levels are achieved

Estimated Capital Present Worth Cost: \$860,000

Estimated O&M Present Worth Cost: \$483,000

Cost Estimate Duration: 10 years

Estimated Present Worth Cost: \$1,343,000

Alternative 4 – In Situ Bioremediation for Eastern Plume followed by MNA and LUC; MNA and LUC for Western Plume

In this alternative, the western and eastern plumes have separate treatments. The major components of this alternative include the following:

Eastern plume

- In situ bioremediation in a target area that has the highest contaminant concentrations
- MNA with LTM to reduce groundwater contamination to cleanup levels
- LUC until the cleanup levels are achieved

Western plume

- MNA to return groundwater to its potential beneficial use, wherever practicable
- Performance objectives to evaluate the MNA remedy performance after two years
- LTM semiannually for three years, annually until the next five-year review, then once every five years to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen until cleanup levels are reached
- A contingency remedy to enhance MNA to reach the RAOs if MNA is found to be ineffective
- LUC until the cleanup levels are achieved

Estimated Capital Present Worth Cost: \$191,000

Estimated O&M Present Worth Cost: \$594,000

Cost Estimate Duration: 30 years

Estimated Present Worth Cost: \$785,000

2.9.2 *Common Elements and Distinguishing Features of Each Alternative*

Common Elements of Alternatives 2, 3, and 4

Common elements of Alternatives 2, 3, and 4 are described below.

MNA – MNA is a passive remedial action that relies on natural biological, chemical, and physical processes to reduce the mass and concentrations of groundwater COCs under favorable conditions. The natural attenuation evaluation indicates that MNA is a feasible technology for the groundwater in the western plume at LHAAP-35A(58) (Shaw, 2009). Alternative 2 would implement MNA in both the eastern and western plumes. Alternative 4 will implement only MNA in the western plume. In Alternatives 3 and 4, natural attenuation would reduce contaminant concentrations in areas outside of the treated target areas. Monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume.

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

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

In order to transfer this property (LHAAP-35A[58]), an Environmental Condition of Property (ECOP) document would be prepared and the Environmental Protection Provisions from the

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

Inspection/Long-Term Groundwater Monitoring – Alternatives 2, 3, and 4 include inspection and long-term groundwater monitoring activities. Monitoring would be continued as required to demonstrate effectiveness of the remedy, to demonstrate compliance with applicable or relevant and appropriate requirements (ARARs) and RAOs, and to support five-year reviews.

Distinguishing features of Alternatives 3 and 4

The distinguishing feature of Alternative 3 and 4 compared to Alternative 2 is the inclusion of in situ bioremediation action. The components of this action are described below.

Determining effective treatment – Currently shallow monitoring wells 35AWW06, 35AWW08, 03WW01, LHSMW04, LHSMW05, and LHSMW07 are impacted. Contaminated groundwater is present in shallow thin sand lenses which occur in a formation consisting primarily of clays and silty clays. Two separate plumes are evident. Alternative 2 and 3 uses the same process options in both plumes. Alternative 2 would implement MNA in both plumes. Alternative 3 would implement in situ bioremediation in both plumes. Alternative 4 would implement in situ bioremediation in the eastern plume, because the natural attenuation evaluation (Shaw, 2009) indicated that there was sufficient evidence of natural attenuation in the western plume, and less evidence of it in the eastern plume. A bench-scale treatability study may be conducted during the design phase to determine the most effective bioaugmentation additive (i.e., quantities and types of microbial cultures and nutrients to accelerate attenuation in a shorter time and/or disperse to treat a larger area).

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

Injecting microbial cultures and nutrients into the subsurface – Bacteria present in the groundwater can use chlorinated solvents as electron acceptors. Electron donors may include a wide variety of nutrients: sugars (molasses), alcohols (methanol, ethanol), volatile acids (acetate, lactate), and/or wastes (food processing, manure). The COCs at LHAAP-35A(58) can degrade under anaerobic conditions, but microorganisms, mechanisms, and redox requirements differ. Based on results of the treatability study, bioaugmentation additives, appropriate nutrients and other materials, would be injected into the subsurface. For this ROD, it is assumed that bioaugmentation will be used at the site. This form of bioremediation combines the injection of microbial cultures capable of degrading the contaminants with a carbon source to provide adequate conditions for the proliferation of the dechlorinating organisms. For costing purposes, it is assumed that Alternative 3 will include 70 injection points installed using direct-push technology, and Alternative 4 will include 10 injection points. It is anticipated that the bioaugmentation material would be injected twice and that the injection would occur in the shallow zone, at approximately 20 feet bgs.

Sampling wells to monitor effectiveness – Monitoring for contaminants, bacteria, and geochemical parameters would be performed to assess the effectiveness of the treatment. Anticipated remediation times may be short with appropriate contact. Assuming first order anaerobic degradation rates and reasonable half-lives for the COCs, the COCs within the treated areas could be reduced to their respective cleanup levels in approximately 2 to 3 years. However, it is anticipated that COCs will remain in the plumes outside the treated areas and will attenuate to levels below MCLs over time. The MNA sampling will occur quarterly for the first 2 years. The LTM will then be conducted semiannually for years 3 through 5, then annually until the next five-year review, then once every 5 years. This frequency has been assumed for the estimate. Periodic reports will be prepared to document the monitoring program.

Injecting additional substrate – It is also assumed for the cost estimate that a second bioaugmentation treatment in the area of highest contamination may be required during year 2 of the remediation program to further treat COCs. However, this would only occur if warranted based on the first six quarters of data.

2.9.3 Expected Outcomes of Each Alternative

Alternative 1 would allow the site to remain a hazard to human health, since it simply leaves the site as is. Alternatives 3 and 4 have very similar outcomes, and the main difference is in the time required to reach the cleanup levels, which is anticipated to occur in 10 years for Alternative 3, 200 years for Alternative 4, and longer than 200 years for Alternative 2. The similar outcomes are considered to be attainment of the SDWA MCLs to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C). For the daughter products of TCA (1,1-DCA and chloroethane), no MCL has been promulgated, so the GW-Ind is used in place of the MCL, in accordance with 30 TAC 335. In addition, the monitoring activities associated with MNA would

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

2.10 *Summary of Comparative Analysis of Alternatives*

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

2.10.1 *Overall Protection of Human Health and the Environment*

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

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

Alternatives 2, 3, and 4 satisfy the RAOs for LHAAP-35A(58). Alternatives 2, 3 and 4 provide confirmation that human health and the environment will be protected because monitoring will be conducted to ensure that MNA is returning the contaminated shallow groundwater zone at LHAAP-35A(58) to its potential beneficial uses as a drinking water, wherever practicable, and to document that the plumes are contained and prevented from impacting surface water at levels that could present a risk to human health and the environment. Furthermore, the LUC would protect human health by preventing access to the contaminated groundwater until contaminants in the groundwater attain the cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) for all contaminants above the cleanup levels and attain the cleanup levels for all contaminant by-products (daughter contaminants) above the cleanup levels.

2.10.2 *Compliance with ARARs*

Section 121(d) of CERCLA and NCP §300.430(f)(1)(ii)(B) requires that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and State

requirements, standards, criteria, and limitations, which are collectively referred to as “ARARs” unless such ARARs are waived under CERCLA Section 121(d)(4). The ARARs that pertain to this ROD are discussed in **Section 2.13.2**.

Because contaminated groundwater has the potential to discharge to surface water features that flow to Caddo Lake, a drinking water supply, chemical-specific ARARs for surface water consumption are appropriate and relevant. Specifically, Texas surface water quality standards are set forth in 30 TAC 307.6(d)(1) for PCE (5 µg/L), TCE (5 µg/L), 1,1,2-TCA (5 µg/L), 1,1-DCE (7 µg/L), and VC (2 µg/L) for LHAAP-35A(58). These standards are equivalent to the MCLs. For contaminants that are not listed in 30 TAC 307.6(d)(1), the TCEQ groundwater MSC for residential use (GW-Res) for cis-1,2-DCE (70 µg/L) (MCL), trans-1,2-DCE (100 µg/L) (MCL), 1,1-DCA(3,700 µg/L) (non-MCL), and chloroethane (15,000 µg/L) (non-MCL) apply.

Alternative 1 does not comply with chemical-specific ARARs because no additional remedial action would be implemented. Alternatives 2, 3, and 4 return the contaminated shallow groundwater zone at LHAAP-35A(58) to its potential beneficial use as drinking water, wherever practicable, which for the purposes of this ROD is considered to be attainment of the relevant and appropriate cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C) and 30 TAC 335. If a return to potential beneficial uses is not practicable, these alternatives would still meet the NCP expectation to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. Alternative 2 does comply with surface water ARARs because modeling results indicate that MNA will reduce TCE, 1,1-DCE, and PCE concentrations in groundwater to the cleanup levels prior to discharge as base flow into surface water; monitoring would be used to confirm it.. Alternatives 3 and 4 also comply with surface water chemical specific ARARs because active remedial processes will reduce contaminant levels in groundwater to levels below water quality standards prior to discharge as base flow into surface water.

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

2.10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

For Alternative 1, contaminant removal would occur by natural attenuation processes, but the long-term effectiveness and permanence would be unknown because of the absence of monitoring. Also, no measures would be implemented to control exposure risks posed by contaminated site groundwater.

Alternative 2 offers a moderate degree of long-term effectiveness through the implementation of MNA with LUC, which would minimize the potential risk posed by the contaminated groundwater. Alternative 2 may pose the same risk as Alternative 1 if MNA is not effective, the plume is not stable and migrates. Alternatives 3 and 4 use active in situ bioremediation which will reduce groundwater contaminant concentrations. The long-term effectiveness of the in situ bioremediation may be limited by: 1) the nature of the permeable water-bearing zones; and 2) the distribution and presence of COCs remaining in the groundwater in untreated areas. Alternatives 2, 3 and 4 are remedial actions that would permanently reduce contaminant levels in the groundwater over time and return the groundwater to its potential beneficial use as drinking water wherever practicable, with Alternative 3 requiring the least amount of time. Monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume.

2.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

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

Alternative 1 has the potential to reduce the mass and concentration of contaminants through natural attenuation processes, although the progress would be unmonitored and undocumented. Alternative 2 would use MNA to permanently reduce the mass and concentration of contaminants through natural processes and, therefore, the volume, toxicity and mobility of the contaminants. Alternatives 3 and 4 would use in situ bioremediation to achieve the same reductions in contamination that are expected from Alternative 2. MNA is a passive remedial action, and bioremediation is an active treatment process.

Biological activity would generate daughter products that may temporarily increase toxicity or mobility of the contaminant plume. Alternatives 2, 3, and 4 include monitoring so that daughter products would be quantified, documented, and evaluated. The same biological activities would also consume the daughter products, and it is anticipated that these concentrations would be reduced to levels below their associated cleanup levels to return groundwater to its potential beneficial use as drinking water, wherever practicable.

Achievement of cleanup levels in groundwater would be expedited under Alternative 3 or 4 by implementing in situ bioremediation treatment in areas of highest contaminant concentrations in

the groundwater. It is noted that monitoring for contaminants would be performed to assess the effectiveness of the treatment. Also, it is anticipated that COCs will remain above cleanup levels in the plume outside the treated areas and will continue to attenuate to levels below cleanup levels over time.

2.10.5 Short-Term Effectiveness

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

Because Alternative 1 does not involve any remedial measures, no short-term risk to workers, the community or the environment would exist. The activities associated with Alternative 2, 3, and 4 are protective to the surrounding community from short-term risks. Alternatives 2, 3, and 4 involve potential short-term risks to workers associated with exposure to contaminated groundwater and operation of drilling/construction equipment. Alternatives 3 and 4 require more drilling/construction activities than Alternative 2. MNA presents negligible risks to workers associated with the exposure to contaminants during groundwater monitoring activities.

Since Alternatives 2, 3, and 4 contain LUC as an element of their remedies, they would provide almost immediate protection through implementation of LUC that prohibits installation of wells for any purposes other than environmental monitoring and testing. The time period to achieve groundwater cleanup levels is a significant difference between Alternatives 2, 3, and 4. Alternative 3 is expected to take the least time to achieve RAOs.

2.10.6 Implementability

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

Under the no action alternative, no remedial action would be taken. Therefore, no difficulties or uncertainties would be associated with its implementation. Alternative 2 is easily implemented from a technical standpoint because no construction activities would be performed, although the U.S. Army would be responsible for long-term maintenance and enforcement of the LUC, long-term evaluation of MNA, long-term sampling; and long-term maintenance and operation of sampling equipment.

Alternatives 3 and 4 are also technically implementable, although less so than Alternative 2 because of the uncertainties associated with the effective field implementation of in situ bioremediation to lower contaminant levels and to enhance natural attenuation. These alternatives would be somewhat more difficult to implement due to the specialized expertise required for design and construction.

Administratively, all of the alternatives are implementable.

2.10.7 Cost

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

The cost estimates include capital costs (including fixed-price remedial construction) and long-term O&M costs (post-remediation). Present worth costs were developed for each alternative assuming a discount rate of 2.8 percent. The estimates for Alternatives 2 and 4 utilize a 30-year project life for costing purposes, although the timeframe to achieve RAOs is expected to be longer. Alternative 3 would be expected to be complete approximately 10 years after injection.

The progression of present worth costs from the least expensive alternative to the most expensive alternative is as follows: Alternative 1, Alternative 2, Alternative 4, and Alternative 3. No costs are associated with Alternative 1 because no remedial activities would be conducted. Alternative 2 has the lowest present worth and capital costs of the remedial action alternatives. The highest capital cost is associated with Alternative 3 primarily due to the activities associated with the injection phase of in situ bioremediation into both plumes.

2.10.8 State/Support Agency Acceptance

The USEPA and TCEQ have reviewed the Proposed Plan, which presented Alternative 4 as the preferred alternative. Comments received from the USEPA and TCEQ during the Proposed Plan development have been incorporated. Both agencies concur with the selected remedial action.

2.10.9 Community Acceptance

Community acceptance is an important consideration in the final evaluation of the selected remedy. Public comments were received during the 60-day public comment period, including written comments sent to the U.S. Army and verbal comments made at the January 26, 2010 and March 9, 2010, public meetings. Two sets of comments were submitted by the public. Questions included: the timeframe to achieve MCLs, potential for contamination of surface water by groundwater, and adequacy of monitoring wells for determining the plume extent. Comment responses were provided and incorporated into the ROD, including clarification of times to restoration, surface water-groundwater interaction, and explanation of why current well locations provide satisfactory data for determining plume extent. Significant comments are

discussed in the Responsiveness Summary (**Section 3.0**). Responses to written comments have been filed in the Administrative Record.

2.11 Principal Threat Wastes

LHAAP-35A(58) has no known principal threat wastes (e.g., source materials such as DNAPLs).

2.12 The Selected Remedy

2.12.1 Summary of Rationale for the Selected Remedy

Alternative 4, in situ bioremediation followed by MNA and LUC for the eastern plume and MNA and LUC for the western plume, is the selected alternative for LHAAP-35A(58) and is consistent with the intended future use of the site as a wildlife refuge. This alternative is selected because it satisfies the RAOs for the site through groundwater use restriction LUC, which will ensure protection of human health by preventing human exposure to contaminated groundwater, and MNA and in situ bioremediation, which will return the contaminated water to its potential beneficial use as a drinking water, wherever practicable. The LUC will remain in place until cleanup levels are met. Furthermore, LTM will assure that human health and the environment are being protected by verifying that contaminated groundwater does not migrate into nearby surface water bodies at levels that exceed MCLs. The LTM and reporting associated with this remedy will continue until primary COC and daughter product cleanup levels are attained. Based on a preliminary natural attenuation evaluation and groundwater modeling, groundwater cleanup levels are expected to be met through natural attenuation in approximately 200 years in the western plume (Shaw, 2009) and within the same timeframe for the eastern plume. Considering the lithologic variability, particularly the lateral and vertical change from sand to clay, the times to the cleanup levels may vary. The groundwater flow rates are within the normal range for the formation material at these sites. Thus, no adverse impact is expected to the surface water during the time it would take natural attenuation to reduce contaminant concentrations to cleanup levels. The selected alternative offers a high degree of long-term effectiveness, can be implemented, and costs less than the Alternative 3.

The performance of MNA in the western plume will be evaluated after two years of performance monitoring using data from eight quarterly sampling events and from the historical sampling events of the prior ten years. The performance objectives for groundwater remediation will be included in the RD. If it is found that the performance objectives are not met, a contingency remedy such as in situ bioremediation (see Alternative 3 description for basic elements) will be implemented, after approval of the RD for the contingency remedy. If MNA is found to be effective, the LTM program will be conducted as follows: 3 years of semiannual monitoring, then annual monitoring until the next five-year review, and then every 5 years until the cleanup levels are reached.

Based on the information currently available, the U.S. Army believes that the selected alternative provides the best balance of tradeoffs among the other alternatives with respect to the CERCLA §121(b) criteria used to evaluate remedial alternatives. The selected alternative will: 1) be protective of human health and the environment; 2) comply with ARARs; 3) be cost-effective; 4) utilize a permanent solution; and 5) utilize treatment as a principal element. No source materials constituting a principle threat will be addressed within the scope of this action.

The U.S. Army will present details of the LUC implementation plan, the groundwater monitoring plan, and the MNA remedy implementation in an RD for LHAAP-35A(58).

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

2.12.2 Description of the Selected Remedy

The selected remedy, Alternative 4, was outlined in **Section 2.9**; that description is expanded in the following discussion. The remedy may change somewhat as a result of the RD and construction processes. Changes to the remedy described in the ROD will be documented using a technical memorandum in the Administrative Record, an Explanation of Significant Differences (ESD), or ROD amendment.

The major components of the remedy for the impacted groundwater include:

Eastern plume

- *In situ bioremediation in a target area that has the highest contaminant concentrations.* A bench-scale treatability study will be conducted to evaluate the effects of plume-specific conditions on the effectiveness of the bioremediation design, and the RD would be adjusted accordingly. Both nutrients and microbes will be injected. Following the study, bioremediation will be implemented in the target area. The treatment will be evaluated, and a second round of injections will be considered when the results from 6 quarterly sampling events are available.
- *MNA to reduce groundwater contamination to cleanup levels.* MNA will be implemented in the plume area that is outside of the target area. It will be evaluated as described below for the western plume. LTM will be conducted to evaluate the remedy performance and determine if the plume conditions remain constant, improve or worsen after the baseline is established. The performance monitoring plan will be developed in the RD and will be based on USEPA guidance (USEPA, 2004).
- *LUC until the cleanup levels are achieved.* LUC for the eastern plume would be similar as those described below for the western plume.

Western plume

- *MNA to return groundwater to its potential beneficial use, wherever practicable.* Historic data suggests that natural attenuation of COCs is occurring at the site;

however, additional data collection is necessary to fully evaluate natural attenuation. Monitoring wells will be sampled for eight consecutive quarters to evaluate and confirm the occurrence of natural attenuation in conjunction with historical data. Data from the eight quarterly events will be combined with historic data to evaluate the effectiveness of various natural physical, chemical, and biological processes in reducing contaminant concentrations.

- *Performance objectives to evaluate the MNA remedy performance after two years.* During the RD prior to implementing the remedy, the specific evaluation criteria will be developed. However, each of the general performance objectives must be met as indicated below. If the criteria are not met to illustrate that MNA is an effective remedy, a contingency action would be initiated. If MNA is effective, a baseline will be established from the data to this point in time. The MNA evaluation will be based on the USEPA lines of evidence (USEPA, 1999) and the anaerobic screening (USEPA, 1998) as follows:
 - MNA potential based on evaluating biodegradation screening scores using USEPA guidance
 - Plume stability (i.e., the plume concentrations are decreasing in the majority of performance wells, and the plume is not expanding in area as demonstrated with compliance wells)
 - MNA Process Evaluation demonstrated based on an attenuation rate calculated with empirical performance monitoring data and MNA Process Demonstration based on the presence of daughter products and bacterial culture counts
- *A contingency remedy to enhance MNA to reach the RAOs if MNA is found to be ineffective.* The contingency remedy will use elements from the active remedial alternative included in this ROD to address the ineffective aspects of MNA. The area and the elements of the contingency remedy would be selected based on the entire data set available. If a contingency remedy is implemented, it will be documented in an ESD.
- *Initiate LTM.* If MNA is determined to be effective, monitoring will be conducted to evaluate the remedy performance and determine if the plume conditions remain constant, improve or worsen after the baseline is established. Monitoring will continue after the initial eight quarters at a frequency of semiannual for three years, then annually until the next five-year review. The performance monitoring plan will be developed in the RD and will be based on USEPA guidance (USEPA, 2004).
- *Because of the historical levels of 1,1,2-TCA at LHAAP-35A(58), include 1,1,2-TCA and its daughter products (1,1-DCA, and chloroethane) in the LTM program until their cleanup levels are attained.* The cleanup levels are shown in **Table 2-8.**

- *Continue LTM every five years to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen.* The baseline of the plume for future five-year reviews will be established as part of the MNA evaluation program. The initial LTM plan will be developed during RD.
- *LUC to restrict access to the contaminated groundwater to environmental monitoring and testing only until cleanup levels are reached.* LUC implementation details will be included in the RD. The recordation notification for the site which will be filed with Harrison County will include a description of the LUC. The boundary of the LUC would enclose the site boundaries and the plume boundaries shown on **Figure 2-8**.

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

LUC implementation and maintenance actions would be described in the RD for LHAAP-35A(58). The selected LUC will prevent human exposure to groundwater contaminated with chlorinated solvents and perchlorate through the restriction of groundwater use. The groundwater restriction LUC shall be maintained until the concentrations of contaminants and by-product (daughter) contaminants have been reduced to below their respective cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) to allow unlimited use and unrestricted exposure at LHAAP-35A(58). The LUC would be included in the property transfer documents. In addition, the Texas Department of Licensing and Regulation responsible for notifying well drillers of groundwater restrictions would be notified and a recordation of the area of groundwater restriction would be filed in the Harrison County Courthouse.

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

Long-term operational requirements under this alternative would include maintenance of the LUC. The need for continued monitoring will be evaluated every five years during the reviews. Sampling frequency and analytical requirements will be presented in the RD for LHAAP-35A(58).

2.12.3 Cost Estimate for the Selected Remedy

Table 2-10 presents the present worth analysis of the cost for the selected remedy, Alternative 4. The information in the table is based on the best available information regarding the anticipated scope of the remedial alternative. The quantities used in the estimate are for estimating purposes only. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within -30 to +50 percent of the actual project cost.

The total project present worth cost of this alternative is approximately \$785,000, using a discount rate of 2.8%. The capital cost is estimated at \$191,000. The total O&M present value cost is estimated at approximately \$594,000. The O&M cost includes evaluation of MNA, maintenance of LUC, and LTM through Year 30. The LTM would support the required CERCLA five-year reviews.

2.12.4 Expected Outcomes of Selected Remedy

The purpose of this response action is to attain the RAOs stated in **Section 2.8** of this document. **Table 2-8** presents the cleanup levels. The cleanup levels for the COCs in the groundwater are the Federal SDWA MCLs or if no MCL exists for that chemical, the cleanup level is the GW-Ind (TCEQ, 2006).

The expected outcome of the selected remedy is that the VOC plumes in the groundwater would be reduced to the cleanup levels. Achievement of the cleanup levels is anticipated to be completed in 200 years. When the contaminants in the groundwater reach cleanup levels, the LUC will be removed. In the short-term (prior to the groundwater achieving cleanup levels), the site will be made part of a national wildlife refuge operated by USFWS, and will continue as such in the long-term (after the groundwater achieves cleanup levels).

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

2.13 Statutory Determinations

Under CERCLA §121 and the NCP, the U.S. Army must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA

includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets the statutory requirements.

2.13.1 Protection of Human Health and the Environment

The selected remedy, Alternative 4, will achieve the RAOs for LHAAP-35A(58). For the western plume, this alternative does not provide for human intervention to remediate groundwater; the alternative is a passive subsurface remedial action conducted natural processes and mechanisms. For the eastern plume, the alternative does utilize active treatment. This alternative would eventually achieve the destruction of the COCs present in the groundwater plumes at LHAAP-35A(58) to protective ARAR levels. Continued maintenance of the LUC would prevent human access and exposure to groundwater that poses an unacceptable risk to human health, until COCs have sufficiently degraded to below the action levels. Therefore, the residual risk upon completion of the remedial actions will be within the risk range for the hypothetical future maintenance worker. At LHAAP-35A(58) the evaluation of historical groundwater contaminant trends indicates that natural attenuation processes are occurring at the site and have stabilized the western plume and slowed the migration of the eastern plume. The monitoring activities associated with MNA will ensure that COCs and by-product (daughter) contaminants in groundwater do not discharge to nearby surface water bodies at such levels that ARARs are exceeded.

Additionally, the results of plume migration modeling for LHAAP-35A(58), which assumes that discharge could occur into Goose Prairie Creek, indicated that the maximum concentrations of the COCs at the point of entry of the groundwater into Goose Prairie Creek, after plume impact, would not be detected, or if detected would be below groundwater and surface water ARARs, which would also be protective of Caddo Lake (see **Section 2.5.5**).

Hazardous substances detected in soil at the site were considered to represent no threat to the environment, and it was determined that no remediation for the protection of ecological receptors was necessary at LHAAP-35A(58) (Shaw, 2007a).

2.13.2 Compliance with ARARs

The selected remedy complies with all ARARs. The ARARs are presented below and in **Table 2-11**.

Chemical-Specific ARARs

The chemical-specific ARAR is to reduce the contaminants in groundwater to Federal SDWA MCLs or GW-Ind when no MCL is available, as presented in **Table 2-8**. This alternative will return the contaminated shallow groundwater zone at LHAAP-35A(58) to its potential beneficial

use as drinking water, wherever practicable, which for the purposes of this ROD is considered to be attainment of the relevant and appropriate cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C) and 30 TAC 335. If a return to potential beneficial uses is not practicable, this alternative would still meet the NCP expectation to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. Because modeling results indicate that maximum concentrations of COCs would be below their respective cleanup levels in the nearby surface water bodies where groundwater discharges, nearby surface water bodies will be protected from ARAR exceedances. In the event of remedy failure resulting in or potentially resulting in a release to surface water, 40 CFR 122, 125, 129, 130, and 131 and 30 TAC 307.1, 307.2, 307.3, 307.4, 307.5(a) and (b), 307.6, 307.7, 307.8 and 307.9 are considered potential future ARARs.

Location-Specific ARARs

There are no location-specific ARARs associated with this alternative.

Action-Specific ARARs

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

- **Waste and disposal activities:** The processes of monitoring, intercepting, or treating contaminated groundwater may generate a variety of primary and secondary waste streams (e.g., soil, personal protective equipment, and dewatering and decontamination fluids). These waste streams are expected to be non-hazardous waste. All solid waste (defined as any solid, liquid, semisolid, or contained gaseous material intended for discard [40 CFR 261.2]) generated during remedial activities must be appropriately characterized to determine whether it contains RCRA hazardous waste (40 CFR 262.11; 30 TAC 335.62; 30 TAC 335.503[a][4]; 30 TAC 335.504). All wastes must be managed, stored, treated (if necessary), and disposed of in accordance with the ARARs for waste management listed in **Table 2-11** for the particular type of waste stream or contaminants in the waste.
- **Well construction:** The remedial action may involve the placement, use, or eventual plugging and abandonment of some type of groundwater monitoring, injection, and/or extraction wells, either for in situ treatment of the contaminated groundwater or for LTM of the groundwater. Available standards for well construction and plugging/abandonment would provide ARARs for such actions and include 30 TAC 331, Subchapters A, C, and H. Texas has promulgated technical requirements in Chapter 76 of Title 16 of the TAC applicable to construction, operation, and plugging/abandonment of water wells. In particular, 16 TAC 76.1000 (*Locations and Standards of Completion for Wells*), 16 TAC 76.1002 (*Standards for Wells Producing Undesirable Water or Constituents*) (LHAAP-35A[58] contaminated groundwater could be considered “undesirable water” defined pursuant to Section 76.10[36] as

“water that is injurious to human health and the environment or water that can cause pollution to land or other waters”), 16 TAC 76.1004 (*Standards for Capping and Plugging of Wells and Plugging Wells that Penetrate Undesirable Water or Constituent Zones*), and 16 TAC 76.1008 (*Pump Installation*) may provide ARARs for the placement, construction, and eventual plugging/abandonment of groundwater injection or extraction wells or the placement and long-term operation of groundwater monitoring wells for proposed groundwater remedial strategies.

- Water Treatment:** Contaminated groundwater and wastewaters collected during well drilling or decontamination activities could be transported to the groundwater treatment plant at LHAAP-18/24 for processing, and would subsequently be discharged in compliance with the effluent limits for that plant. Such waters would be characterized, as required, before transport and managed accordingly in compliance with requirements for the type of waste contaminating the water. To assure compliance with the groundwater treatment plant’s discharge limits, the incoming water must meet the waste acceptance criteria for the facility. On-site wastewater treatment units (as defined in 40 CFR 260.10) that are part of a wastewater treatment facility that is subject to regulation under Section 402 or Section 307(b) of the Clean Water Act of 1972 are not subject to RCRA Subtitle C hazardous waste management standards (40 CFR 270.1[c][2][v]; 40 CFR 264.1[g][6]; 30 TAC 335.42[d][1]). The USEPA has clarified that this exemption applies to all tanks, conveyance systems, and ancillary equipment, including piping and transfer trucks, associated with the wastewater treatment unit (Federal Register [FR] Title 53, 34079, September 2, 1988).

2.13.3 Cost-Effectiveness

The progression of present worth costs from the least expensive alternative to the most expensive alternative is as follows: Alternative 1, Alternative 2 (with no contingency implemented), Alternative 4, and Alternative 3. No costs are associated with Alternative 1 because no remedial activities would be conducted. Alternative 2 has the lowest present worth and capital costs of the remediation alternatives (Alternatives 2 through 4). The present worth costs for Alternative 2 is lower than that of Alternatives 3 and 4, primarily due to the costs and activities associated with the installation of the bioremediation system and the two injection phases of in situ bioremediation for the eastern plume. Alternative 3 is approximately 71% more than the cost of Alternative 4.

Table 2-10 is the cost estimate summary table for the selected remedy. **Table 2-9** compares the cost and effectiveness of each alternative.

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

For the eastern plume, the selected remedy addresses the issue of permanent solution through treatment with in situ bioremediation. For the western plume, the selected remedy does not

address the issue of a permanent solution through disposal, treatment, or recovery of contaminants. The selected remedy provides the best balance of trade offs in terms of five balancing criteria and considering State and community acceptance. Alternative 4 would document effectiveness through the confirmation of MNA and the routine monitoring of the attenuation and migration of the contaminants in groundwater. Natural attenuation effectively controls plume migration and has stabilized the size of the western plume area exhibiting COC and by-product (daughter) contaminant concentrations exceeding cleanup levels. Natural biodegradation is an irreversible treatment process that would reduce the mass and concentration of contaminants. Alternative 4 would provide almost immediate protection because the LUC would be implemented relatively quickly. Maintenance of these controls would be required until natural attenuation processes reduce COC and by-product (daughter) contaminant concentrations to below cleanup levels. Alternative 4 is easily implemented from a technical standpoint; it requires in situ bioremediation in the eastern plume, routine maintenance of the LUC, evaluation of MNA, and sampling. Alternative 4 has a moderate present worth and capital cost compared to the other remedial alternatives.

2.13.5 Preference for Treatment as a Principal Element

The selected remedy would reduce the toxicity, mobility, or volume of contaminants in the groundwater through an active remedial process. By utilizing in situ bioremediation as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied. In addition, there is no known principal threat material in the groundwater and there is no known source of groundwater contamination in soils remaining at LHAAP-35A(58).

2.13.6 Five-Year Review Requirements

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

2.14 Significant Changes from the Proposed Plan

The Proposed Plan for LHAAP-35A(58) was released for public comments on January 25, 2010. The Proposed Plan identified Alternative 4 as the Preferred Alternative for groundwater remediation. The U.S. Army reviewed all written and verbal comments submitted during the public comment period. After careful consideration of the comments, it was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

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

Scenario Timeframe: Current						
Medium: Groundwater						
Exposure Medium: Groundwater						
Exposure Point	Chemical	Concentration Detected ¹ (mg/L)		Frequency of Detection	Exposure Point Concentration (mg/L)	Statistical Measure
		Minimum	Maximum			
Ingestion, inhalation, dermal contact	Volatile Organic Compounds					
	1,1,2-Trichloroethane	1.60E-03	8.00E-03	4/35	8.00E-03	maximum
	1,1-Dichloroethene	1.30E-03	1.34E+00	7/35	1.34E+00	maximum
	1,2-Dichloroethane	5.10E-04	3.00E-03	4/35	3.00E-03	maximum
	Benzene	2.20E-04	8.00E-04	2/35	8.00E-04	maximum
	Methylene Chloride	9.70E-04	9.70E-04	1/35	9.70E-04	maximum
	Tetrachloroethene	2.70E-04	5.40E+00	9/35	5.40E+00	maximum
	Trichloroethene	4.30E-04	1.60E-01	12/35	1.60E-01	maximum
	Vinyl Chloride	6.20E-04	1.00E-02	4/35	1.00E-02	maximum
	Semi-Volatile Organic Compounds					
	bis(2-Ethylhexyl)phthalate	1.00E-03	8.80E-02	4/30	8.80E-02	maximum
	Metals					
	Aluminum	2.56E-01	9.82E+01	29/33	9.82E+01	maximum
	Antimony	1.00E-02	1.30E-02	2/35	1.30E-02	maximum
	Beryllium	5.00E-04	3.70E-03	9/27	3.70E-03	maximum
	Cadmium	9.00E-04	2.00E-03	2/35	2.00E-03	maximum
	Chromium	1.00E-02	2.80E+00	33/35	2.80E+00	maximum
	Cobalt	3.10E-03	2.50E-01	10/35	2.50E-01	maximum
	Lead	7.00E-03	9.00E-02	10/35	9.00E-02	maximum
	Manganese	4.90E-02	5.80E+00	34/35	5.80E+00	maximum
	Nickel	4.00E-02	1.10E+00	22/27	1.10E+00	maximum
	Selenium	2.80E-03	6.58E-02	10/35	6.58E-02	maximum
	Strontium	1.50E-01	2.30E+01	35/35	2.30E+01	maximum
	Thallium	1.10E-03	3.60E-03	7/35	3.60E-03	maximum
	Vanadium	3.00E-02	5.60E-02	4/27	5.60E-02	maximum
	Pesticides					
	Aldrin	6.30E-06	6.30E-06	1/4	6.30E-06	maximum
	alpha-BHC	7.60E-06	7.60E-06	1/4	7.60E-06	maximum
	beta-BHC	5.40E-06	5.40E-06	1/4	5.40E-06	maximum
	delta-BHC	4.60E-06	4.60E-06	1/4	4.60E-06	maximum
	Explosive					
	RDX	1.80E-03	8.83E-02	3/30	8.83E-02	maximum
	Anion					
	Perchlorate	1.00E-02	3.69E-02	2/3	8.10E-02	---

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

Scenario Timeframe: Current						
Medium: Soil						
Exposure Medium: Soil (0 to 2 feet below ground surface)						
Exposure Point	Chemical	Concentration Detected ¹ (mg/kg)		Frequency of Detection	Exposure Point Concentration (mg/kg)	Statistical Measure
		Minimum	Maximum			
Ingestion, inhalation, dermal contact	<i>Semi-Volatile Organic</i>					
	Benzo(a)anthracene	5.10E-02	1.60E+00	4/30	1.60E+00	maximum
	Benzo(a)pyrene	1.50E-01	2.00E+00	3/30	2.00E+00	maximum
	Benzo(b)fluoranthene	8.80E-02	3.10E+00	5/30	3.10E+00	maximum
	Bis(2-Ethylhexyl)phthalate	7.00E-02	2.00E+02	7/30	2.00E+02	maximum
	Dibenzo(a,h)anthracene	3.70E-02	3.00E-01	2/30	3.00E-01	maximum
	Indeno(1,2,3-cd)pyrene	1.20E-01	2.10E+00	2/30	2.10E+00	maximum
	<i>Metals</i>					
	Aluminum	1.80E+03	1.63E+04	30/30	9.23E+03	95% UCL
	Antimony	3.40E+00	8.50E+00	2/30	8.50E+00	maximum
	Cadmium	1.10E+00	1.85E+01	5/30	1.85E+01	maximum
	Mercury	8.80E-02	4.37E+01	4/28	4.37E+01	maximum
	Silver	7.66E-01	1.09E+02	4/30	1.09E+02	maximum
	Vanadium	7.00E+00	6.60E+01	13/13	5.12E+01	95% UCL
	<i>Dioxin/Furan</i>					
	2,3,7,8-TCDD	---	---	---	2.53E-05	maximum
Notes						
¹ Minimum/maximum detected concentration above the reporting limit ---: No information available 95% UCL: 95% upper confidence level of the mean µg/L: micrograms per liter mg/kg: milligrams per kilogram TCDD: tetrachlorodibenzo-p-dioxin						
References						
Jacobs Engineering Group, Inc. (Jacobs), 2003, <i>Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas, Final</i> , Oak Ridge, TN, June.						
Summary of Chemicals of Potential Concern and Medium-Specific Exposure Point Concentrations						
The table presents the chemicals of potential concern (COPCs) and exposure point concentration (EPC) for each (i.e. the concentration used to estimate the exposure and risk from each COPC). The table includes the range of concentrations detected for each COPC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and the statistical measure upon which the EPC was based. The COPCs listed are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003). The EPCs for bis(2-ethylhexyl)phthalate, aluminum, perchlorate, and RDX became invalid for the risk assessment for LHAAP-35A(58) when the site boundary was redefined. This is further discussed in Section 2.7.1.5.						

Table 2-2
Carcinogenic Toxicity Data Summary

Pathway: Ingestion, Dermal Contact				
Chemical of Concern	Oral Cancer Slope Factor (mg/kg-day) ⁻¹	Dermal Cancer Slope Factor (mg/kg-day) ⁻¹	Weight of Evidence/ Carcinogen Guideline Description	Source/Date
<i>Volatile Organic Compounds</i>				
1,1,2-Trichloroethane	5.70E-02	7.04E-02	C	USEPA-IRIS, 2001
1,1-Dichloroethene	6.00E-01	6.00E-01	C	USEPA-IRIS, 2001
1,2-Dichloroethane	9.10E-02	9.10E-02	B2	USEPA-IRIS, 2001
Benzene	5.50E-02	5.67E-02	A	USEPA-IRIS, 2001
Methylene Chloride	7.50E-03	7.89E-03	B2	USEPA-IRIS, 2001
Tetrachloroethene	5.20E-02	5.20E-02	B2	USEPA-IRIS, 2001
Trichloroethene	1.10E-02	1.10E-02	B2	USEPA-IRIS, 2001
Vinyl Chloride	1.50E+00	1.50E+00	A	USEPA-IRIS, 2001
<i>Semivolatile Organics</i>				
bis(2-Ethylhexyl)phthalate	1.40E-02	7.37E-02	B2	USEPA-IRIS, 2001
<i>Metals</i>				
Aluminum	NTV	NTV	not classified	---
Antimony	NTV	NTV	not classified	---
Beryllium	NTV	NTV	B1	USEPA-IRIS, 2001
Cadmium(Water)	NTV	NTV	B1	TCEQ, 2001
Chromium	NC	NC	not classified	---
Cobalt	NTV	NTV	not classified	---
Lead	NTV	NTV	not classified	---
Manganese	NC	NC	D	USEPA-IRIS, 2001
Nickel	NTV	NTV	A	USEPA-IRIS, 2001
Selenium	NC	NC	D	USEPA-IRIS, 2001
Strontium	NTV	NTV	not classified	---
Thallium	NC	NC	not classified	---
Vanadium	NTV	NTV	not classified	---
<i>Pesticides</i>				
Aldrin	1.70E+01	3.40E+01	B2	USEPA-IRIS, 2001
alpha-BHC	6.30E+00	6.49E+00	B2	USEPA-IRIS, 2001
beta-BHC	1.80E+00	1.98E+00	C	USEPA-IRIS, 2001
delta-BHC	1.80E+00	3.60E+00	B2	TCEQ, 2001
<i>Explosive</i>				
RDX	1.10E-01	1.10E-01	C	USEPA-IRIS, 2001
<i>Anion</i>				
Perchlorate	NTV	NTV	not classified	---

Table 2-2 (continued)
Carcinogenic Toxicity Data Summary

Pathway: Inhalation			
Chemical of Concern	Unit Risk Factor (mg/m ³) ⁻¹	Weight of Evidence/ Carcinogen Guideline Description	Source/Date
Volatile Organic Compounds			
1,1,2-Trichloroethane	1.60E-05	C	USEPA-IRIS, 2001
1,1-Dichloroethene	5.00E-02	C	USEPA-IRIS, 2001
1,2-Dichloroethane	2.60E-02	B2	USEPA-IRIS, 2001
Benzene	7.80E-06	A	USEPA-IRIS, 2001
Methylene Chloride	4.70E-04	B2	USEPA-IRIS, 2001
Tetrachloroethene	5.80E-07	B2	USEPA-IRIS, 2001
Trichloroethene	1.70E-03	B2	USEPA-IRIS, 2001
Vinyl Chloride	8.80E-03	A	USEPA-IRIS, 2001
Semivolatile Organic Compounds			
bis(2-Ethylhexyl)phthalate	4.00E-03	B2	USEPA-IRIS, 2001
Metals			
Aluminum	NTV	not classified	---
Antimony	NTV	not classified	---
Beryllium	2.40E+00	B1	USEPA-IRIS, 2001
Cadmium(Water)	1.80E+00	B1	TCEQ, 2001
Chromium	NC	not classified	---
Cobalt	NTV	not classified	---
Lead	NTV	not classified	---
Manganese(Non-Diet)	NC	D	USEPA-IRIS, 2001
Manganese(Food)	NC	D	TCEQ, 2001
Nickel	4.80E-01	A	USEPA-IRIS, 2001
Selenium	NC	D	USEPA-IRIS, 2001
Strontium	NTV	not classified	---
Thallium	NC	not classified	---
Vanadium	NTV	not classified	---
Pesticides			
Aldrin	4.90E-03	B2	USEPA-IRIS, 2001
alpha-BHC	1.80E-03	B2	USEPA-IRIS, 2001
beta-BHC	5.30E-04	C	USEPA-IRIS, 2001
delta-BHC	5.10E-04	B2	TCEQ, 2001
Explosive			
RDX	NTV	C	USEPA-IRIS, 2001
Anion			
Perchlorate	NTV	not classified	---

Table 2-2 (continued)
Carcinogenic Toxicity Data Summary

Notes --- : No information available BHC: benzenehexachloride (hexachlorocyclohexane) mg/kg-day: milligrams per kilogram per day mg/m³: milligrams per cubic meter NC: Chemical not classified as a carcinogen NTV: no toxicity value available RDX: 1,3,5-Trinitroperhydro-1,3,5-triazine	Weight of Evidence/Carcinogen Guideline Description: A - Human carcinogen B1- Probable human carcinogen – Indicates that limited human data are available B2- Probable human carcinogen – Indicates sufficient evidence in animals and inadequate or no evidence in humans C - Possible human carcinogen D - Not classifiable as a human carcinogen
References Jacobs Engineering Group, Inc. (Jacobs), 2003, <i>Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas</i>, Final, Oak Ridge, TN, June. Texas Commission on Environmental Quality (TCEQ), 2001. Update to 1998 Consistency Memorandum. Toxicity Factors Table, 15 March 2001. U.S. Environmental Protection Agency (USEPA)-IRIS, 2001. Integrated Risk Information System (IRIS). United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 2001.	
Summary of Toxicity Assessment The table provides carcinogenic risk information which is relevant to the contaminants of potential concern in soil and ground water. The list of chemicals of concern presented here are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003).	

Table 2-3
Non-Carcinogenic Toxicity Data Summary

Pathway: Ingestion, Dermal Contact						
Chemical of Concern	Chronic/ Subchronic	Oral RfD Value mg/kg-day	Dermal RfD mg/kg-day	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source/Date
<i>Volatile Organics</i>						
1,1,2-Trichloroethane	Chronic	4.00E-03	3.24E-03	Blood alterations	1000/1	USEPA-IRIS, 2001
1,1-Dichloroethene	Chronic	9.00E-03	9.00E-03	Hepatic lesions	1000/1	USEPA-IRIS, 2001
1,2-Dichloroethane	NA	3.00E-02	3.00E-02	NA	NA	USEPA-NCEA, 2001
Benzene	NA	3.00E-03	2.91E-03	NA	NA	USEPA-NCEA, 2001
Methylene Chloride	Chronic	6.00E-02	5.70E-02	Liver toxicity	100/1	USEPA-IRIS, 2001
Tetrachloroethene	Chronic	1.00E-02	1.00E-02	Hepatotoxicity, weight gain	1000/1	USEPA-IRIS, 2001
Trichloroethene	NA	6.00E-03	6.00E-03	NA	NA	---
Vinyl Chloride	Chronic	3.00E-03	3.00E-03	Liver cell polymorphism	30/1	USEPA-IRIS, 2001
<i>Semivolatile Organics</i>						
bis(2-Ethylhexyl)phthalate	Chronic	2.00E-02	3.80E-03	Liver effects	1000/1	USEPA-IRIS, 2001
<i>Metals</i>						
Aluminum	NA	1.00E+00	1.00E-01	NA	NA	USEPA-NCEA, 2001
Antimony	Chronic	4.00E-04	6.00E-05	blood	1000/1	USEPA-IRIS, 2001
Beryllium	Chronic	2.00E-03	1.40E-05	Small Intestine	300/1	USEPA-IRIS, 2001
Cadmium(Water)	Chronic	5.00E-04	1.25E-05	Proteinuria	10/1	USEPA-IRIS, 2001
Chromium	Chronic	1.50E+00	1.95E-02	No effects observed	100/10	USEPA-IRIS, 2001
Cobalt	NA	2.00E-02	1.60E-02	NA	NA	---
Lead	NA	NTV	NTV	NA	NA	---
Manganese (Non-diet)	Chronic	4.70E-02	2.82E-03	CNS	1/1	USEPA-IRIS, 2001
Nickel	Chronic	2.00E-02	8.00E-04	Decreased body weight	300/1	USEPA-IRIS, 2001
Selenium	Chronic	5.00E-03	2.50E-03	Skin	3/1	USEPA-IRIS, 2001
Strontium	Chronic	6.00E-01	1.20E-01	Rachitic bone	300/1	USEPA-IRIS, 2001
Thallium	Chronic	8.00E-05	8.00E-05	Blood	3000/1	USEPA-IRIS, 2001
Vanadium	NA	7.00E-03	1.82E-04	NA	NA	---
<i>Pesticides</i>						
Aldrin	Chronic	3.00E-05	1.50E-05	Liver	1000/1	USEPA-IRIS, 2001
alpha-BHC	NA	8.00E-03	7.76E-03	NA	NA	ATSDR, 1997
beta-BHC	NA	NTV	NTV	NA	NA	---
delta-BHC	NA	3.00E-04	1.50E-04	NA	NA	TCEQ-derived
<i>Explosive</i>						
RDX	Chronic	3.00E-03	3.00E-03	Inflammation of the prostate	100/1	USEPA-IRIS, 2001
<i>Anion</i>						
Perchlorate	Chronic	9.00E-04	9.00E-04	NA	NA	USEPA, 1998

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

Pathway: Inhalation					
Chemical of Concern	Chronic/ Subchronic	Inhalation RfC mg/m ³	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source/Date
Volatile Organics					
1,1,2-Trichloroethane	---	NTV	---	---	---
1,1-Dichloroethene	---	NTV	---	---	---
1,2-Dichloroethane	NA	0.005	NA	NA	USEPA-NCEA, 2001
Benzene	NA	0.006	NA	NA	USEPA-NCEA, 2001
Methylene Chloride	Chronic	3	Liver toxicity	100/1	USEPA-HEAST, 1997
Tetrachloroethene	NA	0.49	NA	NA	USEPA-NCEA, 2001
Trichloroethene	---	NTV	---	---	---
Vinyl Chloride	Chronic	0.1	Liver	30/1	USEPA-IRIS, 2001
Semivolatile Organics					
bis(2-Ethylhexyl)phthalate	---	NTV	---	---	---
Metals					
Aluminum	NA	0.0035	NA	NA	USEPA-NCEA, 2001
Antimony	Chronic	0.0005	Pulmonary toxicity, chronic interstitial inflammation	300/1	USEPA- IRIS, 2001
Beryllium	Chronic	0.00002	Lungs	10/1	USEPA-IRIS, 2001
Cadmium(Water)	NA	0.0002	NA	NA	USEPA-NCEA, 2001
Chromium	NA	0.0001	NA	NA	TCEQ, 2001
Cobalt	NA	0.0000175	NA	NA	USEPA-NCEA, 2001
Lead	---	NTV	---	---	---
Manganese(Non-diet)	Chronic	0.00005	Impairment of neurobehavioral function	1000/1	USEPA-IRIS, 2001
Nickel	Chronic	0.0002	Respiratory effects	NA	ATSDR, 1997
Selenium	NA	0.0002	NA	NA	TCEQ, 2001
Strontium	---	NTV	---	---	---
Thallium	NA	0.0001	NA	NA	TCEQ, 2001
Vanadium	NA	0.00005	NA	NA	TCEQ, 2001
Pesticides					
Aldrin	---	NTV	---	---	---
alpha-BHC	---	NTV	---	---	---
beta-BHC	---	NTV	---	---	---
delta-BHC	---	NTV	---	---	---
Explosive					
RDX	NA	0.0005	NA	NA	TCEQ, 2001
Anion					
Perchlorate	---	NTV	---	---	---

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

Notes
---: No information for a compound with no toxicity value (NTV) BHC: benzenehexachloride (hexachlorocyclohexane) CNS: Central nervous system IRIS: Integrated Risk Information System, USEPA mg/kg-day: milligrams per kilogram per day mg/m³: milligrams per cubic meter NA: Information not available NTV: No toxicity value available RDX: 1,3,5-Trinitroperhydro-1,3,5-triazine RfC: Reference concentration RfD: Reference dose
References
Agency for Toxic Substances and Disease Registry (ATSDR), 1997, Minimal Risk Levels (MRLs) for Hazardous Substances. Jacobs Engineering Group, Inc. (Jacobs), 2003, <i>Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas</i>, Final, Oak Ridge, TN, June. Texas Commission on Environmental Quality (TCEQ), 2001. Update to 1998 Consistency Memorandum. Toxicity Factors Table, 15 March, 2001. U.S. Environmental Protection Agency (USEPA), 1998. <i>Perchlorate Environmental Contamination Toxicological Review and Risk Characterization based on Emergency Information</i>, Review Draft, Office of Research and Development. NCEA-1-0503, 31 December, 1998. USEPA-HEAST, 1997. Health Effects Summary Table (HEAST). FY 1995, Annual Office of Emergency and Remedial Response. Washington, D.C. EPA/340/R-95-036. USEPA-IRIS, 2001. Integrated Risk Information System (IRIS). United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 2001. USEPA-NCEA, 2001. USEPA Region 3 Risk-Based Concentration Tables (5/8/2001). Referenced values from National Center for Environmental Assessment (NCEA).
Summary of Toxicity Assessment
This table provides non-carcinogenic risk information relevant to the contaminants of concern in both soil and ground water. The list of chemicals of potential concern presented here are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003). The uncertainty factor and modifying factor are used in the development of a reference dose. The uncertainty factor adjusts results from dose-response studies in animals to make them applicable to humans. The modifying factor is used to account for uncertainties in the available toxicity data from which the reference dose is derived. In the risk assessment, the reference doses and concentrations were for the chronic case, to be conservative.

