DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

March 7, 2019

DAIM-ODB-LO

Mr. Rich Mayer
U.S. Environmental Protection Agency
Federal Facilities Section R6
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Draft Final Remedial Design/Remedial Action Work Plan, LHAAP-17 Burning Ground No. 2/ Flashing Area, Group 2, Longhorn Army Ammunition Plant, Karnack, Texas, March 2019

Dear Mr. Mayer,

One hard copy and one compact disc (CD) of the above-referenced document are being transmitted to you for your records. The document includes revisions based upon the Environmental Protection Agency's (EPA) comments on the Draft version received on February 7, 2019, and Texas Commission on Environmental Quality's (TCEQ) comments received on January 30, 2019. In accordance with Federal Facility Agreement, this Draft Final will be considered Final after 30 days without further comment. Response to comments on the Draft version of the document are included with this Draft Final.

The document was prepared by Bhate Environmental Associates, Inc., (Bhate) team, on behalf of the Army as part of Bhate's Performance Based Remediation contract for the facility. I ask that Kim Nemmers, Bhate's Project Manager, be copied on any communications related to the project.

The point of contact for this action is the undersigned. I may be contacted at 479-635-0110, or by email at rose.m.zeiler.civ@mail.mil.

Sincerely,

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

Copies furnished:
A. Palmie, TCEQ, Austin, TX (letter)
P. Bruckwicki, Caddo Lake NWR, TX (1 hard copy and 1 CD)
A. Williams, USACE, Tulsa District, OK (1 CD)
R. Smith, USACE, Tulsa District, OK (electronic only)
A. Maly, USAEC, San Antonio, TX (1 CD)
K. Nemmers, Bhate, Lakewood, CO (1 CD)
P. Srivastav, APTIM, Houston, TX (letter)

DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

March 7, 2019

DAIM-ODB-LO

Ms. April Palmie
Texas Commission on Environmental Quality
Superfund Section, MC-136
12100 Park 35 Circle, Bldg D
Austin, TX 78753

Re: Draft Final Remedial Design/Remedial Action Work Plan, LHAAP-17 Burning Ground No. 2/ Flashing Area, Group 2, Longhorn Army Ammunition Plant, Karnack, Texas, March 2019

Dear Ms. Palmie,

One hard copy and one compact disc (CD) of the above-referenced document are being transmitted to you for your records. The document includes revisions based upon the Environmental Protection Agency's (EPA) comments on the Draft version received on February 7, 2019, and Texas Commission on Environmental Quality's (TCEQ) comments received on January 30, 2019. In accordance with Federal Facility Agreement, this Draft Final will be considered Final after 30 days without further comment. Response to comments on the Draft version of the document are included with this Draft Final.

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Response to Comments on
Draft Remedial Design / Remedial Action Work Plan
LHAAP-17 Burning Ground No. 2 / Flashing Area, Group 2

Document Date: 27 December 2018
Comment Date: 7 February 2019

Reviewer: Mr. Richard Mayer, USEPA
Respondent: Dr. Rose Zeiler

1. Respondent Concurs (C), Does Not Concur (D), Takes Exception (E), or Delete (X)
2. Commenter Agrees (A) with response, or Does Not Agree (D) with response

Comment No.	Section, Page ref.	USEPA Comment	C, D, E, or X[1]	Response	A or D[2]
1.	Page 1-2, Table 1-1	Under chemicals of concern for soils, 2,4-dinitrotolune is misspelled.	C	Text will be revised to correct the typographical error.	
2.	Page 1-6, Section 1.5	Bhate, 2018 should be Bhate, 2018b	C	Text will be revised to correct the reference as suggested.	
3.	Table 1-3	Table 1-3 indicates that 5 soil sample locations are above the cleanup levels for Barium; however, Figure 3-1 indicates 11 soil sample locations. Which is correct?	C	Table 1-3 was duplicated from Table 2-11 of the Final ROD, and the sample locations referred to in the ROD table were the known exceedances at that time. Figure 3-1 shows the exceedances identified following the conclusion of the PDI sampling. Table 1-3 has been revised to remove the Sample Location column since the information in it is not referenced in the document, and Figure 3-1 has been revised to show 17SS22 as a barium exceedance location.	
4.	Page 2-1, Section 2.1	The text indicates that a clay layer between the uppermost alluvial zone and Wilcox acts as an aquitard. Based on the water levels provided (several sections further in the report) there is a slight gradient downward which suggests using the term aquiclude instead of aquitard or the term leaky aquitard.	C	The text has been revised to refer to the clay layer as an aquiclude.	