Table 2-4
Risk Characterization Summary – Carcinogens

Scenario Timeframe:		Future					
Receptor Population:		Maintenance Worker					
Receptor Age:		Adult					
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Ingestion or exposure through showering	<i>Anion</i>				
			Perchlorate	NTV	NE	NE (Kp<=0.01)	N/A
			<i>Explosives</i>				
			RDX	3.4E-05	NE	NE (Kp<=0.01)	3.4E-05
			<i>Pesticides</i>				
			Aldrin	3.7E-07	NE	NE (Kp<=0.01)	3.7E-07
			alpha-BHC	1.7E-07	NE	2.1E-08	1.9E-07
			beta-BHC	3.4E-08	NE	4.6E-09	3.9E-08
			delta-BHC	2.9E-08	NE	4.7E-09	3.4E-08
			<i>Metals</i>				
			Aluminum	NTV	NE	NE (Kp<=0.01)	N/A
			Antimony	NTV	NE	NE (Kp<=0.01)	N/A
			Beryllium	NTV	NE	NE (Kp<=0.01)	N/A
			Cadmium	NTV	NE	NE (Kp<=0.01)	N/A
			Chromium	NC	NE	NE (Kp<=0.01)	N/A
			Cobalt	NTV	NE	NE (Kp<=0.01)	N/A
			Lead	NTV	NE	NE (Kp<=0.01)	N/A
			Manganese	NC	NE	NE (Kp<=0.01)	N/A
			Nickel	NTV	NE	NE (Kp<=0.01)	N/A
			Selenium	NC	NE	NE (Kp<=0.01)	N/A
			Strontium	NTV	NE	NE (Kp<=0.01)	N/A
			Thallium	NC	NE	NE (Kp<=0.01)	N/A
			Vanadium	NTV	NE	NE (Kp<=0.01)	N/A
			<i>Semivolatile Organics</i>				
			Bis(2-ethylhexyl)phthalate	4.3E-06	NE	2.8E-06	7.1E-06
			<i>Volatile Organics</i>				
			1,1,2-Trichloroethane	1.6E-06	7.8E-09	1.4E-06	3.0E-06
			1,1-Dichloroethene	2.8E-03	4.1E-03	3.8E-03	1.1E-02
			1,2-Dichloroethane	9.5E-07	4.8E-06	4.4E-07	6.2E-06
			Benzene	1.5E-07	3.8E-10	1.1E-08	1.7E-07
			Methylene chloride	2.5E-08	2.8E-08	NE (Kp<=0.01)	5.3E-08
			Tetrachloroethene	9.8E-04	1.9E-07	3.9E-03	4.9E-03
			Trichloroethene	6.2E-06	1.7E-05	8.2E-06	3.1E-05
			Vinyl Chloride	5.2E-05	5.4E-06	NE (Kp<=0.01)	5.8E-05
Groundwater risk total =							1.6E-02

Table 2-4 (continued)
Risk Characterization Summary – Carcinogens

Scenario Timeframe:		Future					
Receptor Population:		Maintenance Worker					
Receptor Age:		Adult					
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 to 2 feet)	Soil and particulates	Incidental ingestion, inhalation of particulates, and dermal contact	<i>Dioxin/Furan</i>				
			2,3,7,8-TCDD	1.3E-06	4.4E-11	5.1E-07	1.8E-06
			<i>Metals</i>				
			Aluminum	NTV	NTV	NTV	NA
			Antimony	NTV	NTV	NTV	NA
			Cadmium	NTV	1.8E-09	NTV	1.8E-09
			Mercury	NC	NC	NC	NA
			Silver	NC	NC	NC	NA
			Vanadium	NTV	NTV	NTV	NA
			<i>Semivolatile Organics</i>				
			Benzo(a)anthracene	4.1E-07	7.4E-15	3.8E-07	7.9E-07
			Benzo(a)pyrene	5.1E-06	9.3E-14	4.8E-06	9.9E-06
			Benzo(b)fluoranthene	7.9E-07	1.4E-11	7.4E-07	1.5E-06
			Bis(2-ethylhexyl)phthalate	9.8E-07	4.2E-11	3.3E-06	4.3E-06
			Dibenzo(a,h)anthracene	7.7E-07	1.4E-14	7.2E-07	1.5E-06
			Indeno(1,2,3-cd)pyrene	5.4E-07	9.8E-15	5.0E-07	1.0E-06
Soil risk total =					2.1E-05		
Total risk (soil and groundwater) =					1.6E-02		
Notes							
BHC		benzenehexachloride (hexachlorocyclohexane)					
Kp		Dermal permeability coefficient					
N/A		Not applicable					
NC		Not classified as a carcinogen					
NE		Not evaluated through this exposure pathway. Chemical is not identified as volatile.					
NE(Kp<=0.01)		Based on USEPA Region 6 guidance, chemicals of potential concern with a Kp<=0.01 were not evaluated for dermal contact while showering (USEPA, 1995)					
NTV		No toxicity value available to quantitatively address this exposure					
RDX		1,3,5-Trinitroperhydro-1,3,5-triazine					
TCDD		Tetrachlorodibenzo-p-dioxin					
References							
USEPA, <i>Supplemental Region VI Risk Assessment Guidance</i> , May 5, 1995.							
Summary of Risk Characterization							
The table provides risk estimates for the significant routes of exposure at LHAAP-35A(58). These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a hypothetical future maintenance worker's exposure to soil and groundwater, as well as the toxicity of the chemicals of concern. The total risk from exposure to contaminated soil and groundwater at this site is estimated to be 1.6×10 ⁻² . A risk below 1×10 ⁻⁴ is generally considered to be acceptable. The soil risk is acceptable, while the groundwater risk is unacceptable.							

Table 2-5
Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe:		Future						
Receptor Population:		Maintenance Worker						
Receptor Age:		Adult						
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Ingestion or exposure through showering	<i>Explosives</i>					
			RDX	Prostate	2.9E-01	NE	NE (Kp<=0.01)	2.9E-01
			<i>Metals</i>					
			Aluminum	N/A	9.6E-01	NE	NE (Kp<=0.01)	9.6E-01
			Antimony	Blood	3.2E-01	NE	NE (Kp<=0.01)	3.2E-01
			Beryllium	Small intestine	1.8E-02	NE	NE (Kp<=0.01)	1.8E-02
			Cadmium	Proteinuria	3.9E-02	NE	NE (Kp<=0.01)	3.9E-02
			Chromium	No effects observed	1.8E-02	NE	NE (Kp<=0.01)	1.8E-02
			Cobalt	N/A	1.2E-01	NE	NE (Kp<=0.01)	1.2E-01
			Lead	N/A	NTV	NE	NE (Kp<=0.01)	N/A
			Manganese	CNS	1.2E+00	NE	NE (Kp<=0.01)	1.2E+00
			Nickel	Body weight	5.4E-01	NE	NE (Kp<=0.01)	5.4E-01
			Selenium	Skin	1.3E-01	NE	NE (Kp<=0.01)	1.3E-01
			Strontium	Bone	3.8E-01	NE	NE (Kp<=0.01)	3.8E-01
			Thallium	Blood	4.4E-01	NE	NE (Kp<=0.01)	4.4E-01
			Vanadium	N/A	7.8E-02	NE	NE (Kp<=0.01)	7.8E-02
			<i>Anion</i>					
			Perchlorate	N/A	8.8E-01	NE	NE (Kp<=0.01)	8.8E-01
			<i>Pesticides</i>					
			Aldrin	Liver	2.1E-03	NE	NE (Kp<=0.01)	2.1E-03
			alpha-BHC	N/A	9.3E-06	NE	1.2E-06	1.0E-05
			beta-BHC	N/A	NTV	NE	NTV	N/A
			delta-BHC	N/A	1.5E-04	NE	2.5E-05	1.7E-04
			<i>Semivolatile Organics</i>					
			Bis(2-ethylhexyl)phthalate	Liver	4.3E-02	NE	2.8E-02	7.1E-02
			<i>Volatile Organics</i>					
			1,1,2-Trichloroethane	N/A	2.0E-02	NTV	1.8E-02	3.7E-02
			1,1-Dichloroethene	Liver	1.5E+00	NTV	1.9E+00	3.4E+00
			1,2-Dichloroethane	N/A	9.8E-04	1.0E-01	4.5E-04	1.0E-01
			Benzene	N/A	2.6E-03	2.3E-02	1.9E-04	2.6E-02
			Methylene chloride	Liver	1.6E-04	5.5E-05	NE (Kp<=0.01)	2.1E-04
			Tetrachloroethene	Liver	5.3E+00	1.9E+00	2.1E+01	2.8E+01
			Trichloroethene	N/A	2.6E-01	NTV	3.5E-01	6.1E-01
			Vinyl Chloride	Liver	3.3E-02	1.7E-02	NE (Kp<=0.01)	5.0E-02
Groundwater Hazard Index Total =								3.8E+01

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

Scenario Timeframe:		Future							
Receptor Population:		Maintenance Worker							
Receptor Age:		Adult							
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient				
					Ingestion	Inhalation	Dermal	Exposure Routes Total	
Soil (0 to 2 feet)	Soil and particulates	Incidental ingestion, inhalation of particulates, dermal contact	<i>Dioxin/Furan</i>						
			2,3,7,8-TCDD	NA	NTV	NTV	NTV	NA	
			<i>Metals</i>						
			Aluminum	NA	9.0E-03	3.9E-04	5.8E-03	1.5E-02	
			Antimony	Blood	2.1E-02	2.5E-06	8.9E-03	3.0E-02	
			Cadmium	Proteinuria	1.8E-02	1.4E-05	4.6E-03	2.3E-02	
			Mercury	Immune system	1.4E-01	2.2E-05	1.3E-01	2.7E-01	
			Silver	Argyria	2.1E-02	1.6E-03	3.4E-02	5.7E-02	
			Vanadium	Decrease in erythrocyte superoxide dismutase	7.2E-03	1.5E-04	1.8E-02	2.5E-02	
			<i>Semivolatile Organics</i>						
			Benzo(a)anthracene	NA	NTV	NTV	NTV	NA	
			Benzo(a)pyrene	NA	NTV	NTV	NTV	NA	
			Benzo(b)fluoranthene	NA	NTV	NTV	NTV	NA	
			Bis(2-ethylhexyl)phthalate	Liver effects	9.8E-03	NTV	3.3E-02	4.3E-02	
			Dibenzo(a,h)anthracene	NA	NTV	NTV	NTV	NA	
			Indeno(1,2,3-cd)pyrene	NA	NTV	NTV	NTV	NA	
Soil Hazard Index Total =						4.7E-01			
Receptor Hazard Total (soil and groundwater) =						3.8E+01			
Liver Hazard Total =						8.8E-02			
Notes									
BHC	benzenehexachloride (hexachlorocyclehexane)								
CNS	Central nervous system								
Kp	Dermal permeability coefficient								
NA	Information was not available								
NE	Not evaluated through this exposure pathway								
NE (Kp<=0.01)	Based on USEPA Region 6 guidance, chemicals of potential concern with a Kp<=0.01 were not evaluated for dermal contact while showering (USEPA, 1995)								
NTV	No toxicity value								
RDX	1,3,5-Trinitroperhydro-1,3,5-triazine								
TCDD	Tetrachlorodibenzo-p-dioxin								
References									
U.S. Environmental Protection Agency (USEPA), 1989, <i>Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual, (Part A)</i> , EPA/540/1-89/002, December.									
USEPA, <i>Supplemental Region 6 Risk Assessment Guidance</i> , May 5, 1995.									
Summary of Risk Characterization									
The table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure for LHAAP-35A(58). The Risk Assessment Guidance for Superfund (USEPA, 1989) states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse non-carcinogenic effects. The estimated HI of 38 for groundwater indicates that the potential for adverse non-carcinogenic effects could occur from exposure to contaminants in that medium; the components having HQs greater than 1 are tetrachloroethene, 1,1-dichloroethene, and manganese. The estimated HI of 0.47 for soil is acceptable.									

Table 2-6
Chemicals with Hazard Quotient Greater than 0.1 in Groundwater

Chemical	Hazard Quotient ^a	Exposure Point Concentration ^b (µg/L)	MCL (µg/L)	GW-Ind (µg/L)	Retained as Chemical of Concern?
Tetrachloroethene (PCE)	28	5,400	5	5	Yes, 1
1,1-Dichloroethene (1,1-DCE)	3.4	1,340	7	7	Yes, 1
Manganese	1.2	5,800	-	14,000	No, 2,3
Aluminum	0.96	98,200	-	100,000	No, 4
Perchlorate	0.88	81	-	72	No, 4
Trichloroethene (TCE)	0.61	160	5	5	Yes, 1
Nickel	0.54	1,100	-	2,000	No, 3
Thallium	0.44	3.6	2	2	No, 5
Strontium	0.38	23,000	-	61,000	No, 3
Antimony	0.32	13	6	6	No, 4
RDX	0.29	88.3	-	--	No, 4
Selenium	0.13	65.8	50	50	No, 4
Cobalt	0.12	250	-	6,100	No, 3

Notes and Abbreviations:

All chemicals with hazard indexes exceeding 0.1 are listed.

1. Identified as COC since noncancer hazard quotient is greater than 0.1 and the Exposure Point Concentration is above the Safe Drinking Water Act MCL or Texas Commission on Environmental Quality (TCEQ) GW-Ind.
2. Excluded as COC since Exposure Point Concentration is less than LHAAP perimeter well background.
3. Excluded as COC based on since Exposure Point Concentration is less than a proposed cleanup level based on GW-Ind.
4. Excluded as COC based on more recent data showing much lower concentrations that are below TCEQ GW-Ind or MCL.
5. Excluded as COC based on difference in sampling methods.

^a From Baseline Risk Assessment Table 3-74 and Table C-44 (Jacobs, 2003).

^b From Baseline Risk Assessment Table 3-49 (Jacobs, 2003).

COC chemical of concern

GW-Ind TCEQ Risk Reduction Standard 2, groundwater medium-specific concentration for industrial use

MCL Safe Drinking Water Act maximum contaminant level

µg/L micrograms per liter

References

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

Table 2-7
Chemicals with Carcinogenic Risk Greater than 1×10^{-6} in Groundwater

Chemical	Cancer Risk Groundwater ^a	Exposure Point Concentration ^b (µg/L)	MCL/ GW-Ind (µg/L)	Retained as Chemical of Concern?
1,1-Dichloroethene (1,1-DCE)	1.1×10^{-2}	1,340	7	Yes, 1
Tetrachloroethene (PCE)	4.9×10^{-3}	5,400	5	Yes, 1
Vinyl Chloride	5.8×10^{-5}	10	2	Yes, 1
RDX	3.4×10^{-5}	88.3	-	No, 3
Trichloroethene (TCE)	3.1×10^{-5}	160	5	Yes, 1
bis(2-Ethylhexyl)phthalate	7.1×10^{-6}	88	6	No, 3, 4
1,2-Dichloroethane (1,2-DCA)	6.2×10^{-6}	3	5	No, 2
1,1,2-Trichloroethane (1,1,2-TCA)	3.0×10^{-6}	8	5	No, 3

Notes and Abbreviations:

All Chemicals with cancer risks exceeding 1.0×10^{-6} are listed.

1. Identified as COC since Exposure Point Concentration is above the Safe Drinking Water Act MCL.
2. Excluded because since Exposure Point Concentration is below the Safe Drinking Water Act MCL.
3. Excluded based on more recent data showing much lower concentrations.
4. Excluded as COC based on bis(2-ethylhexyl)phthalate being a common laboratory contaminant.

^a From Baseline Risk Assessment Table 3-73 (Jacobs, 2003).

^b From Baseline Risk Assessment Table 3-49 (Jacobs, 2003).

COC chemical of concern

GW-Ind Texas Commission on Environmental Quality, Risk Reduction Standard 2, groundwater medium-specific concentration for industrial use

MCL Safe Drinking Water Act maximum contaminant level

RDX 1,3,5-Trinitroperhydro-1,3,5-triazine

µg/L micrograms per liter

References

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

**Table 2-8
Cleanup Levels**

COC	ARAR
	MCL (µg/L)
1,1,2-Trichloroethane (TCA) ^a	5
1,1-Dichloroethene (DCE)	7
cis-1,2-Dichloroethene	70
trans-1,2-Dichloroethene	100
Tetrachloroethene (PCE)	5
Trichloroethene (TCE)	5
Vinyl Chloride (VC)	2
	GW-Ind (µg/L) ^b
1,1-Dichloroethane (TCA daughter product) ^a	10,000
Chloroethane (TCA daughter product) ^a	41,000

Notes and Abbreviations

^a Not currently classified as a COC, but will be included in the list of COCs for long-term monitoring (see Section 2.12.2)

^b Groundwater medium-specific concentration for industrial use since no MCL exists

µg/L micrograms per liter

ARAR applicable or relevant and appropriate requirement

COC chemical of concern

GW-Ind Texas Commission on Environmental Quality groundwater medium-specific concentration for industrial use

MCL maximum contaminant level as established in the Safe Drinking Water Act

Table 2-9
Comparative Analysis of Alternatives

Comparative Analysis of Alternatives Criteria	Alternative 1 No Action	Alternative 2 Monitored Natural Attenuation with LUC	Alternative 3 In Situ Bioremediation with Short Term LUC and Long-Term Monitoring	Alternative 4 In Situ Bioremediation for Eastern Plume followed by MNA and LUC; MNA and LUC for Western Plume
Overall protection of human health and the environment	Does not confirm achievement of the RAO for the return of groundwater to its potential beneficial use as a drinking water since there is no monitoring involved.	Achieves RAOs. Protection of human health and environment provided by maintenance of LUC. Monitored natural attenuation activities would demonstrate that degradation of plume is occurring.	Achieves RAOs. Protection of human health and environment provided by bioremediation of groundwater COCs. Groundwater monitoring and LUC will remain in place until remainder of plume degrades to MCLs.	Achieves RAOs. Protection of human health and environment provided by remediation of groundwater COCs in the area of highest contamination in the eastern plume and monitored natural attenuation in the western plume. Groundwater monitoring and LUC would remain in place until MCLs are met
Compliance with ARARs	Possible that it would meet cleanup levels by (unmonitored) natural attenuation, but this would be unverifiable without monitoring.	Complies with ARARs.	Complies with ARARs.	Complies with ARARs.
Long-term effectiveness and permanence	Natural attenuation would occur, but is progress would be unverified by monitoring. No evaluation of natural attenuation's long-term effectiveness and permanence.	Decrease in contaminant concentrations and presence of degradation products suggests that contaminants are degrading naturally. LUC would be effective and reliable so long as it is maintained until RAOs are met.	Should be effective and permanent; however, uncertainty exists concerning the effectiveness and time needed for in situ biological treatment and degradation to reduce contaminant concentrations to preliminary remediation goals. A treatability study may be required. Long-term groundwater monitoring will be conducted after treatment. LUC would be effective and reliable so long as it is maintained until remainder of plume reaches MCLs.	Should be effective and permanent; however, uncertainty exists concerning the effectiveness and time needed for in situ biological treatment and degradation to reduce contaminant concentrations to preliminary remediation goals. A treatability study may be required. Long-term groundwater monitoring will be conducted after treatment. LUC would be effective and reliable so long as it is maintained until remainder of plume reaches MCLs.

Table 2-9 (continued)
Comparative Analysis of Alternatives

Comparative Analysis of Alternatives Criteria	Alternative 1 No Action	Alternative 2 Monitored Natural Attenuation with LUC	Alternative 3 In Situ Bioremediation with Short Term LUC and Long-Term Monitoring	Alternative 4 In Situ Bioremediation for Eastern Plume followed by MNA and LUC; MNA and LUC for Western Plume
Reduction of toxicity, mobility, or volume through treatment	No active reduction.	No active reduction.	Provides permanent reduction through in situ bioremediation in the areas of highest contamination provided conditions are favorable.	For western plume, no active reduction. For eastern plume, provides permanent reduction through in situ bioremediation in the areas of highest contamination provided conditions are favorable.
Short-term effectiveness	Continued risk to community through no action. No risk to workers. To impact to the environment.	Minimal impacts to the community, workers, or the environment from short-term activities. Provides almost immediate protection.	Minimal impacts to the community, workers, or the environment from short-term activities. Provides almost immediate protection.	Minimal impacts to the community, workers, or the environment from short-term activities. Provides almost immediate protection.
Implementability	Inherently implementable.	Readily implemented.	Implementable, but uncertainty exists in the effectiveness and time required to reduce contaminants to preliminary remediation goals. Specialized knowledge required for implementation.	Implementable, but uncertainty exists in the effectiveness and time required to reduce contaminants to preliminary remediation goals. Specialized knowledge required for implementation.
Cost				
• Capital present worth	\$0	\$60,500	\$860,000	\$191,000
• O&M present worth	\$0	\$432,300	\$483,000	\$594,000
• Total present worth	\$0	\$492,800	\$1,343,000	\$785,000
State acceptance	Not acceptable	Not acceptable	Acceptable	Acceptable
Community acceptance	Responded to comments			

Notes and Abbreviations:

ARAR	applicable or relevant and appropriate requirement
COC	chemical of concern
LUC	land use control
MCL	maximum contaminant level
MNA	monitored natural attenuation
O&M	operation and maintenance
RAO	remedial action objective

Table 2-10
Remediation Cost Table
Selected Remedy (Alternative 4)
Present Worth Analysis

Year	Fiscal Year	Capital Costs	Operation & Maintenance Costs			Present Value (NPV)		
			Long-Term Monitoring	Bioremediation	Total	Discount Rate	Capital	O&M
						2.8%		
1	2010	\$190,712	\$118,108		\$118,108	NPV	\$190,712	\$593,996
2	2011		50,353	101,397	151,750			
3	2012		24,558		24,558		NPV Total	\$784,708
4	2013		24,558		24,558			
5	2014		67,083		67,083			
6	2015		17,135		17,135			
7	2016		17,135		17,135			
8	2017		17,135		17,135			
9	2018		17,135		17,135			
10	2019		58,074		58,074			
11	2020				0			
12	2021				0			
13	2022				0			
14	2023				0			
15	2024		53,572		53,572			
16	2025				0			
17	2026				0			
18	2027				0			
19	2028				0			
20	2029		53,572		53,572			
21	2030				0			
22	2031				0			
23	2032				0			
24	2033				0			
25	2034		53,572		53,572			
26	2035				0			
27	2036				0			
28	2037				0			
29	2038				0			
30	2039		53,572		53,572			
		\$190,712	\$625,564	\$101,397	\$726,961			

Table 2-10 (continued)
Remediation Cost Table
Selected Remedy (Alternative 4)

Notes

O&M operation & maintenance
 UIC underground injection control
 VOC volatile organic compounds

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

Capital costs related to bioremediation include: 1) Work plans/safety plans, 2) UIC permit and design, 3) Treatability study and related costs (including sample collection, driller, per diem and travel costs, mobilization/demobilization), 4) Field Health & Safety, 5) Field supervisor and geologist, 6) Vehicles, 7) Per diem, 8) Driller mobilization/demobilization, 9) Installation of injection wells, 10) Well survey, 11) Well drill waste disposal, 12) Collection and preparation of well waste drum samples, 13) Sample analysis for waste characterization, 14) Bioaugmentation materials, 15) Collection and preparation of samples, 16) Samples analysis for VOCs.

Long-term monitoring activities in Year 1 include: 1) Establishment of a database, licenses, and development of work plans, etc; 2) Geoprobe installation of two additional monitoring wells.

Monitoring costs are based on the assumption that 8 wells are sampled in sampling events from Years 1 through 10, and that sampling is reduced to 4 wells for subsequent years. The frequency of sampling events is in accordance with the frequency described in the Record of Decision. In Years 1 and 2, the samples are analyzed for VOCs and MNA parameters. Subsequent years are analyzed for VOCs only. Five-year reviews are conducted in Years 5, 10, 15, 20, 25, and 30.

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

Table 2-11
Description of ARARs for Selected Remedy

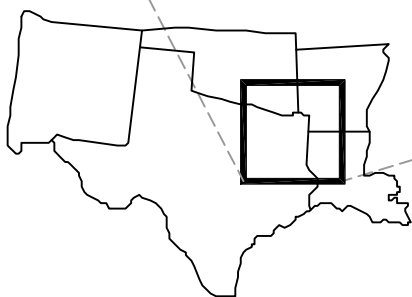
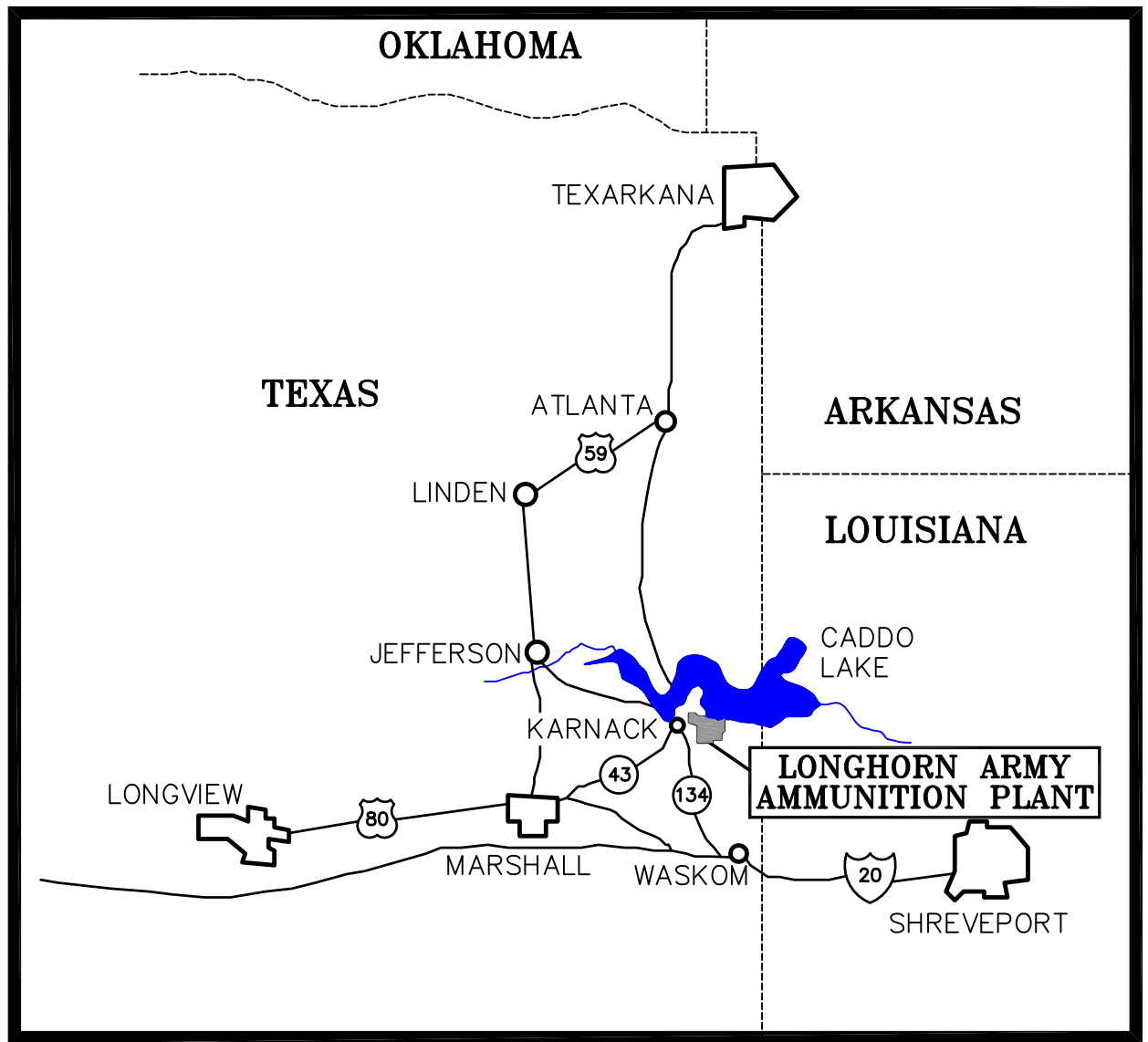
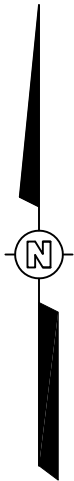
Citation	Activity or Prerequisite/Status	Requirement
Groundwater		
State of Texas Primary Drinking Water Standards 30 TAC 290, Subchapter F	Applicable to drinking water for a public water system— relevant and appropriate for water that could potentially be used for human consumption	Must not exceed drinking water standard for water designated as a current or potential source of drinking water. See Table 3-2 for specific numeric criteria.
State of Texas Risk Reduction Standards 30 TAC 335.558 and 335.559(d)(2) as updated in the Texas Commission on Environmental Quality memorandum July 23, 1998	Applicable to industrial groundwater— relevant and appropriate for potential hypothetical future maintenance worker exposure to groundwater	If no maximum contaminant level has been promulgated, groundwater must not exceed the industrial medium-specific concentration.
Waste Generation, Management, and Storage		
Characterization of Solid Waste 40 CFR 262.11 30 TAC 335.62 30 TAC 335.504 30 TAC 335.503(a)(4)	Generation of solid waste, as defined in 30 TAC 335.1— applicable .	Must determine whether the generated solid waste is RCRA hazardous waste by using prescribed testing methods or applying generator knowledge based on information regarding material or process used. If the waste is determined to be hazardous, it must be managed in accordance with 40 CFR 262–268. After making the hazardous waste determination as required, if the waste is determined to be nonhazardous, the generator shall then classify the waste as Class 1, Class 2, or Class 3 (as defined in Section 335.505 through Section 335.507) using one or more of the methods listed in Section 335.503(a)(4) and Section 335.508 and manage the waste in accordance with the requirements of Chapter 335 of the TAC for industrial solid waste.
Characterization of Hazardous Waste 40 CFR 264.13(a)(1); 40 CFR 268.7 30 TAC 335.504(3) 30 TAC 335.509 30 TAC 335.511	Generation of a RCRA hazardous waste for treatment, storage, or disposal— applicable if hazardous waste is generated (e.g., PPE).	Must obtain a detailed chemical and physical analysis of a representative sample of the waste(s) that at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with 40 CFR 264 and 268. Must also determine whether the waste is restricted from land disposal under 40 CFR 268 et seq. by testing in accordance with prescribed methods or use of generator knowledge of waste.
Management of RCRA Hazardous Waters—Wastewater Treatment Unit Exclusion 40 CFR 264.1(g)(6) 40 CFR 270.1(c)(2) 30 TAC 335.41(d)(1)	Treatment/disposal of wastewater containing RCRA hazardous waste— applicable to management of contaminated groundwater if it is determined to contain RCRA characteristically hazardous waste.	On-site wastewater treatment units, as defined in 40 CFR 260.10, that are part of a wastewater treatment facility subject to regulation under Section 402 or Section 307(b) of the CWA are excluded from the requirements of RCRA Subtitle C (Note: USEPA has clarified that this exemption applies to all tank systems, conveyance systems, and ancillary equipment, including transfer trucks, associated with the wastewater treatment unit [53 FR 34079, September 2, 1988]).

Table 2-11 (continued)
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Requirements for Temporary Storage of Hazardous Waste in Accumulation Areas 40 CFR 262.34(a) and (c)(1) 30 TAC 335.69(a) and (d)	On-site accumulation of 55 gallons or less of RCRA hazardous waste for 90 days or less at or near the point of generation—applicable if hazardous waste is generated (e.g., PPE) and stored in an accumulation area.	A generator may accumulate hazardous waste at the facility provided that • Waste is placed in containers that comply with 40 CFR 264.171 to 264.173 (Subpart I); and • Container is marked with the words "hazardous waste"; or • Container may be marked with other words that identify the contents.
Requirements for the Use and Management of Containers 40 CFR 264.171–264.173 30 TAC 335.69(e) 30 TAC 335.152(a)(7)	On-site storage/treatment of RCRA hazardous waste in containers for greater than 90 days—applicable if hazardous waste is generated (e.g., PPE) and is stored in containers.	Design and operating standards of 40 CFR 264.175(c) and 40 CFR 264.171, 264.172, and 264.173(a) and (b) must be met for the use and management of hazardous waste in containers.
Wells		
Well Construction Standards—Monitoring or Injection Wells 16 TAC 76.1000	Construction of water wells—applicable to construction of new monitoring or injection wells, if needed.	Wells shall be completed in accordance with the technical requirements of Section 76.1000, as appropriate.
Class V Injection Wells 30 TAC 331, Subchapters A, C, and H	Installation, operation, and closure of injection wells for in situ bioremediation fall in the category of Class V Injection Wells—relevant and appropriate	Injection wells shall be constructed to the required specifications for isolation casing, surface completion, prevention of commingling, and confinement of undesirable groundwater to its zone of origin. Closure shall be accomplished by removing all of the removable casing and the entire well shall be pressure filled via a tremie pipe with cement from bottom to the land surface, or closure shall be performed by the alternative method for Class V Wells completed in zones of undesirable groundwater. Groundwater concentrations at time of well closure will determine the appropriate method of abandonment.

Table 2-11 (continued)
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Well Construction Standards—Extraction Wells 16 TAC 76.1000(a) and (c) through (h) 16 TAC 76.1002(a) through (c) 16 TAC 76.1008(a) through (c)	Construction of water wells— applicable to construction of extraction (recovery) wells.	Wells shall be completed in accordance with the technical requirements of Section 76.1000, as appropriate. Water wells completed to produce undesirable water shall be cased to prevent the mixing of water or constituent zones. The annular space between the casing and the wall of the borehole shall be pressure grouted with cement or bentonite grout to the land surface. Bentonite grout may not be used if a water zone contains chloride water above 1500 ppm or if hydrocarbons are present. Wells producing undesirable water or constituents shall be completed in such a manner that will not allow undesirable fluids to flow onto the land surface. During installation of a water well pump, installer shall make a reasonable effort to maintain integrity of groundwater and to prevent contamination by elevating the pump column and fittings, or by other means suitable under the circumstances. Pump shall be constructed so that no unprotected openings into the interior of the pump or well casing exist.
Treatment/Disposal		
Disposal of Wastewater (e.g., contaminated groundwater, dewatering fluids, decontamination liquids) 40 CFR 268.1(c)(4)(i) 30 TAC 335.431(c)	RCRA-restricted characteristically hazardous waste intended for disposal— applicable if extracted groundwater is determined to be RCRA characteristically hazardous .	Disposal is not prohibited if such wastes are managed in a treatment system subject to regulation under Section 402 of the CWA that subsequently discharges to waters of the United States.
Closure		
Standards for Plugging Wells that Penetrate Undesirable Water or Constituent Zones 16 TAC 76.1004(a) through (c)	Plugging and abandonment of wells— applicable to plugging and closure of monitoring and/or extraction wells.	If a well is abandoned, all removable casing shall be removed and the entire well pressure filled via a tremie pipe with cement from bottom up to the land surface. In lieu of this procedure, the well shall be pressure-filled via a tremie tube with bentonite grout of a minimum 9.1 lb/gal weight followed by a cement plug extending from land surface to a depth of not less than 2 feet. Undesirable water or constituents or the freshwater zone(s) shall be isolated with cement plugs.
Abbreviations:		
%	percent	lb/gal
µg/L	micrograms per liter	LHAAP
ARAR	applicable or relevant and appropriate requirement	PPE
CFR	Code of Federal Regulations	ppm
CWA	Clean Water Act of 1972	RCRA
DCE	dichloroethene	TAC
USEPA	U.S. Environmental Protection Agency	TCE
FR	Federal Register	VC
FS	feasibility study	
		pound per gallon
		Longhorn Army Ammunition Plant
		personal protective equipment
		part per million
		Resource Conservation and Recovery Act of 1976
		Texas Administrative Code
		trichloroethene
		vinyl chloride

DRAWING 117591-A55
NUMBERAPPROVED BY
P. SRIVASTAV 10/07/09CHECKED BY
G. JONES 10/07/09DRAWN BY
L. JONES 12/17/03OFFICE
Houston, TexasX-REF
---IMAGE
---PLOT DATE: 10/07/09
FORMAT REVISION 3/25/99

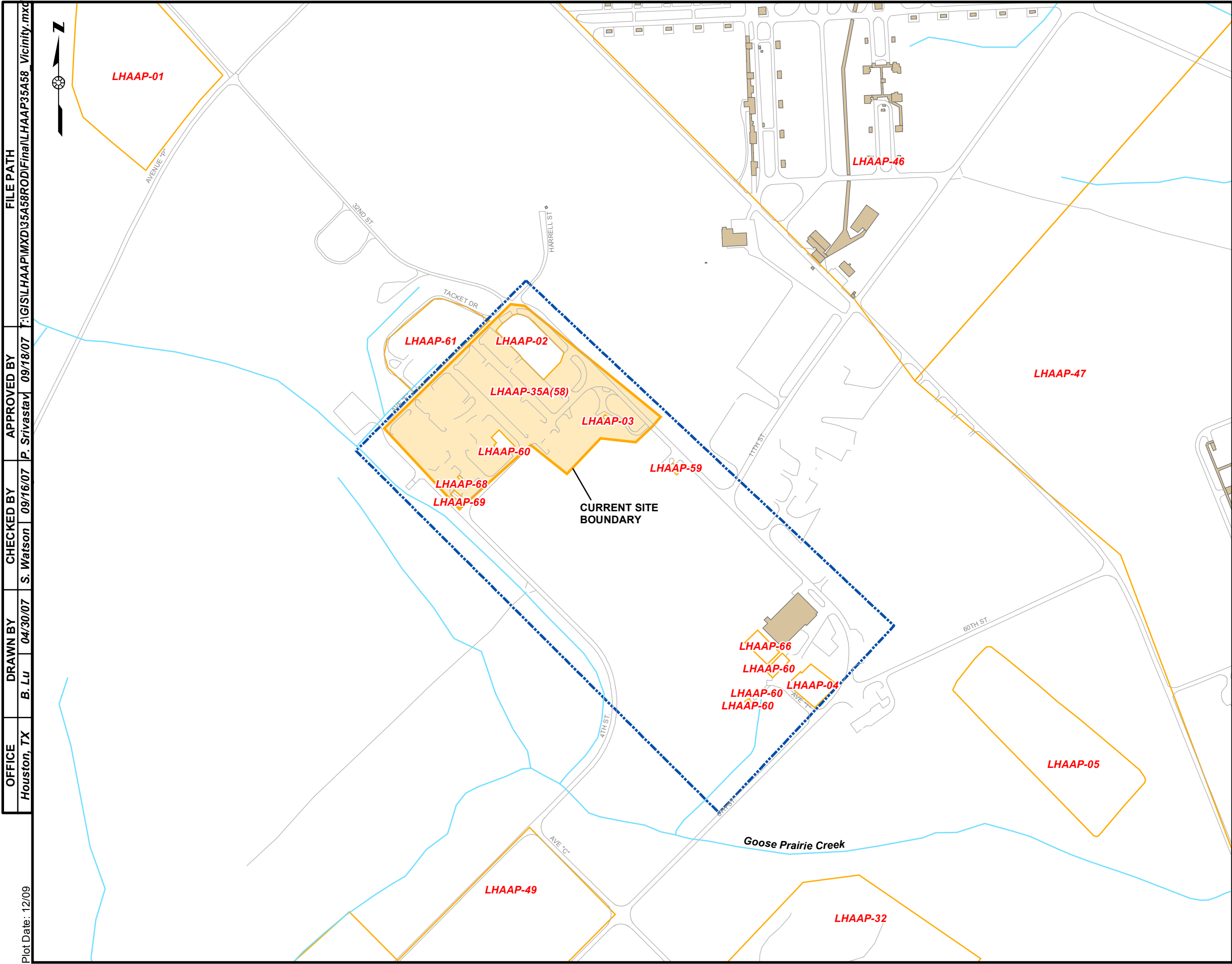
"DRAWING NOT TO SCALE"

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TULSA DISTRICT
TULSA, OKLAHOMA

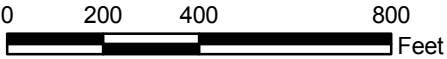
FIGURE 2-1

LHAAP LOCATION MAP

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



- LEGEND**
- Stream
 - Road
 - Existing Building
 - Historic LHAAP-35A(58) Site Boundary
 - Other LHAAP Site
 - LHAAP-35A(58) Site
 - Lake/Pond

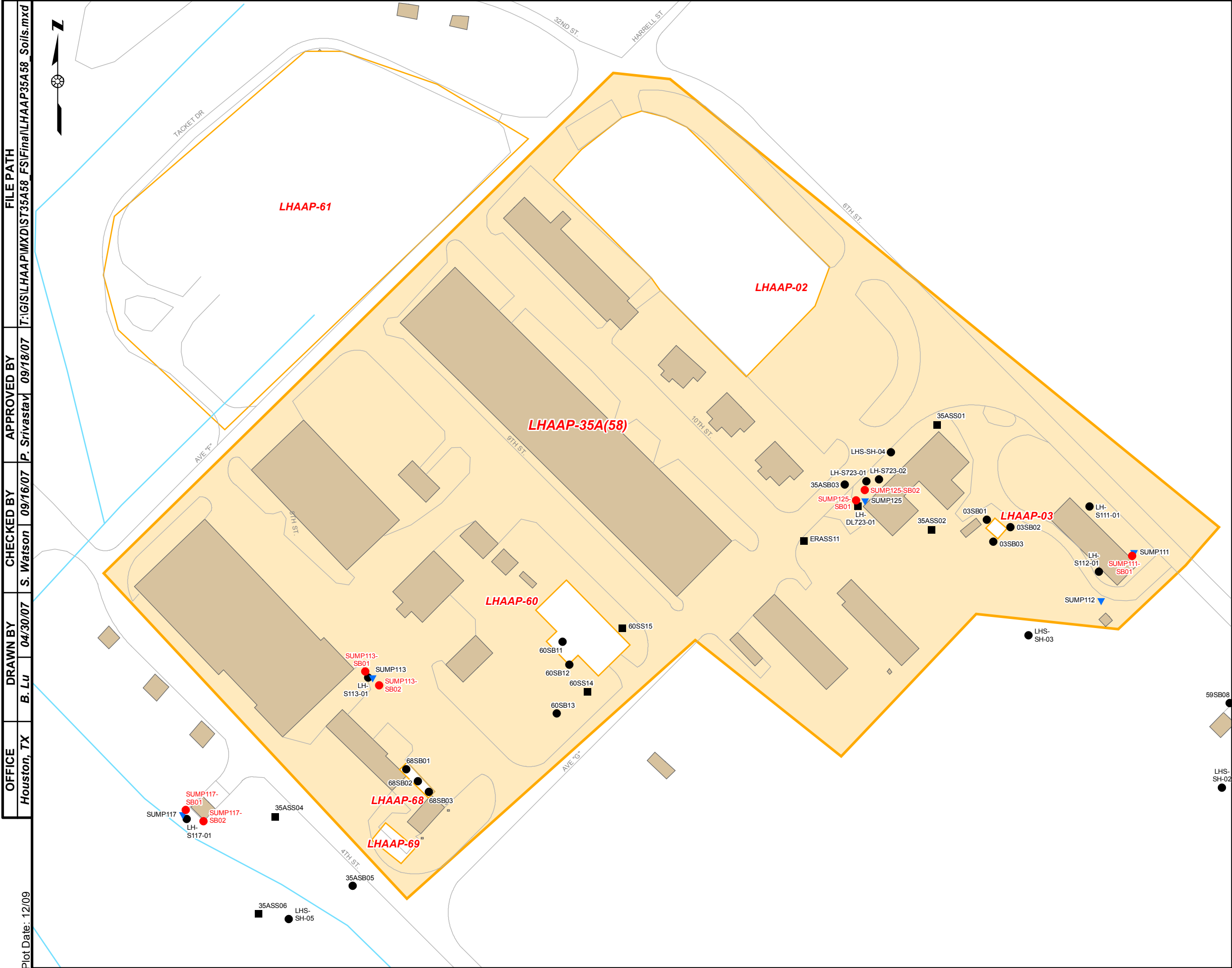


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TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-2

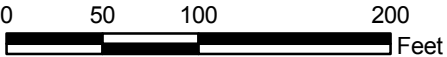
SITE VICINITY MAP
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



LEGEND

- Soil Boring (2006 Sump Investigation)
- Soil Boring (Phase I, II)
- Surface Soil Sample (Phase II)
- ▼ Sump
- Stream
- Road
- Former Building or Tank
- LHAAP-35A(58) Site
- Other LHAAP Site



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TULSA, OKLAHOMA

FIGURE 2-3

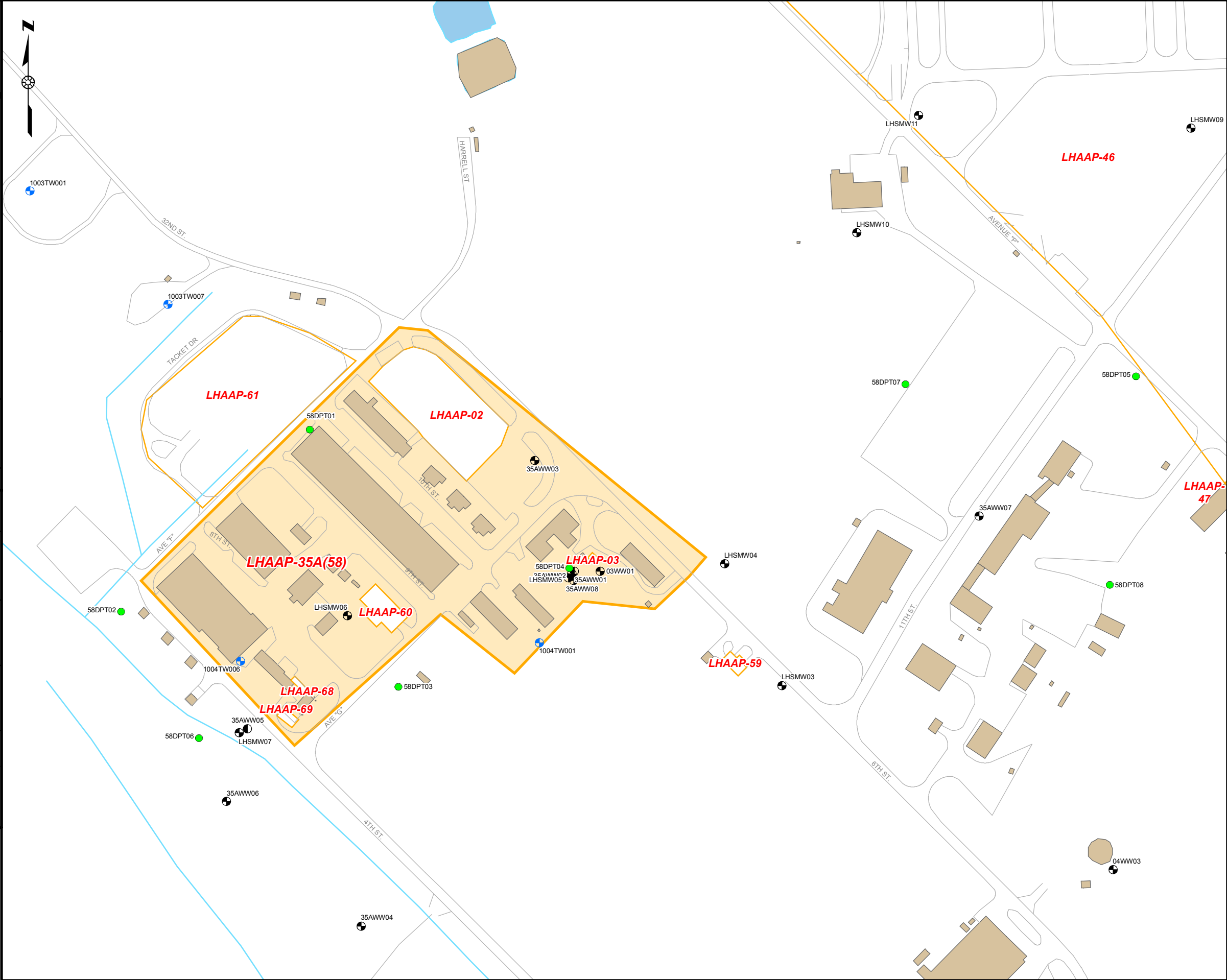
SOIL SAMPLE LOCATION MAP
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE Houston, TX
DRAWN BY B. Lu
CHECKED BY S. Watson
APPROVED BY P. Srivastav
FILE PATH T:\GIS\LHAAP\MXD\IST35A58_FSV\Final\LHAAP35A58_Soils.mxd

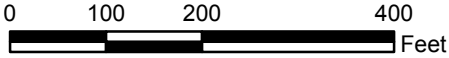
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LEGEND

- DPT Location
- Plexus Temporary Monitoring Well
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- Stream
- Road
- LHAAP-35A(58) Site
- Other LHAAP Site
- Former Building or Tank



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

FIGURE 2-4

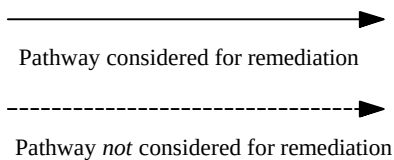
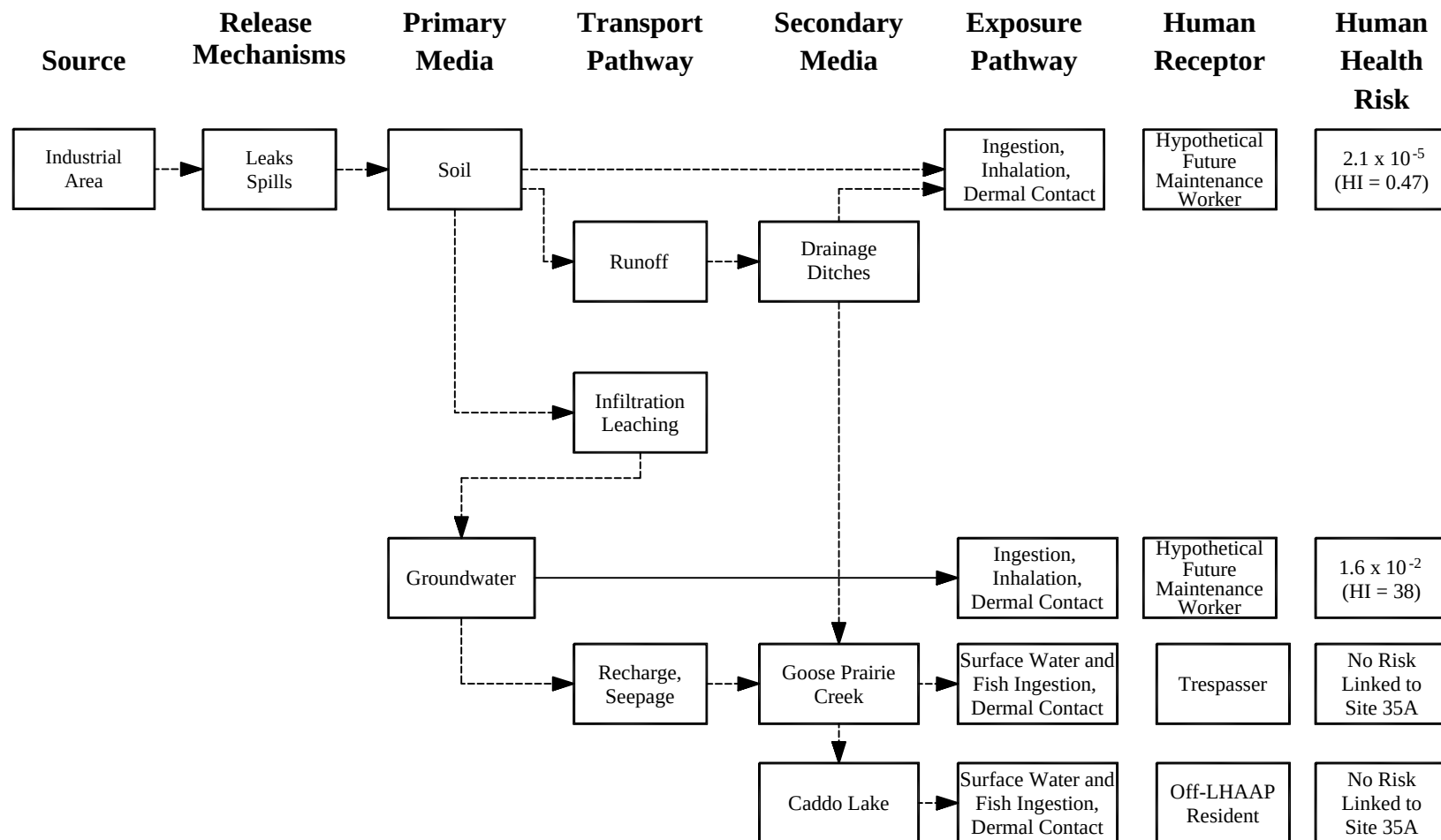
WELL LOCATION MAP
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

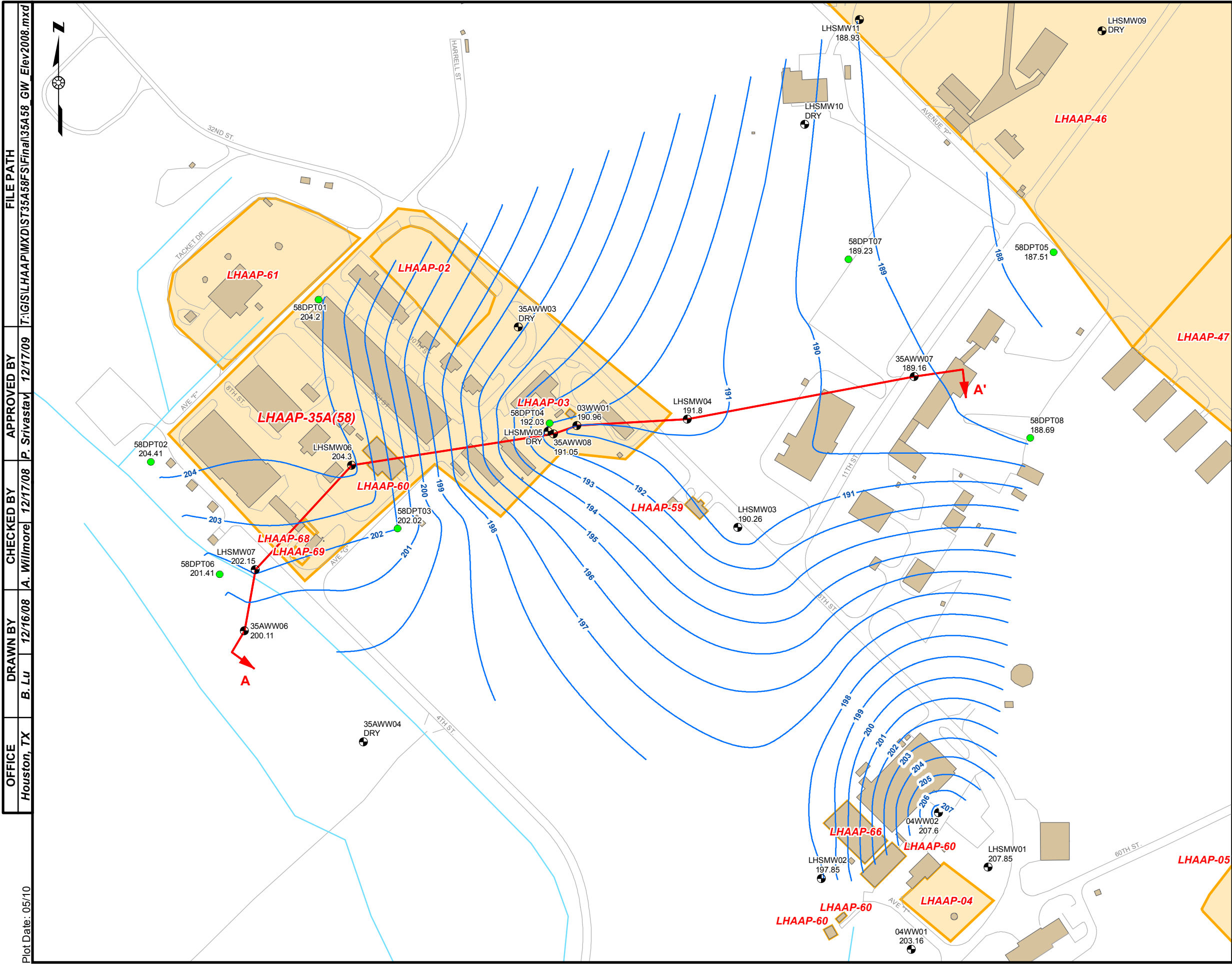
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PLOT DATE: 05/12/10
 FORMAT REVISION 5/13/02

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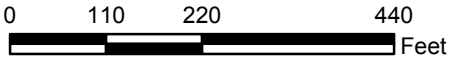


	U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT TULSA, OKLAHOMA
	FIGURE 2-5 CONCEPTUAL SITE MODEL LHAAP-35A(58) GROUP 4 LONGHORN ARMY AMMUNITION PLANT KARNACK, TEXAS



- LEGEND**
- Shallow Monitoring Well
 - DPT Location
 - Groundwater Elevation Contour
 - Cross-Section Line
 - Stream
 - Road
 - Former Building or Tank
 - Site

NOTE:
Contours generated using 3D Analyst Extension in ArcGIS 9.3.



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TULSA, OKLAHOMA

FIGURE 2-6
GROUNDWATER ELEVATION MAP
SHALLOW ZONE, 2008
LHAAP-35A(58), GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

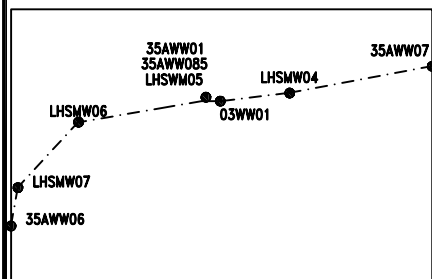
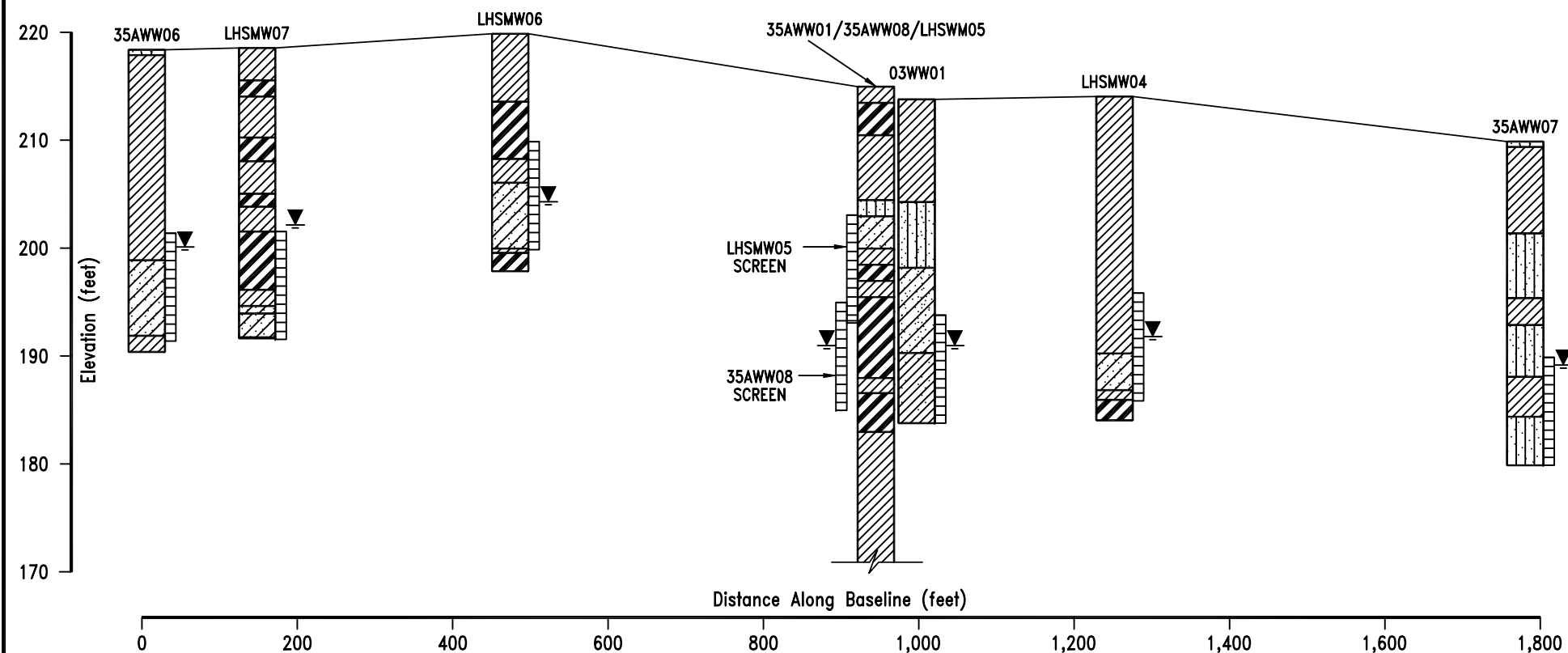
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PLOT DATE: 05/12/10
FORMAT REVISION

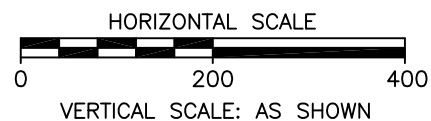
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---	---	HOUSTON, TX	L. JONES	05/12/10	A. WILLMORE 12/23/08	P. SRIVASTAV 12/23/08



LEGEND:

- (CH) FAT CLAY
- (CL) LEAN CLAY
- (SC) CLAYEY SAND
- (MLS) SANDY SILT

- STATIC WATER LEVEL (11/08)
- SCREEN

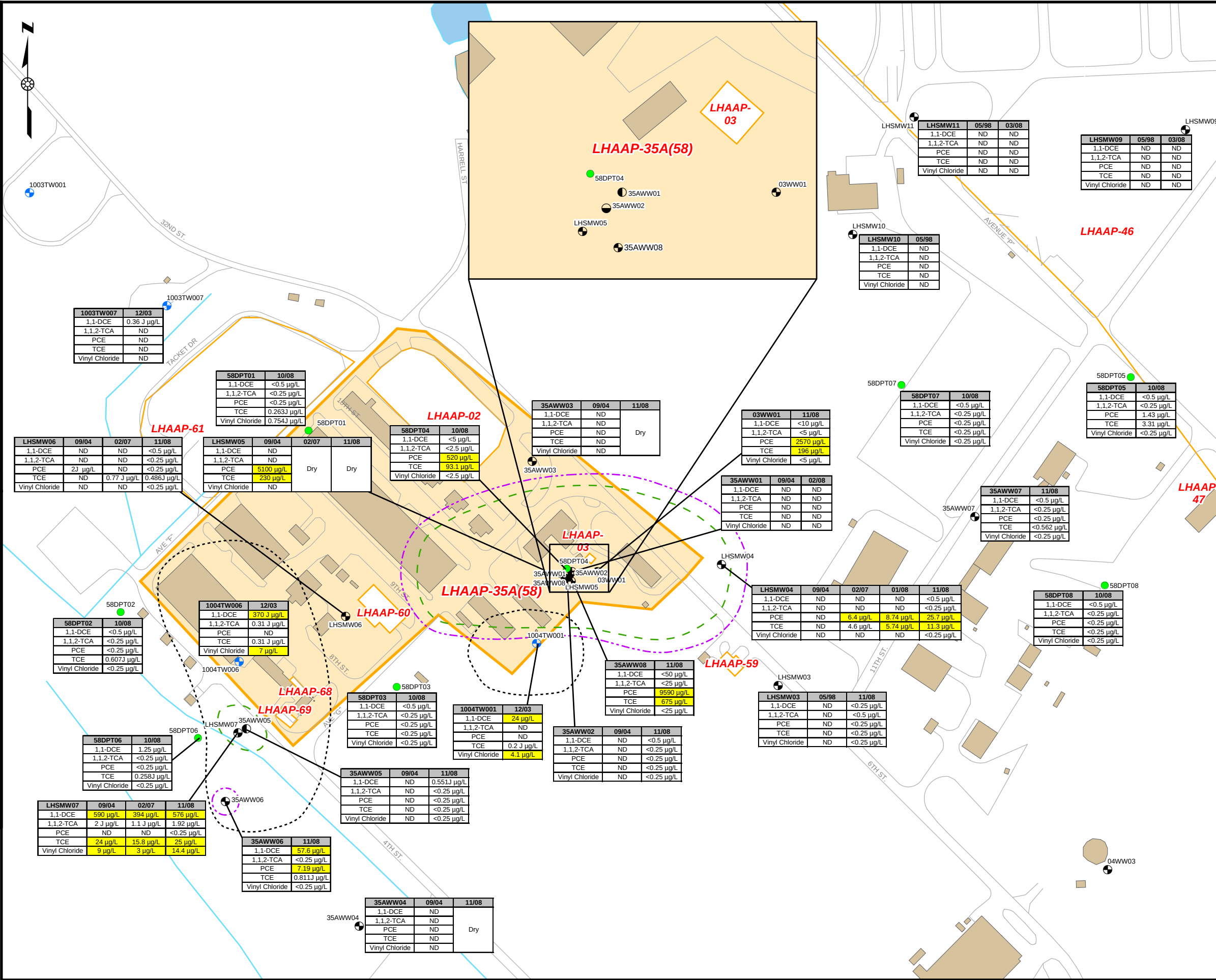


U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-7

CROSS SECTION A-A'
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



- DPT Location
- Plexus Temporary Monitoring Well
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well

_____ Road

Former Building or Tank

Estimated TCE Contamination Extent
at Concentration = 5 µg/L

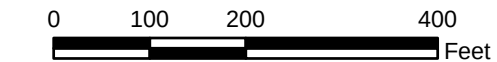
----- Estimated PCE Contamination Extent
at Concentration = 5 µg/L

..... Estimated 1,1-DCE Contamination Extent
at Concentration = 7 µg/L

COC Concentration Exceeds MCL

Safe Drinking Water Act Maximum Contaminant Levels (MCL)	
1,1-DCE	7 µg/L
1,1,2-TCA	5 µg/L
PCE	5 µg/L
TCE	5 µg/L
Vinyl Chloride	2 µg/L

1,1-DCE: 1,1-dichloroethene
1,1,2-TCA: 1,1,2-trichloroethane
PCE: tetrachloroethene
TCE: trichloroethene
µg/L: micrograms per liter
ND: not detected
COC: chemical of concern



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TULSA, OKLAHOMA

FIGURE 2-8
GROUNDWATER RESULTS FOR VOCs
2003 THROUGH 2008
LHAAP-35A(58), GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

3.0 *Responsiveness Summary*

The Responsiveness Summary serves three purposes. First, it provides the U.S. Army, USEPA, and TCEQ with information about community concerns with the preferred alternative at LHAAP-35A/58 as presented in the Proposed Plan. Second, it shows how the public's comments were considered in the decision-making process for selection of the remedy. Third, it provides a formal mechanism for the U.S. Army to respond to public comments.

The U.S. Army, USEPA, and TCEQ provide information regarding LHAAP-35A/58 through public meetings, the Administrative Record for the facility, and announcements published in the Shreveport Times and Marshall News Messenger newspapers. **Section 2.3** discusses community participation on LHAAP-35A/58, including the dates for the public comment period, the date, location, and time of the public meetings, and the location of the Administrative Record. The following documents related to community involvement were added to the Administrative Record:

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

The public questions/comments are summarized in **Section 3.1** below, and a response is provided. No written or verbal comments were received from the regulatory agencies during the public comment period or at the public meeting. **Appendix A** contains the public announcement for the public comment period as well as its extension to March 25, 2010. These announcements also provided notification of the open house on January 26, 2010, and the public meeting on March 9, 2010.

3.1 *Stakeholder Issues and Lead Agency Responses*

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

Question/comment: The proposed plan states that contaminant levels will be reduced to MCLs in approximately 200 years. The uncertainty associated with this estimate is an order of magnitude. That is, the time to achieve MCLs could range from 20 years to 2000 years. It is not reasonable to propose a plan that could require the maintenance of LUCs for many decades or centuries.

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

Question/comment: In order to rely on MNA as a remedy, the U.S. Army should show that natural attenuation is occurring at the site. However, the evidence for natural attenuation at LHAAP-35A(58) is limited. Concentrations of COCs appear to be decreasing in only one monitor well at the site (PCE and 1,1-DCE in well LHSMW007). In most cases, COC concentrations are either remaining fairly constant or are increasing (PCE and TCE at well LHSMW004, PCE and TCE at well LHSMW005, and TCE at well LHSMW007). The U.S. Army should explain why it expects contaminant concentrations to decrease in the future when they are not decreasing in the present.

Response: The use of MNA at LHAAP-35A(58) at LHSMW07 in the western plume is supported by decreasing concentration of contaminants. A more aggressive remedy is proposed for the eastern plume where the other mentioned wells (LHSMW05 and LHSMW04) are located. The statutory five-year reviews will evaluate the effectiveness of the remedy and estimated durations to reach MCLs, and other measures would be recommended for implementation if needed.

Question/comment: The half-life calculation for 1,1-DCE is not in accord with the USEPA's recommendation for performing such calculations. The USEPA states that a decrease in contaminant concentration of at least one order of magnitude is necessary in order to reliably calculate a half-life (rate law).

The half-life calculation for 1,1-DCE is the basis for the U.S. Army's estimate that contaminant levels will be reduced to MCLs in approximately 200 years. The Army should either explain

why the calculation is appropriate, or it should re-do its estimates for the time required for MNA to reduce contaminant concentrations to acceptable levels at LHAAP-50.

Response – The comment correctly quotes the USEPA directive in the footnotes. One difficulty is that the estimated half-life of 21 years would not be expected to generate an order of magnitude reduction within the sampling period (14 years). The estimated attenuation rate does not have a 95% confidence level at this time. As further stated in the USEPA directive (the paragraph following the one quoted in the footnotes), a number of factors should be considered in evaluating reasonable time frames. As more data becomes available during the 2 year MNA evaluation period, the half-lives and estimates of restoration time will be revised. The statutory five-year reviews will evaluate the effectiveness of the remedy and estimated durations to reach MCLs. If unreasonable time frames are estimated, other measures would be recommended for implementation if needed.

Question/comment – The proposed plan states that the progress of MNA will be evaluated for the western plume after two years. If performance objectives for MNA are not being met, a contingency remedy (e.g., bioremediation) will be implemented. The performance objectives will be included in the RD. However, the RD has not been written. Thus, it is not possible to evaluate suitability of the performance objectives.

Response – The performance objectives will follow USEPA Performance Monitoring of MNA Remedies for VOCs in Ground Water, EPA/600/R-04/027, April, 2005.

Question/comment – The proposed plan does not mention a contingency remedy for the eastern plume. Given the uncertainty associated with bioremediation and MNA, a contingency remedy should also be developed for the eastern plume.

Response – The continued performance of the in situ bioremediation will be evaluated during the statutory five-year reviews. If the USEPA determines that it is not effective, additional measures will be evaluated during the five-year review process.

Question/comment – Groundwater flow directions at LHAAP-35A(58) vary with time. Groundwater at the site may flow to the east, southeast, south, or southwest. However, the U.S. Army did not assess the potential effects of contaminated groundwater on the tributary to Goose Prairie Creek that flows about 120 feet from the site's western boundary. Instead, The U.S. Army assessed effects of contaminated groundwater on a segment of Goose Prairie Creek that is approximately 6300 feet east of the site.

The Army claims that groundwater will not enter the nearby tributary because the base of the creek channel is above the elevation of the groundwater. However, the elevation of the groundwater will change, both seasonally and over the longer term. Unless the U.S. Army can produce the data to show that groundwater levels will not reach the base of the channel, the

Army should assess the potential effects of contaminated groundwater on the tributary to Goose Prairie Creek.

The model used to simulate contaminant transport, including the transport of groundwater contaminants to Goose Prairie Creek, used some non-conservative assumptions. These assumptions have the effect of reducing the predicted contaminant concentrations in the creek.

Response – The modeling report (Shaw, 2007c) did not evaluate any potential effect on the tributary to Goose Prairie Creek that runs along the western side of the site since groundwater elevations at that time did not indicate any flow to the south. Additional wells were installed and the recent groundwater elevations indicate flow to the south (Shaw, 2009). As noted in Appendix A of the FS (and expanded upon here), the likelihood of groundwater seeping to surface water in the Goose Prairie Creek tributary is small. With a creek bed elevation of 213 feet MSL, and the measured groundwater elevations at nearby well LHSMW07 ranging from 202.4 feet MSL (2008) to 205 feet MSL (1998), there are 8 feet between the highest measured groundwater level and the creek bed. At another area of LHAAP, there is a series of wells where water levels have been checked monthly for more than 6 years. The largest groundwater elevation difference, from minimum to maximum, measured over that time in any well was 5.68 feet. From this information, it is inferred that flow from groundwater to surface water in the Goose Prairie Creek tributary at LHAAP-35A(58) is unlikely. Infiltration from the surface water to groundwater is more likely (when there is water in the creek).

Question/comment – The full extent of groundwater contamination at LHAAP-38A(58) has not been determined. Data gaps exist in the following areas: to the south of the western plume between 35AWW06 and 35AWW04; to the southeast of the western plume between 58DPT03 and 35AWW04; to the north of the western plume between 1004TW006 and 58DPT01; to the east of the eastern plume between LHSMW04 and 35AWW07, and to the southeast of the eastern plume between 35AWW01 and LHSMW03. The U.S. Army should install at least one monitor well in each of these areas.

Response – The extent of groundwater contamination has been determined, and plume delineation work for the purpose of identifying the nature and extent of contamination is generally complete. There are wells with results less than the cleanup level up, down and cross gradient to the wells with contamination. However, additional data from existing wells will be gathered during the design phase to implement the remedy.

3.2 *Technical and Legal Issues*

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

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Glossary of Terms

Glossary of Terms

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

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

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

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

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

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

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

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

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

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

Glossary of Terms (continued)

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

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

National Priorities List (NPL) – The USEPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. USEPA is required to update the NPL at least once a year. A site must be on the NPL to receive money from the Trust Fund for remedial action.

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

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

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

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

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

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

Glossary of Terms (continued)

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

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

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

Appendix A

Public Meeting Newspaper and Media Notices

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

MEDIA RELEASE

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

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

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

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



Date: October 25, 2010

Project No.: 117591

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 Record of Decision, LHAAP-46, Plant 2 Area, Group 4,
Longhorn Army Ammunition Plant

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

For: Review ☐ As Requested ☐ Approval ☐ Corrections ☐ Submittal ☐ Other ☒ X

<i>Item No:</i>	<i>No. of Copies</i>	<i>Date:</i>	<i>Document Title</i>
1	2	September 2010	Final Record of Decision, LHAAP-46, Plant 2 Area, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas

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

Sincerely:

Praveen Srivastav
Project Manager

CC: Distribution List:

Mr. J. Lambert – USACE, Tulsa (sent to A. Williams for distribution)

Mr. A. Maly – USAEC (electronic only)

Ms. Rose Zeiler – BRAC-LHAAP

Mr. S. Tzhone – EPA Region 6 (2)

Ms. F. Duke – TCEQ, Austin (2)

Mr. D. Vodak – TCEQ, Tyler

Mr. P. Bruckwicki – U.S. Fish and Wildlife Service



DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

October 25, 2010

DAIM-ODB-LO

Mr. Stephen Tzhone
US Environmental Protection Agency
Superfund Division (6SF-AT)
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Final Record of Decision, LHAAP-46, Plant 2 Area, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2010

Dear Mr. Tzhone,

The above-referenced document is being transmitted to you for your records. The document has been prepared by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility.

The point of contact for this action is the undersigned. I ask that Praveen Srivastav, 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,

A handwritten signature in black ink, reading "Rose M. Zeiler", is positioned below the word "Sincerely,".

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
A. Maley, USAEC, TX
P. Srivastav, Shaw – Houston, TX (for project files)



DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

October 25, 2010

DAIM-ODB-LO

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

Re: Final Record of Decision, LHAAP-46, Plant 2 Area, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2010
SUP 126

Dear Ms. Duke,

The above-referenced document is being transmitted to you for your records. The document has been prepared by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility.

The point of contact for this action is the undersigned. I ask that Praveen Srivastav, 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,

A handwritten signature in cursive script, reading "Rose M. Zeiler", is positioned below the "Sincerely," text.

Rose M. Zeiler, Ph.D.
Longhorn AAP Site Manager

Copies furnished:

S. Tzhone, USEPA Region 6, Dallas, TX
D. Vodak, TCEQ, Tyler, TX
P. Bruckwicki, Caddo Lake NWR, TX
J. Lambert, USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
A. Maly, USAEC, TX
P. Srivastav, Shaw, Houston, TX (for project files)

FINAL
RECORD OF DECISION
LHAAP-46, PLANT 2 AREA, GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



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

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

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

September 2010

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Appendix A	Public Meeting Newspaper and Media Notices

Glossary of Terms

Located at the end of this ROD

Acronyms and Abbreviations

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
µg/L	micrograms per liter
ARARs	applicable or relevant and appropriate requirements
AT123D	Analytical Transient One-, Two-, Three-Dimensional
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
cm/s	centimeters per second
COC	chemical of concern
COEC	chemical of ecological concern
COPC	chemical of potential concern
CWA	Clean Water Act of 1972
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
ECOP	Environmental Condition of Property
EPC	exposure point concentration
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FR	Federal Register
FS	Feasibility Study
ft ²	square feet
GW-Ind	groundwater medium-specific concentration for industrial use
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
Jacobs	Jacobs Engineering Group, Inc.
LHAAP	Longhorn Army Ammunition Plant
LTM	long-term monitoring
LUC	land use control
MARC	Multiple Award Remediation Contract
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
MNA	monitored natural attenuation

Acronyms and Abbreviations (continued)

MOA	memorandum of agreement
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
PCB	polychlorinated biphenyl
Plexus	Plexus Scientific Corporation
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RFA	RCRA Facility Assessment
RfD	reference dose
RI	remedial investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
Shaw	Shaw Environmental, Inc.
STEP	Solutions to Environmental Problems, Inc.
SVOC	semivolatile organic compound
TAC	Texas Administrative Code
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TDLR	Texas Department of Licensing and Regulation
U.S. Army	U.S. Department of the Army
USACE	U.S. Army Corps of Engineers
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Material Agency
USC	U.S. Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UTL	upper tolerance limit
VC	vinyl chloride
VOC	volatile organic compound

1.0 Declaration

1.1 Site Name and Location

Longhorn Army Ammunition Plant-46 (LHAAP-46), Plant 2 Area, Group 4

Longhorn Army Ammunition Plant
Karnack, Texas

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

1.2 Statement of Basis and Purpose

This decision document presents the selected remedy for LHAAP-46, the Plant 2 Area, located at the Longhorn Army Ammunition Plant (LHAAP) in Karnack, Texas. The remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Code of Federal Regulations (CFR) Title 40 §300.

The remedy selection was based on the Administrative Record for this site, including the remedial investigation (RI) (Jacobs Engineering Group, Inc. [Jacobs], 2002), baseline human health risk assessment (BHHRA) report (Jacobs, 2003), installation-wide baseline ecological risk assessment (BERA) report (Shaw Environmental, Inc. [Shaw], 2007a), feasibility study (FS) (Shaw, 2009), Proposed Plan (U.S. Department of the Army [U.S. Army], 2010), and other related documents contained in the Administrative Record for LHAAP-46.

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

1.3 Assessment of the Site

The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants from this site which may present an unacceptable risk to human health and the environment.

1.4 Description of the Selected Remedy

The final selected remedy for LHAAP-46 protects human health and the environment by preventing human exposure to trichloroethene (TCE)-contaminated groundwater and preventing TCE-contaminated groundwater from migrating into nearby surface water. No principal threat source material has been identified at LHAAP-46. The remedy includes the components described below.

- Monitored natural attenuation (MNA) will be implemented to verify that the TCE plume is stable and will not migrate to nearby surface water at levels that may present an unacceptable risk to human health and the environment. MNA will return groundwater to its potential beneficial use, wherever practicable.
 - Performance objectives will be evaluated after 2 years of MNA. During those 2 years, monitoring will be quarterly. If MNA is found to be ineffective, a contingency remedy to enhance MNA will be implemented. If MNA is found to be effective, it will be continued, and monitoring will be semiannual for 3 years. In subsequent years, monitoring will be annual until the next five-year review. The monitoring and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue every 5 years until cleanup levels are achieved. Based on calculated attenuation rates for LHAAP-46, groundwater cleanup levels are expected to be met through natural attenuation in approximately 23 years. Considering the lithologic variability, particularly the lateral and vertical change from sand to clay, the times to maximum contaminant level (MCL) may vary.
- Land use control (LUC) in the impacted area will ensure the protection of human health by restricting the use of groundwater to environmental monitoring and testing only. The LUC will remain in place until the MCLs are met.

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

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

The management strategy at LHAAP is to approach each site separately to address human health issues and to approach the sites by sub-area to address ecological risk. Thus, the implementation of this remedy at LHAAP-46 is independent of any other remedial action at LHAAP to address human health issues. To address ecological risk, LHAAP-46 was grouped with several other sites as part of the Industrial Sub-Area. Because no chemicals exceeded ecological thresholds of concern in the Industrial Sub-Area, no action is needed at LHAAP-46 to address ecological risk (Shaw, 2007a).

1.5 Statutory Determinations

The selected remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. Although the final selected remedy is not intended to address the statutory preference for treatment to the maximum extent practicable, the final selected remedy offers, within a reasonable time frame and at a lower cost, a similar level of protection to human health and the environment than those remedy alternatives which satisfy the preference for treatment. In addition, no source materials constituting principal threats will be addressed within the scope of this action. In addition, the remedy offers long-term effectiveness through the implementation of the LUC, which would minimize the potential risk posed by the contaminated groundwater. Further, evaluation of MNA including routine monitoring of the attenuation until MCLs are met would document the effectiveness of the selected remedy. The selected remedies are easily and immediately implementable and cost less than the other alternatives considered for LHAAP-46, with the exception of Alternative 1 (No Action).

The selected remedy of MNA would reduce the toxicity, mobility, or volume of contaminants in the groundwater through a passive remedial action. There is no known principal threat material or contaminant source in the LHAAP-46 groundwater.

Because hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure, a five-year review will be conducted every five years to ensure protection of human health and the environment under CERCLA §121(c), U.S. Code (USC) Title 42 §9621(c). In accordance with 30 Texas Administrative Code (TAC) §335.566, a notification will be recorded in Harrison County records stating that the site is

suitable for nonresidential use and that a restriction of groundwater usage to environmental monitoring and testing is in place until the MCL is achieved. Although the U.S. Army may later pass these procedural responsibilities to the transferee by property transfer agreement, the U.S. Army shall retain ultimate responsibility for remedy integrity, per the FFA and CERCLA §121.

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for this site.

- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater as identified in the baseline risk assessment and ROD (**Section 2.6**).
- Potential land and groundwater use that will be available at the site as a result of the selected remedy (**Section 2.6**).
- Chemicals of concern (COCs) and their respective concentrations (**Section 2.7**).
- Baseline risk represented by the COCs (**Section 2.7**).
- Cleanup levels established for COCs and the basis for these levels (**Section 2.8**).
- Absence of source materials constituting principal threats that need to be addressed at this site (**Section 2.11**).
- Key factor(s) that led to selecting the remedy (**Section 2.12**).
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (**Section 2.12**).

1.7 Authorizing Signatures

As the lead agency, the United States Army issues this ROD for LHAAP-46 which documents the final selected remedy. The undersigned is the appropriate approval authority for this decision.

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

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

The United States Environmental Protection Agency approves the selected remedy as provided in the ROD for LHAAP-46.

Samuel Coleman 9-30-10
(Name) (Date)

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

2.0 Decision Summary

2.1 Site Name, Location, and Description

LHAAP-46, Plant 2 Area, Group 4

Longhorn Army Ammunition Plant
Karnack, Texas

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

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

Source of Cleanup Money: U.S. Army, Department of Defense

Site type: Industrial facility

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

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

LHAAP-46, also known as the Plant 2 Area, is located in the north-central portion of LHAAP. The site is shown on **Figure 2-2** and covers approximately 190 acres.

2.2 *Site History and Enforcement Activities*

2.2.1 *History of Site Activities*

LHAAP was established in December 1941 and had three plants that manufactured a variety of ammunition and explosives at various times, among other industrial activities. LHAAP-46 is the current designation of the former Plant 2 Area. Construction of facilities for producing JB-2 propellant fuel at Plant 2 began in 1944, but construction was halted in 1945 with the end of World War II. Plant 2 was used to produce pyrotechnic ammunition, such as photoflash bombs, simulators, hand signals, and tracers for 40 mm ammunition from 1952 to 1956. Plant 2 was reactivated to produce pyrotechnic and illuminating devices from 1964 to 1997. LHAAP, including Plant 2, operated until 1997 when it was placed on inactive status and classified by the U.S. Army Armament, Munitions, and Chemical Command as excess property.

2.2.2 *History of Investigative Activities*

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

- In 1980, U.S. Army Toxic and Hazardous Material Agency (USATHAMA, 1980) conducted a record search to assess the impact of the LHAAP installation activities including usage, storage, treatment, and disposal of toxic and hazardous materials on the environment, and defined conditions that may have adversely affected human health and the environment.
- Contamination Survey – In 1982, as part of the LHAAP contamination survey, Environmental Protection Systems collected six groundwater samples for laboratory analyses. Subsequently, in 1987, as part of the Resource Conservation and Recovery Act (RCRA) permit application process, and as a continuation of the contamination survey, U.S. Army Environmental Hygiene Agency (USAEHA) identified, described, and evaluated all solid waste management units at LHAAP (USAEHA, 1987). Units requiring further sampling, investigation, and corrective action were delineated.
- RCRA Facility Assessment (RFA) – In 1988, a preliminary RFA was conducted by the U.S. Army (Maley, 1988). Waste at the various sites was characterized, but no samples were collected.

Several investigations to determine the nature and extent of contamination in the soil, groundwater, surface water, and sediments at LHAAP-46 were conducted and are listed below. Samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, explosive compounds, perchlorate, pesticides, polychlorinated biphenyls (PCBs), and/or dioxins/furans, depending on the focus of the investigation. For some of the earlier investigations, LHAAP sites were organized into groups, and LHAAP-46 was

included in Group 4. The group designation was de-emphasized as the complexities of the individual sites became greater. The following summarizes the investigations at LHAAP-46.

- **Multi-phase investigation of Group 4 sites:** Between 1992 and 2001, numerous investigations were conducted in a phased approach by Jacobs, U.S. Army Corps of Engineers (USACE), and BCM Engineers, Inc. Activities included installation of 24 monitoring wells and analysis of groundwater, surface water, sump contents, soil, and sediment samples. The results are documented in the RI report for Group 4 sites (Jacobs, 2002).
- **Plant-wide perchlorate investigation:** The investigation was conducted by Solutions to Environmental Problems, Inc. (STEP) in 2000 through 2002 (STEP, 2005). Groundwater samples were collected from five wells.
- **Baseline Human Health Risk Assessment:** The BHHRA (Jacobs, 2003) used data from the investigations conducted through 2001 including the plant-wide perchlorate investigation results up to that time. The report concluded that the soil at LHAAP-46 required no action because the associated carcinogenic risk and non-carcinogenic hazard were acceptable. Groundwater was found to pose acceptable carcinogenic risk but unacceptable non-carcinogenic hazard.
- **Phase II Environmental Site Assessment:** Media investigated in 2003 included soil and groundwater (Plexus Scientific Corporation [Plexus], 2005).
- **Baseline Ecological Risk Assessment:** The BERA (Shaw, 2007a) determined that LHAAP-46, as a part of the Industrial Sub-Area, did not have chemicals of ecological concern (COECs). The evaluation was based on environmental investigations from 1993 to 2006.
- **Data gaps:** Additional investigations were conducted by Shaw in 2004 after the BHHRA was finalized to further delineate the extent of groundwater contamination identified during previous sampling events. The results of the 2004 investigation were presented in the Data Gaps Report (Shaw, 2007b).
- **Sumps report:** The 146 sumps/waste rack sumps across LHAAP were grouped together and were designated as LHAAP-35/36. Sixty of these sumps/waste rack sumps were located on LHAAP-46. All sumps were removed from the site in the mid-1990s, and it was determined that no further action is necessary for sump-related soil (Shaw, 2008).
- **Feasibility Study (FS):** The FS (Shaw, 2009) was based on the available results from previous investigations. In addition, it included sampling results from Building 407 soil and ash samples in 2006, natural attenuation and geochemical evaluations based on 2007 results, monitoring well sampling for volatile organic compounds (VOCs) in 2008, and details of new intermediate zone well installations.

2.2.3 History of CERCLA Enforcement Activities

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

The FS for LHAAP-46 (Shaw, 2009) was issued in October 2009, and the Proposed Plan (U.S. Army, 2010) was issued in January 2010.

2.3 Community Participation

The U.S. Army, USEPA, TCEQ, and the Restoration Advisory Board have provided public outreach to the surrounding community concerning LHAAP-46 and other environmental sites at LHAAP. The outreach program has included fact sheets, media interviews, site visits, invitations to attend quarterly technical and regulatory review meetings, and public meetings consistent with its public participation responsibilities under Sections 113(k)(2)(B), 117(a), and 121(f)(1)(G) of CERCLA.

The Final Proposed Plan (U.S. Army, 2010) for the selection of the remedy for LHAAP-46 was released to the Administrative Record file and made available to the public for review and comment on January 25, 2010. The initial 30-day public comment period for the Proposed Plan also began on January 25, 2010. An open house was held on January 26, 2010. The initial notice of availability of the Proposed Plan and other related documents in the Administrative Record was published in the *Marshall News Messenger* and *The Shreveport Times* on two dates in both publications: January 17 and 24, 2010. A notice of a 30-day extension of the public comment period and announcement of the March 9, 2010, public meeting was published in the *Marshall News Messenger* on February 21 and 28, 2010, and in *The Shreveport Times* on February 22 and 28, 2010. The public comment period for the Proposed Plan was held from January 25 to March 25, 2010, which includes the 30 day extension. The newspaper and media notices for the meetings are provided in **Appendix A**. The transcript for the meeting on March 9, 2010 is part of the Administrative Record. Significant comments are addressed in the Responsiveness Summary, which is **Section 3.0** of this ROD.

Currently, the Administrative Record can be found locally at the information repository maintained at the following location:

Location: Marshall Public Library
300 S. Alamo
Marshall, Texas, 75670

Business Hours: Monday – Thursday 10:00 a.m. – 8:00 p.m.
Friday – Saturday 10:00 a.m. – 5:00 p.m.

2.4 *Scope and Role of Response Action*

The recommended action at LHAAP-46 will prevent potential risks associated with exposure to contaminated groundwater. Although groundwater at Longhorn is not currently being used as drinking water, nor may it be used in the future based on its reasonably anticipated use as a national wildlife refuge, when establishing the remedial action objectives (RAOs) for this response action, the U.S. Army has considered the NCP's expectation to return usable groundwaters to their potential beneficial uses wherever practicable and has also considered the State of Texas designation of all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 TAC 335.563(h)(1). The U.S. Army intends to return the contaminated shallow groundwater zone at LHAAP-46 to its potential beneficial uses, which for the purposes of this ROD is considered to be attainment of the Safe Drinking Water Act (SDWA) MCLs to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C). If a return to potential beneficial uses is not practicable, the NCP expectation is to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction.

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

In addition, the preferred action will include groundwater monitoring to demonstrate that the plume is not migrating at levels that present a potential impact to nearby surface water bodies and to verify that contaminant levels are being reduced to drinking water standards (MCLs) when the LUC may be terminated.

2.5 *Site Characteristics*

2.5.1 *Conceptual Site Model*

Figure 2-3 illustrates the overall conceptual site model for LHAAP-46 and presents those pathways that are being considered for remediation. Pathways that are likely to have a negligible impact are not being considered for remediation.

All sumps have been removed at LHAAP-46. Analytical results from samples of sump contents and soil near the sumps did not indicate that they were likely sources of contamination.

The original sources of contamination at LHAAP-46 were most likely spills resulting from the variety of support services that occurred in the area. The spills would have resulted in minor soil contamination that would migrate, depending on the contaminants, through overland flow via

surface runoff or through leaching to the groundwater. Overland flow does not currently appear to be contributing to a migration of contaminants, as the ditch surface water did not contain any VOCs, SVOCs, explosives, pesticides, or PCBs. Likewise, the sediment data do not show detections of VOCs, SVOCs, explosives, or pesticides. Some metals were detected in the surface water and sediment at low concentrations that occur naturally.

Metals and VOCs have been detected in the groundwater at elevated concentrations, but there is no associated soil contamination to indicate that contaminants are currently leaching from the soil to the groundwater. However, use of groundwater by a hypothetical future maintenance worker is a potential pathway that should be remediated.

Modeling calculations were completed to assess the potential for the COCs present in shallow groundwater at LHAAP-46 to migrate toward and discharge into Goose Prairie Creek. The modeling concluded that contaminants present in the shallow groundwater at LHAAP-46 will not adversely impact Goose Prairie Creek surface water (Shaw, 2007c).

2.5.2 Overview of the Site

The size of LHAAP-46 is approximately 190 acres. The surface features at the site are a mixture of asphalt-paved roads, parking areas, building foundation remnants, old buildings, and overgrown wooded and grassy vegetation-covered areas. There are no notable subsurface features. The topography in this area is relatively flat with the surface drainage flowing east into tributaries of Goose Prairie Creek, which eventually flows into Caddo Lake. The lake is a source of drinking water for several neighboring communities in Louisiana. LHAAP-46 has no known areas of archaeological or historical importance.

2.5.3 Geology and Hydrogeology

The soils at LHAAP-46 consist primarily of silty clay with thin lenses of sand. The first saturated sand layer encountered when drilling was designated as the shallow zone, the next was designated as the intermediate zone, followed by the deep zone. The three zones are separated by clay or silty clay layers of variable thicknesses that are generally not laterally continuous for large distances. At wells LHSMW23 and LHSMW26 there is no apparent separation between the shallow and intermediate zones at these wells and the zones appear to be interconnected. These wells have been designated as shallow/intermediate zone wells and they will be used in the discussions of both the shallow and intermediate zone.

Groundwater is present within a shallow saturated sand zone, which varies from 3 to 5 feet thick (Jacobs, 2002). Groundwater elevations were measured by Shaw in November/December 2007. The shallow zone groundwater elevation contours based on these data are shown on **Figure 2-4**. Depth to groundwater in the shallow zone is approximately 11 to 23 feet below ground surface (bgs) with groundwater flow to the east (Jacobs, 2002; Shaw, 2009). The hydraulic

conductivities in the shallow zone wells varied from 2.5×10^{-5} to 1.9×10^{-3} centimeters per second (cm/s) (Jacobs, 2002).

Groundwater is also present in an intermediate zone and a deep zone. **Figure 2-5** shows measured groundwater elevations and groundwater contours for the intermediate wells based on the data collected in November/December 2007. Depth to groundwater in the intermediate zone is approximately 23 to 30 feet bgs. Groundwater flows to the northeast according to the November/December 2007 groundwater elevation measurements. Hydraulic conductivities in three intermediate zone wells varied from 4.5×10^{-4} to 9.5×10^{-4} cm/s.

Groundwater in the deep zone is approximately 33 feet bgs with flow to the east or northeast, based on the November/December 2007 groundwater elevation measurements. The hydraulic conductivity in the deep zone was measured at 1.4×10^{-3} cm/s (Jacobs, 2002). With only one deep zone well at LHAAP-46, the groundwater flow direction was extrapolated from wells at multiple LHAAP sites, and thus no specific figure for the deep zone at LHAAP-46 has been prepared.

2.5.4 Sampling Strategy

Several sampling events were conducted at LHAAP-46 from 1992 to 2008, as outlined in **Section 2.2.2** on site investigations. In the early investigations, soil samples were collected from throughout the site to determine the areas of contamination. Subsequent investigations focused on the areas where contamination was found, performing additional soil, groundwater, and sediment sampling and installing monitoring wells to delineate the contamination. Samples were analyzed for various analytes including VOCs, SVOCs, metals, explosives, perchlorate, pesticides, and dioxins/furans. In the area of the contaminant plume, groundwater samples were also analyzed for indicators of conditions that promote natural attenuation (biodegradation), such as sulfide, methane, and chloride.

2.5.5 Nature and Extent of Contamination

Based on the risk assessment and subsequent evaluations, it was determined that the COCs for this site are dissolved TCE and the daughter products cis-1,2-dichloroethene (DCE) and vinyl chloride (VC) in the shallow and intermediate groundwater zones. **Figures 2-6** and **2-7** present the current TCE plumes for the shallow and intermediate zones, respectively, as defined by the MCL of 5 micrograms per liter ($\mu\text{g/L}$). The figures also show historical data. The COCs are toxic and carcinogenic. No principal threat source material (such as dense non-aqueous phase liquid [DNAPL]) was identified or suspected to exist at LHAAP-46.

The shallow zone plume is roughly centered on well LHSMW19, and has a lateral extent of approximately 210,000 square feet (ft^2), and a vertical extent of approximately 3 feet. Assuming a total porosity of 0.3, the calculated volume of contaminated groundwater is 1.41 million

gallons. During the February 2007 sampling event, the highest concentration of TCE detected was 85.5 µg/L at LHSMW19. The plume's edge is defined by the MCL of 5 µg/L. Wells surrounding LHSMW19 were below the MCL, thus LHSMW19 is currently the only well within the plume boundaries as shown in **Figure 2-6**. During the 2007 sampling event, the maximum concentration for cis-1,2-DCE was an estimated 1.5 µg/L at LHSMW18 (which is below the MCL of 70 µg/L), and VC was not detected (detection limit of 0.32 µg/L).

The intermediate zone plume is roughly centered on well 46WW02, which is approximately 200 feet east of LHSMW19. In this zone, the lateral extent of contamination is approximately 700,000 ft², and the vertical extent is approximately 5 feet. Assuming a total porosity of 0.3, the calculated volume of contaminated groundwater is 7.85 million gallons. The highest concentration of TCE detected was 31.2 µg/L on October 28, 2008 at 46WW02. Currently there are two wells, 46WW02 and 46WW05, within the plume boundary, as shown in **Figure 2-7**. COCs in the surrounding wells were below the MCL. During the 2008 sampling event, the maximum concentration for cis-1,2-DCE was 1.72 µg/L at 46WW05 (which is below the MCL of 70 µg/L), and VC was not detected (detection limit of 0.32 µg/L).

Modeling calculations were completed to assess the potential for the COC present in shallow groundwater at LHAAP-46 to migrate toward and discharge to Goose Prairie Creek. The modeling concluded that contaminants present in the shallow groundwater at LHAAP-46 will not adversely impact Goose Prairie Creek surface water (Shaw, 2007c). The results were obtained by using the transport model Analytical Transient One-, Two-, and Three-Dimensional Simulation of Waste Transport in the Aquifer System (AT123D). AT123D assumes the aquifer to be homogeneous and isotropic. It accounted for advection, dispersion, adsorption, and chemical degradation.

2.6 Current and Potential Future Land and Resource Uses

2.6.1 Current and Future Land Uses

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

LHAAP has been an industrial facility since 1942. Production activities and associated waste management activities continued until the facility was determined to be in excess of the U.S. Army's needs in 1997. The plant area has been relatively dormant since that time. LHAAP is surrounded by a fence (except on the border with Caddo Lake), and current security measures at

the LHAAP preclude unlimited public access to areas within the fence. The fence now represents the Refuge boundary. Approved access for hunters is very limited.

The reasonably anticipated future use of LHAAP-46 is as a national wildlife refuge. This anticipated future use is based on a Memorandum of Agreement (MOA) (U.S. Army, 2004) between the USFWS and the U.S. Army. That memorandum of agreement (MOA) documents the transfer process of the LHAAP acreage to USFWS to become the Caddo Lake National Wildlife Refuge. Presently the Caddo Lake National Wildlife Refuge occupies approximately 7,000 acres of the 8,416-acre former installation. In accordance with the National Wildlife Refuge System Administration Act of 1966 and its amendments (16 USC 668dd), the land will remain as a national wildlife refuge unless there is a change brought about by an act of Congress, or the land is part of an exchange authorized by the Secretary of the Interior.

2.6.2 Current and Future Surface Water Uses

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

The anticipated future uses of surface water are the same as the current uses.

2.6.3 Current and Future Groundwater Uses

Groundwater in the drinking water aquifer (250-430 feet bgs) under and near LHAAP is currently used as a drinking water source. The drinking water aquifer should not be confused with the deep zone groundwater, which begins at approximately 33 ft bgs. There are currently five active water supply wells near LHAAP. One well is located in and owned by Caddo Lake State Park. The well is completed to a depth of 315 feet and has been in use since 1935. A second well owned by the Karnack Water Supply Corporation services the town of Karnack and is located approximately 2 miles southeast of town. This well is approximately 430 feet deep and has been in use since 1942. The Caddo Lake Water Supply Corporation has three wells located both north and northwest of LHAAP. These wells are identified as Caddo Lake Water Supply Corporation Wells 1, 2, and 3 and are all hydraulically upgradient of LHAAP (Jacobs, 2002). Because of the large distance between these wells and LHAAP, water removal from these wells is not expected to affect groundwater flow at the site. In addition, there are several

livestock and domestic wells located in the vicinity of LHAAP with depths averaging approximately 250 feet.

There are three water supply wells located on LHAAP, and all three supply water to buildings currently in use at the installation. None of the water supply wells are associated with or in imminent danger from the localized contaminated groundwater at LHAAP-46. One well is located at the Fire Station/Security Office. A second well is located approximately 0.35 mile southwest of the Fire Station/Security Office. The third well is located north of the administration building, near the entrance to LHAAP. The distances from these wells to the middle of LHAAP-46 are approximately 0.65 mile, 1 mile, and 1.9 miles, respectively. Two additional wells previously supplied water to the installation, but these have been plugged and abandoned. The wells are not currently used for drinking water at LHAAP, although they may supply water for non-potable uses.

Although the anticipated future use of the facility as a wildlife refuge may not include the use of the groundwater at LHAAP-46 as a drinking water source, the State of Texas designates all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 TAC 335.563(h)(1). To be conservative, a hypothetical industrial use scenario was evaluated for risk. The future industrial scenario for LHAAP assumes limited use of groundwater as a drinking water source.

2.7 Summary of Site Risks

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

2.7.1 Summary of Human Health Risk Assessment

This section is based on the conclusions presented in the *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites* (Jacobs, 2003), in the *Data Gaps Investigations* (Shaw, 2007b), and in additional data collected in preparation of the *Final Feasibility Study, LHAAP-46* (Shaw, 2009). The risk assessment used data from the investigations conducted through 2001 including the plant-wide perchlorate investigation. Results from the later investigations did not change the overall outcome of the risk assessment. During the risk assessment, soil and groundwater data were used to calculate the aggregate risk, which was then compared to the USEPA target risk range of 1×10^{-4} to 1×10^{-6} for the excess lifetime carcinogenic risk and to a hazard index (HI) of 1 for non-carcinogenic hazards. If there is no unacceptable risk associated with a medium, and a cleanup level is not exceeded, then the medium is not identified in this ROD for remediation. The conceptual site model that is

associated with the risk assessment was introduced in **Section 2.5.1**, and is presented as **Figure 2-3**.

2.7.1.1 Identification of Chemicals of Potential Concern

The BHHRA identified chemicals of potential concern (COPCs) for LHAAP-46 and evaluated the carcinogenic risk and non-carcinogenic hazard for each. **Table 2-1** summarizes the risk assessment data for the COPCs, including minimum and maximum detected concentrations, frequency of detection, and exposure point concentrations (EPCs). Analytical results for various congeners of dioxins and furans are expressed as toxic equivalents of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD).

2.7.1.2 Exposure Assessment

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

For soil, reasonable exposure pathways according to the conceptual site model are: incidental ingestion of the surface soil (0 to 2 feet bgs), dermal contact with the surface soil, inhalation of particulates, and inhalation of VOCs from the soil (0 to 7 feet bgs). The BHHRA found VOC levels in the soil at 0 to 7 feet bgs to be non-detect; this exposure pathway did not add to carcinogenic risk or non-carcinogenic hazard. Therefore, it was not included in the summary tables (**Tables 2-1, 2-4, and 2-5**). For groundwater, reasonable exposure pathways are ingestion of groundwater, dermal contact while showering with contaminated groundwater, and inhalation of VOCs while showering with contaminated groundwater.

2.7.1.3 Toxicity Assessment

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

2.7.1.4 Risk Characterization

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

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

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

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

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

The HQ is calculated as follows:

$$\text{Non-carcinogenic HQ} = \text{CDI/RfD}$$

where: CDI = chronic daily intake
RfD = reference dose

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

The carcinogenic risks for soil and groundwater are 1.67×10^{-5} and 4.05×10^{-5} , respectively (Jacobs, 2003). Both media are within the acceptable range. The hazard indices for soil and groundwater are 0.12 and 31, respectively. The latter value is outside of the acceptable range.

Therefore, the remedial action focuses on the groundwater. The major contributors to the non-carcinogenic hazard in groundwater were three metals which account for approximately 87% of the total groundwater non-carcinogenic hazard. The three metals are thallium, antimony, and manganese, which had groundwater HQ values of 24, 1.5, and 1.4, respectively. Other chemicals did not have an HQ that exceeded 1. Also, the maximum detected concentrations of the following COPCs exceeded their MCL concentrations (Jacobs, 2002 and 2003): antimony, arsenic, beryllium, cadmium, chromium, lead, thallium, TCE, and bis(2-ethylhexyl)phthalate.