Comment No.	Section, Page ref.	USEPA Comment	C, D, E, or X[1]	Response	A or D[2]
		Confined conditions are seen with most aquitards.			
5.	Figure 2-2	Monitoring well MW-20 is screened between a perched zone and the shallow groundwater. The southwest corner of LHAAP 18/24 has been known to have a perched zone, so it is questionable if the water levels at that location represent the first shallow water zone. However, since there are no other wells in that area that are in the shallow zone, the water levels are most likely similar to those in MW-7.	C	It is assumed that the comment refers to Figure 2-1 instead of Figure 2-2, since neither of the wells referred to are shown on Figure 2-2. Reviewer is correct that MW-20 and nearby 18CPTMW22R are screened ~10' shallower than MW-7. The potentiometric surface figure for the Shallow Zone (Figure 2-1) has been revised to remove the contours above 168.6 and revise the contours to remove the influence of the two locations. The groundwater elevations for MW-20 and 18CPTMW22R are still shown, but a note has been added to the legend stating "The groundwater elevations for MW-20 and 18CPTMW22R were not used to draw potentiometric contours because they are screened significantly shallower than other nearby wells and may not represent elevations in the shallow zone."	
6.	Figure 5-2	The Figure indicates two places in the flow diagram where telemetry will be used. The narratives in sections 5 and 7 do not mention if this will be used. Please clarify	C	The telemetry shown on Figure 5-2 is explained in Note 2 on the figure as a control to close the air line operating the transfer pump (pumping water from LHAAP-17 to the GWTP) if the level in the equalization tank at the GWTP trips the high-level alarm. If the transfer pump remains shut down long enough, the high-level alarm in the holding tank will trigger the pumps in the extraction wells to shut down as well. Discussion of the telemetry connection has been added to Section 5.4.2.	
7.	Page 4-1, Section 4.2	The text refers to Figure 2-1, which should be Figure 3-1. EPA recommends adding the concentrations of explosives and barium that exceeded the health criteria to the Figure.	C/D	The text reference has been revised to refer to Figure 3-1. Each location shown as highlighted may have up to 3 different COC concentrations exceeding the health criteria at one or more depths. Adding the data (COC, depth, and concentration for each	

Comment No.	Section, Page ref.	USEPA Comment	C, D, E, or X[1]	Response	A or D[2]
				exceedance) to each location would make the figure extremely difficult to read and would obscure the primary purpose of showing the overall pattern of the soil areas requiring excavation. The title of the figure has been revised to "Soil Sample Locations with Concentrations Exceeding the Cleanup Levels" to clarify the purpose. A reference to Table 3-1 has been added to the legend of Figure 3-1.	
8.	References	Please add Plexus, 2005 report to the list.	C	The Plexus, 2005 report has been added to the list of references.	
9.	List of Acronyms	There are several acronyms missing from list. Please add the following: MEGA, MATOC, MMRP, FFA, BRAC, TCDD, DCE, mg/kg, TEC, MOA, gpm, PPE, and ORP. Also, O&M needs to be defined on page 1-6 and added to list. The same comment applies to DO. ECP can be removed from the list since it is not used in the body of the report.	C	The acronyms list has been updated as requested and a thorough edit of the document has been performed to properly define the first use of each acronym in the text. The following were only used once in the document and the abbreviation/acronym was removed from the text and is not shown in the table of acronyms and abbreviations: MEGA, MATOC, MMRP, BRAC, TEC, PPE, ORP, DO	

Response to Comments on
Draft Remedial Design / Remedial Action Work Plan
LHAAP-17 Burning Ground No. 2 / Flashing Area, Group 2

Document Date: 27 December 2018
Comment Date: 30 January 2019

Reviewer: Ms. April Palmie, TCEQ
Respondent: Dr. Rose Zeiler

1. Respondent Concurs (C), Does Not Concur (D), Takes Exception (E), or Delete (X)
2. Commenter Agrees (A) with response, or Does Not Agree (D) with response

Comment No.	Section, Page ref.	TCEQ Comment	C, D, E, or X[1]	Response	A or D[2]
1.	Section 1.5, Page 1-6	Excavation sidewall – The composite strategy for the small excavation areas is technically reasonable but may result in the excavation staying unfilled longer than necessary if the composite fails. If you had samples from each wall, it would speed the process for backfilling the excavation.	C	The potential risk of needing to keep the small excavations open longer for additional sampling was considered in the selection of the sampling method. The expected duration of activities and plan to perform the smaller excavations first will allow time for the additional sampling (if needed) without delaying other site activities.	
		Baseline groundwater – The described strategy is appropriate for 17WW01 and should also be evaluated for 17WW02. The TCE and perchlorate concentrations in 17WW02 also decreased by several orders of magnitude between 2009 and 2017 sampling. Were the samples taken from the same interval?	C	The sample collected from 17WW02 was collected using a pump inlet depth of 17 feet in 2017 and 20 feet in 2010. Sections 1.5 and 5.3 have been updated to include a similar discussion for 17WW02.	
2.	Section 2.3 Page 2-2	Revise refuge acreage to 7,100 acres	C	Text has been revised as requested.	
3.	Section 2-5, Page 2-3	This section discusses water wells. Please include the discussed water wells on Figure 1-2 (or another figure).	C	A new figure (Figure 2-3) has been added showing the location of the drinking water supply wells near LHAAP and a callout has been added to Section 2.5.	