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

2.7.1.5 Evaluation of COPCs

To further evaluate the occurrence of the COPCs, a data gap investigation was conducted (Shaw, 2007b) and additional investigations were conducted when preparing the FS (Shaw, 2009). While these investigations did not change the overall outcome of the earlier BHHRA, they concluded there was a single relevant COPC that needed to be targeted by the remedial action, which is TCE. Since TCE has degradation or daughter products, the daughter products, DCE and VC are also considered COPCs. **Table 2-6** is a summary of the justifications for which of the COPCs should be classified as COCs. The list of COPCs in **Table 2-6** excludes compounds that were detected but considered to be insignificant and not in need of further evaluation. Specifically, compounds were excluded if they resulted in a groundwater HQ below 0.1 and had a maximum detection below the MCL. In the evaluation of COPCs, reasons for not considering a COPC as a COC include: the elevated concentration during BHHRA sampling was due to using a non-low flow sampling technique, absence of the COPC from recent sampling, elevated concentration due to well corrosion, the COPC is naturally occurring, the COPC's contribution to the HI is low, and/or the chemical was detected in the laboratory blank. In **Table 2-6**, the maximum detected concentrations indicated is the maximum from all investigations including those after the BHHRA. The following subsections evaluate the COPCs. **Table 2-7** presents the outcome of the evaluation, which is the list of COCs that require remediation.

Metals

The maximum concentration of aluminum in groundwater (80,000 µg/L) was from LHSMW16 in 1994 and exceeded the LHAAP perimeter well groundwater background value (13,400 µg/L). Aluminum was detected in 80 of the 105 groundwater samples analyzed between 1994 and 2007. The maximum concentration of aluminum in the 2007 groundwater samples was 1,360 µg/L. The geochemical evaluation presented in Appendix B of the Final FS (Shaw, 2009) concluded

that aluminum in the groundwater is primarily the result of suspended clay particles. Thus, aluminum is not considered a COC at LHAAP-46.

Groundwater samples were analyzed for antimony between 1994 and 2007. The maximum antimony concentration was 63 µg/L in LHSMW27 in 1996. That was an estimated result because the detection limits were elevated in the 1996 sampling round. In 1998, the detection limits were not elevated, and antimony was detected only in 46WW01 at a concentration of 8 µg/L. Even though this concentration is above the MCL value of 6 µg/L, this concentration is less than the LHAAP perimeter well groundwater background 95% upper tolerance limit (UTL) value of 11.5 µg/L (Shaw, 2007d). Antimony was detected in 4 of 107 groundwater samples at LHAAP-46, and antimony was not detected in the 2007 samples. Due to lack of detection in the 2007 sampling round, and 1998 results below background, antimony is not considered a COC for LHAAP-46.

The maximum concentration of arsenic in groundwater (20 µg/L) that exceeded the MCL (10 µg/L) was detected in LHSMW17 in 1998. Other arsenic results that exceeded the MCL were found at LHSMW12 and 46WW02 in 1998 and at LHSMW22, LHSMW23 and LHSMW24 in 1996. There is no evident pattern to the arsenic detected in the groundwater at LHAAP-46. The most recent (2007) arsenic concentrations were all less than the MCL. The geochemical evaluation identified no definite conclusions about arsenic, but noted that the detected concentrations were all estimated. The most recent samples were collected with low flow sampling methods and showed consistently lower arsenic concentrations than earlier samples. This suggests that elevated arsenic concentrations in earlier samples were associated with suspended solids caused by the sample collection method. Thus, arsenic is considered an artifact of turbid samples collected during historic sampling rounds and is not retained as a COC at LHAAP-46.

The maximum concentration of barium in groundwater (1,400 µg/L) was from LHSMW16 in 1994 and did not exceed the MCL (2,000 µg/L). The LHAAP perimeter well groundwater background value (1,990 µg/L) was less than the MCL, but greater than the highest barium concentration at LHAAP-46. Barium was detected in 84 of the 107 groundwater samples analyzed between 1994 and 2007. The most recent 2007 barium sample concentrations were all less than 50 µg/L. Thus, barium is not considered a COC at LHAAP-46.

The maximum concentration of beryllium in groundwater (76 µg/L) was from LHSMW27 in August 1996, and exceeded the MCL (4 µg/L). In 1998, the beryllium concentration from this well was 0.9 µg/L, below the MCL. Two other detectable concentrations of beryllium were slightly above the MCL in 1998, 5.4 µg/L at LHSMW17 and 6.5 µg/L at LHSMW12. There is no evident pattern to beryllium in the groundwater at LHAAP-46. Beryllium was detected in 19

of 90 groundwater samples at LHAAP-46, mostly from 1998. Beryllium was not detected in the 2007 samples. Thus, beryllium is not considered a COC for LHAAP-46.

The maximum concentration of cadmium in groundwater was 20 µg/L from LHSMW27 in 1996 and exceeded the MCL (5 µg/L). In 1998, the concentration at LHSMW27 was 0.8 µg/L, which is below the MCL. No other cadmium results exceeded the MCL. Cadmium was detected in 19 of 107 groundwater samples at LHAAP-46. The most recent (2007) cadmium concentrations were all less than the MCL. Since the only detection above the MCL was not reproducible, cadmium is not considered a COC for LHAAP-46.

The maximum concentration of chromium in groundwater (4,700 µg/L) was from LHSMW15 in 1998, and exceeded the MCL (100 µg/L). Five wells exceeded the MCL in 1994, one well exceeded the MCL in February 1996, six wells exceeded the MCL in August 1996, ten wells exceeded the MCL in 1998, and four wells exceeded the MCL in 2007. Eight of the ten wells that had chromium concentrations that exceeded the MCL in 1998 were sampled in 2007. All eight wells had detectable concentrations of chromium. Four of the wells had unfiltered results that were above the MCL, but filtered results ranged from 5.26 to 57.6 µg/L and were all lower than the MCL. Comparison of dissolved versus total chromium concentrations from 2007 showed most of the chromium as filterable particulates, not dissolved. The geochemical evaluation suggests that the stainless steel material of the monitoring wells is the source of chromium in groundwater at LHAAP-46. A similar occurrence has been observed at other sites, e.g., LHAAP-12 and LHAAP-53. Detectable chromium concentrations associated with filterable particulates are expected as the stainless steel of the wells degrades over time. Thus, the chromium in groundwater samples at LHAAP-46 is from high filterable particulates in the samples, and chromium is not considered a COC at LHAAP-46.

The maximum concentration of lead in groundwater (673 µg/L) was from LHSMW23 in August 1996, and exceeded the MCL (15 µg/L). The anomalously high lead concentrations observed in 1996 were not duplicated in 1998 or 2007. The geochemical evaluation suggests that any previously present lead contamination has attenuated, and an ongoing source is not present at the site. Thus, lead in groundwater is not considered a COC at LHAAP-46.

Although the risk assessment reported that the maximum concentration of manganese, 6,500 µg/L from LHSMW18 in 1994, is a contributor to the groundwater non-carcinogenic HI (1.4), this maximum manganese concentration is less than the LHAAP perimeter well groundwater background value (95% UTL) of 7,820 µg/L (Shaw, 2007d). The most recent manganese samples from 2007 had a maximum concentration of 3,790 µg/L from LHSMW22. The geochemical evaluation concluded that manganese detected in the site samples is most likely natural. Thus, manganese is not considered a COC for LHAAP-46.

The maximum concentration of nickel in groundwater (3,670 µg/L) was from LHSMW22 in 2007 and exceeded the LHAAP perimeter well groundwater background value (211 µg/L). Nickel was detected in 69 of the 87 groundwater samples analyzed between 1996 and 2007. The geochemical evaluation concluded that nickel in the groundwater is local contamination as a result of corrosion of the stainless steel monitoring wells. Thus, nickel is not considered a COC at LHAAP-46.

The maximum concentration of silver in groundwater (120 µg/L) was from LHSMW15 in 1998. Silver was detected in 5 of the 107 groundwater samples analyzed between 1994 and 2007. Silver was not detected in the most recent (2007) round of sampling. Thus, silver is not considered a COC at LHAAP-46.

The maximum concentration of strontium in groundwater (12,000 µg/L) was from LHSMW25 in 1998. Strontium was detected in 82 of the 87 groundwater samples analyzed between 1994 and 1998. Strontium was not tested in 2007. The HQ associated with the strontium was 0.20. Due to the low HQ, strontium is not considered a COC at LHAAP-46.

The maximum thallium concentration of 200 µg/L was detected in LHSMW27 in 1996. The other three thallium concentrations higher than 90 µg/L were also from 1996. These high concentrations of thallium were not reproducible in subsequent rounds of sampling. The 2007 samples of thallium had a maximum concentration of 5.43 µg/L at LHSMW24, which is above the MCL value of 2 µg/L. However, the geochemical evaluation concludes the thallium concentrations in the groundwater are most likely natural. Thus, thallium is not considered a COC for LHAAP-46.

The maximum concentration of vanadium in groundwater (140 µg/L) was from LHSMW17 in 1998. Vanadium was detected in 11 of the 87 groundwater samples analyzed between 1996 and 2007. Vanadium was detected in only one 2007 sample with a concentration of 9.24 µg/L at LHSMW22, which would have an HQ of less than 0.1. Thus, vanadium is not considered a COC at LHAAP-46.

In summary, metals are not considered to be COCs at LHAAP-46.

Volatile Organic Compounds

TCE and its daughter products are considered COCs at LHAAP-46 in the shallow and intermediate zone groundwater. In the shallow zone, the plume of TCE centers around LHSMW19. The shallow zone plume boundary is decreasing, and it currently encloses fewer wells than it did in the past. The maximum concentration detected for this TCE plume was 85.5 µg/L from LHSMW19. In the intermediate zone, the plume of TCE centers around 46WW02. The maximum concentration detected was 31.2 µg/L at 46WW02. TCE has not been detected in the deep groundwater zone (46WW03). **Figure 2-6** and **Figure 2-7** show the extent of TCE in

the shallow and intermediate zones, respectively. Tabulated analytical results can be found in the FS (Shaw, 2009), Appendix A, *Preliminary Evaluation of Natural Attenuation*.

As biodegradation daughter products of TCE, which is a COC, cis-1,2-DCE and VC are considered COCs regardless of the extent of their presence at the current time. The maximum concentration of cis-1,2-DCE in groundwater (9.8 µg/L) was from LHSMW18 in 1998 and was less than the MCL (70 µg/L). The most recent concentrations from 2007 ranged from nondetect to an estimated 1.5 µg/L. The maximum concentration of VC in groundwater (0.71 µg/L) was from LHSMW18 in 1998 and was less than the MCL (2 µg/L). VC was not detected in the 2007 samples.

Semivolatile Organic Compounds

The maximum concentration of bis(2-ethylhexyl)phthalate in groundwater (27 µg/L) was from 46WW02 in November 1998 and exceeded the MCL (6 µg/L). Two other samples, from 46WW03 in November 1998 and LHSMW11 in 1994 also exceeded the MCL. The most recent results (November 1998) for bis(2-ethylhexyl)phthalate ranged from nondetect to 27 µg/L. In the May 1998 sample round, bis(2-ethylhexyl)phthalate was also found in the laboratory blank. It is likely that the November 1998 samples could have also been impacted by laboratory contamination. Bis(2-ethylhexyl)phthalate is not considered a COC in the groundwater at LHAAP-46 since there were only sporadic detections and the chemical is a common laboratory contaminant.

Perchlorate

Perchlorate was detected in 9 of the 40 groundwater samples analyzed between 2000 and 2007. Perchlorate was not detected in the 2007 samples. Since perchlorate has no MCL, the detected perchlorate results were compared to TCEQ's groundwater medium-specific concentration for industrial use (GW-Ind) developed under the Risk Reduction Rules, Standard 2, in accordance with 30 TAC 335.558 and 335.559(d)(2). The maximum concentration of perchlorate in groundwater was 30 µg/L at 46WW04 in 2001. This value is well below the GW-Ind value (72 µg/L); thus, perchlorate is not considered a COC at LHAAP-46.

2.7.2 Summary of Ecological Risk Assessment

The ecological risk for LHAAP-46 was addressed in the installation-wide BERA (Shaw, 2007a). The BERA provides a process that evaluates the likelihood that adverse ecological effects may occur, or are occurring, as a result of exposure to one or more stressors. A stressor is any physical, chemical, or biological entity that can induce an adverse ecological response. The BERA for LHAAP focuses only on chemical stressors.

Ecological risk does not exist unless:

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

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

LHAAP-46 lies within the Industrial Sub-Area, and the BERA concluded that no chemicals exceeded ecological thresholds of concern in the Industrial Sub-Area (Shaw, 2007a). Thus, there are no COECs at LHAAP-46. Therefore, no action is needed at LHAAP-46 for the protection of ecological receptors.

2.7.3 *Basis of Action*

The remedial action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment. The conclusion reached by the FS investigation and subsequent investigations is that the COCs for groundwater at LHAAP-46 are TCE, DCE, and VC. There are no COCs for soil. **Table 2-7** presents the cleanup levels for the COCs. A SDWA MCL has been determined for each of the COCs, therefore these MCLs will be used as the cleanup levels.

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

2.8 *Remedial Action Objectives*

The RAOs for LHAAP-46, which address contamination associated with the media at the site and take into account the future uses of LHAAP surface waters, land, and groundwater, are:

- Protection of human health by preventing human exposure to the contaminated groundwater;

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

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

2.9 Description of Alternatives

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

2.9.1 Description of Remedy Components

Alternative 1 – No Action Alternative

As required by the NCP, the no action alternative provides a comparative baseline against which the action alternatives can be evaluated. Under this alternative, groundwater would be left “as is” without implementing any additional monitoring, containment, removal, treatment, or other mitigating actions. No actions would be implemented to reduce existing or potential future exposure to human receptors, although natural attenuation would be ongoing.

Estimated Capital Present Worth Cost: \$0

Estimated O&M Present Worth Cost: \$0

Estimated Duration: --

Estimated Total Present Worth Cost: \$0

Alternative 2 – Monitored Natural Attenuation with Land Use Control

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

- MNA to return groundwater to its potential beneficial use, wherever practicable
 - Performance objectives to evaluate the MNA remedy performance after two years
 - A contingency remedy to reach the RAOs if MNA is found to be ineffective
- LUC to restrict access to the contaminated groundwater until the cleanup levels are reached

- Long-term monitoring (LTM) semiannually for three years, annually until the next five-year review, then once every five years to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen until cleanup levels are reached

Estimated Capital Present Worth Cost: \$60,500

Estimated O&M Present Worth Cost: \$460,700

Estimated Duration: 30 years

Estimated Total Present Worth Cost: \$521,200

Alternative 3 – In Situ Bioremediation, MNA, and LUC

The components of the in situ bioremediation action include:

- Injecting microbial cultures and nutrients into the subsurface at predetermined locations
 - Sampling wells to monitor effectiveness
- LUC and LTM until the cleanup levels are reached

Estimated Capital Present Worth Cost: \$379,000

Estimated O&M Present Worth Cost: \$365,000

Estimated Duration: 15 years

Estimated Total Present Worth Cost: \$744,000

2.9.2 Common Elements and Distinguishing Features of Each Alternative

Common Elements of Alternatives 2 and 3

Common elements of Alternatives 2 and 3 are described below.

MNA—MNA is a passive remedial action that relies on natural biological, chemical, and physical processes to reduce the mass and concentrations of groundwater COCs under favorable conditions. The natural attenuation evaluation indicates that MNA is a feasible technology for the groundwater at LHAAP-46 (Shaw, 2009). Monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume.

LUC—The LUC would be implemented to support the RAOs. The U.S. Army would be responsible for long-term implementation, maintenance, inspection, reporting, and enforcement of the LUC. The U.S. Army will provide details of the LUC long-term implementation and long-term maintenance actions in the RD for the site. The LUC would prevent human exposure to residual groundwater contamination presenting an unacceptable risk to the hypothetical future maintenance worker and ensure that there is no withdrawal or use of groundwater beneath the

sites for anything other than environmental monitoring and testing. The groundwater restriction LUC would be maintained until the concentrations of contaminants and by-product (daughter) contaminants in groundwater had been reduced to levels below their respective cleanup levels. In addition, the Texas Department of Licensing and Regulation (TDLR), responsible for notifying well drillers of groundwater restrictions, would be notified and a notification of the LUC with the Harrison County Courthouse would include a map showing the areas of groundwater restriction at the site, in accordance with 30 TAC 335.566.

In order to transfer this property (LHAAP-46), an Environmental Condition of Property (ECOP) document would be prepared and the Environmental Protection Provisions from the ECOP would be attached to the letter of transfer. The ECOP would include the LUC for groundwater as part of the Environmental Protection Provisions. The property would be transferred subject to the LUC identified in the ECOP. These restrictions would prohibit or restrict property uses that might result in exposure to the contaminated groundwater (e.g., drilling restrictions). The U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of an LUC objective at these sites after they have been transferred. The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or significant modification of an LUC, or land use change inconsistent with the LUC objectives and use assumptions of the remedy. In the event that TCEQ and/or USEPA and the U.S. Army agree with respect to any modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the FFA and 40 CFR 300.435(c)(2) and 40 CFR 300.430(f)(4)(iii).

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

Distinguishing Features of Alternative 3

Distinguishing features of Alternative 3 are discussed below.

Alternatives 2 and 3 are similar in that they both depend on MNA processes. Existing biological activity is the biggest component of natural attenuation. Alternatives 2 and 3 are anticipated to provide verifiable long-term reliability. These two alternatives comply with all ARARs, whereas Alternative 1 would not. For Alternative 2, a plan for a contingency action of in situ bioremediation will be in place in case MNA alone is insufficient. The estimated time to reach cleanup goals for these two alternatives is 23 and 15 years, respectively.

Alternative 3 involves active treatment, whereas Alternative 2 does not. In comparison to Alternative 2, Alternative 3 would: 1) require more design and implementation time, including

the time to conduct a treatability study of in situ bioremediation; 2) have more action-specific ARARs, such as those related to drilling work; and 3) have a greater cost, especially capital cost. Alternative 3 is further described below.

Areas to be treated—In situ bioremediation is proposed for an area of the shallow zone centered around the shallow monitoring well LHSMW19, and for an area of the intermediate zone centered around the intermediate monitoring well 46WW02. These two wells are the ones most highly impacted by TCE. Contaminated groundwater is present in shallow thin sand lenses that occur in a formation consisting primarily of clay to silty clay. Separate plumes in the shallow and intermediate zones are assumed.

Injecting microbial cultures and nutrients into the subsurface at predetermined locations—

Bacteria present in the groundwater can use chlorinated solvents as electron acceptors. Electron donors may include a wide variety of nutrients: sugars (molasses), alcohols (methanol, ethanol), volatile acids (acetate, lactate), and/or wastes (food processing, manure). The COCs at LHAAP-46 can degrade under anaerobic conditions, but microorganisms, mechanisms, and redox requirements differ. Bioaugmentation additives, appropriate nutrients, and other materials would be injected into the subsurface. This form of bioremediation combines the injection of microbial cultures capable of degrading the contaminants with a carbon source to provide adequate conditions for the proliferation of the dechlorinating organisms. For costing purposes, it is assumed that the bioaugmentation material will be injected into both the shallow (20 feet bgs) and intermediate zone (40 feet bgs) using direct-push technology within the plumes, targeting areas with higher concentrations.

Sampling wells to monitor effectiveness—Monitoring for contaminants would be performed to assess the effectiveness of the treatment. Anticipated remediation times may be short with appropriate contact of the contaminant and the injected materials. Assuming first order anaerobic degradation rates and reasonable half-lives for the COCs, the COCs within the treated areas could be reduced to their respective cleanup levels in approximately two years. However, it is anticipated that COCs will remain in the plumes outside the treated areas and will attenuate to levels below MCLs over time. Additional monitoring is recommended for up to 15 years after reduction of the COCs at the two biotreated areas or until cleanup levels are attained. Annual reports will be prepared during the first 10 years to document the program.

2.9.3 Expected Outcomes of Each Alternative

Alternative 1 would allow the site to remain a hazard to human health, since it simply leaves the site as is. Alternatives 2 and 3 have very similar outcomes – the main difference is in the time required to reach the MCLs, 23 or 15 years, respectively. The similar outcomes are considered to be attainment of the SDWA MCLs to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C). In addition, the monitoring activities associated with MNA would

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

2.10 *Summary of Comparative Analysis of Alternatives*

Nine criteria identified in the NCP §300.430(e)(9)(iii) are used to evaluate the different remediation alternatives individually and against each other in order to select a remedy. This section profiles the relative performance of each alternative against the nine criteria, noting how it compares to the other options under consideration. The nine evaluation criteria are discussed below. **Table 2-8** summarizes the comparative analysis of the alternatives.

2.10.1 *Overall Protection of Human Health and the Environment*

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

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

Alternatives 2 and 3 both satisfy the RAOs for LHAAP-46. Alternatives 2 and 3 also provide confirmation that human health and the environment will be protected because the monitoring will be conducted to ensure that MNA is returning the contaminated shallow groundwater zone at LHAAP-46 to its potential beneficial uses as a drinking water, wherever practicable, and to document that the plumes are contained and prevented from impacting surface water at levels that could present a risk to human health and the environment. Furthermore, the LUC would protect human health by preventing access to the contaminated groundwater until contaminants in the groundwater attain the SDWA MCLs for all contaminants above the MCLs and attain the MCLs for all contaminants by-products (daughter contaminants) above the MCLs.

2.10.2 *Compliance with ARARs*

Section 121(d) of CERCLA and NCP §300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations, which are collectively referred to as “ARARs”

unless such ARARs are waived under CERCLA Section 121(d)(4). The ARARs that pertain to this ROD are discussed in **Section 2.13.2**.

Because contaminated groundwater has the potential to discharge to surface water features that flow to Caddo Lake, a drinking water supply, chemical specific ARARs for surface water consumption are appropriate and relevant. Specifically, Texas surface water quality standards are set forth in 30 TAC 307.6(d)(1) for TCE (5 µg/L), cis-1,2-DCE (70 µg/L), and VC (2 µg/L) for LHAAP-46. These standards are equivalent to the MCLs for the contaminants.

Alternative 1 does not comply with chemical-specific ARARs because no additional remedial action would be implemented. Alternatives 2 and 3 return the contaminated shallow groundwater zone at LHAAP-46 to its potential beneficial use as drinking water, wherever practicable, which for the purposes of this ROD is considered to be attainment of the relevant and appropriate SDWA MCLs to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C). If a return to potential beneficial uses is not practicable, these alternatives would still meet the NCP expectation to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. Alternative 2 does comply with surface water ARARs because modeling results indicate MNA will reduce the TCE concentrations in groundwater to the MCL prior to discharge as base flow into surface water and monitoring would be used to confirm it. Alternative 3 also complies with surface water chemical specific ARARs because active remedial processes will reduce contaminant levels in groundwater to levels below water quality standards prior to discharge as base flow into surface water.

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

2.10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation, and the adequacy and reliability of controls.

For Alternative 1, contaminant removal would occur by natural attenuation processes, but the long-term effectiveness and permanence would be unknown because of the absence of monitoring. Also, no controls would be implemented to prevent access to contaminated groundwater.

Alternatives 2 and 3 are remedial actions that would permanently reduce contaminant levels in the groundwater over time and return the groundwater to its potential beneficial use as drinking water wherever practicable, with Alternative 3 taking the least amount of time. The LUC would prevent human exposure to the groundwater until cleanup levels are achieved.

Natural attenuation processes are effectively controlling plume migration at LHAAP-46 and have stabilized the size of the plume. Based on predictive analysis, natural attenuation is expected to continue to be successful at the site. However, when performance is based on predictive analysis, contingency measures should be included in the decision document (USEPA, 1999). Therefore, Alternative 2 includes a contingency remedy of in-situ bioremediation.

Alternative 3 would also control plume migration through contaminant reduction by in situ bioremediation. Until a treatability study is conducted, some uncertainty exists regarding the ability of in situ bioremediation to effectively reduce concentrations further and enhance natural attenuation. However, in situ bioremediation is expected to be effective for the contaminants at this site. Should in situ bioremediation be considered ineffective after implementation, the remedy may need to be reevaluated. Alternatives 2 and 3 rely on the LUC for the protection of human health until the MCLs are achieved. Monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume.

2.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

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

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

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

Since there is no known residual source of groundwater contamination in the soils at LHAAP-46, achievement of cleanup levels in groundwater would be expedited under Alternative 3 by implementing in situ bioremediation in areas of highest contaminant concentrations in the groundwater. It is noted that monitoring for contaminants would be performed to assess the effectiveness of the treatment. Also, it is anticipated that COCs will remain above MCLs in the plume outside the treated areas and will continue to attenuate to levels below MCLs over time.

2.10.5 Short-Term Effectiveness

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

Because Alternative 1 does not involve any remedial measures, no short-term risk to workers, the community, or the environment would exist. The activities associated with Alternative 2 would have little potential for short-term risk to workers or the environment, other than the negligible risks to workers associated with the exposure to contaminants during groundwater monitoring activities. Alternatives 2 and 3 involve potential short-term risks to workers associated with exposure to contaminated groundwater and operation of drilling/construction equipment.

Alternatives 2 and 3 both contain the LUC as an element of their remedies and would provide almost immediate protection through implementation of the LUC that prohibits installation of wells for any purposes other than environmental monitoring and testing. The time period to achieve groundwater cleanup levels is the most significant difference between Alternatives 2 and 3. Alternative 3 is expected to take less time to achieve RAOs. The implementation of Alternative 2 would require more time than Alternative 3.

2.10.6 Implementability

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

Under the no action alternative, no remedial action would be taken. Therefore, no difficulties or uncertainties would be associated with its implementation. Alternative 2 is easily implemented from a technical standpoint because no construction activities would be performed, although the U.S. Army would be responsible for long-term maintenance and enforcement of the LUC, long-term evaluation of MNA, long-term sampling; and long-term maintenance and operation of sampling equipment.

Alternative 3 is also technically implementable, although less so than Alternative 2 because of the uncertainties associated with the ability of in situ bioremediation to effectively lower

contaminant levels and to enhance natural attenuation in the complex hydrogeologic conditions of the site. Alternative 3 would be somewhat more difficult to implement than Alternative 2 from a technical standpoint due to the specialized expertise required to design and construct the in situ bioremediation treatment elements.

Administratively, all of the alternatives are implementable.

2.10.7 Cost

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

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

The progression of present worth costs from the least expensive alternative to the most expensive alternative is as follows: Alternative 1, Alternative 2, and Alternative 3. No costs are associated with Alternative 1 because no remedial activities would be conducted.

Alternative 2 has the lowest present worth and capital costs of the action alternatives. The highest capital cost is associated with Alternative 3 primarily due to the activities associated with the injection phase of in situ bioremediation. The selection of Alternative 2 over Alternative 3 saves 30% in total present worth cost. The capital present worth cost of Alternative 3 is 6 times higher than Alternative 2.

2.10.8 State/Support Agency Acceptance

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

2.10.9 Community Acceptance

Community acceptance is an important consideration in the final evaluation of the selected remedy. Public comments were received during the 60-day public comment period, including written comments sent to the U.S. Army and verbal comments made at the January 26, 2010 and March 9, 2010 public meetings. The public expressed some reservations about the proposed plan, especially about the proximity of the plume to public drinking water wells outside LHAAP.

This concern was addressed in the March 9, 2010 public meeting with further explanation that the water wells are upgradient of the plume. Responses to this and other concerns have been provided and can be found in the Responsiveness Summary (**Section 3.0** of the ROD), in the transcript of the March 9, 2010 meeting, and in the U.S. Army's response to written comments which has been filed in the Administrative Record.

2.11 Principal Threat Wastes

LHAAP-46 has no known principal threat wastes (e.g., source materials such as DNAPLs).

2.12 The Selected Remedy

2.12.1 Summary of Rationale for the Selected Remedy

Alternative 2, MNA and LUC, is the preferred alternative for LHAAP-46 and is consistent with the intended future use of the site as a national wildlife refuge. This alternative is selected because it satisfies the RAOs for the site through the groundwater use restriction LUC, which will ensure protection of human health by preventing human exposure to contaminated groundwater, and MNA, which will return the contaminated water to its potential beneficial use as drinking water, wherever practicable. The LUC will remain in place until MCLs are met. Furthermore, MNA will ensure protection of human health and the environment by documenting that the contaminated groundwater remains localized and is not migrating into nearby surface water bodies at levels that exceed MCLs. The LTM and reporting associated with the MNA remedy will continue until primary COC and daughter product MCLs are attained. Based on a preliminary natural attenuation evaluation and groundwater modeling, MCLs are expected to be met through natural attenuation in approximately 23 years for TCE (Shaw, 2009). Considering the lithologic variability, particularly the lateral and vertical change from sand to clay, the times to MCL may vary by an order of magnitude. The groundwater flow rates are within the normal range for the formation material at these sites. Thus, no adverse impact is expected to the surface water during the time it would take natural attenuation to reduce contaminant concentrations to MCLs. The selected alternative offers a high degree of long-term effectiveness, can be easily and immediately implemented, and costs significantly less than Alternative 3.

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

until the next five-year review, and finally LTM every 5 years until the cleanup levels are reached.

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

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

The U.S. Army will present details of the LUC implementation plan, the groundwater monitoring plan, and the MNA remedy implementation in an RD for LHAAP-46.

2.12.2 Description of the Selected Remedy

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

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

- *MNA to reduce concentrations in groundwater to MCLs.* Historic data suggest that natural attenuation of COCs is occurring at the site; however, additional data collection is necessary to fully evaluate natural attenuation. Monitoring wells will be sampled for eight consecutive quarters to evaluate and confirm the occurrence of natural attenuation in conjunction with historical data. Data from the eight quarterly events will be combined with historic data to evaluate the effectiveness of various natural physical, chemical, and biological processes in reducing contaminant concentrations.
- *Performance objectives to evaluate the MNA remedy performance after two years. Each of the general performance objectives must be met as indicated below. If the criteria are not met to illustrate that MNA is an effective remedy, the contingency action would be initiated. If MNA is effective, a baseline will be*

established from the data to this point in time. Specific evaluation criteria will be developed in the RD. The MNA evaluation will be based on the USEPA lines of evidence (USEPA, 1999) and the anaerobic screening (USEPA, 1998) as follows:

- MNA potential based on evaluation biodegradation screening scores using USEPA guidance
- Plume stability (i.e., the plume concentrations are decreasing in the majority of performance wells, and the plume is not expanding in area as demonstrated with compliance wells).
- MNA Process Evaluation demonstrated based on an attenuation rate calculated with empirical performance monitoring data, and MNA Process Demonstration based on the presence of daughter products and bacterial culture counts.
- *A contingency remedy involving in situ bioremediation to reach the RAOs if MNA is found to be ineffective.* The contingency remedy will use elements of in situ bioremediation from Alternative 3 to address the ineffective aspects of MNA. The area and the elements of the contingency remedy would be selected based on the entire data set available. If the contingency remedy is implemented, it will be documented in an ESD.
- *Initiate LTM.* If MNA is determined to be effective, monitoring will be conducted to evaluate the remedy performance and determine if the plume conditions remain constant, improve or worsen after the baseline is established. Monitoring will continue after the initial eight quarters at a frequency of semiannual for three years, then annually until the next five-year review. The performance monitoring plan will be developed in the RD and will be based on USEPA guidance (USEPA, 2004).
- Continue LTM every five years to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen. The baseline of the plume for future five-year reviews will be established as part of the MNA evaluation program. The initial LTM plan will be developed during RD.
- LUC to restrict access to the contaminated groundwater to environmental monitoring and testing until groundwater is returned to its potential beneficial use as a drinking water. LUC implementation details will be included in the RD. The boundary of the LUC would be the site boundary as shown on **Figure 2-7**; this is sufficient to include all of the plume.

The U.S. Army would be responsible for implementation, maintenance, inspection, reporting, and enforcement of the LUC. Although the U.S. Army may later pass these procedural responsibilities to the transferee by property transfer agreement, the U.S. Army shall retain ultimate responsibility for: (1) CERCLA 121(c) five-year reviews; (2) notification of the appropriate regulators of any known LUC deficiencies or violations; (3) access to the property to

conduct any necessary response; (4) reservation of the authority to change, modify or terminate the LUC and any related transfer or lease provisions; and (5) ensuring that the LUC objectives are met to protect the integrity of the selected remedy. In the event that TCEQ and/or USEPA and the U.S. Army agree with respect to any modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the FFA and 40 CFR 300.435(c)(2) and 40 CFR 300.430(f)(4)(iii).

LUC implementation and maintenance actions would be described in the RD for LHAAP-46. The selected LUC will prevent human exposure to chlorinated solvents-contaminated groundwater through the restriction of groundwater use. The groundwater restriction component of the LUC shall be maintained until the concentrations of contaminants and by-product (daughter) contaminants have been reduced to below their respective MCLs under the SDWA to allow unrestricted use and unlimited exposure at LHAAP-46. The LUC would be included in the property transfer documents. In addition, the TDLR responsible for notifying well drillers of groundwater restrictions would be notified and a recordation of the area of groundwater restriction would be filed in the Harrison County Courthouse.

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

Long-term operational requirements under this alternative would include maintenance of the LUC. The need for continued monitoring will be evaluated every five years during the reviews. Sampling frequency and analytical requirements will be presented in the RD for LHAAP-46.

2.12.3 Cost Estimate of the Selected Remedy

Table 2-9 presents the present worth analysis of the cost for the selected remedy, Alternative 2. The information in the table is based on the best available information regarding the anticipated scope of the remedial alternative. The quantities used in the estimate are for estimating purposes only. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within -30 to +50 percent of the actual project cost.

The total project present worth cost of this alternative is approximately \$521,200, using a discount rate of 2.8%. The capital cost is estimated at \$60,500. The total O&M present value cost is estimated at approximately \$460,700. The O&M cost includes evaluation of MNA, maintenance of the LUC, and LTM through Year 30. The LTM would support the required five-year reviews.

2.12.4 *Expected Outcomes of the Selected Remedy*

The purpose of this response action is to attain the RAOs stated in **Section 2.8** of this document. The cleanup levels for the COCs in the groundwater are the Federal SDWA MCLs, to satisfy the chemical-specific ARAR (**Table 2-7**).

The expected outcome of the selected remedy is that the TCE plume in the groundwater, and any plumes of daughter products, would be reduced to the MCLs. MCLs for TCE, cis-1,2-DCE, and VC are 5, 70, and 2 µg/L, respectively. Achievement of the cleanup levels is anticipated to be completed in 23 years, although for cost estimating purposes, it is assumed that five-year reviews will continue until Year 30. When the groundwater is satisfactory, the LUC will be removed. In the short-term (prior to the groundwater achieving MCLs), the site will be made part of a national wildlife refuge operated by USFWS, and is expected to continue as such in the long-term (after the groundwater achieves MCLs).

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

2.13 *Statutory Determinations*

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

2.13.1 *Protection of Human Health and the Environment*

The selected remedy, Alternative 2, will protect human health and the environment, and achieve the RAOs for LHAAP-46, through MNA and LUC. Although this alternative does not provide for human intervention to remediate groundwater, the alternative is a passive subsurface remedial action conducted by natural processes and mechanisms. TCE and daughter products in the groundwater will be reduced to protective ARAR levels. The LUC would prevent human exposure to the contaminated groundwater by restricting access to the groundwater within the LUC boundaries. The monitoring activities associated with MNA will ensure that COCs and by-product (daughter) contaminants in groundwater do not discharge to nearby surface water bodies.

at such levels that ARARs are exceeded. The LUC will be removed when it has been satisfactorily demonstrated through groundwater monitoring that the groundwater has achieved cleanup levels.

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

2.13.2 Compliance with ARARs

The selected remedy of MNA and LUC complies with all ARARs. The ARARs are presented below and in **Table 2-10**.

Chemical-Specific ARARs

The chemical-specific ARAR is to reduce TCE and its daughter products in groundwater to the Federal SDWA MCLs. The MCLs for TCE, cis-1,2-DCE, and VC are 5, 70, and 2 µg/L, respectively. This alternative will return the contaminated shallow groundwater zone at LHAAP-46 to its potential beneficial use as drinking water, wherever practicable, which for the purposes of this ROD is considered to be attainment of the relevant and appropriate SDWA MCLs to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C). If a return to potential beneficial uses is not practicable, this alternative would still meet the NCP expectation to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. Because modeling results indicate that maximum concentrations of COCs were below their respective MCLs where groundwater discharges into nearby surface water bodies, nearby surface water bodies will be protected from ARAR exceedances. In the event of remedy failure resulting in a release to surface water, 40 CFR 122, 125, 129, 130, and 131 and 30 TAC 307.1, 307.2, 307.3, 307.4, 307.5(a) and (b), 307.6, 307.7, 307.8 and 307.9 are considered potential future ARARs.

Location-Specific ARARs

LHAAP-46 has no location-specific ARARs. The USACE has not made a determination that jurisdictional wetlands exist at LHAAP-46 and neither are any identified on the USFWS database, therefore protection of wetlands is not considered a potential location-specific ARAR for this site.

Action-Specific ARARs

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

- **Wastes and disposal activities:** The processes of monitoring, intercepting, or treating contaminated groundwater may generate a variety of primary and secondary

waste surface water (e.g., soil, personal protective equipment, and dewatering and decontamination fluids). These waste surface waters are expected to be non-hazardous waste. All solid waste (defined as any solid, liquid, semisolid, or contained gaseous material intended for discard [40 CFR 261.2]) generated during remedial activities must be appropriately characterized to determine whether it contains RCRA hazardous waste (40 CFR 262.11; 30 TAC 335.62; 30 TAC 335.503[a][4]; 30 TAC 335.504). All wastes must be managed, stored, treated (if necessary), and disposed of in accordance with the ARARs for waste management listed in **Table 2-10** for the particular type of waste stream or contaminants in the waste.

- **Well construction:** The remedial action may involve the placement, use, or eventual plugging and abandonment of some type of groundwater monitoring, injection, and/or extraction wells, either for in situ treatment of the contaminated groundwater or for LTM of the groundwater. Available standards for well construction and plugging/abandonment would provide ARARs for such actions and include 30 TAC 331, Subchapters A, C, and H. Texas has promulgated technical requirements in Chapter 76 of Title 16 of the TAC applicable to construction, operation, and plugging/abandonment of water wells. In particular, 16 TAC 76.1000 (*Locations and Standards of Completion for Wells*), 16 TAC 76.1002 (*Standards for Wells Producing Undesirable Water or Constituents*) (LHAAP-46 contaminated groundwater could be considered “undesirable water” defined pursuant to Section 76.10[36] as “water that is injurious to human health and the environment or water that can cause pollution to land or other waters”), 16 TAC 76.1004 (*Standards for Capping and Plugging of Wells and Plugging Wells that Penetrate Undesirable Water or Constituent Zones*), and 16 TAC 76.1008 (*Pump Installation*) may provide ARARs for the placement, construction, and eventual plugging/abandonment of groundwater injection or extraction wells or the placement and long-term operation of groundwater monitoring wells for proposed groundwater remedial strategies.
- **Water Treatment:** Contaminated groundwater and wastewaters collected during well drilling or decontamination activities could be transported to the groundwater treatment plant at LHAAP-18/24 for processing, and would subsequently be discharged in compliance with the effluent limits for that plant. Such waters would be characterized, as required, before transport and managed accordingly in compliance with requirements for the type of waste contaminating the water. To assure compliance with the groundwater treatment plant’s discharge limits, the incoming water must meet the waste acceptance criteria for the facility. On-site wastewater treatment units (as defined in 40 CFR 260.10) that are part of a wastewater treatment facility that is subject to regulation under Section 402 or Section 307(b) of the Clean Water Act (CWA) are not subject to RCRA Subtitle C hazardous waste management standards (40 CFR 270.1[c][2][v]; 40 CFR 264.1[g][6]; 30 TAC 335.42[d][1]). The USEPA has clarified that this exemption applies to all tanks, conveyance systems, and ancillary equipment, including piping and transfer trucks, associated with the wastewater treatment unit (53 Federal Register [FR] 34079, September 2, 1988).

2.13.3 Cost-Effectiveness

Alternative 2 is considered to be the best balance of tradeoffs because it provides the same level of protection to human health as Alternative 3 but at a lower cost. The selection of Alternative 2 over Alternative 3 saves 30% in total present worth cost. The capital present worth cost of Alternative 3 is 6 times higher than Alternative 2. The relatively high capital cost for Alternative 3 is due to the activities associated with the injection phase of in situ bioremediation. Alternatives 2 and 3 have similar outcomes in terms of short and long-term effectiveness and reduction in toxicity, mobility, and volume; the main difference between the two is that the MCLs are anticipated to be reached approximately 15 years later for Alternative 2.

Table 2-9 is the cost estimate summary table for the selected remedy. **Table 2-11** compares the cost and effectiveness of each alternative.

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

The selected remedy does not address the issue of permanent solution through disposal, treatment, or recovery of contaminants. However, the selected remedy provides the best balance of trade offs in terms of five balancing criteria and considering State and community acceptance. Alternative 2 would document effectiveness through the confirmation of MNA and the routine monitoring of the attenuation and migration of the contaminants in groundwater. Natural attenuation effectively controls plume migration and has stabilized the size of the area exhibiting COC and by-product (daughter) contaminant concentrations exceeding MCL values. Natural biodegradation is an irreversible treatment process that would reduce the mass and concentration of contaminants. Alternative 2 would provide almost immediate protection because the LUC would be implemented relatively quickly. Maintenance of these controls would be required until natural attenuation processes reduce COC and by-product (daughter) contaminant concentrations to below MCLs. Alternative 2 is easily implemented from a technical standpoint because no remedial activities would be performed, although routine maintenance of the LUC, evaluation of MNA, and sampling would be required. Alternative 2 has the lowest present worth and capital costs of the remedial alternatives.

2.13.5 Preference for Treatment as a Principal Element

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

2.13.6 Five-Year Review Requirements

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

2.14 Significant Changes from the Proposed Plan

The Proposed Plan for LHAAP-46 was released for public comment in January 2010. The Proposed Plan identified Alternative 2, MNA and LUC, as the Preferred Alternative for groundwater remediation. The U.S. Army reviewed all written and verbal comments submitted during the public comment period. After careful consideration of the comments, it was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

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

Scenario Timeframe: Current						
Medium: Groundwater						
Exposure Medium: Groundwater						
Exposure Point	Chemical	Concentration Detected ¹ (µg/L)		Frequency of Detection	Exposure Point Concentration (µg/L)	Statistical Measure
		Minimum	Maximum			
Incidental ingestion, inhalation of particulates, dermal contact	<i>Dioxin/Furan</i>					
	2,3,7,8-TCDD	1.98E-06	6.35E-06	---	6.35E-06	maximum
	<i>Explosive</i>					
	RDX	1.90E-01	3.20E-01	2/89	3.20E-01	maximum
	<i>Metals</i>					
	Aluminum	2.20E+02	8.00E+04	79/89	8.00E+04	maximum
	Antimony	8.00E+00	6.30E+01	4/91	6.30E+01	maximum
	Barium	2.00E+01	3.73E+03	68/91	3.73E+03	maximum
	Beryllium	5.00E-01	7.60E+01	18/70	7.60E+01	maximum
	Cadmium	3.00E-01	2.00E+01	15/91	2.00E+01	maximum
	Chromium	4.40E+00	4.70E+03	73/91	4.70E+03	maximum
	Manganese	4.90E+01	6.50E+03	90/91	6.50E+03	maximum
	Nickel	1.70E+01	1.19E+03	53/70	1.19E+03	maximum
	Silver	1.90E+00	1.20E+02	6/88	1.20E+02	maximum
	Strontium	4.60E+01	1.20E+04	87/91	1.20E+04	maximum
	Thallium	1.10E+00	2.00E+02	15/91	2.00E+02	maximum
	Vanadium	2.80E+00	1.40E+02	8/70	1.40E+02	maximum
	<i>Non-Metallic Anion</i>					
	Perchlorate	2.30E+01	3.00E+01	2/10	3.00E+01	maximum
	<i>Pesticides</i>					
	Aldrin	6.30E-03	6.30E-03	2/8	6.30E-03	maximum
	alpha-BHC	7.60E-03	7.60E-03	3/8	7.60E-03	maximum
	beta-BHC	5.40E-03	5.40E-03	3/8	5.40E-03	maximum
	delta-BHC	4.60E-03	4.60E-03	3/8	4.60E-03	maximum
	<i>Semivolatile Organics</i>					
	2,4-Dinitrotoluene	0.00E+00	0.00E+00	0/88	7.30E-02	maximum
	Bis(2-ethylhexyl)phthalate	4.70E-01	2.70E+01	28/87	2.70E+01	maximum
	<i>Volatile Organics</i>					
	Methylene chloride	8.80E-01	1.40E+00	2/91	1.40E+00	maximum
	Tetrachloroethene	1.10E+00	2.40E+00	4/91	2.40E+00	maximum
	Trichloroethene	7.10E-01	7.70E+01	14/91	---	
	Trichlorofluoromethane	2.10E+00	2.10E+00	4/91	2.10E+00	maximum
	Vinyl Chloride	6.80E-01	7.10E-01	2/91	7.10E-01	maximum

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

Scenario Timeframe: Current						
Medium: Soil						
Exposure Medium: Soil (0 to 2 feet below ground surface)						
Exposure Point	Chemical	Concentration Detected ¹ (mg/kg)		Frequency of Detection	Exposure Point Concentration (mg/kg)	Statistical Measure
		Minimum	Maximum			
Incidental ingestion, inhalation of particulates, dermal contact	<i>Dioxin/Furan</i>					
	2,3,7,8-TCDD	2.86E-07	3.30E-05	---	4.23E-06	95% UCL
	<i>Metals</i>					
	Aluminum	7.30E+02	3.28E+04	107/151	8.07E+03	95% UCL
	Antimony	3.10E+00	6.30E+00	7/151	4.17E+00	95% UCL
	Barium	4.70E+00	2.06E+03	97/151	2.06E+03	Maximum
	Cadmium	2.31E+00	7.18E+00	4/151	7.18E+00	maximum
	Manganese	4.70E+00	3.74E+03	111/151	2.53E+02	95% UCL
	Mercury	4.40E-02	5.60E-01	8/142	5.60E-01	maximum
	Vanadium	8.00E+00	8.60E+01	83/83	2.89E+01	95% UCL
	<i>Semivolatile Organics</i>					
	Benzo(a)anthracene	7.50E+01	2.30E+00	5/149	2.30E+00	maximum
	Benzo(a)pyrene	7.70E+01	2.10E+00	9/149	2.10E+00	maximum
	Benzo(b)fluoranthene	7.50E+01	4.50E+00	11/149	4.50E+00	maximum
	Benzo(k)fluoranthene	7.10E+01	1.20E+00	6/149	3.78E-01	95% UCL
	Dibenzo(a,h)anthracene	1.10E+02	3.80E-01	2/149	3.80E-01	maximum
	Indeno(1,2,3-cd)pyrene	2.90E+02	1.60E+00	4/149	1.60E+00	maximum
Notes						
¹ Minimum/maximum detected concentration above the reporting limit ---: No information available 95% UCL: 95% upper confidence level of the mean µg/L: micrograms per liter BHC: benzenehexachloride (hexachlorocyclehexane) mg/kg: milligrams per kilogram RDX: 1,3,5-Trinitroperhydro-1,3,5-triazine TCDD: tetrachlorodibenzo-p-dioxin						
References						
Jacobs Engineering Group, Inc. (Jacobs), 2003, <i>Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas, Final</i> , Oak Ridge, TN, June.						
Summary of Chemicals of Potential Concern and Medium-Specific Exposure Point Concentrations						
The table presents the chemicals of potential concern (COPCs) and exposure point concentration (EPC) for each (i.e. the concentration used to estimate the exposure and risk from each COPC). The table includes the range of concentrations detected for each COPC, the frequency of detection (i.e. the number of times the chemical was detected in the samples collected at the site), the EPC, and the statistical measure upon which the EPC was based. The COPCs listed are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003).						

Table 2-2
Carcinogenic Toxicity Data Summary

Pathway: Ingestion, Dermal Contact				
Chemical of Concern	Oral Cancer Slope Factor (mg/kg-day) ⁻¹	Dermal Cancer Slope Factor (mg/kg-day) ⁻¹	Weight of Evidence/ Carcinogen Guideline Description	Source/Date
<i>Dioxin/Furan</i>				
2,3,7,8-TCDD	1.50E+05	3.00E+05	Not Classified	USEPA-HEAST, 1997
<i>Explosive</i>				
RDX	1.10E-01	1.10E-01	C	USEPA-IRIS, 2001
<i>Metals</i>				
Aluminum	NTV	NTV	Not Classified	---
Antimony	NTV	NTV	Not Classified	---
Barium	NC	NC	D	USEPA-IRIS, 2001
Beryllium	NTV	NTV	B1	USEPA-IRIS, 2001
Cadmium	NTV	NTV	B1	TCEQ, 2001
Chromium	NC	NC	Not Classified	---
Manganese	NC	NC	D	USEPA-IRIS, 2001
Mercury	NC	NC	D	USEPA-IRIS, 2001
Nickel	NTV	NTV	A	USEPA-IRIS, 2001
Silver	NC	NC	D	USEPA-IRIS, 2001
Strontium	NTV	NTV	Not Classified	---
Thallium	NC	NC	Not Classified	---
Vanadium	NTV	NTV	Not Classified	---
<i>Non-Metallic Anion</i>				
Perchlorate	NTV	NTV	Not Classified	---
<i>Pesticides</i>				
Aldrin	1.70E+01	3.40E+01	B2	USEPA-IRIS, 2001
alpha-BHC	6.30E+00	6.49E+00	B2	USEPA-IRIS, 2001
beta-BHC	1.80E+00	1.98E+00	C	USEPA-IRIS, 2001
delta-BHC	1.80E+00	3.60E+00	B2	TCEQ, 2001
<i>Semivolatile Organics</i>				
2,4-Dinitrotoluene	6.80E-01	8.00E-01	B2	USEPA-IRIS, 2001
Benzo(a)anthracene	7.30E-01	8.20E-01	B2	USEPA, 1993
Benzo(a)pyrene	7.30E+00	8.20E+00	B2	USEPA-IRIS, 2001
Benzo(b)fluoranthene	7.30E-01	8.20E-01	B2	USEPA, 1993
Benzo(k)fluoranthene	7.30E-02	8.20E-02	B2	USEPA, 1993
Bis(2-ethylhexyl)phthalate	1.40E-02	7.37E-02	B2	USEPA-IRIS, 2001
Dibenzo(a,h)anthracene	7.30E+00	8.20E+00	B2	USEPA, 1993
Indeno(1,2,3-cd)pyrene	7.30E-01	8.20E-01	B2	USEPA, 1993
<i>Volatile Organics</i>				
Methylene chloride	7.50E-03	7.89E-03	B2	USEPA-IRIS, 2001
Tetrachloroethene	5.20E-02	5.20E-02	B2	USEPA-NCEA, 2001
Trichloroethene	1.10E-02	1.10E-02	B2	USEPA-NCEA, 2001
Trichlorofluoromethane	NTV	NTV	Not Classified	---
Vinyl Chloride	1.50E+00	1.50E+00	A	USEPA-IRIS, 2001

Table 2-2 (continued)
Carcinogenic Toxicity Data Summary

Pathway: Inhalation			
Chemical of Concern	Unit Risk Factor (mg/m ³) ⁻¹	Weight of Evidence/ Carcinogen Guideline Description	Source/Date
<i>Dioxin/Furan</i> 2,3,7,8-TCDD	3.30E+04	Not Classified	USEPA-HEAST, 1997
<i>Explosive</i> RDX	NTV	C	USEPA-IRIS, 2001
<i>Metals</i>			
Aluminum	NTV	Not Classified	---
Antimony	NTV	Not Classified	---
Barium	NC	D	USEPA-IRIS, 2001
Beryllium	2.40E+00	B1	USEPA-IRIS, 2001
Cadmium	1.80E+00	B1	USEPA-IRIS, 2001
Chromium	NC	Not Classified	---
Manganese	NC	D	USEPA-IRIS, 2001
Mercury	NC	D	USEPA-IRIS, 2001
Nickel	4.80E-01	A	USEPA-IRIS, 2001
Silver	NC	D	USEPA-IRIS, 2001
Strontium	NTV	Not Classified	---
Thallium	NC	Not Classified	---
Vanadium	NTV	Not Classified	---
<i>Non-Metallic Anion</i> Perchlorate	NTV	Not Classified	---
<i>Pesticides</i>			
Aldrin	4.90E-03	B2	USEPA-IRIS, 2001
alpha-BHC	1.80E-03	B2	USEPA-IRIS, 2001
beta-BHC	5.30E-04	C	USEPA-IRIS, 2001
delta-BHC	5.10E-04	B2	TCEQ, 2001
<i>Semivolatile Organics</i>			
2,4-Dinitrotoluene	NTV	B2	USEPA-IRIS, 2001
Benzo(a)anthracene	8.80E-05	B2	USEPA, 1993
Benzo(a)pyrene	8.80E-04	B2	USEPA-NCEA, 2001
Benzo(b)fluoranthene	8.80E-02	B2	USEPA, 1993
Benzo(k)fluoranthene	8.80E-06	B2	USEPA, 1993
Bis(2-ethylhexyl)phthalate	4.00E-03	B2	USEPA-NCEA, 2001
Dibenzo(a,h)anthracene	8.80E-04	B2	USEPA, 1993
Indeno(1,2,3-cd)pyrene	8.80E-05	B2	USEPA, 1993
<i>Volatile Organics</i>			
Methylene chloride	4.70E-04	B2	USEPA-IRIS, 2001
Tetrachloroethene	5.80E-07	B2	USEPA-NCEA, 2001
Trichloroethene	1.70E-03	B2	USEPA-NCEA, 2001
Trichlorofluoromethane	NTV	Not Classified	---
Vinyl Chloride	8.80E-03	A	USEPA-IRIS, 2001

Table 2-2 (continued)
Carcinogenic Toxicity Data Summary

Notes --- : No information available BHC: benzenehexachloride (hexachlorocyclohexane) mg/kg-day: milligrams per kilogram per day mg/m³: milligrams per cubic meter NC: Chemical not classified as a carcinogen NTV: no toxicity value available RDX: 1,3,5-Trinitroperhydro-1,3,5-triazine TCDD: tetrachlorodibenzo-p-dioxin	Weight of Evidence/Carcinogen Guideline Description: A - Human carcinogen B1 - Probable human carcinogen – Indicates that limited human data are available B2 - Probable human carcinogen – Indicates sufficient evidence in animals and inadequate or no evidence in humans C - Possible human carcinogen D - Not classifiable as a human carcinogen
References Jacobs Engineering Group, Inc. (Jacobs), 2003, <i>Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas</i>, Final, Oak Ridge, TN, June. Texas Commission on Environmental Quality (TCEQ), 2001. Update to 1998 Consistency Memorandum. Toxicity Factors Table, 15 March 2001. U.S. Environmental Protection Agency (USEPA), 1993, <i>Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons</i>, Office of Research and Development, EPA/600/R-93/089, July 1993. USEPA-HEAST, 1997. Human Health Effects Summary Tables (HEAST). FY-1995, Annual. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R-95-036. USEPA-IRIS, 2001. Integrated Risk Information System (IRIS). United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 2001. USEPA-NCEA, 2001. USEPA Region 3 Risk-Based Concentration Tables (5/8/2001). Referenced values from National Center for Environmental Assessment (NCEA).	
Summary of Toxicity Assessment The table provides carcinogenic risk information which is relevant to the contaminants of potential concern in soil and groundwater. The list of chemicals of concern presented here are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003).	

Table 2-3
Non-Carcinogenic Toxicity Data Summary

Pathway: Ingestion, Dermal Contact						
Chemical of Concern	Chronic/ Subchronic	Oral RfD Value (mg/kg-day)	Dermal RfD (mg/kg-day)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source/Date
<i>Dioxin/Furan</i> 2,3,7,8-TCDD	Chronic	NTV	NTV	---	---	---
<i>Explosive</i> RDX	Chronic	3.00E-03	3.00E-03	Prostate	100/1	USEPA-IRIS, 2001
<i>Metals</i>						
Aluminum	Chronic	1.00E+00	1.00E-01	NA	NA	USEPA-NCEA, 2001
Antimony	Chronic	4.00E-04	6.00E-05	Longevity, blood glucose, and cholesterol	1000/1	USEPA-IRIS, 2001
Barium	Chronic	7.00E-02	4.90E-03	Kidney	3/1	USEPA-IRIS, 2001
Beryllium	Chronic	2.00E-03	1.40E-05	GIT	300/1	USEPA-IRIS, 2001
Cadmium	Chronic	5.00E-04	1.25E-05	Kidney	10/1	USEPA-IRIS, 2001
Chromium	Chronic	1.50E+00	1.95E-02	NA	100/10	USEPA-IRIS, 2001
Manganese	Chronic	4.70E-02	2.82E-03	CNS	1/1	USEPA-IRIS, 2001
Mercury	Chronic	3.00E-04	2.10E-05	Autoimmune effects	1000/1	USEPA-IRIS, 2001
Nickel	Chronic	2.00E-02	8.00E-04	Body weight	300/1	USEPA-IRIS, 2001
Silver	Chronic	5.00E-03	2.00E-04	Argyria	3/1	USEPA-IRIS, 2001
Strontium	Chronic	6.00E-01	1.20E-01	Bone	300/1	USEPA-IRIS, 2001
Thallium	Chronic	8.00E-05	8.00E-05	Blood	3000/1	USEPA-IRIS, 2001
Vanadium	Chronic	7.00E-03	1.82E-04	NA	NA	USEPA-HEAST, 1997
<i>Non-Metallic Anion</i>						
Perchlorate	Chronic	9.00E-04	9.00E-04	NA	NA	USEPA, 1998
<i>Pesticides</i>						
Aldrin	Chronic	3.00E-05	1.50E-05	Liver	1000/1	USEPA-IRIS, 2001
alpha-BHC	Chronic	8.00E-03	7.76E-03	NA	NA	ATSDR, 1997
beta-BHC	Chronic	NTV	NTV	---	---	---
delta-BHC	Chronic	3.00E-04	1.50E-04	NA	NA	TCEQ-Derived
<i>Semivolatile Organics</i>						
2,4-Dinitrotoluene	Chronic	2.00E-03	1.70E-03	CNS	100/1	USEPA-IRIS, 2001
Benzo(a)anthracene	Chronic	NTV	NTV	---	---	---
Benzo(a)pyrene	Chronic	NTV	NTV	---	---	---
Benzo(b)fluoranthene	Chronic	NTV	NTV	---	---	---
Benzo(k)fluoranthene	Chronic	NTV	NTV	---	---	---
Bis(2-ethylhexyl)phthalate	Chronic	2.00E-02	3.80E-03	Liver	1000/1	USEPA-IRIS, 2001
Dibenzo(a,h)anthracene	Chronic	NTV	NTV	---	---	---
Indeno(1,2,3-cd)pyrene	Chronic	NTV	NTV	---	---	---
<i>Volatile Organics</i>						
Methylene chloride	Chronic	6.00E-02	5.70E-02	Liver	100/1	USEPA-IRIS, 2001
Tetrachloroethene	Chronic	1.00E-02	1.00E-02	Liver	1000/1	USEPA-IRIS, 2001
Trichloroethene	Chronic	6.00E-03	6.00E-03	NA	NA	USEPA-NCEA, 2001
Trichlorofluoromethane	Chronic	3.00E-01	6.90E-02	Whole body (increased mortality)	1000/1	USEPA-IRIS, 2001
Vinyl Chloride	Chronic	3.00E-03	3.00E-03	Liver	30/1	USEPA-IRIS, 2001

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

Pathway: Inhalation					
Chemical of Concern	Chronic/ Subchronic	Inhalation RfC (mg/m ³)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source/Date
Dioxin/Furan 2,3,7,8-TCDD	Chronic	NTV	---	---	---
Explosive RDX	Chronic	0.0005	NA	NA	TCEQ, 2001
Metals					
Aluminum	Chronic	0.0035	NA	NA	USEPA-NCEA, 2001
Antimony	Chronic	0.0005	Pulmonary toxicity, chronic interstitial inflammation	300/1	TCEQ, 2001
Barium	Chronic	0.00049	Fetus developmental effects	1000/1	USEPA-HEAST, 1997
Beryllium	Chronic	0.00002	Lungs	10/1	USEPA-IRIS, 2001
Cadmium	Chronic	0.0002	NA	NA	USEPA-NCEA, 2001
Chromium	Chronic	0.0001	NA	NA	TCEQ, 2001
Manganese	Chronic	0.00005	Impairment of neurobehavioral function	1000/1	USEPA-IRIS, 2001
Mercury	Chronic	0.0003	Hand tremor, memory loss	30/1	USEPA-IRIS, 2001
Nickel	Chronic	0.0002	Respiratory effects	NA	ATSDR, 1997
Silver	Chronic	0.00001	NA	NA	TCEQ, 2001
Strontium	Chronic	NTV	---	---	---
Thallium	Chronic	0.0001	NA	NA	TCEQ, 2001
Vanadium	Chronic	0.00005	NA	NA	TCEQ, 2001
Non-Metallic Anion					
Perchlorate	Chronic	NTV	---	---	---
Pesticides					
Aldrin	Chronic	NTV	---	---	---
alpha-BHC	Chronic	NTV	---	---	---
beta-BHC	Chronic	NTV	---	---	---
delta-BHC	Chronic	NTV	---	---	---
Semivolatile Organics					
2,4-Dinitrotoluene	Chronic	0.00015	NA	NA	TCEQ, 2001
Benzo(a)anthracene	Chronic	NTV	---	---	---
Benzo(a)pyrene	Chronic	NTV	---	---	---
Benzo(b)fluoranthene	Chronic	NTV	---	---	---
Benzo(k)fluoranthene	Chronic	NTV	---	---	---
Bis(2-ethylhexyl)phthalate	Chronic	NTV	---	---	---
Dibenzo(a,h)anthracene	Chronic	NTV	---	---	---
Indeno(1,2,3-cd)pyrene	Chronic	NTV	---	---	---
Volatile Organics					
Methylene chloride	Chronic	3	Liver	100/1	USEPA-HEAST, 1997
Tetrachloroethene	Chronic	0.49	NA	NA	USEPA-NCEA, 2001
Trichloroethene	Chronic	NTV	---	---	---
Trichlorofluoromethane	Chronic	0.7	Whole Body	1000/1	USEPA-HEAST, 1997
Vinyl Chloride	Chronic	0.1	Liver	30/1	USEPA-IRIS, 2001

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

Notes ---: No information for a compound with no toxicity value (NTV) BHC: benzenehexachloride (hexachlorocyclohexane) CNS: Central nervous system GIT: Gastrointestinal tract IRIS: Integrated Risk Information System, USEPA mg/kg-day: milligrams per kilogram per day		mg/m ³ : milligrams per cubic meter NA: Information not available NTV: No toxicity value available RDX: 1,3,5-Trinitroperhydro-1,3,5-triazine RfC: Reference concentration RfD: Reference dose
References Agency for Toxic Substances and Disease Registry (ATSDR), 1997, Minimal Risk Levels (MRLs) for Hazardous Substances. Jacobs Engineering Group, Inc. (Jacobs), 2003, <i>Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas, Final</i> , Oak Ridge, TN, June. Texas Commission on Environmental Quality (TCEQ), 2001. Update to 1998 Consistency Memorandum. Toxicity Factors Table, 15 March, 2001. U.S. Environmental Protection Agency (USEPA), 1998. <i>Perchlorate Environmental Contamination Toxicological Review and Risk Characterization based on Emergency Information</i> , Review Draft, Office of Research and Development. NCEA-1-0503, 31 December, 1998. USEPA-HEAST, 1997. Health Effects Summary Table (HEAST). FY 1995, Annual Office of Emergency and Remedial Response. Washington, D.C. EPA/340/R-95-036. USEPA-IRIS, 2001. Integrated Risk Information System. United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 2001. USEPA-NCEA, 2001. USEPA Region 3 Risk-Based Concentration Tables (5/8/2001). Referenced values from National Center for Environmental Assessment (NCEA).		
Summary of Toxicity Assessment This table provides non-carcinogenic risk information relevant to the contaminants of concern in both soil and groundwater. The list of chemicals of potential concern presented here are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003). The uncertainty factor and modifying factor are used in the development of a reference dose. The uncertainty factor adjusts results from dose-response studies in animals to make them applicable to humans. The modifying factor is used to account for uncertainties in the available toxicity data from which the reference dose is derived. In the risk assessment, the reference doses and concentrations were for the chronic case, to be conservative.		

Table 2-4
Risk Characterization Summary – Carcinogens

Scenario Timeframe:		Future					
Receptor Population:		Maintenance Worker					
Receptor Age:		Adult					
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogen Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 to 2 feet)	Soil and particulates	Incidental ingestion, inhalation of particulates, and dermal contact	<i>Dioxin/Furan</i>				
			2,3,7,8-TCDD	2.2E-07	7.4E-12	8.5E-08	3.1E-07
			<i>Metals</i>				
			Cadmium	NTV	6.8E-10	NTV	6.8E-10
			<i>Semivolatile Organics</i>				
			Benzo(a)anthracene	5.9E-07	1.1E-14	5.5E-07	1.1E-06
			Benzo(a)pyrene	5.4E-06	9.8E-14	5.0E-06	1.0E-05
			Benzo(b)fluoranthene	1.1E-06	2.1E-11	1.1E-06	2.2E-06
			Benzo(k)fluoranthene	9.7E-09	1.8E-13	9.0E-09	1.9E-08
			Dibenzo(a,h)anthracene	9.7E-07	1.8E-14	9.1E-07	1.9E-06
Indeno(1,2,3-cd)pyrene	4.1E-07	7.4E-15	3.8E-07	7.9E-07			
Soil risk total =						1.7E-05	
Groundwater	Groundwater	Ingestion or exposure through showering	<i>Dioxin/Furan</i>				
			2,3,7,8-TCDD	3.3E-06	NE	2.8E-05	3.1E-05
			<i>Explosives</i>				
			RDX	1.2E-07	NE	NE (Kp<=0.01)	1.2E-07
			<i>Pesticides</i>				
			Aldrin	3.7E-07	NE	NE (Kp<=0.01)	3.7E-07
			alpha-BHC	1.7E-07	NE	2.1E-08	1.9E-07
			beta-BHC	3.4E-08	NE	4.6E-09	3.9E-08
			delta-BHC	2.9E-08	NE	4.7E-09	3.4E-08
			<i>Semivolatile Organics</i>				
			2,4-Dinitrotoluene	1.7E-07	NE	NE (Kp<=0.01)	1.7E-07
			Bis(2-ethylhexyl)phthalate	1.3E-06	NE	8.6E-07	2.2E-06
			<i>Volatile Organics</i>				
			Methylene chloride	3.7E-08	4.0E-08	NE (Kp<=0.01)	7.7E-08
			Tetrachloroethene	4.4E-07	8.5E-11	1.7E-06	2.2E-06
			Vinyl Chloride	3.7E-06	3.8E-07	NE (Kp<=0.01)	4.1E-06
Groundwater risk total =						4.0E-05	
Total risk (soil and groundwater) =						5.7E-05	

Table 2-4 (continued)
Risk Characterization Summary – Carcinogens

Notes	
BHC	benzenehexachloride (hexachlorocyclohexane)
Kp	Dermal permeability coefficient
NE	Not evaluated through this exposure pathway. Chemical is not identified as volatile.
NE(Kp<=0.01)	Based on USEPA Region 6 guidance, COPCs with a Kp<=0.01 were not evaluated for dermal contact while showering (USEPA, 1995)
NTV	No toxicity value available to quantitatively address this exposure
RDX	1,3,5-Trinitroperhydro-1,3,5-triazine
TCDD	Tetrachlorodibenzo-p-dioxin
References	
U.S. Environmental Protection Agency (USEPA), <i>National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule, 40 CFR Part 300</i> , March 8, 1990.	
USEPA, <i>Supplemental Region VI Risk Assessment Guidance</i> , May 5, 1995.	
Summary of Risk Characterization	
The table provides risk estimates for the significant routes of exposure at LHAAP-46. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a hypothetical future maintenance worker's exposure to soil and groundwater, as well as the toxicity of the chemicals of concern. The total risk from exposure to contaminated soil and groundwater at this site is estimated to be 5.7E-05. A risk below 10⁻⁴ is generally considered to be acceptable (USEPA, 1990). The soil and groundwater risks are acceptable.	

Table 2-5
Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe:		Future						
Receptor Population:		Maintenance Worker						
Receptor Age:		Adult						
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 to 2 feet)	Soil and particulates	Incidental ingestion, inhalation of particulates, dermal contact	<i>Metals</i>					
			Aluminum	N/A	7.9E-03	3.4E-04	5.1E-03	1.3E-02
			Antimony	Blood	1.0E-02	1.2E-06	4.3E-03	1.5E-02
			Barium	Kidney	2.9E-02	6.2E-04	2.6E-02	5.6E-02
			Cadmium	Kidney	7.0E-03	5.3E-06	1.8E-03	8.8E-03
			Manganese	CNS	5.3E-03	7.5E-04	5.6E-03	1.2E-02
			Mercury	Immune system	1.8E-03	2.8E-07	1.7E-03	3.5E-03
Vanadium	N/A	4.0E-03	8.5E-05	9.9E-03	1.4E-02			
Soil Hazard Index Total =								1.2E-01
Groundwater	Groundwater	Ingestion or exposure through showering	<i>Explosives</i>					
			RDX	Prostate	1.0E-03	NE	NE (Kp<=0.01)	1.0E-03
			<i>Metals</i>					
			Aluminum	N/A	7.8E-01	NE	NE (Kp<=0.01)	7.8E-01
			Antimony	Blood	1.5E+00	NE	NE (Kp<=0.01)	1.5E+00
			Barium	Kidney	5.2E-01	NE	NE (Kp<=0.01)	5.2E-01
			Beryllium	Small intestine	3.7E-01	NE	NE (Kp<=0.01)	3.7E-01
			Cadmium	Kidney	3.9E-01	NE	NE (Kp<=0.01)	3.9E-01
			Chromium	N/A	3.1E-02	NE	NE (Kp<=0.01)	3.1E-02
			Manganese	CNS	1.4E+00	NE	NE (Kp<=0.01)	1.4E+00
			Nickel	Body weight	5.8E-01	NE	NE (Kp<=0.01)	5.8E-01
			Silver	Argyria	2.3E-01	NE	NE (Kp<=0.01)	2.3E-01
			Strontium	Bone	2.0E-01	NE	NE (Kp<=0.01)	2.0E-01
			Thallium	Blood	2.4E+01	NE	NE (Kp<=0.01)	2.4E+01
			Vanadium	N/A	2.0E-01	NE	NE (Kp<=0.01)	2.0E-01
			<i>Non-Metallic Anion</i>					
			Perchlorate	N/A	3.3E-01	NE	NE (Kp<=0.01)	3.3E-01
			<i>Pesticides</i>					
			Aldrin	Liver	2.1E-03	NE	NE (Kp<=0.01)	2.1E-03
			alpha-BHC	N/A	9.3E-06	NE	1.20E-06	1.0E-05
			delta-BHC	N/A	1.5E-04	NE	2.50E-05	1.7E-04
			<i>Semivolatile Organics</i>					
			2,4-Dinitrotoluene	CNS	3.6E-04	NE	NE (Kp<=0.01)	3.6E-04
			Bis(2-ethylhexyl)phthalate	Liver	1.3E-02	NE	8.60E-03	2.2E-02
			<i>Volatile Organics</i>					
			Methylene chloride	Liver	2.3E-04	8.0E-05	NE (Kp<=0.01)	3.1E-04
			Tetrachloroethene	Liver	2.3E-03	8.4E-04	9.4E-03	1.3E-02
			Trichlorofluoromethane	Whole body	6.8E-05	5.1E-04	4.4E-04	1.0E-03

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

Scenario Timeframe:		Future						
Receptor Population:		Maintenance Worker						
Receptor Age:		Adult						
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
			Vinyl Chloride	Liver	2.3E-03	1.2E-03	NE (Kp<=0.01)	3.5E-03
Groundwater Hazard Index Total =								31
Receptor Hazard Total (soil and groundwater) =								31
Liver Hazard Total =								4.1E-02
Notes								
BHC	benzenehexachloride (hexachlorocyclohexane)							
CNS	Central nervous system							
Kp	Dermal permeability coefficient							
N/A:	Information was not available							
NE	Not evaluated through this exposure pathway							
NE (Kp<=0.01)	Based on USEPA Region 6 guidance, chemicals of potential concern with a Kp<=0.01 were not evaluated for dermal contact while showering (USEPA, 1995)							
RDX	1,3,5-Trinitroperhydro-1,3,5-triazine							
References								
U.S. Environmental Protection Agency (USEPA), 1989, <i>Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual, (Part A)</i> , EPA/540/1-89/002, December.								
USEPA, <i>Supplemental Region 6 Risk Assessment Guidance</i> , May 5, 1995.								
Summary of Risk Characterization								
The table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure for LHAAP-46. The Risk Assessment Guidance for Superfund (USEPA, 1989) states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse non-carcinogenic effects. The estimated HI of 31 for groundwater indicates that the potential for adverse non-carcinogenic effects could occur from exposure to contaminants in that medium; the components having HQs greater than 1 are thallium, antimony, and manganese. The non-carcinogenic risk from exposure to trichloroethene in groundwater could not be evaluated due to the lack of non-carcinogenic toxicity criteria for trichloroethene. The estimated HI of 0.12 for soil is acceptable.								

Table 2-6
Chemicals of Potential Concern in Groundwater

Chemical	Maximum Detected Concentration (µg/L)	Chemical Hazard Quotient	MCL (µg/L)	Retained as Chemical of Concern
Aluminum	80,000	0.78	--	No – Note 1
Antimony	63	1.5	6	No – Note 2
Arsenic	20	--	10	No – Note 2
Barium	1,400	0.20	2,000	No – Note 2
Beryllium	76	0.37	4	No – Note 2
Cadmium	20	0.39	5	No – Note 2
Chromium	4,700	0.03	100	No – Note 3
Lead	673	--	15	No – Note 2
Manganese	6,500	1.4	--	No – Note 4
Nickel	3,670	0.58	--	No – Note 3
Silver	120	0.23	--	No – Note 2
Strontium	12,000	0.20	--	No – Note 5
Thallium	200	24	2	No – Note 4
Vanadium	140	0.20	--	No – Notes 2 and 5
TCE	85.5	--	5	Yes
bis(2-ethylhexyl)phthalate	27	0.02	6	No – Note 6
Perchlorate	47.9	0.33	--	No – Note 2

Notes and Abbreviations:

1 – Elevated concentration in samples due to suspended particles from sampling techniques (low flow techniques not used)

2 – Recent samples do not have elevated concentration

3 – Elevated concentration due to suspended particles from well corrosion

4 – Chemical is naturally occurring

5 – Contribution to hazard index low

6 – Chemical detected in laboratory blank

-- No chemical hazard quotient or no MCL available for the chemical

MCL Federal Safe Drinking Water maximum contaminant level

TCE trichloroethene

µg/L micrograms per liter

Table 2-7
Chemicals of Concern in Groundwater and Cleanup Levels

Chemical	MCL (µg/L)	Note
Trichloroethene (TCE)	5	Retained as chemical of concern
cis-1,2-dichloroethene (DCE)	70	TCE daughter product
Vinyl chloride (VC)	2	DCE daughter product

Notes and Abbreviations:

MCL Federal Safe Drinking Water maximum contaminant level

µg/L micrograms per liter

Table 2-8
Comparative Analysis of Alternatives

Criteria	Alternative 1 No Action	Alternative 2 Monitored Natural Attenuation and Land Use Control	Alternative 3 In Situ Bioremediation, Monitored Natural Attenuation, and Land Use Control
Overall protection of human health and the environment	No active reduction in risk to a hypothetical future maintenance worker from contaminated groundwater (ingestion, contact when used as shower water, inhalation of volatiles when used as shower water).	Achieves RAOs. MNA would verify that groundwater was being attenuated to the MCLs. LUC would provide protection of human health until MCLs are achieved and the LUC becomes unnecessary.	Achieves RAOs. ISB and MNA would restore groundwater to the MCLs. LUC would provide protection of human health until MCLs are achieved and the LUC becomes unnecessary.
Compliance with ARARs	Possible that it would meet MCLs in an estimated 23 years by (unmonitored) natural attenuation, but this would be unverifiable without monitoring. No location-specific ARARs. Action-specific ARARs would not apply.	Would meet MCLs in an estimated 23 years to satisfy chemical-specific ARAR. No location-specific ARARs. Would meet action-specific ARARs for any wastes generated.	Would meet MCLs in an estimated 15 years to satisfy chemical-specific ARAR. No location-specific ARARs. Would meet action-specific ARARs for any wastes generated or wells constructed or abandoned.
Long-term effectiveness and permanence	Natural attenuation would occur, but its progress would be unverified by monitoring. No evaluation of natural attenuation's long-term effectiveness and permanence.	MNA would verify permanent reduction of contaminant levels in the groundwater over time. LUC would be effective and reliable so long as it is maintained until natural attenuation processes reduce groundwater contaminant levels to the MCLs.	Should be effective and permanent; however, some uncertainty exists regarding the ability of in-situ bioremediation to effectively reduce concentrations further and enhance natural attenuation; therefore further evaluation would be required. LUC would be effective and reliable so long as it is maintained until natural attenuation processes reduce groundwater contaminant levels to the MCLs.
Reduction of toxicity, mobility, or volume through treatment	No active reduction.	No active reduction.	Active treatment with ISB.
Short-term effectiveness	Continued risk to community through no action. No risk to workers. No impact to the environment.	Minimal impact to the community and the environment from short-term activities; installation of potable wells would be prohibited within the area protected by the LUC. Some potential short-term risks to workers associated with exposure to contaminated groundwater.	Minimal impact to the community and the environment from short-term activities; installation of potable wells would be prohibited within the area protected by the LUC. Some potential short-term risks to workers associated with exposure to contaminated groundwater and operation of drilling/construction equipment.

Table 2-8 (continued)
Comparative Analysis of Alternatives

Criteria	Alternative 1 No Action	Alternative 2 Monitored Natural Attenuation and Land Use Control	Alternative 3 In Situ Bioremediation, Monitored Natural Attenuation, and Land Use Control
Implementability	Readily implemented; no construction or operation. May require ROD amendment if future problems arise. No monitoring to verify that natural attenuation is in progress and that the plume is not migrating. No special materials or technology required.	Readily implemented. No construction. May require ROD amendment if a more active treatment is required (i.e., ISB). Regular monitoring to verify that MNA is effective and that the plume is not migrating. No special materials or technology required.	Involves common drilling work and possibly well construction. Treatability study may be necessary to verify that ISB is effective for the site conditions. Regular monitoring to verify that ISB is effective. Nutrients and microbes for ISB are commercially available.
Cost			
• Capital present worth	\$0	\$60,500	\$379,000
• O&M present worth	\$0	\$460,700	\$365,000
• Total present worth	\$0	\$521,200	\$744,000
State Acceptance	Not acceptable. Not protective of human health and the environment.	Acceptable	Acceptable
Community Acceptance	Not acceptable	Acceptable with reservations because of the proximity of the plume to drinking water wells outside LHAAP. Well proximity in relation to the plume was discussed in the March 9, 2010 public meeting.	Acceptable

Notes and Abbreviations:

ARAR applicable or relevant and appropriate requirement
 ISB in situ bioremediation
 LUC land use control
 MCL maximum contaminant level
 MNA monitored natural attenuation
 O&M operation and maintenance
 RAO remedial action objective

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

Year	Fiscal Year	Capital Costs	Operation & Maintenance Costs			Present Value		
			MNA	Monitoring	Total	Discount Rate	Capital	O&M
						2.8%		
1	2010	\$60,513	\$55,833		\$55,833	NPV	\$60,514	\$460,689
2	2011	0	\$55,833		\$55,833			
3	2012	0		\$31,185	\$31,185		Total Present Value	\$521,203
4	2013	0		\$26,811	\$26,811			
5	2014	0		\$69,336	\$69,336			
6	2015	0		\$16,674	\$16,674			
7	2016	0		\$16,674	\$16,674			
8	2017	0		\$16,674	\$16,674			
9	2018	0		\$16,674	\$16,674			
10	2019	0		\$59,199	\$59,199			
11	2020	0			0			
12	2021	0			0			
13	2022	0			0			
14	2023	0			0			
15	2024	0		\$59,199	\$59,199			
16	2025	0			0			
17	2026	0			0			
18	2027	0			0			
19	2028	0			0			
20	2029	0		\$59,199	\$59,199			
21	2030	0			0			
22	2031	0			0			
23	2032	0			0			
24	2033	0			0			
25	2034	0		\$59,199	\$59,199			
26	2035	0			0			
27	2036	0			0			
28	2037	0			0			
29	2038	0			0			
30	2039	0		\$59,199	\$59,199			
		\$60,513	\$111,666	\$490,018	\$601,684			

Notes

MNA monitored natural attenuation

O&M operation & maintenance

VOC volatile organic compounds

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

Capital costs include: 1) Allowance for legal fees, administration controls, and documentation; 2) Establishment of a database, licenses, and work plans.

Monitoring costs are based on the assumption that 8 wells are sampled in each sampling event. The frequency of sampling events is in accordance with the frequency described in the Record of Decision. In Years 1, 2, and 3, the samples are analyzed for VOCs and MNA parameters. Subsequent years are analyzed for VOCs only. Five-year reviews are conducted in Years 5, 10, 15, 20, 25, and 30.

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

Table 2-10
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Groundwater		
Federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs)	Applicable to drinking water at the tap—relevant and appropriate for water that could potentially be used for human consumption	Water designated as a current or potential source of drinking water must not exceed drinking water standard. The daughter products of TCE are cis-1,2-DCE and VC. The MCLs for TCE, cis-1,2-DCE, and VC are 5, 70, and 2 µg/L, respectively.
Waste Generation, Management, and Storage		
Characterization of Solid Waste 40 CFR 262.11 30 TAC 335.62 30 TAC 335.504 30 TAC 335.503(a)(4)	Generation of solid waste, as defined in 30 TAC 335.1— applicable .	Must determine whether the generated solid waste is RCRA hazardous waste by using prescribed testing methods or applying generator knowledge based on information regarding material or process used. If the waste is determined to be hazardous, it must be managed in accordance with 40 CFR 262–268. After making the hazardous waste determination as required, if the waste is determined to be nonhazardous, the generator shall then classify the waste as Class 1, Class 2, or Class 3 (as defined in Section 335.505 through Section 335.507) using one or more of the methods listed in Section 335.503(a)(4) and Section 335.508 and manage the waste in accordance with the requirements of Chapter 335 of the TAC for industrial solid waste.
Characterization of Hazardous Waste 40 CFR 264.13(a)(1); 40 CFR 268.7 30 TAC 335.504(3) 30 TAC 335.509 30 TAC 335.511	Generation of a RCRA hazardous waste for treatment, storage, or disposal— applicable if hazardous waste is generated (e.g., personal protective equipment [PPE]).	Must obtain a detailed chemical and physical analysis of a representative sample of the waste(s) that at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with 40 CFR 264 and 268. Must also determine whether the waste is restricted from land disposal under 40 CFR 268 et seq. by testing in accordance with prescribed methods or use of generator knowledge of waste.
Management of RCRA Hazardous Wastes—Wastewater Treatment Unit Exclusion 40 CFR 264.1(g)(6) 40 CFR 270.1(c)(2) 30 TAC 335.41(d)(1)	Treatment/disposal of wastewater containing RCRA hazardous waste— applicable to management of contaminated groundwater if it is determined to contain RCRA characteristically hazardous waste.	On-site wastewater treatment units, as defined in 40 CFR 260.10, that are part of a wastewater treatment facility subject to regulation under Section 402 or Section 307(b) of the CWA are excluded from the requirements of RCRA Subtitle C (Note: USEPA has clarified that this exemption applies to all tank systems, conveyance systems, and ancillary equipment, including transfer trucks, associated with the wastewater treatment unit [53 FR 34079, September 2, 1988]).
Requirements for Temporary Storage of Hazardous Waste in Accumulation Areas 40 CFR 262.34(a) and (c)(1) 30 TAC 335.69(a) and (d)	On-site accumulation of 55 gallons or less of RCRA hazardous waste for 90 days or less at or near the point of generation— applicable if hazardous waste is generated (e.g., PPE) and stored in an accumulation area.	A generator may accumulate hazardous waste at the facility provided that • Waste is placed in containers that comply with 40 CFR 264.171 to 264.173 (Subpart I); and • Container is marked with the words "hazardous waste"; or • Container may be marked with other words that identify the contents.

Table 2-10 (Continued)
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Requirements for the Use and Management of Containers 40 CFR 264.171–264.173 30 TAC 335.69(e) 30 TAC 335.152(a)(7)	On-site storage/treatment of RCRA hazardous waste in containers for greater than 90 days— applicable if hazardous waste is generated (e.g., PPE) and is stored in containers.	Design and operating standards of 40 CFR 264.175(c) and 40 CFR 264.171, 264.172, and 264.173(a) and (b) must be met for the use and management of hazardous waste in containers.
Well Construction Standards—Monitoring or Injection Wells 16 TAC 76.1000	Construction of water wells— applicable to construction of new monitoring or injection wells, if needed.	Wells shall be completed in accordance with the technical requirements of Section 76.1000, as appropriate.
Well Construction Standards—Extraction Wells 16 TAC 76.1000(a) and (c) through (h) 16 TAC 76.1002(a) through (c) 16 TAC 76.1008(a) through (c)	Construction of water wells— applicable to construction of extraction (recovery) wells.	Wells shall be completed in accordance with the technical requirements of Section 76.1000, as appropriate. Water wells completed to produce undesirable water shall be cased to prevent the mixing of water or constituent zones. The annular space between the casing and the wall of the borehole shall be pressure grouted with cement or bentonite grout to the land surface. Bentonite grout may not be used if a water zone contains chloride water above 1500 ppm or if hydrocarbons are present. Wells producing undesirable water or constituents shall be completed in such a manner that will not allow undesirable fluids to flow onto the land surface. During installation of a water well pump, installer shall make a reasonable effort to maintain integrity of groundwater and to prevent contamination by elevating the pump column and fittings, or by other means suitable under the circumstances. Pump shall be constructed so that no unprotected openings into the interior of the pump or well casing exist.
Class V Injection Wells 30 TAC 331, Subchapters A,C and H	Installation, operation, and closure of injection wells fall in the category of Class V Injection Wells – relevant and appropriate.	Injection wells shall be constructed to the required specifications for isolation casing, surface completion, prevention of commingling, and confinement of undesirable groundwater to its zone of origin. Closure shall be accomplished by removing all of the removable casing and the entire well shall be pressure filled via a tremie pipe with cement from bottom to the land surface, or closure shall be performed by the alternative method for Class V Wells completed in zones of undesirable groundwater. Groundwater concentrations at time of well closure will determine the appropriate method of abandonment.

Table 2-10 (Continued)
Description of ARARs for Selected Remedy

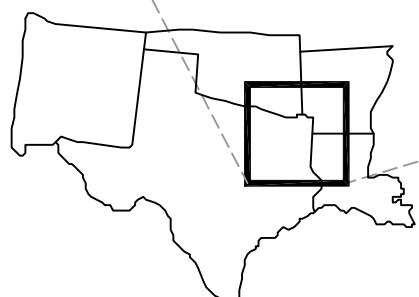
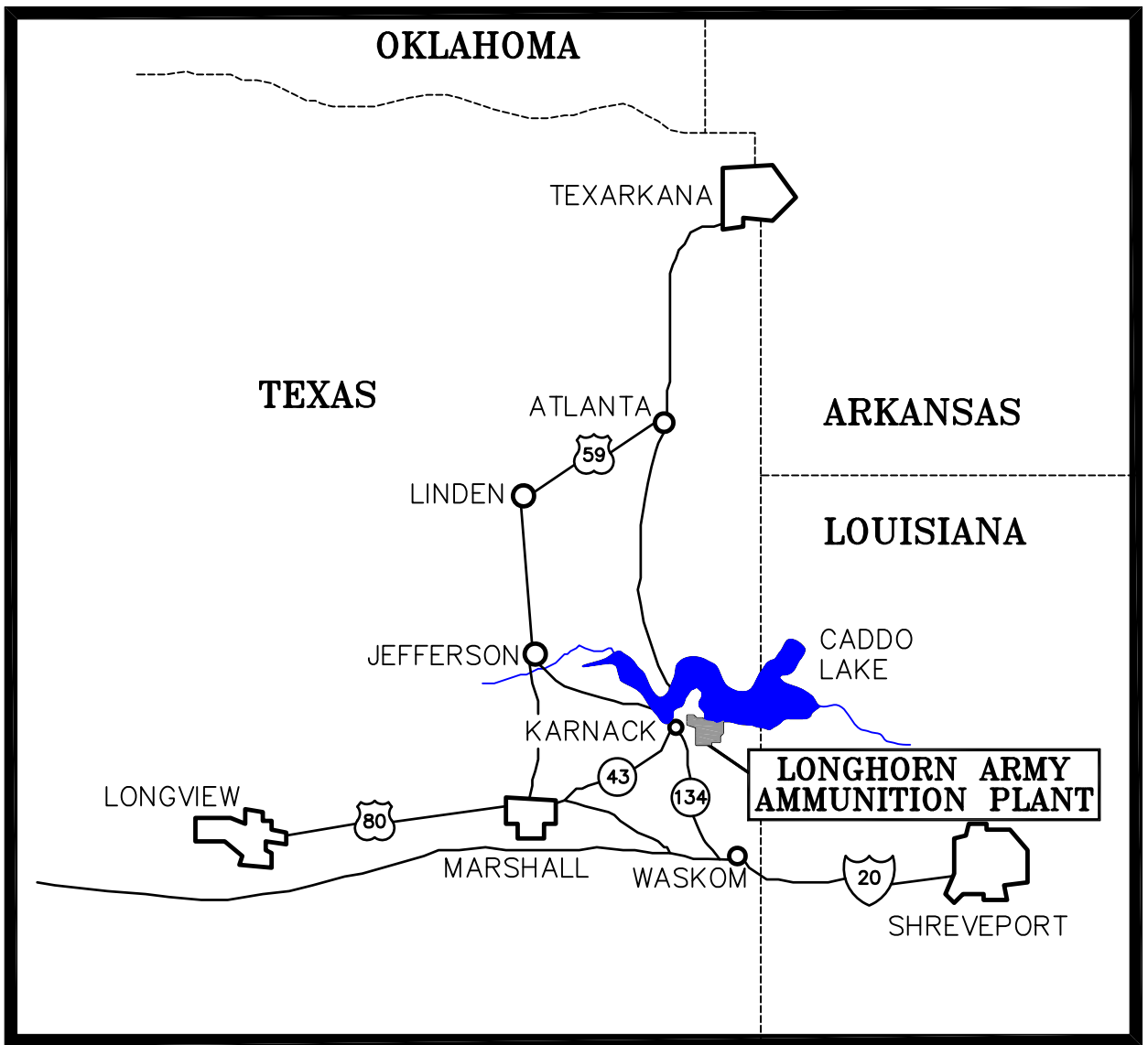
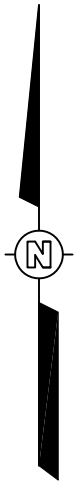
Citation	Activity or Prerequisite/Status	Requirement
Treatment/Disposal		
Disposal of Wastewater (e.g., contaminated groundwater, dewatering fluids, decontamination liquids) 40 CFR 268.1(c)(4)(i) 30 TAC 335.431(c)	RCRA-restricted characteristically hazardous waste intended for disposal— applicable if extracted groundwater or rinsate from incinerator is determined to be RCRA characteristically hazardous .	Disposal is not prohibited if such wastes are managed in a treatment system subject to regulation under Section 402 of the CWA that subsequently discharges to waters of the United States.
Closure		
Standards for Plugging Wells that Penetrate Undesirable Water or Constituent Zones 16 TAC 76.1004(a) through (c)	Plugging and abandonment of wells— applicable to plugging and closure of monitoring and/or extraction wells.	If a well is abandoned, all removable casing shall be removed and the entire well pressure filled via a tremie pipe with cement from bottom up to the land surface. In lieu of this procedure, the well shall be pressure-filled via a tremie tube with bentonite grout of a minimum 9.1 lb/gal weight followed by a cement plug extending from land surface to a depth of not less than 2 feet. Undesirable water or constituents or the freshwater zone(s) shall be isolated with cement plugs.
Abbreviations % percent µg/L micrograms per liter ARAR applicable or relevant and appropriate requirement CFR Code of Federal Regulations CWA Clean Water Act of 1972 DCE dichloroethene FR Federal Register FS feasibility study lb/gal pound per gallon LHAAP Longhorn Army Ammunition Plant PPE personal protective equipment ppm part per million RCRA Resource Conservation and Recovery Act of 1976 TAC Texas Administrative Code TCE trichloroethene USEPA U.S. Environmental Protection Agency VC vinyl chloride		

Table 2-11
Cost and Effectiveness Data

	Alternative 1 No Action	Alternative 2 MNA and LUC	Alternative 3 ISB, MNA, and LUC
Present Worth Cost	\$0	\$521,200	\$744,000
Incremental Cost	---	+\$521,200	+\$222,800
Long-Term Effectiveness and Permanence	Unmonitored and undocumented effectiveness and permanence	Effectiveness and permanence confirmed with monitoring	Effectiveness and permanence confirmed with monitoring
Reduction of Toxicity, Mobility, and Volume	Unmonitored and undocumented reduction	Reduction of COCs in groundwater to MCLs in 23 years	Reduction of COCs in groundwater to MCLs in 15 years
Short-Term Effectiveness	No short-term effectiveness, as the site will be left as-is	Immediate short-term effectiveness with LUC	Immediate short-term effectiveness with LUC
Cost-Effective	---	Yes	---
Notes COC chemical of concern ISB in situ bioremediation LUC land use control MCL maximum contaminant level MNA monitored natural attenuation			
Cost Effectiveness Summary The alternatives are shown from left to right in order of increasing cost. Incremental cost is the cost difference between the alternative in question and the alternative that is one step down in cost. The table focuses on the additional benefit gained from the incremental cost. Alternative 2 is the most cost effective. It is anticipated to achieve an outcome similar to that of Alternative 3. Alternative 2 has a longer period of performance than Alternative 3, but has significant cost savings.			

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	---	Houston, Texas	L. JONES	G. JONES	P. SRIVASTAV	117591-A55

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



"DRAWING NOT TO SCALE"

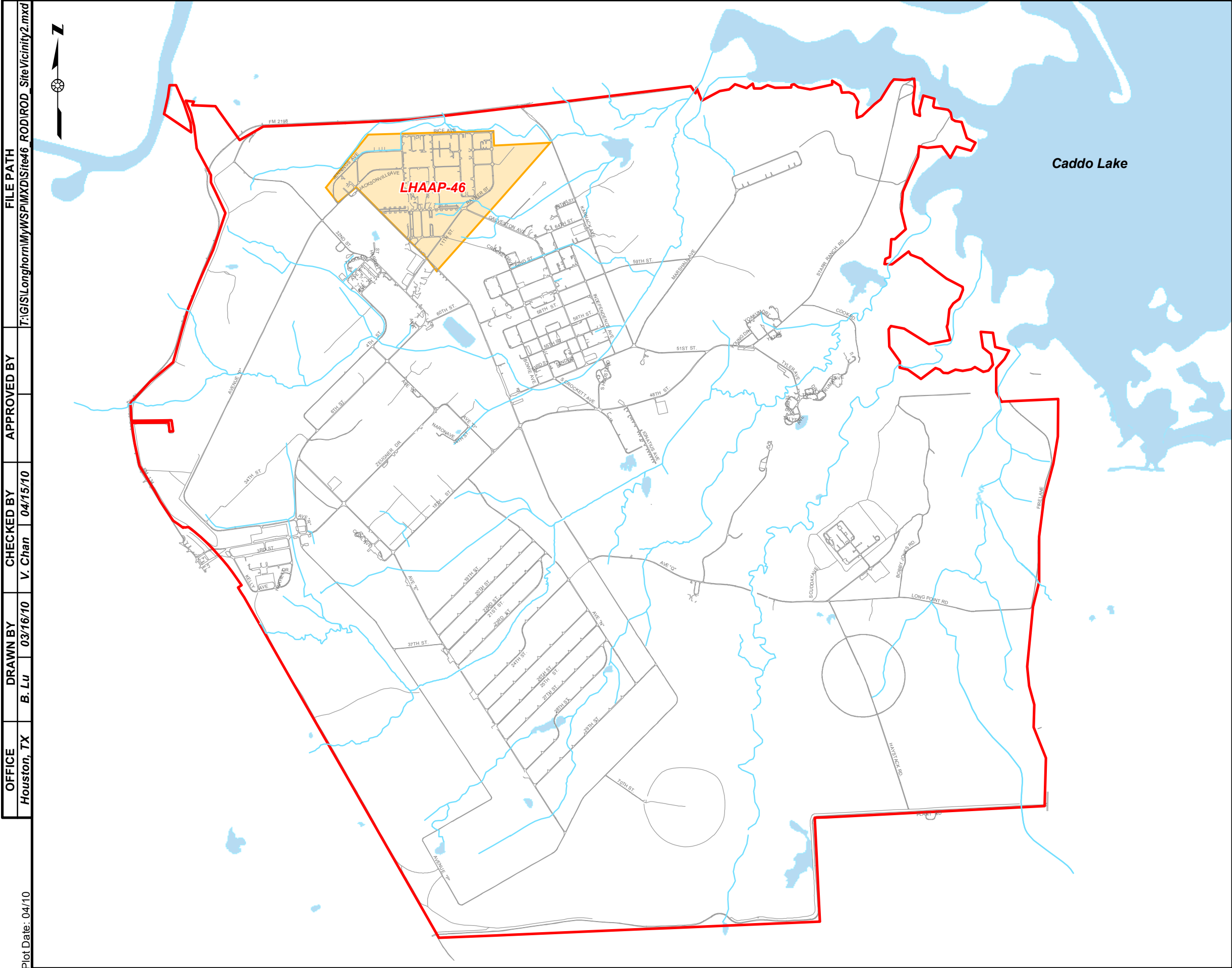


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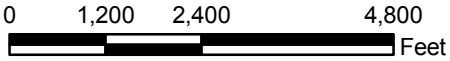
FIGURE 2-1

LHAAP LOCATION MAP

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



- LEGEND**
- Stream
 - Road
 - Site
 - Lake
 - LHAAP Boundary



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

FIGURE 2-2

SITE VICINITY MAP
LHAAP-46, GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

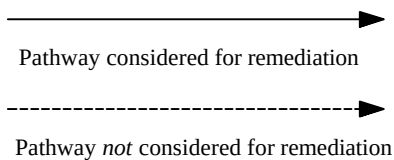
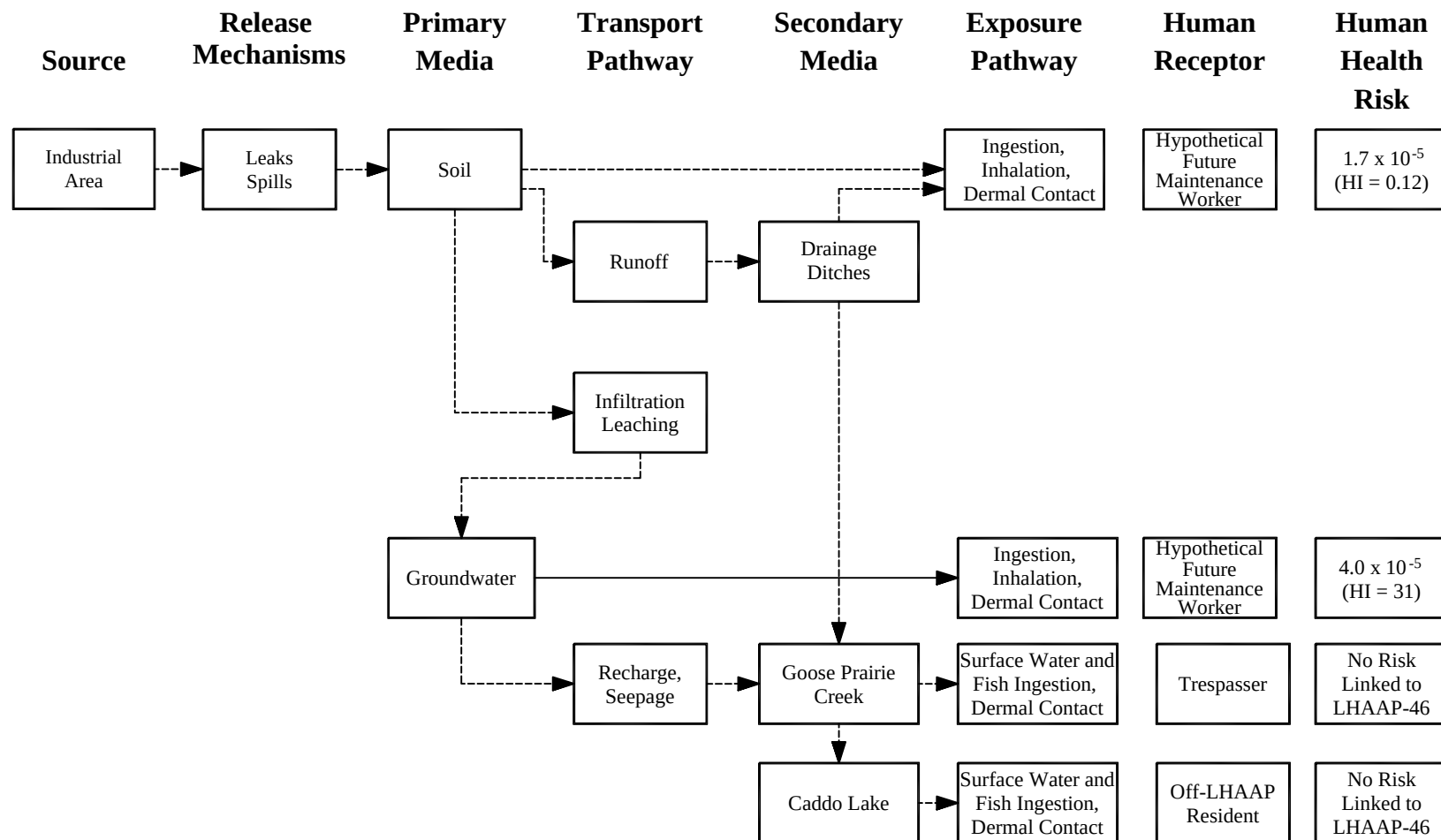
OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Lu	V. Chan		T:\GIS\Longhorn\MyWSP\MXD\Site46_ROD\ROD_SiteVicinity2.mxd

Plot Date: 04/10

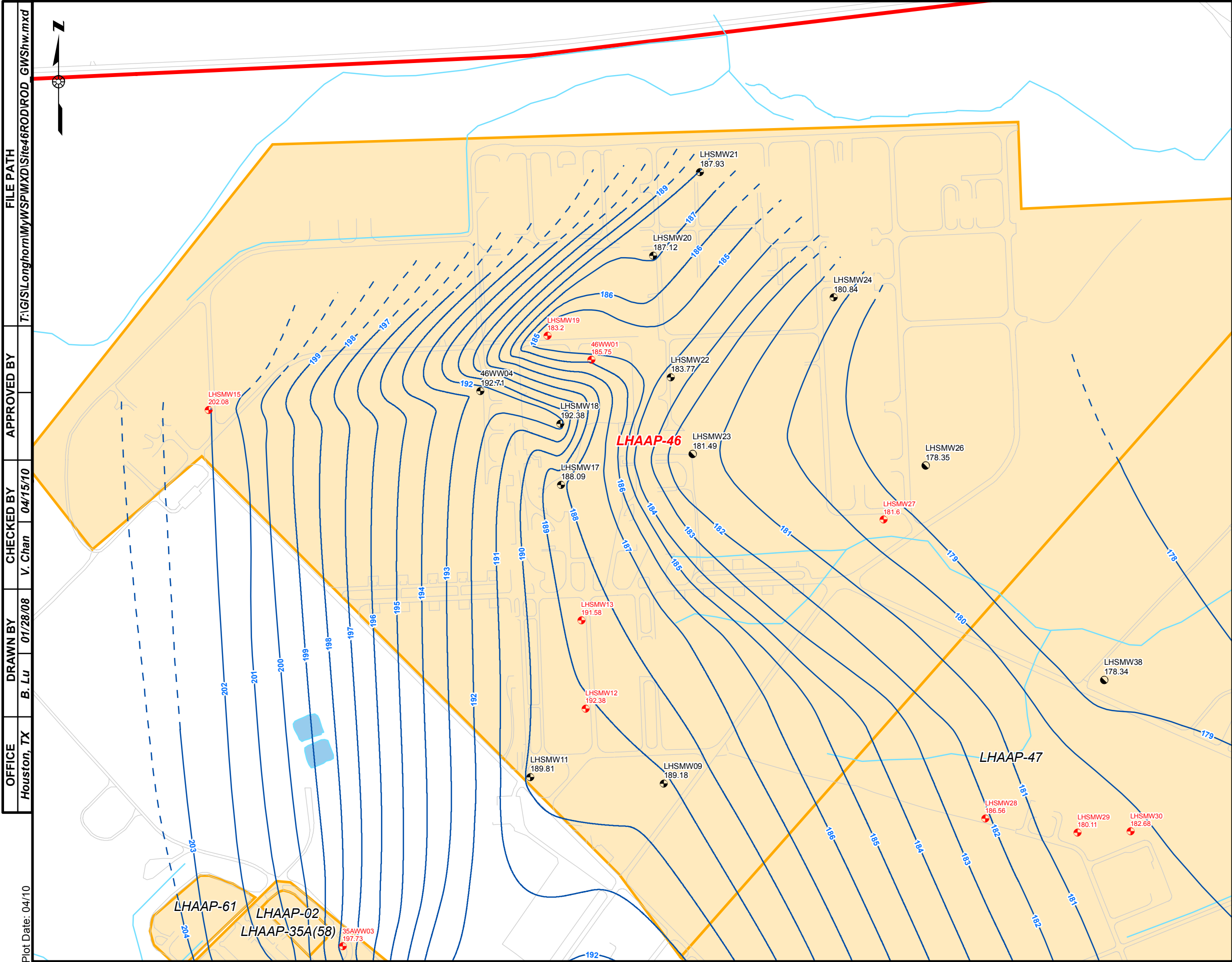
00098870

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

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	---	Houston, Texas	L. JONES 04/27/10	S. WATSON 04/2010	P. SRIVASTAV 04/2010	117591-A67



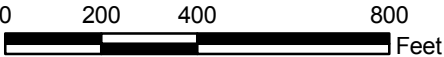
	U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT TULSA, OKLAHOMA
	FIGURE 2-3 CONCEPTUAL SITE MODEL LHAAP-46, GROUP 4 LONGHORN ARMY AMMUNITION PLANT KARNACK, TEXAS



LEGEND

- Shallow Monitoring Well
- Shallow/Intermediate Monitoring Well
- Dry Shallow Monitoring Well (Elevation Represents Bottom of Well)
- Groundwater Elevation Contour
- Inferred Groundwater Elevation Contour
- Stream
- Road
- Approximate LHAAP Boundary
- Site

- Notes:
- Groundwater elevation measured on November 29 -- December 3, 2007.
 - Contours around LHSMW19 were based on the best assessment at the time of study.

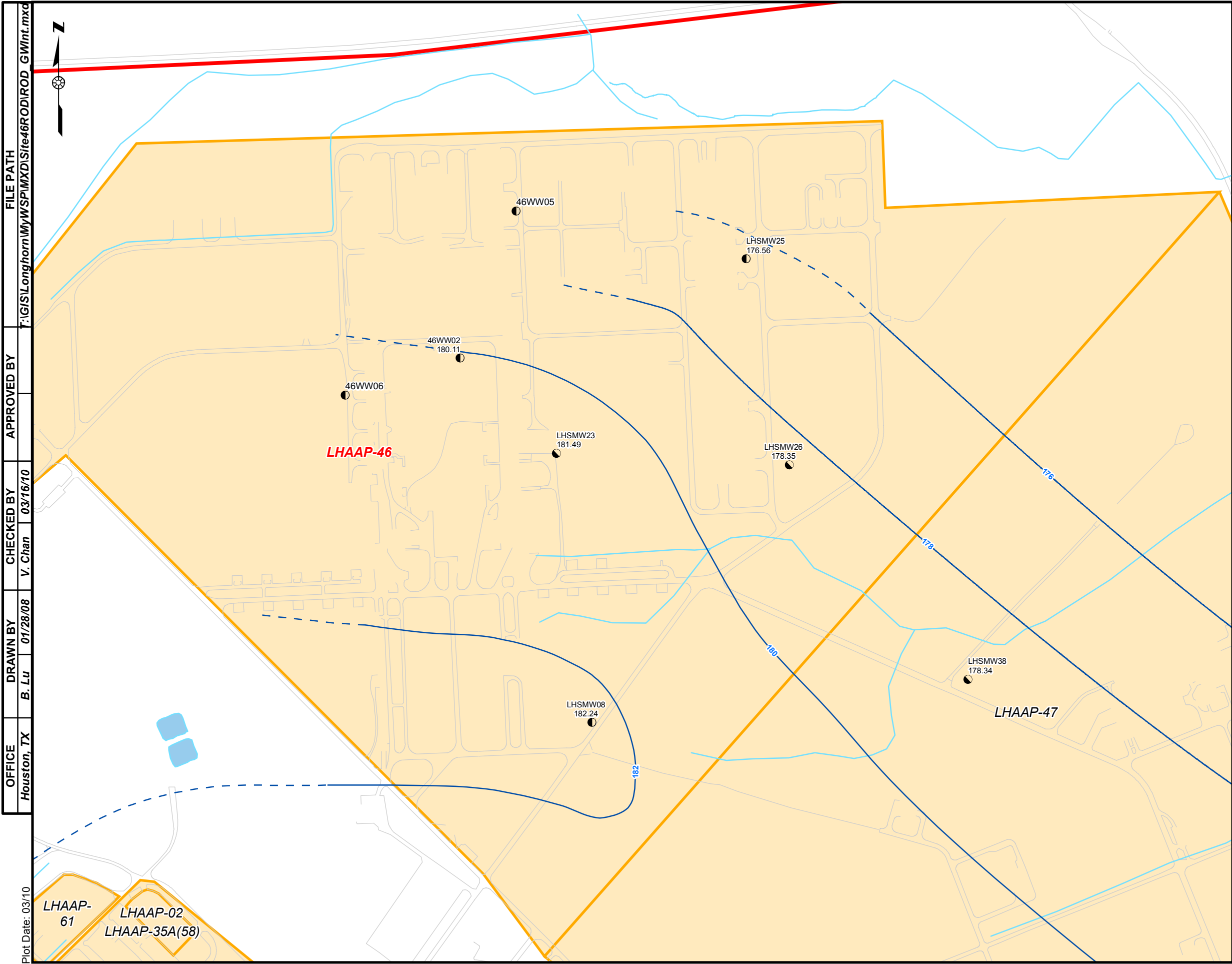


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FIGURE 2-4

GROUNDWATER ELEVATION
CONTOUR MAP (SHALLOW ZONE)
LHAAP-46, GROUP 4

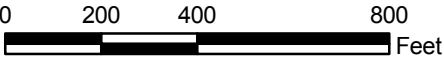
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



LEGEND

- Shallow/Intermediate Monitoring Well
- Intermediate Monitoring well
- Groundwater Elevation Contour
- Inferred Groundwater Elevation Contour
- Stream
- Road
- Approximate LHAAP Boundary
- Site

Note:
Groundwater elevation measured on November 29 -- December 3, 2007.



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TULSA, OKLAHOMA

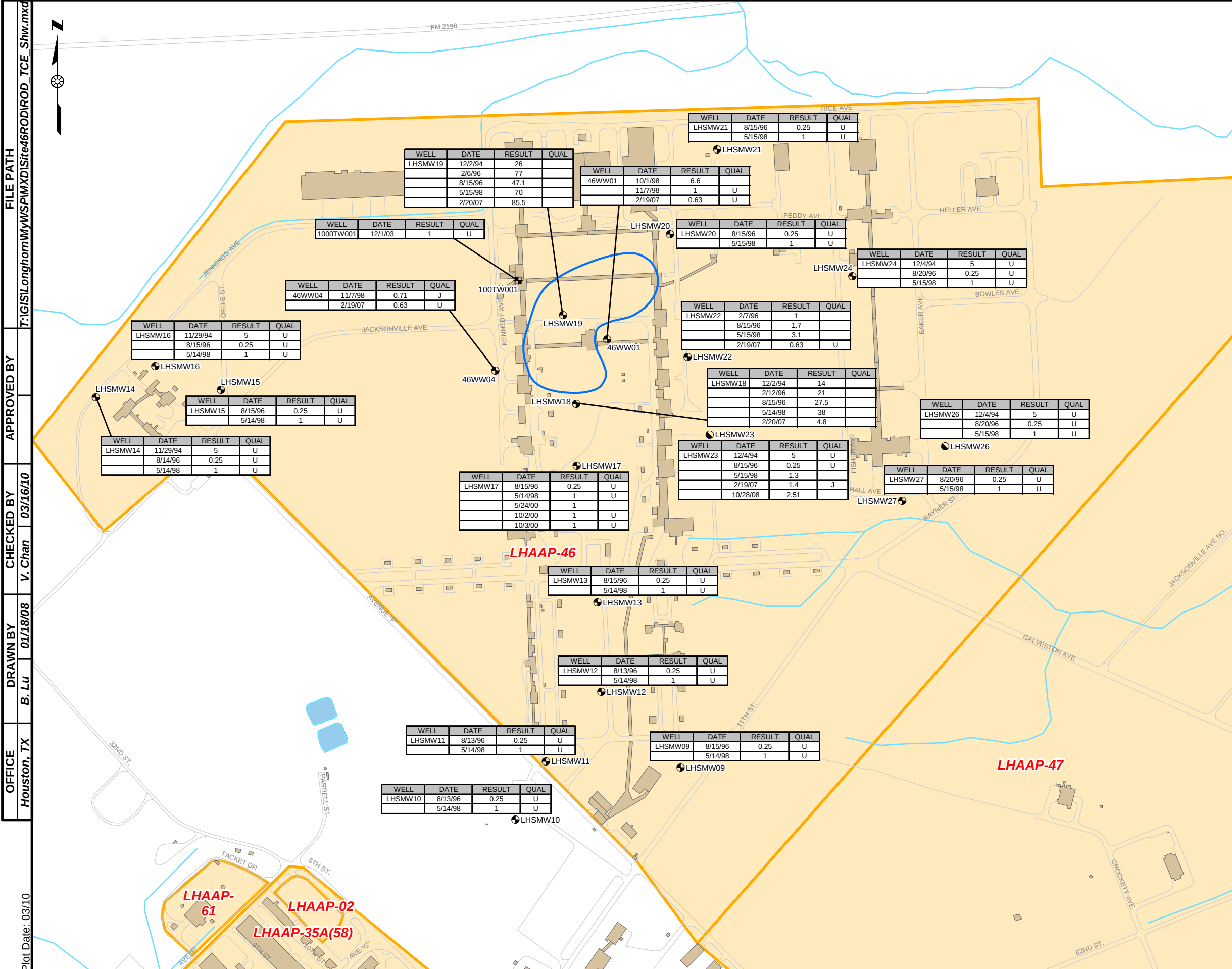
FIGURE 2-5

GROUNDWATER ELEVATION
CONTOUR MAP (INTERMEDIATE ZONE)
LHAAP-46, GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE: Houston, TX
DRAWN BY: B. Lu
CHECKED BY: V. Chan
APPROVED BY:
FILE PATH: T:\GIS\Longhorn\MyWSP\WXD\Site46\ROD\ROD GWInt.mxd

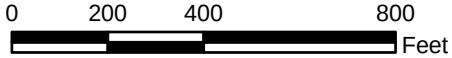
Plot Date: 03/10



LEGEND

- Shallow Monitoring Well
- Shallow/Intermediate Monitoring Well
- Temporary Monitoring Well
- 2007 TCE Plume (5 µg/L)
- Stream
- Road
- Former Building or Concrete Slab
- Site

Note:
1. Sampling results reported in micrograms per liter (µg/L).

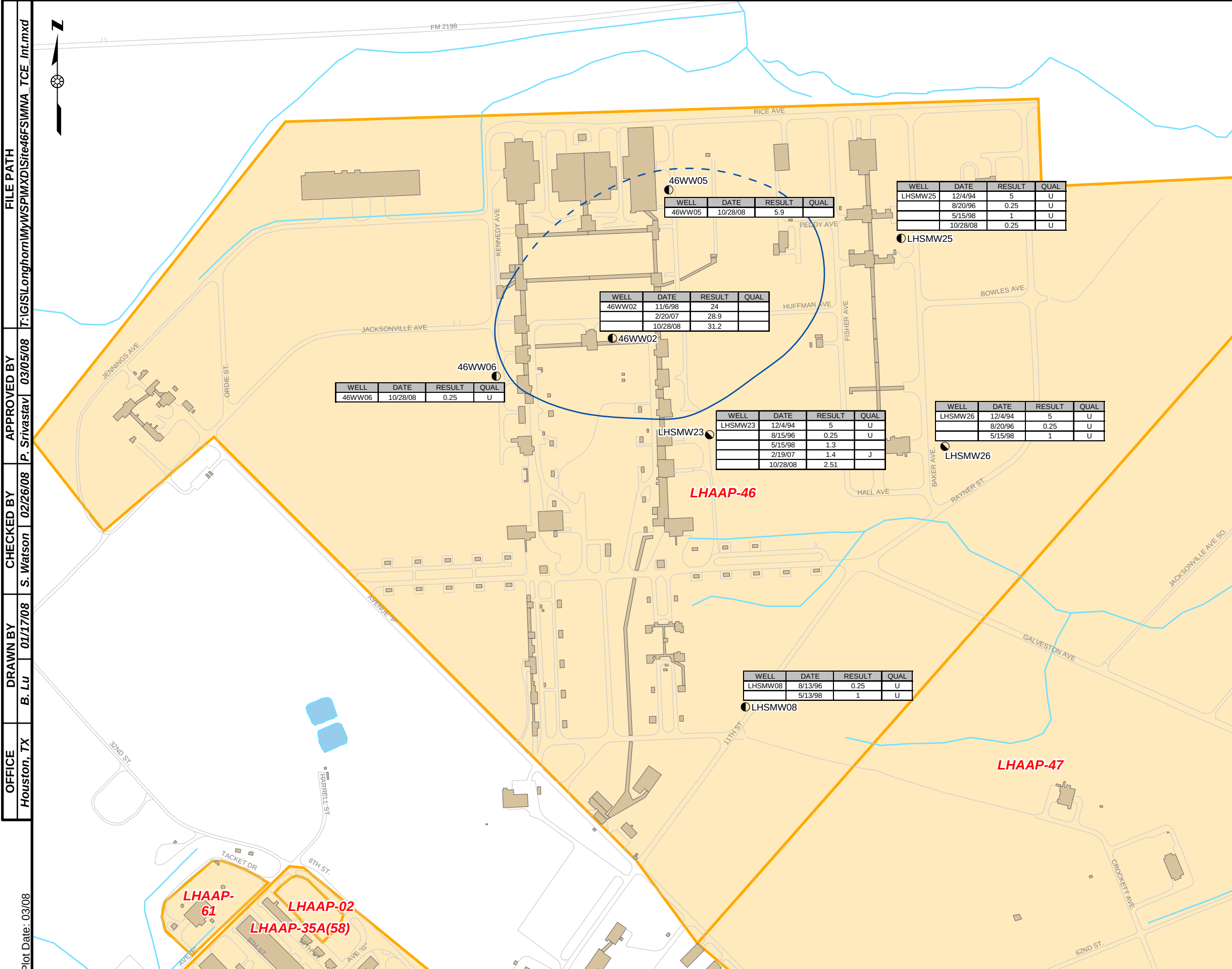


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TULSA, OKLAHOMA

FIGURE 2-6

TCE IN SHALLOW ZONE
LHAAP-46, GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



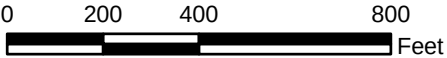
LEGEND

- Shallow/Intermediate Monitoring Well
- Intermediate Monitoring Well

TCE Plumes (5 µg/L)

- 2008
- 2008 (Inferred)
- Stream
- Road
- Former Building or Concrete Slab
- Site

Note:
1. Sampling results reported in micrograms per liter (µg/L).



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

FIGURE 2-7

TCE IN INTERMEDIATE ZONE
LHAAP-46, GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

FILE PATH T:\GIS\Longhorn\MyWSP\MXD\Site46\FSMNA_TCE_Int.mxd
APPROVED BY P. Srivastav 03/05/08
CHECKED BY S. Watson 02/26/08
DRAWN BY B. Lu 01/17/08
OFFICE Houston, TX

Plot Date: 03/08

3.0 *Responsiveness Summary*

The Responsiveness Summary serves three purposes. First, it provides the U.S. Army, USEPA, and TCEQ with information about community concerns with the preferred alternative at LHAAP-46 as presented in the Proposed Plan. Second, it shows how the public's comments were considered in the decision-making process for selection of the remedy. Third, it provides a formal mechanism for the U.S. Army to respond to public comments.

The U.S. Army, USEPA, and TCEQ provide information regarding LHAAP-46 through public meetings, the Administrative Record file for the facility, and announcements published in the Shreveport Times and Marshall News Messenger newspapers. **Section 2.3** discusses community participation on LHAAP-46, including the dates for the public comment period, the date, location, and time of the public meetings, and the location of the Administrative Record. The following documents related to community involvement were added to the Administrative Record:

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

3.1 *Stakeholder Issues and Lead Agency Responses*

This section summarizes and responds to significant issues raised by stakeholders, including the public and community groups, received in written or verbal form. These concerns were addressed by the U.S. Army in the public meetings as much as possible as well as in the U.S. Army's response to comments available in the Administrative Record. The questions and comments from the public shown below may have been summarized.

Question/comment: What is the rationale behind the choice of Alternative 2 (MNA) over Alternative 3 (in situ bioremediation)? How do you know the plume is stable?

Response: The success of meeting the RAOs with Alternative 2 is ensured in several ways: 1) findings from past site investigations, 2) the monitoring program that is to be implemented, and 3) the inclusion of the contingency remedy to address uncertainties. The basis for presenting MNA as a suitable remedy for LHAAP-46 is the Preliminary Evaluation of Natural Attenuation, which is Appendix A of the FS (Shaw, 2009). The evaluation evaluated evidence of ongoing natural attenuation in accordance with USEPA guidelines (USEPA, 1998). It concluded that natural attenuation was at work and could be anticipated to degrade COC concentrations to the

cleanup levels. The evaluation of MNA will continue as the monitoring program provides new data. For 2 years, sampling will occur quarterly. Provided that MNA is satisfactory as described in **Section 2.12.2**, sampling will occur semiannually for the next 3 years. In subsequent years, sampling will occur annually until the next CERCLA five-year review for LHAAP sites. Then, sampling will occur every 5 years, on the same schedule as the other LHAAP CERCLA five-year reviews. To address the uncertainty of natural attenuation, a contingency remedy is included in the remedy. The contingency remedy would implement in situ bioremediation at the site if MNA performance is not satisfactory. The decision on whether MNA has been successful will be made after 2 years of MNA, when results will be available for the 8 quarterly sampling events and a performance evaluation is conducted. The specific criteria of the performance evaluation will be developed in the RD, but are generally discussed in **Section 2.12.2**.

A participant in the public meeting asked why Alternative 3 (in situ bioremediation) was not selected as the preferred alternative. The selection was made in accordance with statutory determinations that steer the decision making process. The FS (Shaw, 2009), Proposed Plan (U.S. Army, 2010), and ROD walk step-by-step through the process. Alternatives 2 and 3 are both expected to attain RAOs, and both would ultimately return groundwater to its potential beneficial use. Since the alternatives have similar long-term effectiveness, the alternative with the lower cost was selected.

The estimated time to achieve cleanup levels is within 23 years based on TCE; the derivation of the estimate is described in the FS, Appendix A (Shaw, 2009). In the course of the remedy, the additional monitoring results will allow more accurate time estimates. Currently, no daughter products have been detected above their associated MCLs. As the TCE continues to degrade, daughter products may begin to exceed their MCLs. Degradation rates will also be calculated for daughter products when enough data is available.

Question/comment: The potential migration of the TCE plume towards the public drinking water wells outside LHAAP is a key concern to the public.

Response: The U.S. Army has evaluated the VOC plume at LHAAP-46 and its potential to migrate offsite to three public drinking water wells (Caddo Lake Water Supply Corporation Wells 1, 2, and 3). The wells are located in close proximity to the LHAAP perimeter, along the northwest corner. The wells are isolated from the plumes by distance, depth, and groundwater flow direction. The closest of the three wells is approximately a half mile away from the plume. These wells draw from the drinking water aquifer, which is separate from the TCE plumes in the shallow and intermediate groundwater zones. The wells are upgradient of the plumes, meaning groundwater from the plume does not flow towards these wells. Furthermore, the plume is stable and has not shown evidence of migrating. LTM will provide assurance that any plume migration will be discovered so that mitigation measures can be evaluated.

Participants in the public meeting inquired about evidence that the plume is stable in the lateral and vertical directions. Sampling results and investigations support that the plume is stable. Regarding the lateral direction, the *Preliminary Evaluation of Natural Attenuation*, Appendix A of the FS (Shaw, 2009) reports that the plume was degrading at a greater rate than it could migrate, and that MNA was acting as an adequate containment mechanism. The apparent plume edge in the shallow zone has been decreasing in time as demonstrated by data from 1996 to 2007 show. Regarding the vertical direction, there is a cluster of wells completed in the shallow, intermediate, and deep groundwater zones. The wells are located within the areal extent of the intermediate groundwater plume. The deep zone is not contaminated as demonstrated by results from well 46WW03. It should be noted that the Caddo Lake Water Supply Corporation Wells draw water from a drinking water aquifer, not to be confused with the deep zone groundwater. The drinking water aquifer is at a depth of 250 to 430 feet bgs, while the deep zone groundwater at LHAAP-46 begins at approximately 33 ft bgs.

Another participant questioned the sampling frequency and procedures. The sampling frequency is in accordance with USEPA recommendations for this site. Sampling and analytical processes follow set procedures to ensure consistency and to provide quality data.

Question/comment: All analyses of thallium in filtered groundwater samples at LHAAP-46 exceeded the MCL. The Army has stated that the thallium is probably naturally occurring. Thus, it is not considered to be a COC. However, this conclusion does not appear to be supported by the data. First, there is no reliable background data for thallium. Second, the filtered/unfiltered ratios are approximately 1, indicating that the thallium is dissolved in the groundwater and not associated with suspended sediment. Finally, "... the consistent thallium/iron ratios..." that the U.S. Army cites as evidence of a natural source do not appear to exist. The thallium/iron ratios vary by more than a factor of ten. That is not consistent. The Army should perform reliable analyses of background thallium concentrations and re-evaluate its conclusion regarding the source of thallium. If the U.S. Army cannot clearly show that the thallium found at LHAAP-46 is naturally occurring, thallium should be considered a COC.

Response: The U.S. Army has reviewed the commenter's concerns over the geochemical evaluation for thallium; however the conclusion reached continues to be that thallium is naturally occurring at LHAAP-46. The reviewer's three concerns (regarding background data, filtered/unfiltered ratios, and thallium/iron [Tl/Fe] ratios) are discussed below.

The reporting limits for the background data set were high (mostly at 20 µg/L compared to an MCL of 2 µg/L), but it is believed that other lines of evidence adequately indicate that thallium is naturally occurring, specifically, the Tl/Fe ratios (discussed below) and the soil investigation results that do not indicate a release of thallium-based compounds at LHAAP-46.

In regards to the filtered/unfiltered ratios, the U.S. Army recognizes that some portion of the thallium detected in the samples may be in solution and not associated with suspended particulates. The LHAAP-46 geochemical evaluation report clearly states that some portion of the thallium detected in the site samples may be in solution, as evidenced by the filtered/unfiltered ratios that range from 0.897 to 1.72 (median of 1.11). However, that is not a proof of thallium contamination, as the element can naturally occur in solution. It should also be noted that the filtration process may not remove all suspended materials, especially fine particulates that can pass through a 0.45-micron filter.

Regarding the Tl/Fe ratios, it is important to note that naturally occurring elements in groundwater commonly exhibit a wide range in trace/major element ratios. At LHAAP-46, the Tl/Fe ratios of the September 2007 samples range from a minimum of 7.75E-04 to a maximum of 1.26E-02, which is common for this trace element. Higher thallium concentrations would also be expected if contamination were present; however, the September 2007 site concentrations only range from 1.94 J µg/L to 8.54 J µg/L. These Tl/Fe ratios and thallium concentrations are comparable with background groundwater data sets at other facilities. For example, at Redstone Arsenal, Alabama, the background Tl/Fe ratios range from 8.34E-05 to 9.98E-02, and the unfiltered background thallium concentrations range from 3.4 J to 9.2 µg/L. At a military facility in New Mexico, the background Tl/Fe ratios range from 9.12E-06 to 1.04E-02, and the unfiltered background thallium concentrations range from 0.0513 J µg/L to 13 µg/L.

The geochemical evaluation in the FS (Shaw, 2009) acknowledged that four 1996 groundwater samples contained anomalously high thallium, collected from wells LHSMW24 and LHSMW27 in February and from LHSMW08 and LHSMW21 in August. These detections may or may not reflect contamination. Of note is the fact that one of these anomalously high concentrations (200 µg/L) is observed in a field duplicate sample (LHSMW08-960813-FD); the corresponding regular sample (LHSMW08-960813) is nondetect for thallium, with a reporting limit of 90 µg/L. The lack of reproducibility suggests that the field duplicate's thallium detection is questionable. Another important observation is that the elevated 1996 thallium concentrations are not reproducible in subsequent sampling rounds. The 1998 samples from wells LHSMW08 and LHSMW27 are nondetect for thallium, at a reporting limit of 1 µg/L. The 1998 thallium detections for the LHSMW21 and LHSMW24 samples, 1.5 µg/L and 4.5 µg/L, are two orders of magnitude lower than their 1996 detections. Well LHSMW24 was resampled in September 2007 and its thallium concentration remains low (5.29 J µg/L in the regular sample and 5.22 J µg/L in its field duplicate). The significant decrease in recent thallium concentrations argues against the presence of thallium contamination in site groundwater.

Given the lack of corroborative soil results, the inability to reproduce the high concentrations of the earlier samples, and the recent thallium concentrations that are similar to those of background groundwater data sets at other facilities, the U.S. Army considers thallium in the recent

LHAAP-46 groundwater samples to be naturally occurring. Thus, thallium is not considered a COC. However, to respond to the public concern and to confirm this decision, additional groundwater sampling for thallium will be integrated into the RD phase for LHAAP-46.

Question/comment: There are large areas at LHAAP-46 without any monitor wells e.g., the western area between LHSMW15 and 46WW04, the eastern area east of LHSMW24, and the southern area south of LHSMW27. Given the long history of LHAAP, it is not possible to know where all spills or disposal of hazardous materials occurred, whether authorized or unauthorized. No area should be presumed to be uncontaminated. The Army should install monitor wells in all areas of LHAAP-46.

Response: The site was evaluated during several investigations focusing on areas where operations occurred. It is unlikely that spills occurred in areas far away from the main production areas. Groundwater wells are positioned to evaluate groundwater both in suspect areas where there were operations and downgradient of those areas. An Environmental Baseline Study by Plexus collected groundwater samples across Longhorn using temporary wells in suspect areas not previously evaluated. The results did not indicate the presence of contaminated areas other than those reported in the RI (Jacobs, 2002a).

3.2 *Technical and Legal Issues*

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

4.0 References

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USEPA, 1999, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, OSWER Directive 9200.4.-17P, April.

USEPA, 2004, *Performance Monitoring of MNA Remedies for VOCs in Ground Water*, EPA/600/R-04/027, April.

Glossary of Terms

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

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

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

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

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

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

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

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

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

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – CERCLA was enacted by Congress in 1980 and was amended by the Superfund Amendments and Reauthorization Act in 1986. CERCLA provides federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the

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

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

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

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

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

National Priorities List (NPL) – The USEPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. USEPA is required to update the NPL at least once a year. A site must be on the NPL to receive money from the Trust Fund for remedial action.

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

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

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

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

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

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

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

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

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

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

Appendix A
Public Meeting Newspaper and Media Notices

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

MEDIA RELEASE

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

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

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

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



Date: October 25, 2010

Project No.: 117591

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 Record of Decision, LHAAP-50, Former Sump Water Tank, Group 4,
Longhorn Army Ammunition Plant

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

For: Review ☐ As Requested ☐ Approval ☐ Corrections ☐ Submittal ☐ Other ☒

<i>Item No:</i>	<i>No. of Copies</i>	<i>Date:</i>	<i>Document Title</i>
1	2	September 2010	Final Record of Decision, LHAAP-50, Former Sump Water Tank, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas

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

Sincerely:

Praveen Srivastav
Project Manager

CC: Distribution List:

Mr. J. Lambert – USACE, Tulsa (sent to A. Williams for distribution)

Mr. A. Maly – USAEC (electronic only)

Ms. Rose Zeiler – BRAC-LHAAP

Mr. S. Tzhone – EPA Region 6 (2)

Ms. F. Duke– TCEQ, Austin (2)

Mr. D. Vodak– TCEQ, Tyler

Mr. P. Bruckwicki– U.S. Fish and Wildlife Service



DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

October 25, 2010

DAIM-ODB-LO

Mr. Stephen Tzhone
US Environmental Protection Agency
Superfund Division (6SF-AT)
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Final Record of Decision, LHAAP-50, Former Sump Water Tank, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2010

Dear Mr. Tzhone,

The above-referenced document is being transmitted to you for your records. The document has been prepared by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility.

The point of contact for this action is the undersigned. I ask that Praveen Srivastav, 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,

A handwritten signature in cursive script, reading "Rose M. Zeiler", is positioned above the typed name.

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
A. Maley, USAEC, TX
P. Srivastav, Shaw – Houston, TX (for project files)



DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

October 25, 2010

DAIM-ODB-LO

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

Re: Final Record of Decision, LHAAP-50, Former Sump Water Tank, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2010
SUP 126

Dear Ms. Duke,

The above-referenced document is being transmitted to you for your records. The document has been prepared by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility.

The point of contact for this action is the undersigned. I ask that Praveen Srivastav, 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,

A handwritten signature in black ink, reading "Rose M. Zeiler", is positioned below the "Sincerely," text.

Rose M. Zeiler, Ph.D.
Longhorn AAP Site Manager

Copies furnished:

S. Tzhone, USEPA Region 6, Dallas, TX
D. Vodak, TCEQ, Tyler, TX
P. Bruckwicki, Caddo Lake NWR, TX
J. Lambert, USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
A. Maly, USAEC, TX
P. Srivastav, Shaw, Houston, TX (for project files)

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



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

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

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

September 2010

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Appendix A	Public Meeting Newspaper and Media Notices

Glossary of Terms

Located at the end of this Record of Decision

Acronyms and Abbreviations

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

Acronyms and Abbreviations (continued)

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

1.0 Declaration

1.1 Site Name and Location

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

Longhorn Army Ammunition Plant
Karnack, Texas

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

1.2 Statement of Basis and Purpose

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

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

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

1.3 Assessment of the Site

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

1.4 Description of the Selected Remedy

The selected remedy protects human health and the environment by preventing human exposure to perchlorate and volatile organic compounds (VOCs) including tetrachloroethene (PCE),

trichloroethene (TCE), 1,1-dichloroethene (DCE), 1,2-dichloroethane (DCA), cis-1,2-DCE, and vinyl chloride (VC) in the shallow groundwater. No principal threat source material has been identified at LHAAP-50. The remedy for LHAAP-50 includes:

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

Soil

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

Groundwater

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

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

associated with this remedy will be used to track the effectiveness of MNA and will continue every five years until cleanup levels are achieved.

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

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

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

The management strategy at LHAAP is to approach each site separately to address human health issues and to approach the sites by sub-area to address ecological risk. Thus, the implementation of this remedy at LHAAP-50 is independent of any other remedial action at LHAAP to address

human health issues. To address ecological risk, LHAAP-50 was grouped with several other sites as part of the Industrial Sub-Area. No chemicals exceeded ecological thresholds of concern in the Industrial Sub-Area. Thus, no action is needed at LHAAP-50 to address ecological risk (Shaw, 2007a).

1.5 *Statutory Determinations*

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

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

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

1.6 *ROD Data Certification Checklist*

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

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

- Potential land and groundwater use that will be available at the site as a result of the selected remedy (**Section 2.6**).
- Chemicals of concern (COCs) and their respective concentrations (**Section 2.7**).
- Baseline risk represented by the COCs (**Section 2.7**).
- Cleanup levels established for COCs and the basis for these levels (**Section 2.7**).
- No principal threat source materials identified (**Section 2.11**).
- Key factors that led to selecting the remedy (**Section 2.12**).
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (**Section 2.12**).

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

1.7 Authorizing Signatures

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

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

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

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

Samuel Coleman 9-30-10
(Name) (Date)

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

2.0 *Decision Summary*

2.1 *Site Name, Location, and Description*

LHAAP-50, Former Sump Water Tank, Group 4

Longhorn Army Ammunition Plant
Karnack, Texas

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

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

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

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

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

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

2.2 *Site History and Enforcement Activities*

2.2.1 *History of Site Activities*

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

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

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

2.2.2 *History of Investigative Activities*

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

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

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

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

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

2.2.3 History of CERCLA Enforcement Activities

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

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

2.3 Community Participation

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

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

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

Location: Marshall Public Library
300 S. Alamo
Marshall, Texas 75670

Business Hours: Monday – Thursday 10:00 a.m. – 8:00 p.m.
Friday – Saturday 10:00 a.m. – 5:00 p.m.

2.4 Scope and Role of Response Action

The recommended action at LHAAP-50 will prevent potential risks associated with exposure to contaminated groundwater. Although groundwater at Longhorn is not currently being used as

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

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

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

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

2.5 *Site Characteristics*

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

2.5.1 *Conceptual Site Model*

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

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

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

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

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

2.5.2 Overview of Site

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

2.5.3 *Geology and Hydrology*

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

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

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

2.5.4 *Sampling Strategy*

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

2.5.5 *Nature and Extent of Contamination*

Chemicals in the groundwater at LHAAP-50 pose an unacceptable risk to human health. Evaluation of data generated after the risk assessment did not identify any additional COCs with

risks exceeding the USEPA target risk level of 1×10^{-4} or a hazard quotient (HQ) greater than 0.1. Chemicals in the soil do not pose an unacceptable risk or hazard to human health.

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

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

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

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

2.6 Current and Potential Future Site and Resource Uses

2.6.1 Current and Future Land Uses

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

LHAAP has been an industrial facility since 1942. Production activities and associated waste management activities continued until the facility was determined to be in excess of the U.S. Army's needs in 1997. The plant area has been relatively dormant since that time. LHAAP is

surrounded by a fence (except on the border with Caddo Lake), and current security measures at the LHAAP preclude unlimited public access to areas within the fence. The fence now represents the Refuge boundary. Approved access for hunters is very limited.

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

2.6.2 Current and Future Surface Water Uses

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

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

2.6.3 Current and Future Groundwater Uses

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

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

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

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

2.7 Summary of Site Risks

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

2.7.1 Summary of Human Health Risk Assessment

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

associated with the risk assessment was introduced in **Section 2.5.1**, and is presented as **Figure 2-3**.

2.7.1.1 Identification of Chemicals of Potential Concern

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

2.7.1.2 Exposure Assessment

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

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

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

2.7.1.3 Toxicity Assessment

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

2.7.1.4 Risk Characterization

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

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

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

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

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

The HQ is calculated as follows:

$$\text{Non-carcinogenic HQ} = \text{CDI/RfD}$$

Where: CDI = chronic daily intake
RfD = reference dose

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

The carcinogenic risks for soil and groundwater are 5.8×10^{-7} and 5.5×10^{-3} , respectively (Jacobs, 2003). The soil is in the acceptable range while the groundwater is not. The hazard indices for soil and groundwater are 0.035 and 305, respectively. Again, the soil is acceptable while the groundwater is not. Therefore, the remedial action focuses on the groundwater. The primary contributor to carcinogenic risk for the groundwater at LHAAP-50 is TCE; other significant

contributors are VC, 1,1-DCE, and 1,2-DCA. The chemicals in groundwater with the highest HQs are perchlorate and TCE, with values of 200 and 84, respectively. Other chemicals with high HQs include cis-1,2-DCE, and 1,1-DCA.

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

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

2.7.2 Summary of Ecological Risk Assessment

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

Ecological risk does not exist unless:

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

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

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

2.7.3 *Basis of Action*

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

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

2.8 *Remedial Action Objectives*

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

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

The above RAO recognizes USEPA's policy to return all groundwater to beneficial uses, based on the non-binding programmatic expectation in the NCP and is consistent with the NCP

regulations requiring the lead agency, the U.S. Army in this case, to establish RAOs specifying contaminants and media of concern, potential exposure pathways, and remediation goals.

2.9 *Description of Alternatives*

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

2.9.1 *Description of Remedy Components*

Alternative 1 – No Action Alternative

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

Estimated Capital Present Worth Cost: \$0

Estimated O&M Present Worth Cost: \$0

Cost Estimate Duration: --

Estimated Total Present Worth Cost: \$0

Alternative 2 – Excavation, MNA, LUC

The major components of this alternative include the following:

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

Estimated Capital Present Worth Cost: \$215,000

Estimated O&M Present Worth Cost: \$424,000

Cost Estimate Duration: 30 years

Estimated Total Present Worth Cost: \$639,000

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

The major components of this alternative include the following:

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

Estimated Capital Present Worth Cost: \$402,000

Estimated O&M Present Worth Cost: \$512,000

Cost Estimate Duration: 30 years

Estimated Total Present Worth Cost: \$914,000

2.9.2 Common Elements and Distinguishing Features of Each Alternative

Common Elements of Alternative 2 and 3

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

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

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

MNA performance monitoring will be performed quarterly for the first two years. After eight quarterly sampling events, MNA will be evaluated. The analytical program will consist of VOCs, including chlorinated compounds and degradation products, methane, ethene, and ethane. Initially, the following geochemical parameters will also be included in the analytical program,

dissolved oxygen (field), redox potential (field), sulfate, nitrate, nitrites, alkalinity, total organic carbon, and ferrous iron (field).

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

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

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

Distinguishing features of Alternative 3

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

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

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

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

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

Sampling wells to monitor effectiveness – Monitoring for contaminants would be performed to assess the effectiveness of the treatment. Anticipated remediation times may be short in the

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

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

2.9.3 *Expected Outcomes of Each Alternative*

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

2.10 *Summary of Comparative Analysis of Alternatives*

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

2.10.1 Overall Protection of Human Health and the Environment

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

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

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

2.10.2 Compliance with ARARs

Section 121(d) of CERCLA and NCP §300.430(f)(1)(ii)(B) requires that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations, which are collectively referred to as “ARARs” unless such ARARs are waived under CERCLA Section 121(d)(4). The ARARs that pertain to this ROD are discussed in **Section 2.13.2**.

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

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

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

2.10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

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

The potential long-term risk from soil would be permanently removed for Alternatives 2 and 3 since the soil will be excavated and placed in a permitted landfill with the necessary facilities and long-term maintenance to control risks from the perchlorate contaminated soil. MNA processes at LHAAP-50 are controlling plume migration and have stabilized the size of the areas exhibiting COC concentrations exceeding cleanup levels. Monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of

the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume. Alternative 3 would reduce contaminant levels quicker than Alternative 2 through in situ bioremediation.

2.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

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

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

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

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

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

2.10.5 Short-Term Effectiveness

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

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

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

2.10.6 Implementability

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

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

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

Administratively, all of the alternatives are implementable.

2.10.7 Cost

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

competitive market conditions, final scope, final schedule, final engineering design, and other variables.

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

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

2.10.8 State/Support Agency Acceptance

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

2.10.9 Community Acceptance

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

2.11 Principal Threat Wastes

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

2.12 *The Selected Remedy*

2.12.1 *Summary of Rationale for the Selected Remedy*

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

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

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

Although the selected remedy is not intended to address the statutory preference for treatment to the maximum extent possible, the selected remedy offers, within a time frame reasonable for its anticipated use and at a lower cost, a similar level of protection to human health and the environment than the remedy alternative which satisfies the preference for treatment. In addition,

no source materials constituting principle threats have been indentified at the site; therefore none will be addressed within the scope of this action.

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

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

2.12.2 Description of Selected Remedy

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

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

- Excavation of the contaminated soil and disposal in a RCRA-permitted landfill will remove soil that is considered to be a contaminant source to groundwater, thereby, protecting groundwater. The estimated volume of soil to be removed is 150 cubic yards and is based on the conservative TCEQ GWP-Ind of 7,200 µg/kg for perchlorate in soil. The approximate limits of excavation are shown on **Figure 2-7**. The removal of soil contamination will be verified by collecting confirmation samples from the walls and floors of the excavation area and submitting them for laboratory analysis for perchlorate.
- Semi-annual performance monitoring of Goose Prairie Creek adjacent to the LHAAP-50 will be conducted at two locations after excavation of the contaminated perchlorate pathway. Evaluation of this data will be included in the annual reports. The frequency and locations of sampling may be modified after evaluation of data. If perchlorate levels in the creek are consistently above the GW-Res after two years of monitoring, then additional evaluation will be conducted and any proposed actions will be included in the annual evaluation report to be submitted after year 2. The need to continue creek sampling will be evaluated during the five-year reviews.
- *MNA to return groundwater to its potential beneficial use, wherever practicable.* Historic data suggest that natural attenuation of COCs is occurring at the site; however, additional data collection is necessary to fully evaluate natural attenuation. Monitoring wells will be sampled for eight consecutive quarters to evaluate and confirm the occurrence of natural attenuation in conjunction with historical data. Data from the eight quarterly events will be combined with historic data to evaluate the effectiveness of various natural physical, chemical, and biological processes in reducing contaminant concentrations.

- *Performance objectives to evaluate the MNA remedy performance after two years.* Each of the general performance objectives must be met as indicated below. If the criteria are not met to illustrate that MNA is an effective remedy, a contingency action would be initiated. If MNA is effective, a baseline will be established from the data to this point in time. Specific evaluation criteria will be developed in the RD. The MNA evaluation will be based on the USEPA lines of evidence (USEPA, 1999) and the anaerobic screening (USEPA, 1998) as follows:
 - MNA potential based on evaluating biodegradation screening scores using USEPA guidance
 - Plume stability (i.e., the plume concentrations are decreasing in the majority of performance wells, and the plume is not expanding in area as demonstrated with compliance wells).
 - MNA Process Evaluation demonstrated based on an attenuation rate calculated with empirical performance monitoring data, and MNA Process Demonstration based on the presence of daughter products and bacterial culture counts.
- *A contingency remedy to enhance MNA to reach the RAOs if MNA is found to be ineffective.* The contingency remedy will use elements from other active remedial alternatives included in this ROD to address the ineffective aspects of MNA. The area and the elements of the contingency remedy would be selected based on the entire data set available. If a contingency remedy is implemented, it will be documented in an ESD.
- *Initiate LTM.* If MNA is determined to be effective, monitoring will be conducted to evaluate the remedy performance and determine if the plume conditions remain constant, improve or worsen after the baseline is established. Monitoring will continue after the initial eight quarters at a frequency of semiannual for three years, then annually until the next five-year review. The performance monitoring plan will be developed in the RD and will be based on USEPA guidance (USEPA, 2004).
- *Continue LTM every five years to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen.* The baseline of the plume for future five-year reviews will be established as part of the MNA evaluation program. The initial LTM plan will be developed during RD.
- *LUC to restrict access to the contaminated groundwater to environmental monitoring and testing only until cleanup levels are reached.* LUC implementation details will be included in the RD. The recordation notification for the site which will be filed with Harrison County will include a description of the LUC. The boundary of the LUC would enclose the site boundaries and the plume boundaries shown on **Figure 2-6**.

The U.S. Army would be responsible for implementation, maintenance, inspection, reporting, and enforcement of the LUC. Although the U.S. Army may later pass these procedural responsibilities to the transferee by property transfer agreement, the U.S. Army shall retain

ultimate responsibility for: (1) CERCLA §121(c) five-year reviews; (2) notification of the appropriate regulators of any known LUC deficiencies or violations; (3) access to the property to conduct any necessary response; (4) reservation of the authority to change, modify or terminate LUCs and any related transfer or lease provisions; and (5) ensuring that the LUC objectives are met to protect the integrity of the selected remedy. In the event that TCEQ and/or EPA and the Army agree with respect to any modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the FFA and 40 CFR 300.435(c)(2) and 40 CFR 300.430(f)(4)(iii).

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

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

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

2.12.3 Cost Estimate of the Selected Remedy

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

The total project present worth cost of this alternative is approximately \$639,000, using a discount rate of 2.8%. The capital cost is estimated at \$215,000. The total O&M present value

cost is estimated at approximately \$424,000. The O&M cost includes evaluation of MNA, maintenance of LUC, and LTM through Year 30. The LTM would support the required CERCLA five-year reviews.

2.12.4 Expected Outcomes of the Selected Remedy

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

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

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

2.13 Statutory Determinations

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

2.13.1 Protection of Human Health and the Environment

The selected remedy, Alternative 2, will protect human health and the environment, and achieve the RAOs for LHAAP-50. Although this alternative does not provide for human intervention to remediate groundwater, the alternative is a passive subsurface remedial action conducted by natural processes and mechanisms. The contaminated groundwater will be reduced to protective ARAR levels, and the soil above protective ARAR levels will be removed. LUC would prevent human exposure to the contaminated groundwater by prohibiting the construction of potable

wells within the LUC boundaries. Surface water monitoring of the creek will verify that the soil removal effectively mitigated the soil-to-groundwater pathway. The monitoring activities associated with MNA will ensure that COCs and by-product (daughter) contaminants in groundwater do not discharge to nearby surface water bodies at such levels that ARARs are exceeded.

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

2.13.2 Compliance with ARARs

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

Chemical-Specific ARARs

- **Soil:** There are no Federal promulgated chemical-specific ARARs for soil. The TCEQ Texas Risk Reduction Rules are promulgated State standards for this site. It is anticipated that removal of perchlorate-contaminated soils above the TCEQ GWP-Ind of 7,200 µg/kg will prevent contamination of the groundwater at the site.
- **Surface water:** Section 121(d)(2) of CERCLA states that every remedial action shall require a level of control which at least attains surface water quality criteria established under Sections 304 or 303 of the Clean Water Act of 1972 (CWA). Therefore, surface water quality criteria are ARARs if there is a remedial action that affects surface water, and measures will be implemented during construction to prevent off-site migration of contaminants to surface waters. In the event of remedy failure resulting in or potentially resulting in a release to surface water, 40 CFR 122, 125, 129, 130, and 131 and 30 TAC 307.1, 307.2, 307.3, 307.4, 307.5(a) and (b), 307.6, 307.7, 307.8 and 307.9 are considered potential future ARARs.
- **Groundwater:** Cleanup levels are presented in **Table 2-6**. LHAAP is being addressed using the Risk Reduction Standards (RRS) (30 TAC 335.551 through 335.569). The RRS were provided to ensure adequate protection of human health and the environment from potential exposure to contaminants associated with releases from solid waste management facilities or other areas. There are three sets of RRS that provide cleanup levels ranging from closure/remediation to site background (RRS 1) to closure/remediation with controls (RRS 3). A baseline risk assessment under RRS 3 was completed for LHAAP-50 which identified COCs in groundwater that potentially pose carcinogenic risk and hazard to the hypothetical future maintenance worker. These identified COCs, with the exception of perchlorate, have MCLs. Thus, the cleanup goal for groundwater will be the MCLs which meet health-based standards and criteria, and the MSCs provided under Texas Risk Reduction Rules (30 TAC 335.551 through 335.569) where MCLs are not available, i.e., perchlorate. This alternative will return the contaminated shallow groundwater zone at LHAAP-50 to its potential beneficial use as drinking water, wherever practicable,

which for the purposes of this ROD is considered to be attainment of the relevant and appropriate cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C) and 30 TAC 335. If a return to potential beneficial uses is not practicable, this alternative would still meet the NCP expectation to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. Because modeling results indicate that maximum concentrations of COCs would be below their respective cleanup levels in the nearby surface water bodies where groundwater discharges, nearby surface water bodies will be protected from ARAR exceedances.

Location-Specific ARARs

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

Action-Specific ARARs

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

- **Waste and disposal activities:** The processes of monitoring, intercepting, or treating contaminated groundwater may generate a variety of primary and secondary waste streams (e.g., soil, personal protective equipment, and dewatering and decontamination fluids). These waste streams are expected to be non-hazardous waste. All solid waste (defined as any solid, liquid, semisolid, or contained gaseous material intended for discard [40 CFR 261.2]) generated during remedial activities must be appropriately characterized to determine whether it contains RCRA hazardous waste (40 CFR 262.11; 30 TAC 335.62; 30 TAC 335.503[a][4]; 30 TAC 335.504). All wastes must be managed, stored, treated (if necessary), and disposed of in accordance with the ARARs for waste management listed in **Table 2-9** for the particular type of waste stream or contaminants in the waste.
- **Well construction:** The remedial action may involve the placement, use, or eventual plugging and abandonment of some type of groundwater monitoring, injection, and/or extraction wells, either for in situ treatment of the contaminated groundwater or for LTM of the groundwater. Available standards for well construction and plugging/abandonment would provide ARARs for such actions and include 30 TAC 331, Subchapters A, C, and H. Texas has promulgated technical requirements in Chapter 76 of Title 16 of the TAC applicable to construction, operation, and plugging/abandonment of water wells. In particular, 16 TAC 76.1000 (*Locations and*

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

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

2.13.3 Cost Effectiveness

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

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

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

The selected remedy addresses the issue of permanent solution through disposal with the excavation of the contaminated soil, but does not address the issue of a permanent solution for groundwater through disposal, treatment, or recovery of contaminants. The selected remedy provides the best balance of trade offs in terms of five balancing criteria and considering State and community acceptance. Alternative 2 would document effectiveness through the

confirmation of MNA and the routine monitoring of the attenuation and migration of the contaminants in groundwater. Natural attenuation effectively controls plume migration and has stabilized the size of the area exhibiting COC and by-product (daughter) contaminant concentrations exceeding cleanup levels. Natural biodegradation is an irreversible treatment process that would reduce the mass and concentration of contaminants. Alternative 2 would provide almost immediate protection because the LUC would be implemented relatively quickly. Maintenance of these controls would be required until natural attenuation processes reduce COC and by-product (daughter) contaminant concentrations to below cleanup levels. Alternative 2 is easily implemented from a technical standpoint; it requires soil excavation, routine maintenance of the LUC, evaluation of MNA, and sampling. Alternative 2 has the lowest present worth and capital costs of the remedial alternatives.

2.13.5 Preference for Treatment as a Principle Element

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

2.13.6 Five-Year Review Requirements

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

2.14 Significant Changes from the Proposed Plan

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

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

Scenario Timeframe: Current						
Medium: Soil						
Exposure Medium: Soil (0 to 0.5 feet below ground surface)						
Exposure Point	Chemical	Concentration Detected ¹ (mg/kg)		Frequency of Detection	Exposure Point Concentration (mg/kg)	Statistical Measure
		Minimum	Maximum			
Incidental ingestion, inhalation of particulates, dermal contact	<i>Dioxin/Furan</i>					
	2,3,7,8-TCDD	2.64E-07	7.96E-06	---	7.96E-06	Maximum
	<i>Metals</i>					
	Vanadium	3.30E+00	7.10E+01	13/13	7.10E+01	Maximum
	<i>Non-Metallic Anion</i>					
	Perchlorate	3.00E-02	3.00E-02	1/2	3.61E-02	Maximum
Scenario Timeframe: Current						
Medium: Groundwater						
Exposure Medium: Groundwater						
Exposure Point	Chemical	Concentration Detected ¹ (µg/L)		Frequency of Detection	Exposure Point Concentration (µg/L)	Statistical Measure
		Minimum	Maximum			
Incidental ingestion, inhalation of particulates, dermal contact	<i>Dioxin/Furan</i>					
	2,3,7,8-TCDD	2.93E-06	7.31E-06	---	7.31E-06	Maximum
	<i>Metals</i>					
	Aluminum	2.40E+03	9.90E+03	5/5	9.90E+03	Maximum
	Antimony	9.00E+00	1.40E+01	4/5	1.40E+01	Maximum
	Chromium	3.00E+01	2.00E+02	5/5	2.00E+02	Maximum
	Manganese	9.80E+01	1.11E+03	5/5	1.11E+03	Maximum
	Nickel	6.00E+01	6.90E+02	3/5	6.90E+02	Maximum
	Strontium	2.40E+02	3.40E+03	5/5	3.40E+03	Maximum
	<i>Non-Metallic Anion</i>					
	Perchlorate	1.60E+00	1.80E+04	7/15	1.80E+04	Maximum
	<i>Semi-Volatile Organics</i>					
	Naphthalene	1.30E+00	1.30E+00	1/7	1.30E+00	Maximum
	<i>Volatile Organics</i>					
	1,1,2-Trichloroethane	3.60E+00	3.60E+00	1/7	3.60E+00	Maximum
	1,2,4-trimethylbenzene	3.90E+00	3.90E+00	1/7	3.90E+00	Maximum
	1,1-Dichloroethene	5.00E+01	5.00E+01	1/7	5.00E+01	Maximum
	1,2-Dichloroethane	9.80E+01	9.80E+01	1/7	9.80E+01	Maximum
	Acetone	6.70E+01	6.70E+01	1/7	6.70E+01	Maximum
	Benzene	2.20E+00	2.20E+00	1/7	2.20E+00	Maximum
	Chloroform	6.30E-01	2.50E+01	2/7	2.50E+01	Maximum
	cis-1,2-Dichloroethene	6.40E-01	4.40E+03	4/7	4.40E+03	Maximum
	trans-1,2-Dichloroethene	1.50E+01	1.50E+01	1/7	1.50E+01	Maximum
	Tetrachloroethene	3.50E+01	3.50E+01	1/7	3.50E+01	Maximum
	Trichloroethene	5.70E-01	2.20E+04	6/7	2.20E+04	Maximum
	Vinyl Chloride	1.00E+02	1.00E+02	1/7	1.00E+02	maximum

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

Notes ¹ Minimum/maximum detected concentration above the reporting limit ---: No information available µg/L: micrograms per liter mg/kg: milligrams per kilogram TCDD: tetrachlorodibenzo-p-dioxin
References Jacobs Engineering Group, Inc. (Jacobs), 2003, <i>Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas</i>, Final, Oak Ridge, TN, June.
Summary of Chemicals of Potential Concern and Medium-Specific Exposure Point Concentrations The table presents the chemicals of potential concern (COPCs) and exposure point concentration (EPC) for each (i.e. the concentration used to estimate the exposure and risk from each COPC). The table includes the range of concentrations detected for each COPC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and the statistical measure upon which the EPC was based. The COPCs listed are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003).

Table 2-2
Carcinogenic Toxicity Data Summary

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

Table 2-2 (continued)
Carcinogenic Toxicity Data Summary

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

Table 2-2 (continued)
Carcinogenic Toxicity Data Summary

Notes --- : No information available mg/kg-day: milligrams per kilogram per day mg/m³: milligrams per cubic meter NC: Chemical not classified as a carcinogen NTV: no toxicity value available TCDD: tetrachlorodibenzo-p-dioxin	Weight of Evidence/Carcinogen Guideline Description: A - Human carcinogen B1- Probable human carcinogen – Indicates that limited human data are available B2- Probable human carcinogen – Indicates sufficient evidence in animals and inadequate or no evidence in humans C - Possible human carcinogen D - Not classifiable as a human carcinogen
References Jacobs Engineering Group, Inc. (Jacobs), 2003, <i>Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas</i>, Final, Oak Ridge, TN, June. USEPA-HEAST, 1997. Human Health Effects Summary Tables (HEAST). FY-1995, Annual. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R-95-036. USEPA-IRIS, 2001. Integrated Risk Information System (IRIS). United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 2001. USEPA-NCEA, 2001. USEPA Region 3 Risk-Based Concentration Tables (5/8/2001). Referenced values from National Center for Environmental Assessment (NCEA).	
Summary of Toxicity Assessment The table provides carcinogenic risk information which is relevant to the contaminants of potential concern soil and ground water. The list of chemicals of concern presented here are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003).	

Table 2-3
Non-Carcinogenic Toxicity Data Summary

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

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

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

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

Notes ---: No information for a compound with no toxicity value (NTV) CNS: Central nervous system GIT: Gastrointestinal tract IRIS: Integrated Risk Information System, USEPA mg/kg-day: milligrams per kilogram per day		mg/m ³ : milligrams per cubic meter NA: Information not available NTV: No toxicity value available RfC: Reference concentration RfD: Reference dose
References Agency for Toxic Substances and Disease Registry (ATSDR), 1997, Minimal Risk Levels (MRLs) for Hazardous Substances. Jacobs Engineering Group, Inc. (Jacobs), 2003, <i>Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas</i> , Final, Oak Ridge, TN, June. Texas Commission on Environmental Quality (TCEQ), 2001. Update to 1998 Consistency Memorandum. Toxicity Factors Table, 15 March, 2001. U.S. Environmental Protection Agency (USEPA), 1998. <i>Perchlorate Environmental Contamination Toxicological Review and Risk Characterization based on Emergency Information</i> , Review Draft, Office of Research and Development. NCEA-1-0503, 31 December, 1998. USEPA-HEAST, 1997. Health Effects Summary Table (HEAST). FY 1995, Annual Office of Emergency and Remedial Response. Washington, D.C. EPA/340/R-95-036. USEPA-IRIS, 2001. Integrated Risk Information System (IRIS). United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 2001. USEPA-NCEA, 2001. USEPA Region 3 Risk-Based Concentration Tables (5/8/2001). Referenced values from National Center for Environmental Assessment (NCEA).		
Summary of Toxicity Assessment This table provides non-carcinogenic risk information relevant to the contaminants of concern in both soil and ground water. The list of chemicals of concern presented here are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003). The uncertainty factor and modifying factor are used in the development of a reference dose. The uncertainty factor adjusts results from dose-response studies in animals to make them applicable to humans. The modifying factor is used to account for uncertainties in the available toxicity data from which the reference dose is derived. In the risk assessment, the reference doses and concentrations were for the chronic case, to be conservative.		

Table 2-4
Risk Characterization Summary – Carcinogens

Scenario Timeframe:		Future					
Receptor Population:		Maintenance Worker					
Receptor Age:		Adult					
Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogen Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 to 0.5 ft)	Soil and particulates	Incidental ingestion, inhalation of particulates, dermal contact	<i>Dioxin/Furan</i>				
			2,3,7,8-TCDD	4.2E-07	1.4E-11	1.6E-07	5.8E-07
Soil risk total =							5.8E-07
Groundwater	Groundwater	Ingestion and exposure while showering	<i>Dioxin/Furan</i>				
			2,3,7,8-TCDD	3.8E-06	NE	3.2E-05	3.6E-05
			<i>Volatile Organics</i>				
			1,1,2-Trichloroethane	7.2E-07	3.5E-09	6.5E-07	1.4E-06
			1,1-Dichloroethene	1.0E-04	1.5E-04	1.4E-04	4.0E-04
			1,2-Dichloroethane	3.1E-05	1.6E-04	1.4E-05	2.0E-04
			Benzene	4.2E-07	1.0E-09	3.0E-08	4.5E-07
			Chloroform	5.3E-07	3.5E-05	2.1E-06	3.8E-05
			Tetrachloroethene	6.4E-06	1.2E-09	2.5E-05	3.2E-05
			Trichloroethene	8.5E-04	2.3E-03	1.1E-03	4.3E-03
		Vinyl Chloride	5.2E-04	5.4E-05	NE (Kp<=0.01)	5.8E-04	
Groundwater risk total =							5.5E-03
Total risk (soil and groundwater) =							5.5E-03
Key							
Kp		Dermal permeability coefficient					
NE		Not evaluated through this exposure pathway. Chemical is not identified as a volatile					
NE (Kp<=0.01)		COPCs with a Kp<=0.01 were not evaluated for dermal contact while showering (USEPA, 1995)					
TCDD		Tetrachlorodibenzo-p-dioxin					
References							
U.S. Environmental Protection Agency (USEPA), <i>National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule, 40 CFR Part 300</i> , March 8, 1990.							
USEPA, <i>Supplemental Region VI Risk Assessment Guidance, May 5, 1995.</i>							
Summary of Risk Characterization							
The table provides risk estimates for the significant routes of exposure at LHAAP-50. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a hypothetical future maintenance worker's exposure to soil and groundwater, as well as the toxicity of the chemicals of concern. The total risk from exposure to contaminated soil and groundwater at this site is estimated to be 5.5E-03. A risk below 10 ⁻⁴ is generally considered to be acceptable (USEPA, 1990). The soil risk is acceptable, while the groundwater risk is not. The COC contributing the most to the groundwater risk level is trichloroethene. Other significant contributors are vinyl chloride; 1,1-dichloroethene; and 1,2-dichloroethane. This risk level indicates that if no clean-up action is taken, an individual would have an increased probability of 6 in 1000 of developing cancer as a result of site-related exposure to the chemicals of concern.							

Table 2-5
Risk Characterization Summary – Non-Carcinogens

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

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

Key	
CNS	Central nervous system
Kp	Dermal permeability coefficient
NA	Information was not available
NE	Not evaluated through this exposure pathway
NE (Kp≤0.01)	Based on USEPA 6 guidance, chemicals of potential concern with a Kp≤0.01 were not evaluated for dermal contact while showering (USEPA, 1995)
NTV	No toxicity value available to quantitatively address this exposure
References	
U.S. Environmental Protection Agency (USEPA), 1989, <i>Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual, (Part A)</i> , EPA/540/1-89/002, December.	
USEPA, <i>Supplemental Region 6 Risk Assessment Guidance</i> , May 5, 1995.	
Summary of Risk Characterization	
The table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure at LHAAP-50. The Risk Assessment Guidance for Superfund (USEPA, 1989) states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse non-carcinogenic effects. The estimated HI of 300 for groundwater indicates that the potential for adverse non-carcinogenic effects could occur from exposure to contamination in that medium. The estimated HI of 0.035 for soil indicates that the hazard of the soil is acceptable.	

**Table 2-6
Cleanup Levels**

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

Notes and Abbreviations

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

µg/kg micrograms per kilogram

µg/L micrograms per liter

ARAR applicable or relevant and appropriate requirement

COC chemicals of concern

GWP-Ind soil medium-specific concentration for industrial use based on groundwater protection

MCL maximum contaminant level as established in the Safe Drinking Water Act

Table 2-7
Comparative Analysis of Alternatives

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

Table 2-7 (continued)
Comparative Analysis of Alternatives

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

Notes and Acronyms:

Costs rounded to nearest thousand dollars

ARARs applicable or relevant and appropriate requirements

COCs chemicals of concern

LUC land use control

MNA monitored natural attenuation

O&M operation & maintenance

RAO remedial action objectives

TBC to be considered

TMV toxicity, mobility, or volume

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

Present Worth Analysis

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

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

Notes

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

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

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

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

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

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

Table 2-9
Description of ARARs for Selected Remedy

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

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

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

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

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

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

Citation	Activity or Prerequisite/Status	Requirement
Treatment/Disposal		
Disposal of Wastewater (e.g., contaminated groundwater, dewatering fluids, decontamination liquids) 40 CFR 268.1(c)(4)(i) 30 TAC 335.431(c)	RCRA-restricted characteristically hazardous waste intended for disposal—applicable if extracted groundwater or rinsate from incinerator is determined to be RCRA characteristically hazardous .	Disposal is not prohibited if such wastes are managed in a treatment system subject to regulation under Section 402 of the CWA that subsequently discharges to waters of the United States.
Closure		
Standards for Plugging Wells that Penetrate Undesirable Water or Constituent Zones 16 TAC 76.1004(a) through (c)	Plugging and abandonment of wells—applicable to plugging and closure of monitoring and/or extraction wells.	If a well is abandoned, all removable casing shall be removed and the entire well pressure filled via a tremie pipe with cement from bottom up to the land surface. In lieu of this procedure, the well shall be pressure-filled via a tremie tube with bentonite grout of a minimum 9.1 lb/gal weight followed by a cement plug extending from land surface to a depth of not less than 2 feet. Undesirable water or constituents or the freshwater zone(s) shall be isolated with cement plugs.
<u>Abbreviations:</u>		
µg/L ARAR CFR CWA USEPA FR FS	micrograms per liter applicable or relevant and appropriate requirement Code of Federal Regulations Clean Water Act of 1972 U.S. Environmental Protection Agency Federal Register feasibility study	lb/gal LHAAP % PPE ppm RCRA TAC pound per gallon Longhorn Army Ammunition Plant percent personal protective equipment part per million Resource Conservation and Recovery Act of 1976 Texas Administrative Code

**Figure 2-1
LHAAP Location Map**

**Figure 2-2
Site Vicinity Map**

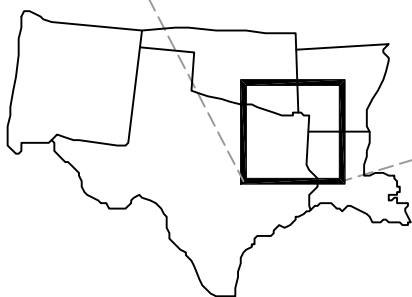
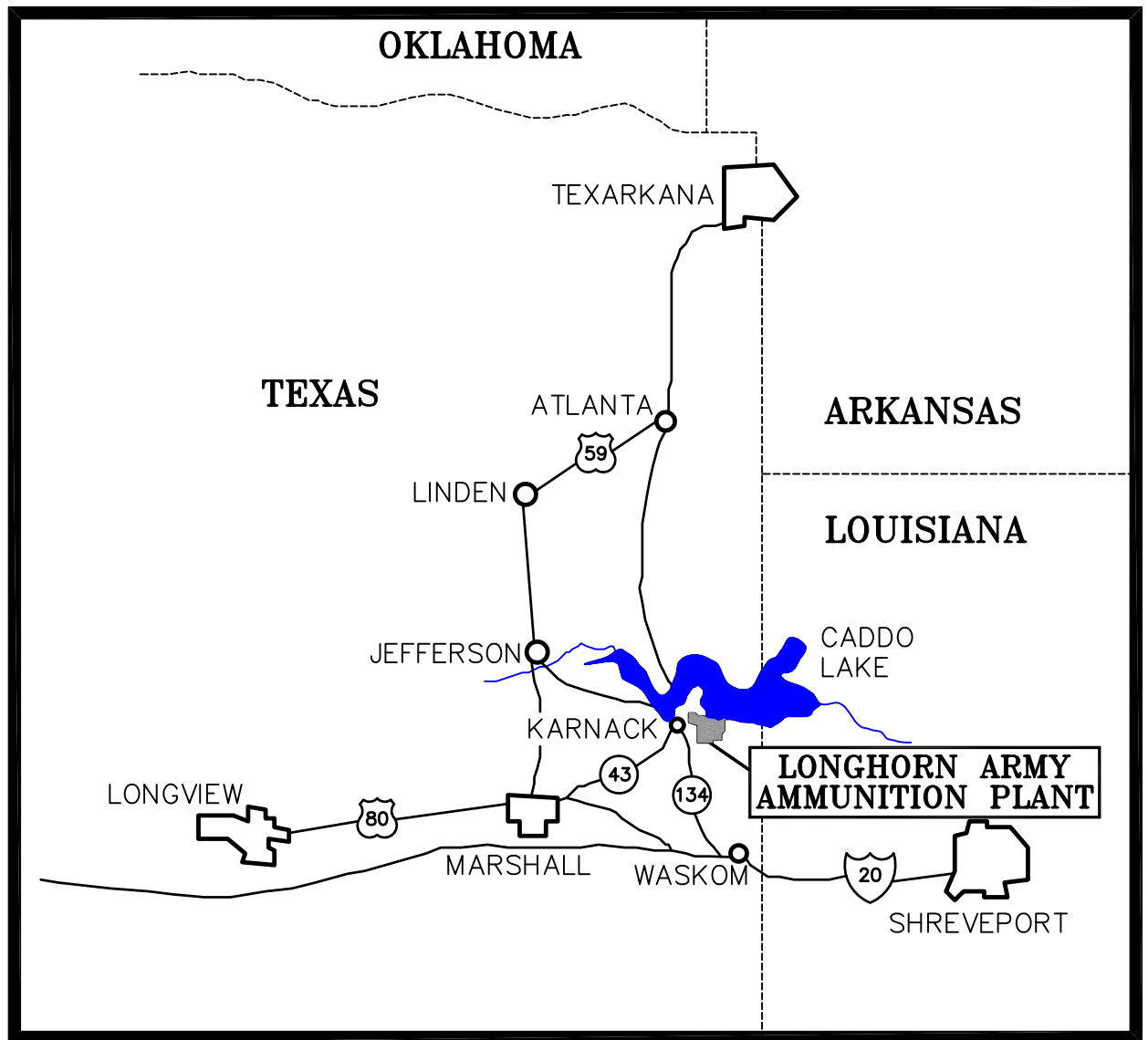
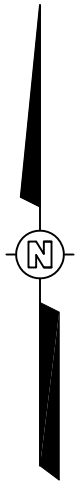
**Figure 2-3
Conceptual Site Model**

**Figure 2-4
Groundwater Elevation Map (Shallow Zone)**

**Figure 2-5
Geological Cross Section A-A'**

**Figure 2-6
VOC Concentrations in Groundwater for Shallow Zone**

**Figure 2-7
TCE and Perchlorate Concentration in Soil**

DRAWING 117591-A55
NUMBERAPPROVED BY
P. SRIVASTAV 10/07/09CHECKED BY
G. JONES 10/07/09DRAWN BY
L. JONES 12/17/03OFFICE
Houston, TexasX-REF
---IMAGE
---PLOT DATE: 10/07/09
FORMAT REVISION 3/25/99

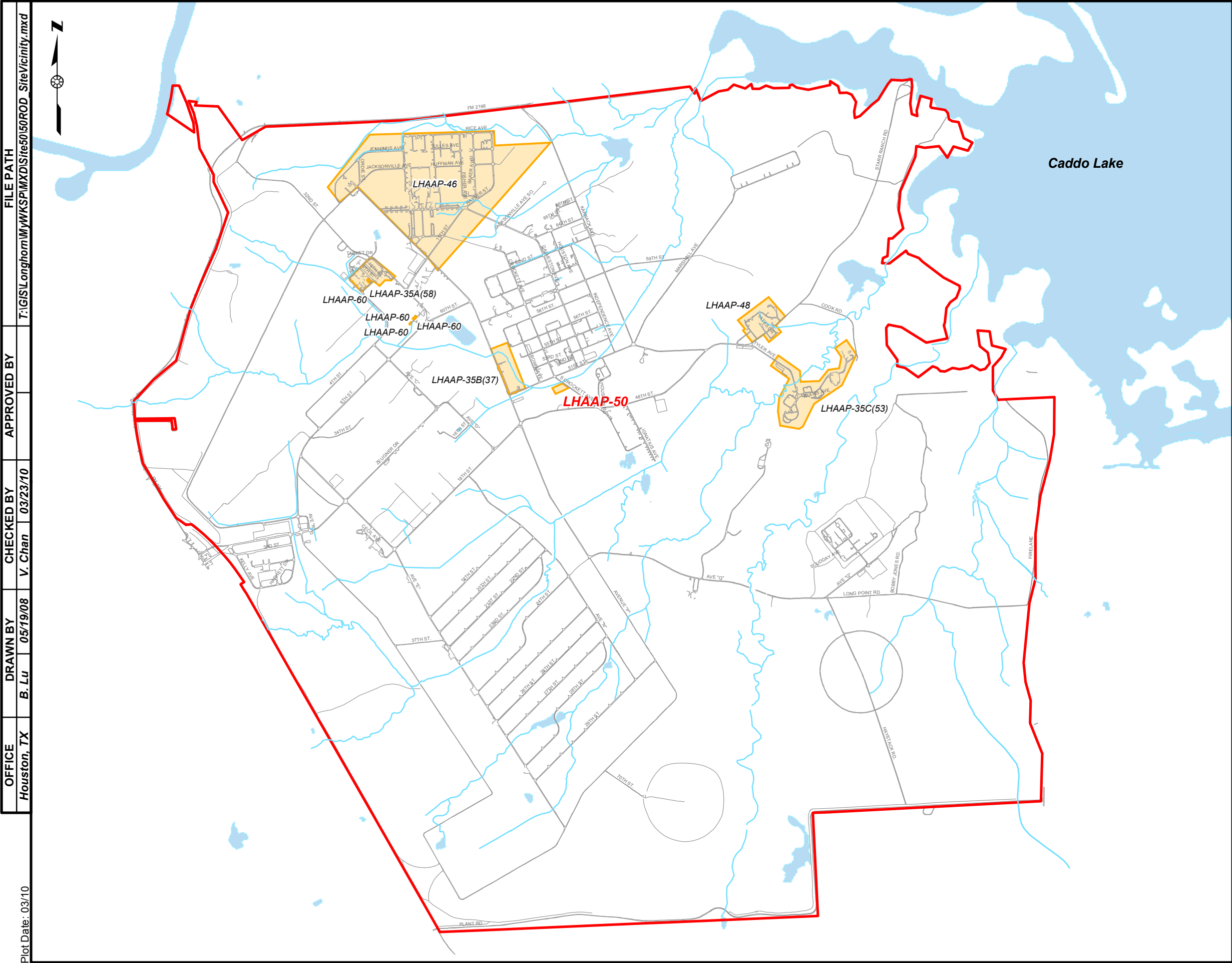
"DRAWING NOT TO SCALE"

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TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-1

LHAAP LOCATION MAP

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



- LEGEND**
- Stream
 - Road
 - Site
 - Lake
 - LHAAP Boundary

0 1,200 2,400 4,800 Feet



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TULSA DISTRICT
TULSA, OKLAHOMA

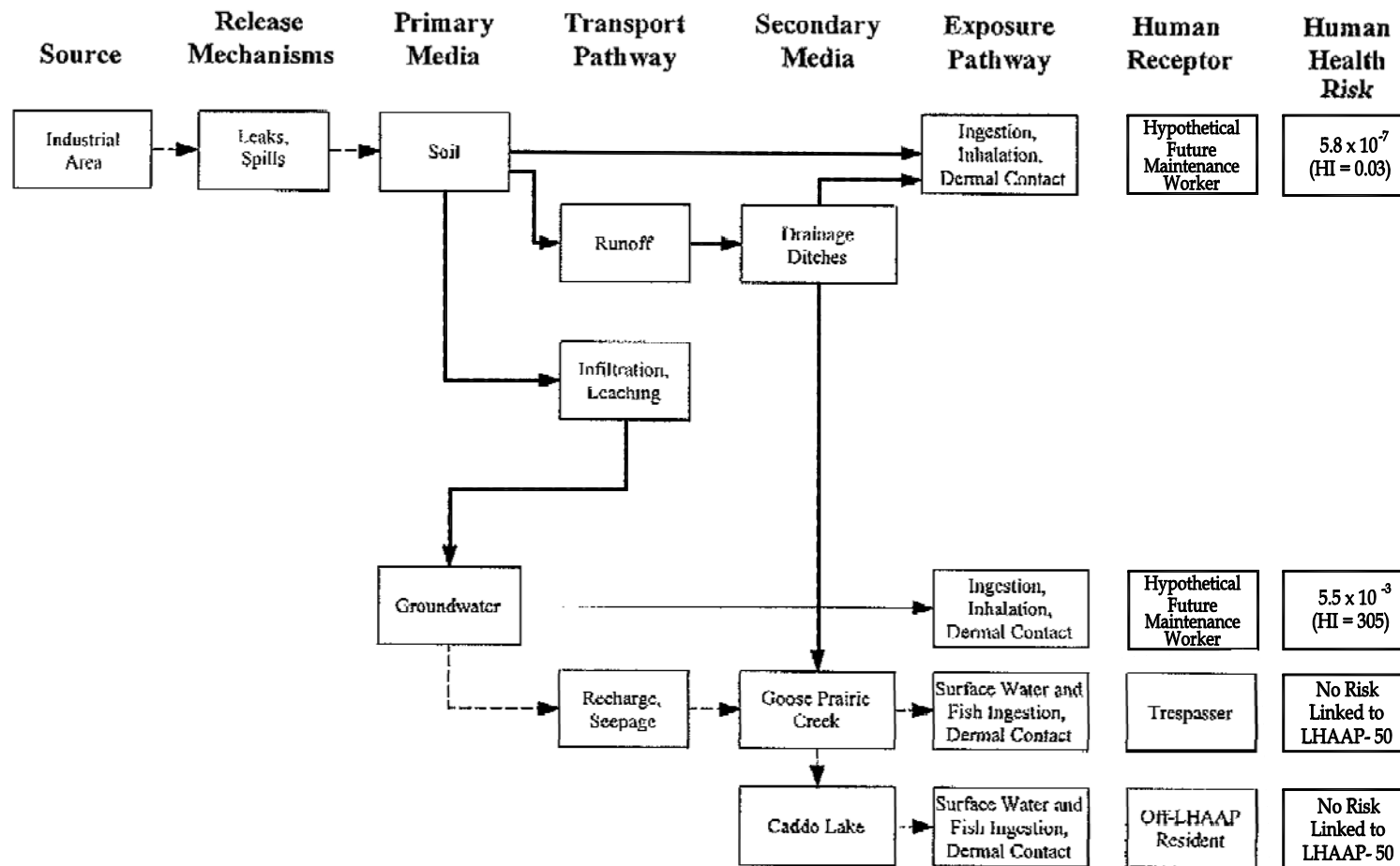
FIGURE 2-2

SITE VICINITY MAP
LHAAP-50, GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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

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

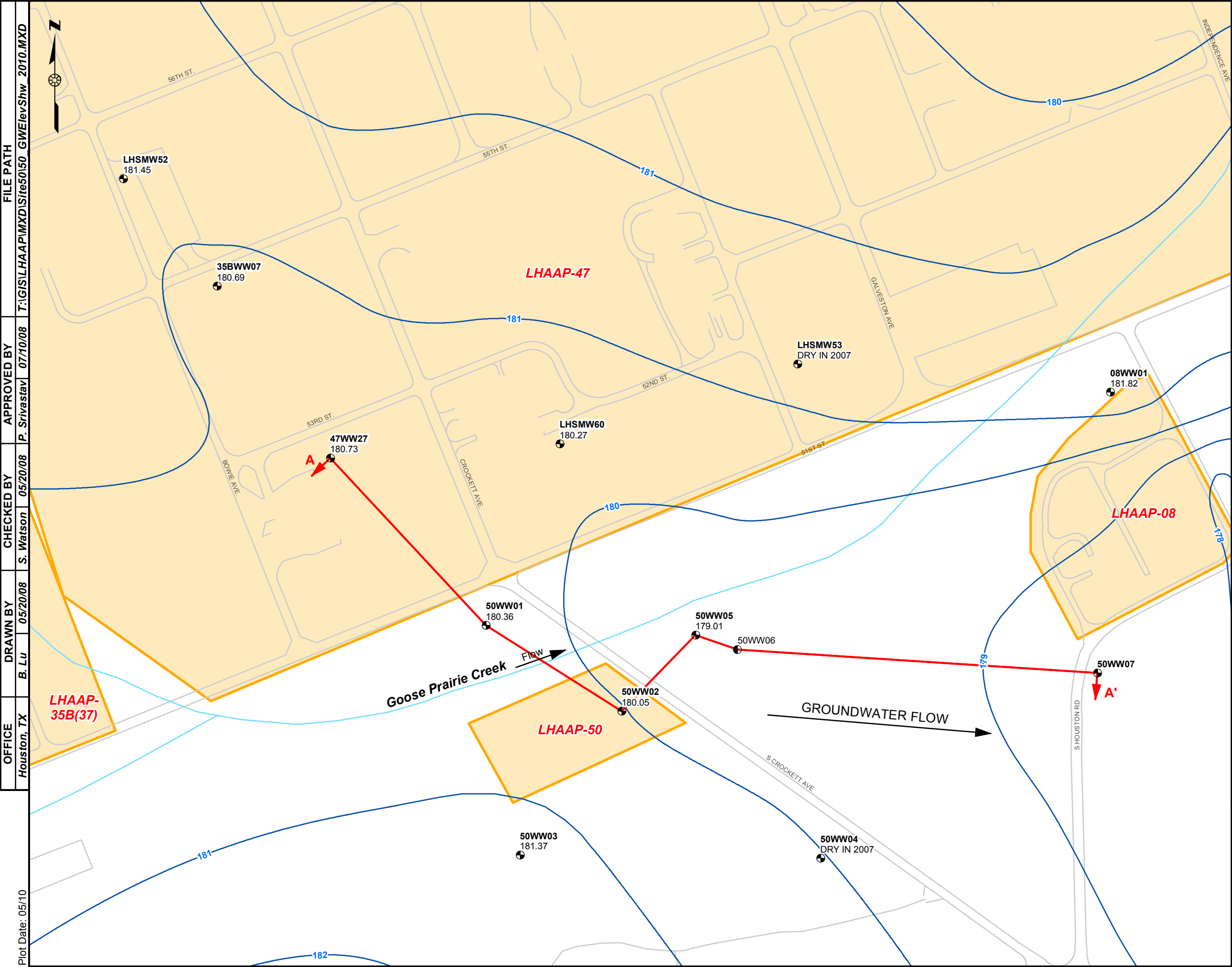


U.S. ARMY CORPS OF ENGINEERS
 TULSA DISTRICT
 TULSA, OKLAHOMA

FIGURE 2-3

CONCEPTUAL SITE MODEL
 LHAAP-50, GROUP 4

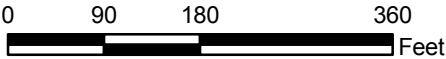
LONGHORN ARMY AMMUNITION PLANT
 KARNACK, TEXAS



LEGEND

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

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



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TULSA, OKLAHOMA

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

OFFICE
Houston, TX

DRAWN BY
B. Lu

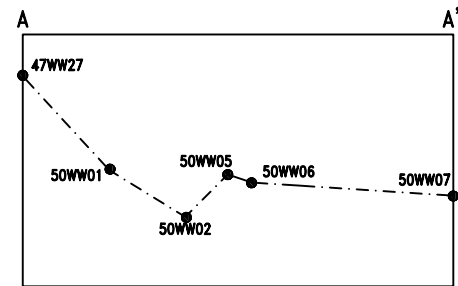
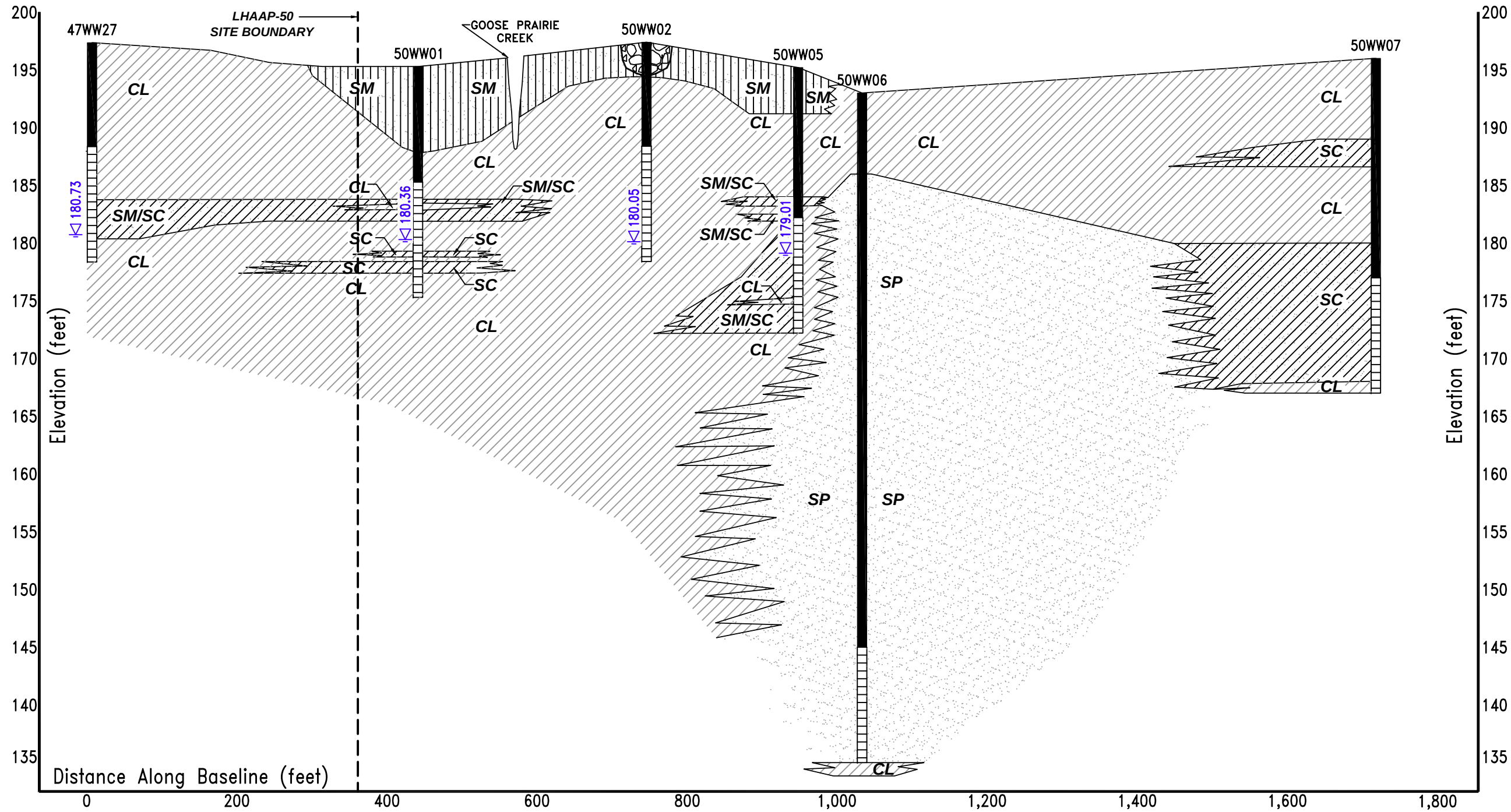
CHECKED BY
S. Watson

APPROVED BY
P. Srivastav

FILE PATH
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Plot Date: 05/10

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	---	Houston, Texas	L. JONES	A. WILLMORE	P. SRIVASTAV	117591-B17
PLOT DATE: 04/27/10 FORMAT REVISION 3/25/99						



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

SECTION A-A'

SCALE: AS SHOWN

- NOTE:
- 1.) THE FEBRUARY 2008 WATER LEVEL FOR 50WW07 IS 179.55 FEET MEAN SEA LEVEL.
 - 2.) NOV/DEC 2007 WATER LEVEL IN FEET MEAN SEA LEVEL.



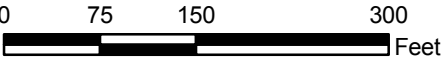
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TULSA, OKLAHOMA

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

LEGEND

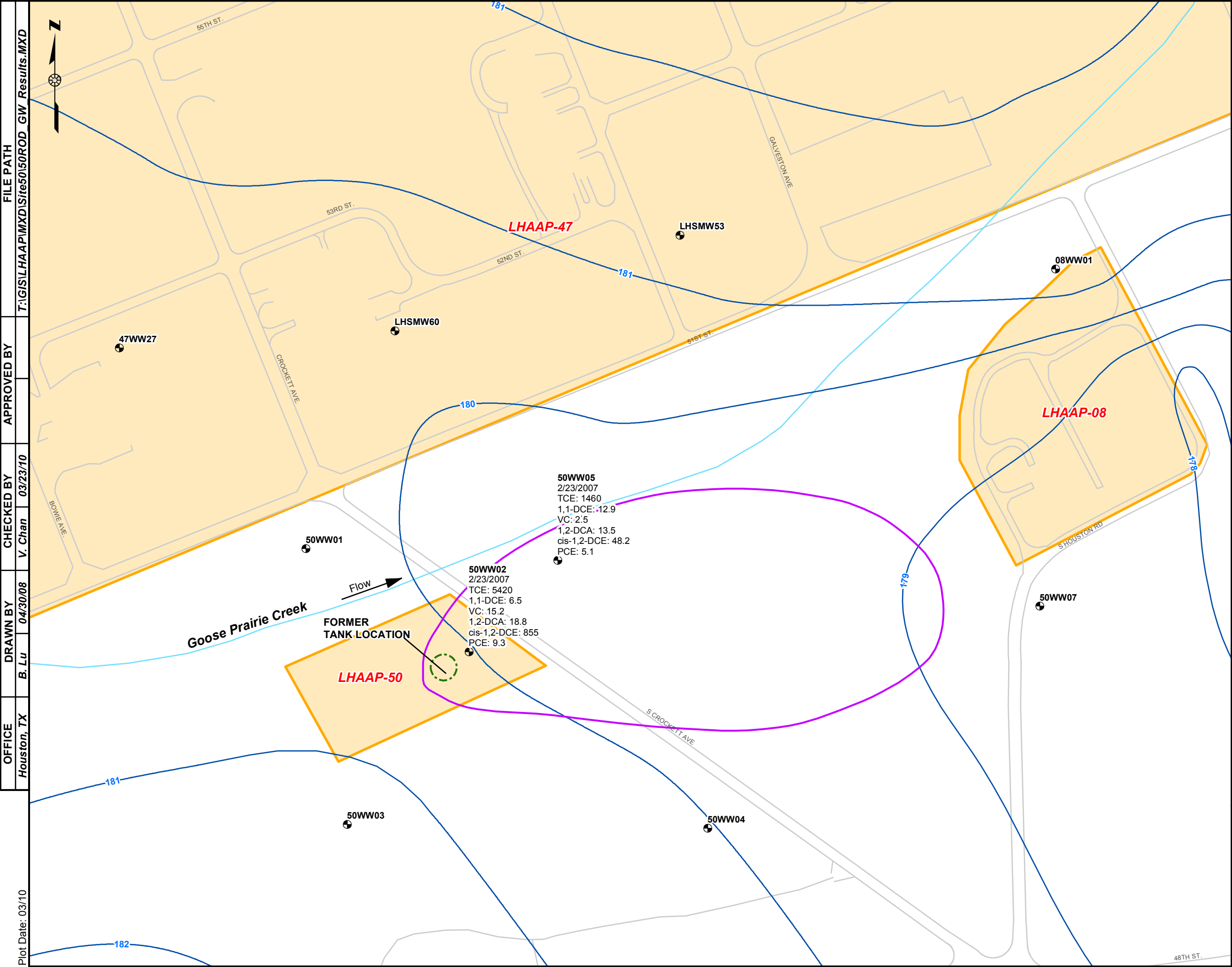
- Shallow Monitoring Well
- Groundwater COCs Exceeding Cleanup Levels
- Groundwater Elevation Contour
- Stream
- Road
- Site

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



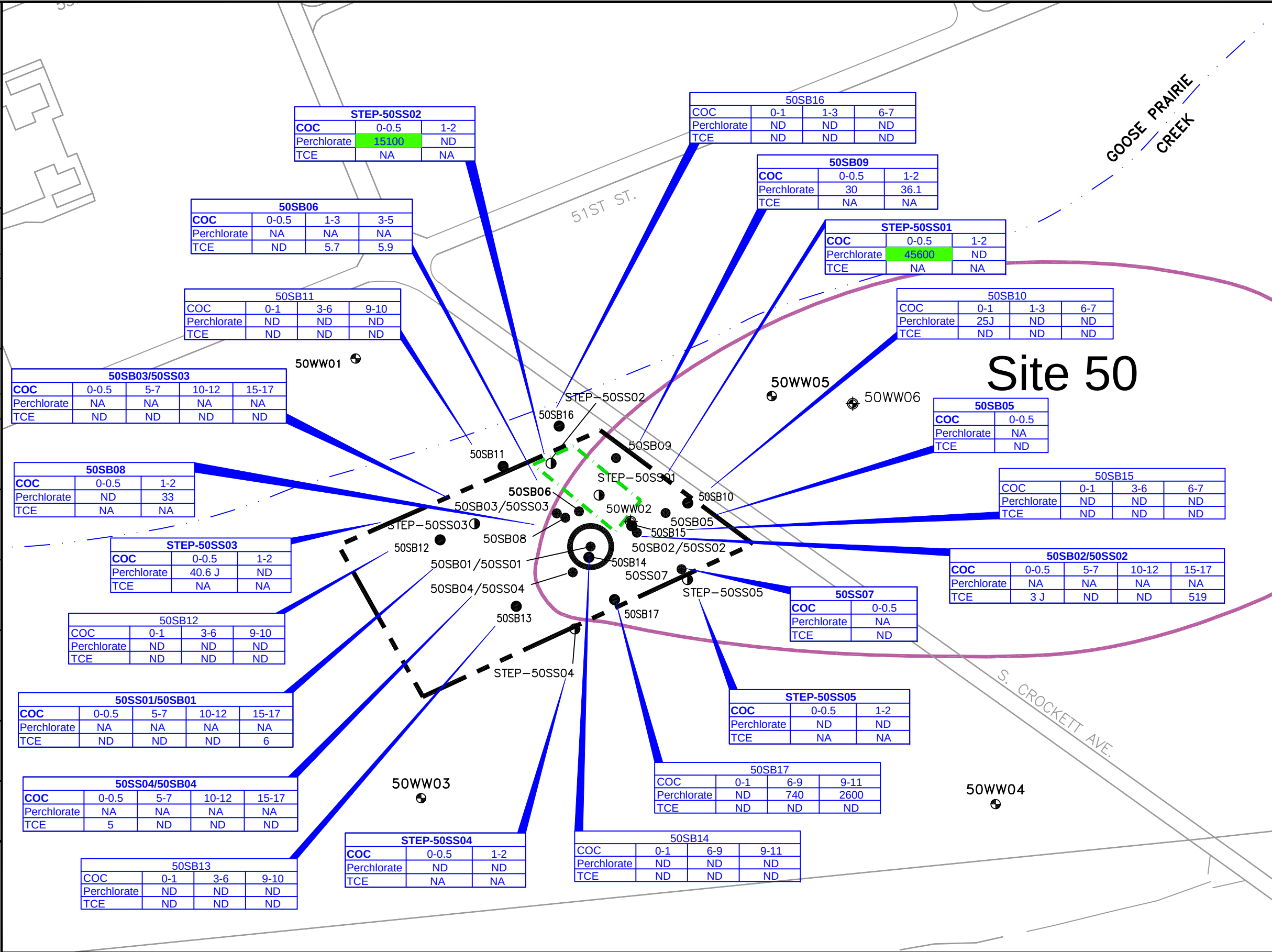
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TULSA, OKLAHOMA

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



OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Lu	V. Chan		T:\GIS\LHAAP\MXD\Site50\50ROD_GW_Results.MXD

Plot Date: 03/10



3.0 *Responsiveness Summary*

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

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

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

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

3.1 *Stakeholder Issues and Lead Agency Responses*

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

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

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

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

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

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

concentrations exceed standards, the Army should develop a plan for remediating the intermediate zone.

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

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

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

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

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

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

Response: The expected surface water sampling location is downstream of the contaminated soil at LHAAP-47 and LHAAP-50 where surface runoff may occur. The sampling location may

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

3.2 *Technical and Legal Issues*

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

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Glossary of Terms

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix A

Public Meeting Newspaper and Media Notices

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

MEDIA RELEASE

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

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

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

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

The Times

PROOF OF PUBLICATION

STATE OF LOUISIANA

PARISH OF CADDO

Before me, the undersigned authority, personally came and appeared

Altheas Critton personally known to me,
Who being duly sworn, deposes and says that she is the Assistant to the
Classified Advertising Manager of The Times, and that the attached
Advertisement entitled:

Media Release Notice of Availability of Final Records of Decision for
Several Sites Longhorn Army Ammunition Plant, Karnack, Texas

The Times on the following dates to wit:

October 31, 2010

(Signed) Altheas Critton

Sworn to and subscribed before me this 1st day of November, 2010

Diana W. Barber

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(Notary)

Obama asks for common ground

By Darlene Superville
The Associated Press

WASHINGTON

Whatever the outcome of Tuesday's election, it's time to put aside partisanship, President Obama is telling Democrats and Republicans.

Yet his appeal for unity includes a jab at GOP leaders in the House and Senate for comments that the president said were troubling.



Obama

House Minority Leader John Boehner of Ohio "actually said that 'this is not the time for compromise,'" Obama said Saturday in his weekly radio and Internet address. The president added that Senate Minority Leader Mitch McConnell of Kentucky "said his main goal after this election is simply to win the next one."

The address was released shortly before Obama left Washington for a day of campaigning in Philadelphia, Bridgeport, Conn., and Chicago.

The three states have competitive House and Senate races, as does Ohio, where the president will hold a rally today in Cleveland.

"I know that we're in the final days of a campaign," Obama said in his weekly address.

"So it's not surprising that we're seeing this heated rhetoric. That's politics. But when the ballots are cast and the voting is done, we need to put this kind of partisanship aside — win, lose or draw."



Carolyn Kaster/AP

Comedian Stephen Colbert gestures on stage with a large puppet of himself during Jon Stewart's and Stephen Colbert's Rally to Restore Sanity and/or Fear on the National Mall in Washington on Saturday.

Colbert, Stewart rally draws laughs, activism

By Hope Yen

The Associated Press

WASHINGTON — In the shadow of the Capitol and the election, comedians Jon Stewart and Stephen Colbert entertained a huge throng Saturday at a "sanity" rally poking fun at the nation's ill-tempered politics, its fear-mongers and doom-sayers.

"We live now in hard times," Stewart said after all the shtick. "Not end times."

Part comedy show, part pep talk, the rally drew together tens of thousands stretched across an expanse of the National Mall, a festive congregation of the goofy and the politically disenchanted. People carried signs merrily protesting the existence of protest signs. Some dressed like bananas, wizards, Martians and Uncle Sam.

Stewart, a satirist who makes his living skewering the famous, came to play nice. He decried the

riety of pundits and politicians from the left and right, engaged in divisive rhetoric. Prominently shown: Glenn Beck, whose conservative Restoring Honor rally in Washington in August was part of the motivation for the Stewart and Colbert event, called the Rally to Restore Sanity and/or Fear. It appeared to rival Beck's rally in attendance.

As part of the comedic routine, Stewart and his associates asked some in the audience to identify themselves by category, eliciting answers such as "half-Mexican, half-white," "American woman single" and "Asian-American from Taiwan."

"It's a perfect demographic sampling of the American people," Stewart cracked to a crowd filled with mostly younger whites. "As you know, if you have too many white people at a rally, your cause is racist. If you have too many people of color

MEDIA RELEASE

Notice of Availability of Final Records of Decision for Several Sites Longhorn Army Ammunition Plant, Karnack, Texas

The United States Army announces several Record of Decision (ROD) documents for several environmental sites at Longhorn Army Ammunition Plant. The RODs, which document the selected remedy for the sites, have been signed by the U.S. Army and the United States Environmental Protection Agency and have concurrence of the Texas Commission on Environmental Quality.

ROD signed June 28, 2010

LHAAP-35B(37), Chemical Laboratory and **LHAAP-67**, Aboveground Storage Tank Farm; Selected Remedy: Land Use Control (LUC) and Monitored Natural Attenuation (MNA);

RODs signed September 7, 2010

LHAAP-49, Former Acid Storage Area; Selected Remedy: No further CERCLA action
Former Pistol Range, Selected Remedy: No further CERCLA action

RODs signed September 30, 2010

LHAAP-46, Plant 2 Area, Group 4; Selected Remedy: LUC and MNA;

LHAAP-50, Former Sump Water Tank, Group 4; Selected Remedy: Excavation and off-site disposal of perchlorate-contaminated soil, MNA, LUC

LHAAP-35A(58), Shops Area, Group 4; Selected Remedy: Eastern Plume--In situ bioremediation, MNA, LUC and Western Plume--MNA and LUC

Copies of the signed RODs are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670, 10:00 A.M. to 8:00 P.M. Monday through Thursday, 10:00 A.M. to 5:30 P.M. Friday and Saturday.

For information regarding these sites, contact Dr. Rose M. Zeiler, Longhorn Army Ammunition Plant, P.O. Box 220, Ratcliff, Arkansas, 72951; phone number 479-635-0110; e-mail rose.zeiler@us.army.mil.

SH-1007182205

World's largest cruise ship clears bridge

Allure of the Seas passed with about 20 inches to spare

The Associated Press
KORSØER, Denmark — The brand new sister ship of the world's largest cruise liner narrowly passed under a Danish bridge Saturday, a feat that required smooth seas and adjustable

smokestacks, officials said.

The Allure of the Seas — a twin to Royal Caribbean's Oasis of the Seas, which made the same narrow squeeze under the Great Belt Fixed Link a year ago — measures around four football fields and accommodates 8,300 people, including crew members.

Hans Nilsen, an official at the Korsøer Naval Station, said the passage went fine, with about

a 20-inch gap and 1.5 spare to the safety margin it squeezed under at a GMT after lowering its smokestacks.

"It went great," Nilsen said. He said traffic on the not have to be stopped passage because the vessel made during daytime any risks.

The Allure of the Seas is worth about \$1.5 billion.

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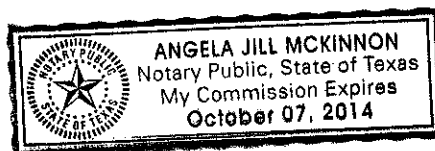
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STATE OF TEXAS
COUNTY OF HARRISONOn this 3rd day of November, 2010
personally appeared before me the undersigned, a Notary Public
in and for said county and state.DIANNE GRAYof the MARSHALL NEWS MESSENGER, a daily newspaper
published at MARSHALL, County of HARRISON, State of
TEXAS, who, being by me duly sworn, states that the attached
advertisement, a true copy of which is hereto annexed, was
published in said newspaper in its issues thereof on the following
dates:31st day of OCTOBER 2010
____ day of _____ 20____
____ day of _____ 20____
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____ day of _____ 20____
____ day of _____ 20____
____ day of _____ 20____Dianne Gray
SIGNATURESubscribed and sworn to before me this 3rd
day of November 2010.Angela Jill McKinnon

Notary Public, Harrison County, Texas

My Commission
expires10/7/14**Notice of Availability of Final Records of Decision
for Several Sites
Longhorn Army Ammunition Plant, Karnack, Texas**

The United States Army announces several Record of Decision (ROD) documents for several environmental sites at Longhorn Army Ammunition Plant. The RODs, which document the selected remedy for the sites, have been signed by the U.S. Army and the United States Environmental Protection Agency and have concurrence of the Texas Commission on Environmental Quality.

ROD signed June 28, 2010

LHAAP-35B(37), Chemical Laboratory and
LHAAP-67, Aboveground Storage Tank Farm;
Selected Remedy: Land Use Control (LUC) and
Monitored Natural Attenuation (MNA);

RODs signed September 7, 2010

LHAAP-49, Former Acid Storage Area; Selected
Remedy: No further CERCLA action
Former Pistol Range, Selected Remedy: No fur-
ther CERCLA action

RODs signed September 30, 2010

LHAAP-46, Plant 2 Area, Group 4; Selected Rem-
edy: LUC and MNA;
LHAAP-50, Former Sump Water Tank, Group 4;
Selected Remedy: Excavation and off-site dis-
posal of perchlorate-contaminated soil, MNA, LUC
LHAAP-35A(58), Shops Area, Group 4; Selected
Remedy: Eastern Plume-In situ bioremediation,
MNA, LUC and Western Plume-MNA and LUC

Copies of the signed RODs are available for pub-
lic review at the Marshall Public Library, 300 S.
Alamo, Marshall, Texas, 75670; 10:00 A.M. to
8:00 P.M. Monday through Thursday, 10:00 A.M.
to 5:30 P.M. Friday and Saturday.

For information regarding these sites, contact Dr.
Rose M. Zeller, Longhorn Army Ammunition Plant,
P.O. Box 220, Ratcliff, Arkansas, 72951; phone
number 479-635-0110; e-mail
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LEGAL NOTICES

Notice of Availability of Final Records of Decision
for Several Sites
Longhorn Army Ammunition Plant, Kamack, Texas

The United States Army announces several Record
of Decision (ROD) documents for several environ-
mental sites at Longhorn Army Ammunition Plant.
The RODs, which document the selected remedy
for the sites, have been signed by the U.S. Army
and the United States Environmental Protection
Agency and have concurrence of the Texas Com-
mission on Environmental Quality.

ROD signed June 28, 2010

LHAAP-35B(37), Chemical Laboratory and
LHAAP-67, Aboveground Storage Tank Farm;
Selected Remedy: Land Use Control (LUC) and
Monitored Natural Attenuation (MNA);

RODs signed September 7, 2010

LHAAP-49, Former Acid Storage Area; Selected
Remedy: No further CERCLA action
Former Pistol Range, Selected Remedy: No fur-
ther CERCLA action

RODs signed September 30, 2010

LHAAP-46, Plant 2 Area, Group 4; Selected Rem-
edy: LUC and MNA;
LHAAP-50, Former Sump Water Tank, Group 4;
Selected Remedy: Excavation and off-site dis-
posal of perchlorate-contaminated soil, MNA, LUC
LHAAP-35A(58), Shops Area, Group 4; Selected
Remedy: Eastern Plume-In situ bioremediation,
MNA, LUC and Western Plume-MNA and LUC

Copies of the signed RODs are available for pub-
lic review at the Marshall Public Library, 300 S.
Alamo, Marshall, Texas, 75670, 10:00 A.M. to
8:00 P.M. Monday through Thursday, 10:00 A.M.
to 5:30 P.M. Friday and Saturday.

For information regarding these sites, contact Dr.
Rose M. Zeiler, Longhorn Army Ammunition Plant,
P.O. Box 220, Ratcliff, Arkansas, 72951; phone
number 479-635-0110; e-mail
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LONGHORN ARMY AMMUNITION PLANT,**Karnack, Texas****MONTHLY MANAGERS' MEETING****AGENDA**

DATE: Tuesday, 09 November 2010
TIME: 2:00 p.m.
PLACE: Teleconference - Call In Number Courtesy of Shaw: 866-797-9304/4155734

Welcome**RMZ****Action Items****Army**

- Provide update on document status for LHAAP-65.

Shaw

- Include USFWS in the distribution of GWTP quarterly reports.
- Provide further information on reanalysis of perchlorate samples from LHAAP-47 that had high detection limits of 12.5 ug/L.
- Prepare and provide a template for the master schedule for performance and LTM sampling

Defense Environmental Restoration Program (DERP) PBC Update**PS/SGW**

- Document Status/Environmental Sites (Table)
- LHAAP-04 discussion
- INF Pond Status
- Groundwater Treatment Plant

DERP Total Environmental Restoration Contract Update**RMZ**

- LHAAP-37/67 – Status of RD
- Remaining TERC Recordations

MMRP Update**RMZ**

- Address EPA-TCEQ Responses to Perchlorate Memo

Other Issues**RMZ**

- Sump at Site 53
- Sitewide Schedule Review – Critical Documents
- IAP website to be provided
- Media Tour
- RAB Tour of GWTP and Sitewide

USFWS Update**RMZ/PB**

- Receipt of Documents for Review
- OPS and Proposed Remedies

Adjourn



Subject: **Final Minutes, Monthly Managers Meeting,
Longhorn Army Ammunition Plant (LHAAP)**

Location of Meeting: **Teleconference**
Date of Meeting: **November 9, 2010; 2:00 PM – 4:00 PM**

Meeting Participants:

BRAC:	Rose M. Zeiler
USACE-Tulsa:	Aaron Williams, John Lambert
Shaw:	Praveen Srivastav, Susan Watson, Kay Everett, Greg Jones
USEPA Region 6:	Steve Tzhone, Terry Burton
TCEQ:	Fay Duke, Dale Vodak
USGS:	Kent Becher
USFWS:	Paul Bruckwicki, Barry Forsythe

Welcome

Rose M. Zeiler

Action Item Status:

Army

- Provide update on document status for LHAAP-65.--The evaluation report is currently in Army review.

Shaw

- Include USFWS in the distribution of GWTP quarterly reports.--Distribution has been revised to include FWS.
- Prepare and provide a template for the master schedule for performance and LTM sampling.—document was sent out within the last hour to the stakeholders. Review and provide any comments on how data should be presented to be useful for all parties. Steve said he liked the format from what he has seen.

Defense Environmental Restoration Program (DERP) PBC Update

Praveen Srivastav

Document Status/Environmental Sites

Praveen Srivastav went over the document status/environmental sites table.

- LHAAP-03: Army comments were resolved for the draft soil removal work plan and draft final in preparation. Will be issued this week. Will be sending a hardcopy and an electronic.
- LHAAP-04: The Draft Final Completion Report is in regulatory review. Received EPA comments but still waiting for TCEQ. Fay said she will try and get it out today or tomorrow.

- LHAAP-16: The public meeting for this site was held on October 19. The preliminary Draft ROD will be submitted to Army by November 15. Public comments were received from Paul Fortune and George Rice (CLI).
- LHAAP-17: Preliminary draft ROD is in Army review and response is being prepared. Several comments are received and have to be compiled before proper responses can be initiated, but plan to get the Draft ROD back to the Army by the end of next week.
- LHAAP-18/24: The RTCs for regulatory comments are in Army's review and are expected to be returned shortly.
- LHAAP-29: Army comments to the preliminary Draft Proposed Plan for LHAAP-29 are in preparation. Rose asked about having the proposed plan ready for the regulators for review in early December so that there is time for regulatory reviews to be completed before the holiday break. Based on scheduling, it may not be possible to produce the Draft document within that timeframe. Rose wanted to make the documents available to the public as soon as they were available. Shaw will confirm the FS submittal to CLI and the RAB members.
- LHAAP-46: The RODs were signed 9/30/10 and submitted. The preliminary Draft Review is in Army Review.
- LHAAP-47: The revised Draft FS is in Army review.
- LHAAP-50: The draft Remedial Design is in preparation.
- LHAAP-58: The draft Remedial Design is in preparation.
- LHAAP-35/36: The final electronic DD with signatures has been submitted to TCEQ for a concurrence letter. Upon receipt of the letter, the document will be finalized.

LHAAP-04 Discussion

INF Pond Status

There are tears on one side of the pond and there is a little less than 1 foot of freeboard. The discharge from GWTP to the pond has been halted. Although there has been some rain there is still no flow in the creek and the effluent from GWTP cannot be discharged to Harrison Bayou. Last Friday, plant personnel began pumping water from the INF Pond into tanker trucks and transporting the water to LHAAP-18/24 for sprinkling on the ground. They have been sprinkling about 22,000 gallons a day. Scott Beesinger, Shaw plant operator, has indicated that this has made only about a ½ foot decrease in the freeboard level, and that they have lowered the FBR rate to accommodate a lower discharge volume. Shaw is bringing in soil to cover the areas of the pond liner that are exposed and preparations are being made to repair the observed tears. Dale Vodak said that he saw holes on the north end and along the south end of the liner. He indicated cleats from a dozer were apparent near the discharge pipe. More discussion ensued on the INF Pond and its subsequent closure as a rocket burn and dismantling area. Kent said that since this was treated water; he wondered why we were worried about the liner leaking. The reason for this was discussed and determined to be a precaution in case an excursion occurs in the GWTP effluent water. The original discharge criteria were discussed. The INF Pond is used only operationally, like Harrison Bayou, as part of LHAAP-18/24 plant, doesn't need a TCEQ NPDES permit, and was not originally built as part of the 18/24 plant. Some discussion occurred on what to do in the future when more sites are tied into the GWTP for treatment during extremely dry seasons when discharge options are limited. Praveen said that one solution would be to take the discharge off site for disposal. Fay indicated that a sample should be collected from the INF pond before the water is discharged to Harrison Bayou. A question regarding the analytical suite was asked and Praveen enumerated a list of parameters. A copy of the analytical parameters will be sent to the stakeholders.

Groundwater Treatment Plant

Sampling criteria for discharge to the creek were discussed. Praveen asked whether water can be released to the creek even if there is no flow, if effluent levels meet discharge criteria. Fay said that discharge criteria are typically calculated assuming some flow in the creek and thus flow is required before any water can be discharged. She further said that she would contact the permit division and verify this.

DERP Total Environmental Restoration Contract Update*LHAAP-37/67 –Status of RD*

The RD is being finalized.

Remaining TERC Recordations

Rose indicated that sites 48/53 are in this ECOP that is being readied to send out. She also mentioned that sites 46 and 47 are going to have 5-year reviews. The sumps at LHAAP-48 and 53 will need to be surveyed soon.

MMRP Update*Address EPA- TCEQ Responses to Perchlorate Memo*

There is nothing new to discuss for this section. The Army is currently working on this.

Other Issues*Sump at Site 53*

The sump is near building 23T and is known as Sump 800 or 124. It is being addressed due to safety concerns and not an environmental issue.

Site-wide Schedule Review – Critical Documents

This document is routinely updated and presented to the RAB during each meeting.

IAP Website to Be Provided

The IAP website link will be sent out shortly

Media Tour

Rose said that Army had received a request via email to conduct a media tour of the treatment plant and areas of Longhorn under current remedial activities for December. No firm plans were made, since there is no activity at the site at the moment and the plant is operating nominally because of the dry conditions. She understood that the agreements had been sent back to the requestor, but the Army has not heard anything back.

RAB Tour of GWTP and Sitewide

Rose indicated that a RAB tour will probably be held in January from 3:00 PM to 5:00PM to coincide with the next RAB meeting. That month's monthly manager's meeting would be held the next morning.

USFWS Update*Receipt of Documents for Review*

As stated in the past, USFWS is receiving copies of environmental documents and this bullet can be removed from future agendas.

OPS and Proposed Remedies

Regarding comments made by USFWS and EPA from the last meeting, a discussion of transfer versus restoration issues ensued. There appears to be confusion for some that these are very separate issues. Rose proposed to put both responses into the minutes for October and attribute both sets of comments by their respective author.

Action Items**Shaw**

- Provide analytical suite for discharge water at the GWTP
- Survey sumps at LHAAP-35/36
- Check that the FS for LHAAP-29 is in the Marshall Library and that CLI and the RAB were provided a copy when it was submitted.
- Collect a sample from effluent water in the pond and report results

Army

- Provide IAP website.

Meeting Adjourned

Next meeting is tentatively set December 7, 2010 at 2 p.m. as a teleconference. However, if the media tour takes place in the first week of December, then the meeting will be held at the site.



**Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
November 09, 2010**

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	Remarks
1	Draft Soil Removal Work Plan, LHAAP-03	7/15/10	x		Draft Final	11/15/10	x	x		Army comments resolved. DF in preparation	
2	Draft Final Completion Report, LHAAP-04	05/24/10	x	x	Final	11/30/10	x	x		In regulatory review.	
3	Final Proposed Plan, LHAAP-16	09/14/10	x	x						Submitted	Public meeting held on 10/19/10
4	Preliminary Draft Record of Decision, LHAAP-16	11/15/10	x							In preparation	
5	Preliminary Draft Record of Decision, LHAAP-17	9/17/10	x		Draft	11/15/10				In Army's review	
6	Draft (Final) Feasibility Study, LHAAP-18/24	5/13/09	x	x	Draft Final	11/30/10	x	x		Received EPA and TCEQ comments on 8/5/10. Responses in Army review	
7	(Preliminary) Draft Proposed Plan, LHAAP-29	5/21/10	x		Draft Proposed Plan	11/30/10	x	x	In progress	RTC resolution in progress	
8	Draft Remedial Design, LHAAP-46	10/1/10	x							In Army review	



**Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
November 09, 2010**

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	Remarks
9	Revised Draft Final Feasibility Study, LHAAP-47	10/27/10	x		Revised Draft Final to Army	11/30/10	x	x		In Army review	
10	Draft Remedial Design, LHAAP-50	11/15/10	x							In preparation	
11	Draft Remedial Design, LHAAP-58	11/22/10	x							In preparation	
12	Draft Final Decision Document, LHAAP-35/36	05/6/10	x	x	Final	11/30/10	x	x		TCEQ concurrence received. Submitted final DD for Army signatures	

Bryan W. Shaw, Ph.D., *Chairman*
Buddy Garcia, *Commissioner*
Carlos Rubinstein, *Commissioner*
Mark R. Vickery, P.G., *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

December 15, 2010

Mr. Thomas E. Lederle, Industrial Branch Chief
Assistant Chief of Staff for Installation Management
ATTN: DAIM-BD (Tom Lederle)
600 Army Pentagon
Washington, D.C. 20310-0600

Re: Decision Document for LHAAP-35/36 Sumps
Longhorn Army Ammunition Plant Superfund Site TX6213820529
Karnack, Harrison County, Texas

Dear Mr. Lederle:

The Texas Commission on Environmental Quality (TCEQ) received the final Army Decision Document for the LHAAP-35/36 Sumps at the Longhorn Army Ammunition Plant Superfund Site in Karnack Texas on November 11, 2010. The TCEQ has completed the review of the above referenced document and concurs that the response action described in the Decision Document is the most appropriate remedy for LHAAP-35/36 Sumps.

Sincerely,

A handwritten signature in black ink, appearing to read "B. Wade", written over a horizontal line.

Brent Wade, Director
Remediation Division

BW/FD



Date: December 21, 2010

Project No.: 117591

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 Decision Document for LHAAP-35/36 Sumps,
Longhorn Army Ammunition Plant

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

For: Review ☐ As Requested ☐ Approval ☐ Corrections ☐ Submittal ☐ Other ☒ X

<i>Item No:</i>	<i>No. of Copies</i>	<i>Date:</i>	<i>Document Title</i>
1	2	October 2010	Final Decision Document for LHAAP-35/36, Sumps, 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:

Praveen Srivastav
Project Manager

CC: Distribution List:

Mr. J. Lambert – USACE, Tulsa (sent to A. Williams for distribution)

Mr. A. Maly – USAEC

Ms. Rose Zeiler – BRAC-LHAAP

Mr. S. Tzhone – EPA Region 6 (2)

Ms. F. Duke – TCEQ, Austin (2)

Mr. D. Vodak – TCEQ, Tyler

Mr. P. Bruckwicki – U.S. Fish and Wildlife Service



DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

December 21, 2010

DAIM-ODB-LO

Mr. Stephen Tzhone
US Environmental Protection Agency
Superfund Division (6SF-AT)
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Final Decision Document for LHAAP-35/36, Sumps,
Longhorn Army Ammunition Plant, Karnack, Texas, October 2010

Dear Mr. Tzhone,

The above-referenced document is being transmitted to you for your records. The document has been prepared by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility.

The point of contact for this action is the undersigned. I ask that Praveen Srivastav, 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,

A handwritten signature in cursive script, reading "Rose M. Zeiler", is positioned above the typed name.

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
A. Maly, USAEC, TX
P. Srivastav, Shaw – Houston, TX (for project files)



DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

December 21, 2010

DAIM-ODB-LO

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

Re: Final Decision Document for LHAAP-35/36 Sumps,
Longhorn Army Ammunition Plant, Karnack, Texas, October 2010
SUP 126

Dear Ms. Duke,

The above-referenced document is being transmitted to you for your records. The document has been prepared by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility.

The point of contact for this action is the undersigned. I ask that Praveen Srivastav, 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,

A handwritten signature in cursive script, reading "Rose M. Zeiler", is positioned below the "Sincerely," text.

Rose M. Zeiler, Ph.D.
Longhorn AAP Site Manager

Copies furnished:

S. Tzhone, USEPA Region 6, Dallas, TX
D. Vodak, TCEQ, Tyler, TX
P. Bruckwicki, Caddo Lake NWR, TX
J. Lambert, USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
A. Maly, USAEC, TX
P. Srivastav, Shaw, Houston, TX (for project files)

FINAL
DECISION DOCUMENT FOR LHAAP-35/36 SUMPS
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



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

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

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

October 2010

1.0 Declaration

1.1 Statement of Basis and Purpose

This document presents the basis for the decision that no action is necessary for site LHAAP-35/36 Sumps at the former Longhorn Army Ammunition Plant (LHAAP) in Karnack, Texas. The decision was made by the Department of the Army (Army) and the Texas Commission on Environmental Quality (TCEQ) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Resource Conservation and Recovery Act (RCRA), and Army Regulation (AR) 200-1, as applicable. Although there are several Superfund National Priorities List (NPL) environmental sites at LHAAP, LHAAP-35/36 is not among them. This site is being addressed under CERCLA as a non-NPL environmental site.

1.2 Description of Selected Remedy

No CERCLA remedial action is necessary for LHAAP-35/36. Site investigations were conducted through which it was determined by Army and TCEQ that the data do not support the implementation of a remedial action because this site does not present unacceptable risks for the reasonably anticipated future use as part of the Caddo Lake National Wildlife Refuge. The risk evaluation does not address unrestricted use. In accordance with 30 Texas Administrative Code (TAC) §335.566, a notification will be recorded in the Harrison County Office stating that the site is suitable for nonresidential use. Limited monitoring will be conducted to ensure that the use of this site remains consistent with the nonresidential use exposure scenarios evaluated in the risk evaluation and will be documented in the form of Letters of Certification transmitted every five years to TCEQ. Although the Army may later pass these procedural responsibilities to the designated transferee, United States Fish and Wildlife Service (USFWS), in conjunction with the property transfer, the Army shall retain responsibility for future environmental response actions.

1.3 Statutory Determinations

None of the CERCLA §121 statutory determinations apply because no remedial action is necessary to protect human health and the environment. Chemicals detected in samples from LHAAP-35/36 are considered to be of no further concern. Therefore, they meet the requirements for no action under U.S. Environmental Protection Agency (USEPA) guidance and 30 TAC §335.

1.4 **Approval and Signature**

No actions are necessary for LHAAP-35/36. There is no cost associated with this decision beyond the cost for limited monitoring to ensure proper land use, which will be documented in the form of Letters of Certification transmitted every five years to TCEQ. The Army will be responsible to conduct the limited monitoring and transmit the Letters of Certification unless the procedural responsibility has been transferred to the designated transferee, USFWS. The Army, however, shall retain responsibility for future environmental response actions. The undersigned is the appropriate approval authority for this decision.

APPROVED BY:


(Name)

4 NOV 2010
(Date)

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

2.0 *Decision Summary*

2.1 *Site Name, Location, and Description*

LHAAP-35/36 consists of 125 process sumps and 20 waste rack sumps located at and near production or process areas within LHAAP, an Army installation that occupied 8,416 acres between State Highway 43 in Karnack, Texas, and the southwestern shore of Caddo Lake. The nearest cities are Marshall, Texas, approximately 14 miles to the southwest, and Shreveport, Louisiana, approximately 40 miles to the southeast (**Figure 1**).

LHAAP operated until 1997 when it was placed on inactive status and classified by the U.S. Army as excess property. In 2003, LHAAP was placed under the administrative control of the Base Realignment and Closure (BRAC) Division as a Non-BRAC Excess property. Environmental activities at LHAAP are conducted in accordance with CERCLA and funded through the Defense Environmental Restoration Program. Army BRAC is the party responsible for environmental restoration.

LHAAP was placed on the NPL on August 9, 1990, and several environmental sites were listed. Activities to remediate the contamination began in 1990. After LHAAP's listing on the NPL, the U.S. Army, the USEPA, and the Texas Water Commission, currently known as TCEQ, entered into a CERCLA Section 120 Federal Facility Agreement (FFA) for remedial activities at the installation. The FFA became effective December 30, 1991.

Although several environmental sites at LHAAP are on the NPL, LHAAP-35/36 is a non-NPL site. The Army is the lead agency for all environmental restoration activities. For non-NPL sites such as LHAAP-35/36, the State of Texas is the lead regulatory agency.

2.2 *Site History*

LHAAP was established in December 1941 with the primary mission of manufacturing trinitrotoluene (TNT). TNT manufacture (Plant 1) activities ended after World War II. In 1952, the facility began production of pyrotechnic ammunition, such as photoflash bombs, simulators, hand signals, and tracers for 40 mm ammunition at Plant 2 that continued through 1956. In December 1954, a third facility, Plant 3, began production of solid-fuel rocket motors for tactical missiles. From September 1988 to May 1991, LHAAP was also used for the static firing and elimination of Pershing I and II rocket motors in compliance with the Intermediate-Range Nuclear Forces Treaty in effect between the United States and the former Union of Soviet Socialist Republics.

The site addressed in this document, LHAAP-35/36, is a collection of 125 process sumps and 20 waste rack sumps found in multiple locations across the installation and predominantly

associated with process areas. All of the production buildings had sumps that collected wash down water. Sumps were also associated with wash racks (waste rack sumps) where containers were cleaned and stored (Plexus, 2005).

The sumps were previously investigated by the U.S. Army Corps of Engineers (USACE, 1994 and 1995). Forty wastewater sumps were subsequently removed and closed under the RCRA (Thiokol Corporation [Thiokol], 1996). The 1996 closure report was approved via a 1997 correspondence from the Texas Natural Resource Conservation Commission (TNRCC, 1997). The closure of 85 additional wastewater sumps was documented in a report by OHM Remediation Services Corp. (OHM, 1997). While all of the wastewater sumps were closed, the documentation included in TNRCC correspondence (1997) and closure certifications included in the OHM Closure Report (1997) indicated that the soil around the former sumps required further evaluation. Closure activities consisted of evaluating sump contents, investigating the surrounding soils, and either removing the sump itself or filling it in place with clean soil. Closure certifications were received for some sump closures (USACE, 1994, 1995; Thiokol, 1996; OHM, 1997; Plexus, 2005).

Environmental restoration activities at LHAAP-35/36, a non-NPL site, have progressed through the remedial investigation (RI), at which point it was agreed by the Army and TCEQ that no significant releases had occurred and the site could be closed under TAC Risk Reduction Rule Standard 3. Concurrence by TCEQ with this Decision Document is attached as **Appendix A**.

2.3 *Public Participation*

The U.S. Army, USEPA, TCEQ, and the Restoration Advisory Board (RAB) have provided public outreach to the surrounding community concerning LHAAP-35/36 and other environmental sites at LHAAP. The outreach program has included fact sheets, media interviews, site visits, invitations to attend quarterly RAB and regulatory review meetings, and public meetings consistent with its public participation responsibilities under Sections 113(k)(2)(b), 117(a), and 121(f)(1)(g) of CERCLA.

The decision for no action at LHAAP-35/36 was discussed at the RAB meeting on March 24, 2009, at LHAAP. Reports supporting the no action determination for this site are included in the Administrative Record for LHAAP, which is available for public review at the Marshall Public Library, (903) 935-4465, 300 South Alamo, Marshall, Texas 75670. The hours of operation are Monday through Thursday 10:00 a.m. – 8:00 p.m. and Friday through Saturday from 10:00 a.m. – 5:00 p.m.

2.4 *Site Characteristics*

LHAAP-35/36 sumps are physically located within or near sites LHAAP-04, -18, -29, -35A(58), -35C(53), -36, -39, -45, -46, -47, -48, -59, and -66 (**Figure 2**) and have been collectively

designated as site LHAAP-35/36. There are 125 wastewater sumps in LHAAP-35 and 20 waste rack sumps in LHAAP-36.

Potential contaminants at LHAAP-35/36 varied according to sump use and proximity to the related process area. Generally, the potential contaminants analyzed included metals, explosives, volatile organic compounds, semivolatile organic compounds, dioxins, polychlorinated biphenyl, and perchlorate, though not all of these potential contaminants would be analyzed at each sump location because not all of the potential contaminants are found or used at that sump location.

2.5 *Current and Potential Future Site Uses*

LHAAP was active from the early 1940s to the late 1990s for the manufacture of explosives, pyrotechnics, and rocket motors for World War II, the Korean War, and the Cold War. LHAAP was placed on inactive status in 1997. Aside from the abundant wildlife, the installation is predominantly unoccupied. All of the production facilities have been demolished. LHAAP now consists of a heavily vegetated landscape with flat to slightly undulating terrain. Nearly 7,000 acres have been transferred to USFWS and are operated as the Caddo Lake National Wildlife Refuge. LHAAP-35/36 will be transferred to the USFWS following the execution of this Decision Document.

2.6 *Site Risk*

Environmental sampling and analysis efforts targeted at the sumps and in the areas surrounding them are described in the RI reports (Jacobs Engineering Group, Inc. [Jacobs], 2001; 2002a) and baseline risk assessments for LHAAP sites (Jacobs, 2002b; 2003). Documentation pertaining to investigations, closure, and removal of sumps is included in various reports (USACE, 1995; Thiokol, 1996; OHM, 1997). Additional investigations conducted by Shaw Environmental, Inc. (Shaw) on soil surrounding the sumps and waste rack sumps are described in the final Data Evaluation Report, the Addendum to the Report and Errata (Shaw, 2008; 2009a; 2010).

Previous risk assessments (Jacobs, 2002b; 2003) indicated acceptable risk to an industrial worker from exposure to chemicals in soil from sites LHAAP-46, LHAAP-47, LHAAP-35A(58), and LHAAP-18/24. Sump data results were compared to available Risk Based Screening Values (RBSV) (Shaw, 2008). If an exceedance was noted, then the chemical was evaluated with respect to the risk assessment (Jacobs 2002b; 2003) for the site within which the sump lies.

There are no soil samples associated with LHAAP-35/36 sumps in LHAAP-04, LHAAP-29, LHAAP-39, or LHAAP-66 that had chemicals with concentrations in soil exceeding RBSVs. However, certain chemicals in the soil samples collected at LHAAP-35/36 sump locations within LHAAP-46, -47, -35A(58), and -18/24 since completion of the Jacobs (2002, 2003) risk assessments exceeded RBSVs. These results were compared to the Jacobs (2002, 2003) risk

assessments to evaluate whether the results would modify the conclusions of those assessments. The results of these evaluations are described in the data evaluation report (Shaw, 2008).

The results of the post-2002 soil sample analysis were evaluated to determine whether they would change the conclusions of the Jacobs (2003) risk assessment. Application of aluminum, arsenic, mercury, and vanadium concentrations reported for post-2002 soil samples collected near sumps associated with LHAAP-46 to the Jacobs (2003) risk assessment contributed to negligible increases to the Jacobs (2003) risk assessment cancer risk and noncancer hazard values with resulting values in the acceptable range. Application of the aluminum, mercury, manganese, and vanadium concentrations reported for post-2003 soil samples collected near sumps associated with LHAAP-47 to the Jacobs (2003) risk assessment contributed negligible increases to Jacobs (2003) risk assessment cancer risk and noncancer hazard values with resulting values in the acceptable range. Application of the maximum manganese concentration measured in soil near sumps associated with LHAAP-35A(58) to the Jacobs (2003) risk assessment contributed negligible increases to the risk assessment cancer risk and noncancer hazard value with resulting values in the acceptable range. Application of the vanadium, trichloroethylene, and vinyl chloride concentrations measured in soil near sumps associated with LHAAP-18/24 to the Jacobs (2003) risk assessment contributed negligible increases to the Jacobs (2003) risk assessment cancer risk and noncancer hazard values with resulting values in the acceptable range. Overall, the application of these sample results to the Jacobs (2003) risk assessment indicated that there were increases to the cancer risk and noncancer hazard values, but these increases were negligible and the overall risk and hazard values were within acceptable ranges. Therefore, no further action is required for soil around LHAAP-35/36 sumps at LHAAP-46, LHAAP-47, LHAAP-35A(58), and LHAAP-18/24.

Risk assessments provided in the Site Evaluation Report for LHAAP-48 and LHAAP-35C(53) (Shaw, 2007a) included results for soil associated with the sumps at those sites. The assessments demonstrated that the sites were acceptable for nonresidential use. Soil associated with the two sumps at LHAAP-59 was addressed within the Site Investigation Report specific to that site (Shaw, 2007b); the findings indicated that no further action was required for LHAAP-59 based on comparison to medium-specific concentrations for commercial/industrial land use.

The evaluation of LHAAP-35/36 also includes analysis of potential for soil-to-groundwater impacts from 18 wastewater sumps and 4 waste rack sumps (Shaw, 2009a) since groundwater at these sump locations is not addressed under another site:

- Nine wastewater sumps (Sump094 – Sump101, Sump123) and three waste rack sumps (WRS001-WRS003) within LHAAP-48.
- Four wastewater sumps (Sump102 – Sump105) within LHAAP-35C(53).
- One wastewater sump (Sump110) approximately 135 feet outside LHAAP-46.

- One wastewater sump (Sump106) at LHAAP-66.
- One wastewater sump (Sump118) approximately 280 feet outside LHAAP-29.
- Two wastewater sumps (Sump119, Sump120) adjacent to LHAAP-59.
- One waste rack sump (WRS013) approximately 120 feet outside LHAAP-45.

Results of modeling performed for the evaluation showed that only a limited set of chemicals associated with soil at former sump locations have the potential to affect groundwater. For these sumps, several metals (antimony, arsenic, barium, cadmium and silver) indicated potential to leach into groundwater at LHAAP-48 and LHAAP-35C(53), but groundwater results from nearby wells showed those same metals to be undetected or present at concentrations below maximum contaminant levels (MCLs) or TCEQ regulatory levels. Several volatile organic compounds (VOCs) were also noted as having leaching potential at one area at LHAAP-48, and an herbicide was noted as having leaching potential at one area at LHAAP-59, but groundwater results from nearby wells showed those chemicals to be undetected or present at concentrations below MCLs or TCEQ regulatory levels. Because operations at the LHAAP facilities ceased in the mid-1990s (Shaw, 2007a, 2007b, 2007c, 2008, 2009b), and subsequent analyses of groundwater showed that concentrations of the chemicals were below regulatory levels, the contaminants associated with soil at the sump locations were judged to be of no further concern.

Except for these 18 wastewater sumps and 4 waste rack sumps, groundwater impacts at all other sump locations are being addressed through investigation and evaluation of the sites in which the sumps are located. The list of sumps and their associated sites are shown on **Table 1**.

Because it was demonstrated that post-2002 sampling results contribute negligible increases to the previous risk assessments, and the cancer risk and noncancer hazard values are well within the acceptable ranges, no further action is required for soil associated with sumps at LHAAP-35/36 (Shaw, 2008; 2009a; 2010).

The ecological risk for site LHAAP-35/36 was addressed in the Installation-Wide Baseline Ecological Risk Assessment (BERA) (Shaw, 2007c). For the BERA, the entire Installation was divided into three large sub-areas (i.e., the Industrial Sub-Area, Waste Sub-Area, and Low Impact Sub-Area) for the terrestrial evaluation. The individual sites at LHAAP were grouped into one of these sub-areas, which were delineated based on commonalities of historical use, habitat type, and spatial proximity to each other. The conclusions regarding the potential for chemicals detected at individual sites to adversely affect the environment must be made in the context of the overall conclusions of the sub-area in which the site falls. The LHAAP-35/36 sumps and waste rack sumps lie within the Low Impact Sub-Area, the Waste Sub-Area, and the Industrial Sub-Area. The BERA concluded that no unacceptable ecological risk was present in the Low Impact and Industrial Sub-Areas (Shaw, 2007c). Ecological risk was identified at the

Waste Sub-Area and is being addressed by a soil remedial action at LHAAP-17. Therefore, no action was needed at the LHAAP-35/36 sumps for the protection of ecological receptors.

TCEQ concurs that no action is required for LHAAP-35/36. None of the CERCLA §121 statutory determinations are necessary in this action because no remedial action is necessary to ensure the protection of human health and the environment. The TCEQ requires that a notification must be filed in the Harrison County records, as required by 30 TAC §335.566, stating that the land is considered suitable for nonresidential use. Limited monitoring will be conducted to ensure that the use of this site remains consistent with the nonresidential use scenarios evaluated in the risk assessment and will be documented in the form of Letters of Certification transmitted every five years to the TCEQ. Although the Army may pass these procedural responsibilities to the designated transferee, USFWS, in conjunction with the property transfer, the Army shall retain responsibility for future environmental response actions.

PRIMARY BACKGROUND DOCUMENTS FOR SITE LHAAP-35/36

Jacobs Engineering Group, Inc. (Jacobs), 2001, *Final Remedial Investigation Report, Group 2 Sites, Sites 12, 17, 18/24, 29, and 32, Volume 1: Report, Longhorn Army Ammunition Plant, Karnack, Texas, Oak Ridge, Tennessee, April.*

Jacobs, 2002a, *Final Remedial Investigation Report, Group 4 Sites, Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Volume 1: Report, Longhorn Army Ammunition Plant, Karnack, Texas, Oak Ridge, Tennessee, January.*

Jacobs, 2002b, *Final Baseline Human Health and Screening Ecological Risk Assessment Volume 1: Report for the Group 2 Sites 12, 17, 18/24, 29, 32, 49, Harrison Bayou and Caddo Lake, Longhorn Army Ammunition Plant, Karnack, Texas, Oak Ridge, Tennessee, August.*

Jacobs, 2003, *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites, Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunder's Branch, and Caddo Lake, Volume 1, Longhorn Army Ammunition Plant, Karnack, Texas, Oak Ridge, Tennessee, June.*

OHM Remediation Services Corp. (OHM), 1997, *Closure Report, Removal and Closure of Wastewater Sumps, Longhorn Army Ammunition Plant, Karnack, Texas, Houston, Texas, April.*

Plexus Scientific, 2005, *Environmental Site Assessment Phase I and II Report, Production Areas, Longhorn Army Ammunition Plant, Karnack, Texas, Houston, Texas, February.*

Shaw Environmental, Inc. (Shaw), 2007a, *Final Site Evaluation Report, LHAAP-48 (Former Igniter Production Area) and LHAAP-35C(53) (Former Static Test Area), Longhorn Army Ammunition Plant, Karnack, Texas, April.*

Shaw, 2007b, *Final Site Investigation Report, LHAAP-59, Longhorn Army Ammunition Plant, Karnack, Texas, August.*

Shaw, 2007c, *Installation-Wide Baseline Ecological Risk Assessment, Longhorn Army Ammunition Plant, Karnack, Texas, Houston, Texas, November.*

Shaw, 2008, *Data Evaluation Report Chemical Concentrations in Soil Samples Associated with LHAAP-35/36 Sumps, Longhorn Army Ammunition Plant, Karnack, Texas, Houston, Texas, January.*

Shaw, 2009a, *Addendum to the Final Data Evaluation Report in Soil Samples Associated with LHAAP-35/36 Sumps, Longhorn Army Ammunition Plant, Karnack, Texas, Houston, TX, April.*

Shaw, 2009b, *Final Feasibility Study, LHAAP-35(58), Shop Area, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas, December.*

Shaw, 2010, *Memorandum: Errata to Final Evaluation Report, Chemical Concentrations in Soil Samples Associated with LHAAP-35/36 Sumps, Longhorn Army Ammunition Plant, Karnack, Texas, To Aaron Williams, U.S. Army Corps of Engineers, From Arthur F. Eidson, Ph.D., Shaw Environmental, Inc., May 4.*

PRIMARY BACKGROUND DOCUMENTS FOR SITE LHAAP-35/36
(Continued)

Texas Commission on Environmental Quality (TCEQ), 2006, *Texas Risk Reduction Rules* (30TAC§335) tables as updated through March.

Thiokol Corporation (Thiokol), 1996, *Closure Report, Closure of 29 Active and 11 Transition Sumps, Longhorn Army Ammunition Plant, Karnack, Texas*, September.

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ACRONYMS

AR	Army Regulation
BERA	Baseline Ecological Risk Assessment
BRAC	Base Realignment and Closure Commission
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
FFA	Federal Facility Agreement
Jacobs	Jacobs Engineering Group, Inc.
LHAAP	Longhorn Army Ammunition Plant
MCLs	maximum contaminant levels
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	Superfund National Priorities List
OHM	OHM Remediation Services Corp.
RAB	Restoration Advisory Board
RBSV	Risk Based Screening Values
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
Shaw	Shaw Environmental, Inc.
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
Thiokol	Thiokol Corporation
TNRCC	Texas Natural Resource Conservation Commission
TNT	trinitrotoluene
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound

Tables

Table 1
Sump and Waste Rack Sumps

Location Code	Nearest Site	Building	Location Code	Nearest Site	Building
LHAAP-35 Sumps (see no. 1 in table notes)			LHAAP-35 Sumps (see no. 2 in table notes)		
SUMP094	LHAAP-48	16-Y	SUMP028	LHAAP-46	P-122
SUMP095	LHAAP-48	34-Y	SUMP029	LHAAP-46	P-123
SUMP096	LHAAP-48	34-Y	SUMP030	LHAAP-46	212-12
SUMP097	LHAAP-48	38-Y	SUMP031	LHAAP-46	212-12
SUMP098	LHAAP-48	38-Y	SUMP032	LHAAP-46	212-14
SUMP099	LHAAP-48	38-Y	SUMP033	LHAAP-46	212-14
SUMP100	LHAAP-48	45-Y	SUMP034	LHAAP-46	212-16
SUMP101	LHAAP-48	45-Y	SUMP035	LHAAP-46	212-18
SUMP102	LHAAP-35C(53)	16-T	SUMP036	LHAAP-46	P-122
SUMP103	LHAAP-35C(53)	16-T	SUMP037	LHAAP-46	212-29
SUMP104	LHAAP-35C(53)	16-T	SUMP038	LHAAP-46	212-32
SUMP105	LHAAP-35C(53)	16-T	SUMP039	LHAAP-46	212-33
SUMP106	LHAAP-66	401	SUMP040	LHAAP-46	212-33
SUMP110	LHAAP-46	207	SUMP041	LHAAP-46	212-35
SUMP118	LHAAP-29	813	SUMP042	LHAAP-46	212-37
SUMP119	LHAAP-59	725	SUMP043	LHAAP-46	212-38
SUMP120	LHAAP-59	725	SUMP044	LHAAP-47	25-C
SUMP123	LHAAP-48	18-Y	SUMP045	LHAAP-47	25-C
LHAAP-36 Waste Rack Sumps (see no. 1 in table notes)			SUMP046	LHAAP-47	25-C
WRSUMP001	LHAAP-48	34-Y	SUMP047	LHAAP-47	25-D
WRSUMP002	LHAAP-48	38-Y	SUMP048	LHAAP-47	26-E
WRSUMP003	LHAAP-48	16-Y	SUMP049	LHAAP-47	26-E
WRSUMP013	LHAAP-45	824	SUMP050	LHAAP-47	26-E
LHAAP-35 Sumps (see no. 2 in table notes)			SUMP051	LHAAP-47	26-E
SUMP001	LHAAP-46	P-1	SUMP052	LHAAP-47	28-G
SUMP002	LHAAP-46	P-3	SUMP053	LHAAP-47	29-D
SUMP003	LHAAP-46	P-3	SUMP054	LHAAP-47	31-G
SUMP004	LHAAP-46	P-3	SUMP055	LHAAP-47	31-G
SUMP005	LHAAP-46	P-3	SUMP056	LHAAP-47	32-H
SUMP006	LHAAP-46	P-116	SUMP057	LHAAP-47	33-G
SUMP007	LHAAP-46	P-116	SUMP058	LHAAP-47	36-B
SUMP008	LHAAP-46	P-117	SUMP059	LHAAP-47	41-E
SUMP009	LHAAP-46	P-117	SUMP060	LHAAP-47	42-E
SUMP010	LHAAP-46	P-118	SUMP061	LHAAP-47	42-H
SUMP011	LHAAP-46	P-118	SUMP062	LHAAP-47	45-E
SUMP012	LHAAP-46	P-118	SUMP063	LHAAP-47	45-E
SUMP013	LHAAP-46	P-118	SUMP064	LHAAP-47	45-E
SUMP014	LHAAP-46	B-5	SUMP065	LHAAP-47	45-E
SUMP015	LHAAP-46	B-7	SUMP066	LHAAP-47	45-E
SUMP016	LHAAP-46	B-7	SUMP067	LHAAP-47	45-E
SUMP017	LHAAP-46	B-9	SUMP068	LHAAP-47	46-A
SUMP018	LHAAP-46	B-9	SUMP069	LHAAP-47	46-B
SUMP019	LHAAP-46	B-10	SUMP070	LHAAP-47	50-G
SUMP020	LHAAP-46	B-11	SUMP071	LHAAP-47	54-F
SUMP021	LHAAP-46	B-12	SUMP072	LHAAP-47	54-F
SUMP022	LHAAP-46	B-13	SUMP073	LHAAP-47	54-G
SUMP023	LHAAP-46	B-14	SUMP074	LHAAP-47	54-G
SUMP024	LHAAP-46	B-15	SUMP075	LHAAP-47	54-G
SUMP025	LHAAP-46	B-16	SUMP076	LHAAP-47	54-H
SUMP026	LHAAP-46	SHED C	SUMP077	LHAAP-47	54-H
SUMP027	LHAAP-46	P-9	SUMP078	LHAAP-47	68-C

Table 1 (continued)
Sump and Waste Rack Sumps

Location Code	Nearest Site	Building	Location Code	Nearest Site	Building
LHAAP-35 Sumps (see no. 2 in table notes)			LHAAP-36 Waste Rack Sumps (see no. 2 in table notes)		
SUMP079	LHAAP-47	68-C	WRSUMP004	LHAAP-46	P-1
SUMP080	LHAAP-47	68-C	WRSUMP005	LHAAP-46	P-117
SUMP081	LHAAP-47	68-F	WRSUMP006	LHAAP-46	P-118
SUMP082	LHAAP-47	68-F	WRSUMP007	LHAAP-46	P-122
SUMP083	LHAAP-47	68-F	WRSUMP008	LHAAP-46	B-8
SUMP084	LHAAP-47	68-G	WRSUMP009	LHAAP-46	S-113
SUMP085	LHAAP-47	68-G	WRSUMP010	LHAAP-46	P-12
SUMP086	LHAAP-47	68-G	WRSUMP011	LHAAP-46	B-13
SUMP087	LHAAP-47	68-G	WRSUMP012	LHAAP-46	P-113
SUMP088	LHAAP-47	68-G	WRSUMP014	LHAAP-37	29-A
SUMP089	LHAAP-47	68-G	WRSUMP015	LHAAP-46	212-14
SUMP090	LHAAP-47	68-G	WRSUMP016	LHAAP-46	407
SUMP091	LHAAP-47	75-I	WRSUMP017	LHAAP-47	68-G
SUMP092	LHAAP-47	75-I	WRSUMP018	LHAAP-47	54-H
SUMP093	LHAAP-47	75-I	WRSUMP019	LHAAP-46	212-20
SUMP107	LHAAP-46	403	WRSUMP020	NA	NA
SUMP108	LHAAP-46	406	WRSUMP021	LHAAP-46	P-11
SUMP109	LHAAP-46	408			
SUMP111	LHAAP-35A(58)	722-P			
SUMP112	LHAAP-35A(58)	722-P			
SUMP113	LHAAP-35A(58)	744			
SUMP114	LHAAP-39 (18)	25-X			
SUMP115	LHAAP-18	33-X			
SUMP116	LHAAP-18	37-X			
SUMP117	LHAAP-58	744-A			
SUMP121	LHAAP-47	32-H			
SUMP122	LHAAP-04	401-C			
SUMP800 (Sump124)	LHAAP-53	23-T			
Unnumbered Sump (Sump125)	LHAAP-58	723			

Notes and Abbreviations:

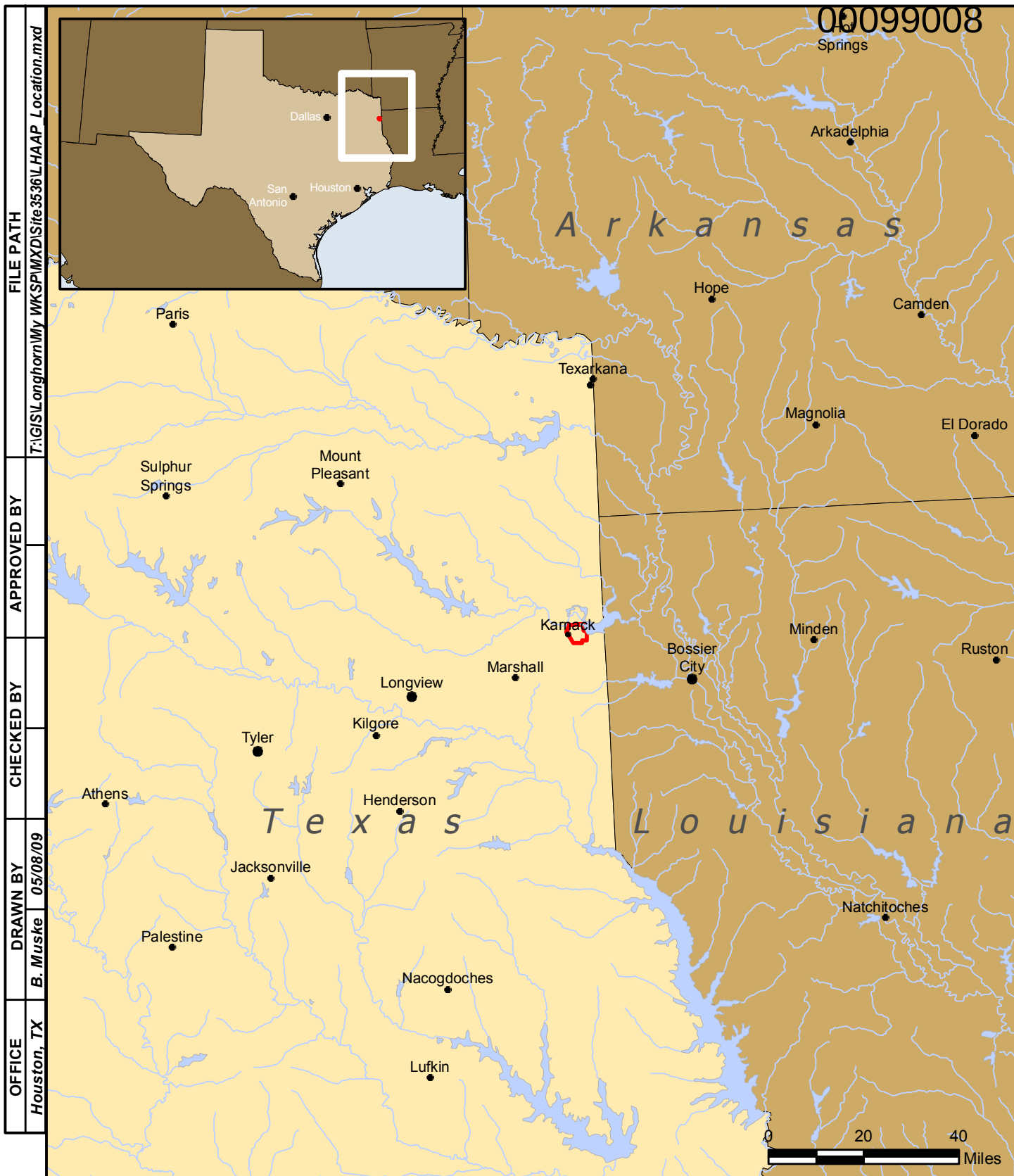
1. Shaded and Bold - Soil-to-groundwater pathway was evaluated by comparing soil results to Standard 3 medium-specific concentration levels in the Final Addendum (Shaw, 2009). See reference below.
 2. The soil-to-groundwater pathways for all other sumps are being addressed under the sites where the sumps are physically located, e.g., LHAAP-46 and 47.
- NA - not applicable (sump never used)

Reference:

Shaw Environmental, Inc., 2009, *Final Addendum to the Data Evaluation Report, LHAAP-35/36 Sumps, Longhorn Army Ammunition Plant, Karnack, Texas*, April.

Figures

00099008



LEGEND

 LHAAP Boundary



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

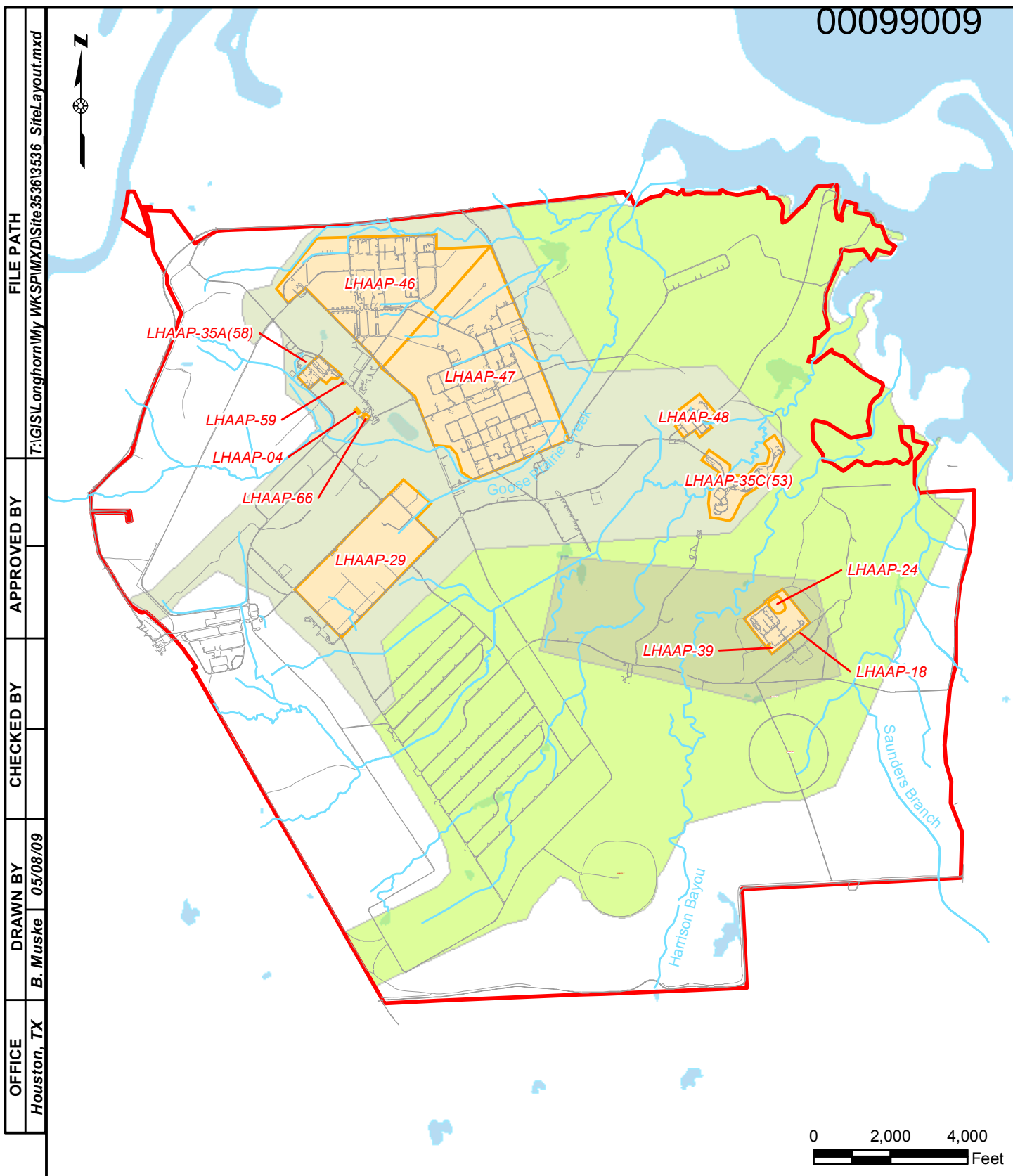
FIGURE 1

Location of LHAAP

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Plot Date: 02/09

00099009



OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Muske	05/08/09		T:\GIS\Longhorn\My WKSP\MXD\Site3536\3536 SiteLayout.mxd

LEGEND

	Stream		Industrial Sub-Area
	Road		Low Impact Sub-Area
	LHAAP Boundary		Waste Sub-Area
	Site		Lake



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

FIGURE 2

SITE LOCATIONS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Plot Date: 02/09

Appendix A

Correspondence of Regulatory Concurrence

Bryan W. Shaw, Ph.D., *Chairman*
Buddy Garcia, *Commissioner*
Carlos Rubinstein, *Commissioner*
Mark R. Vickery, P.G., *Executive Director*



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

December 15, 2010

Mr. Thomas E. Lederle, Industrial Branch Chief
Assistant Chief of Staff for Installation Management
ATTN: DAIM-BD (Tom Lederle)
600 Army Pentagon
Washington, D.C. 20310-0600

Re: Decision Document for LHAAP-35/36 Sumps
Longhorn Army Ammunition Plant Superfund Site TX6213820529
Karnack, Harrison County, Texas

Dear Mr. Lederle:

The Texas Commission on Environmental Quality (TCEQ) received the final Army Decision Document for the LHAAP-35/36 Sumps at the Longhorn Army Ammunition Plant Superfund Site in Karnack Texas on November 11, 2010. The TCEQ has completed the review of the above referenced document and concurs that the response action described in the Decision Document is the most appropriate remedy for LHAAP-35/36 Sumps.

Sincerely,

A handwritten signature in black ink, appearing to read "B. Wade", written over a horizontal line.

Brent Wade, Director
Remediation Division

BW/FD