Comment No.	Section, Page ref.	TCEQ Comment	C, D, E, or X[1]	Response	A or D[2]
4.	Section 3 and general	Search for abbreviated dates and replace all. Examples: 12 Sep 2018 should be September 12, 2018 and 11-15 Jan 2018 should be January 11-15, 2018	C	Text has been revised as requested.	
5.	Section 3-1, Page 3-1	1st paragraph, 2nd sentence – change underwater to under water. 2nd paragraph, add references to the area names from Figure 4-1. Last sentence add reference to Figure 4-1.	C C	Text has been revised as requested. Text has been revised to add the references to the area names and a reference to Figure 4-1 as requested.	
6.	Section 5.4.1, Page 5-3	2nd paragraph – Should the 2nd sentence reference 17WW06 and 17WW02, rather than 17WW01?	D	During the pumping test, the initial pumping well was 17WW02. After 48 hours of pumping in 17WW02, pumping began at 17WW01 and 17WW06.	
7.	Section 5.5, Page 5-4	Additional 17 wells should be sampled and results from certain 18/24 wells should be evaluated during extraction period. At least 17WW03 and 130 should be sampled. The results for MW-18 and MW-19 should be included for evaluation purposes to confirm the 18/24 plume is not being dragged by the pumping wells.	C	Wells 17WW03 and 130 have been added to the monthly/quarterly sampling performed during the extraction period. Semiannual data from MW-18 and MW-19 collected as part of the LHAAP-18/24 monitoring will be included in the RA-O reporting and used to evaluate the impact on the 18/24 plume. Text has been modified to reflect these changes.	
8.	Section 6.1, Page 6-2	3rd bullet, Remove comma between Refuge and Manager	C	Text has been revised as requested.	
9.	Section 8.1, Page 8-1	If 17WW01 is included as an extraction well, it should also be sampled	C	The first sentence of Section 8.1 has been revised to include sampling of 17WW01 if it is included as an extraction well.	
10.	Section 8.3, Page 8-1	Certain additional well should also be sampled at baseline and during pumping (see comment 7).	C	See response to Comment #7. Text has been revised in Section 8.3 for consistency with that response.	
11.	Section 8.3.1, Page 8-2	All impacted wells should be included in the baseline sampling event.	C	17WW03 and 130 have been added to the baseline sampling event as they are the only other LHAAP-17 wells impacted with COCs.	

Comment No.	Section, Page ref.	TCEQ Comment	C, D, E, or X[1]	Response	A or D[2]
12.	Tables	Please add a table to show cumulative groundwater results. The call-out boxes on the figure are helpful but we also need a table.	C	Table 5-1 has been added to show the data requested in tabular form. The previous Table 5-1 has been renamed to 5-2 and callouts have been revised accordingly.	
13.	Table 1-2	Please revise PCL heading to: TRRP $^{GW}GW_{Ing}$ PCL (and revise the note)	C	Table 1-2 has been revised as requested.	
14.	Table 4-1	Area H – The excavation walls cover a long distance. The north and south walls should have two samples each. 17SS28 is not suitable to serve as a confirmation sample for the south wall of Area H.	C	Table 4-1 has been revised as requested to include two samples for the north wall of Area H and one additional sample for the south wall of Area H.	
15.	Table 5-1	Would it be possible to add data for 17WW01?	C	Data for an assumed pumping rate of 1.5 gpm in 17WW01 has been added to the table. The table has been renumbered to 5-2 to accommodate the addition of the table referred to in the response to TCEQ Comment #12	
16.	Table 8-1	Suggest removal of 18WW10 from the list as it is part of 18/24 monitoring and not likely to be impacted by pumping at 17.	C	18WW10 has been removed from the table as requested.	
17.	Figure 4-1	This is very helpful figure. Please change one of the greens to a different color (too similar). The greens look different on the pdf but not on the printout.	C	Figure 4-1 has been revised as requested.	
18.	Figure 5-2	Between V-21 and P-20 the line looks like water line. Should this be air line? Is that a valve with port or just on/off valve after P-20? Would a sample port also be useful at that location (blended)? If 17WW01 is included, would it also have a sample port?	C D C	Figure 5-2 has been revised to show the referenced line as an air line. The valve shown is an on/off valve only. There will be sample ports for each extraction well, so collecting a blended sample does not really have value since the water will ultimately be mixed in the equalization tank at the GWTP with water from LHAAP-18/24. If 17WW01 is added as an extraction well, it will be set up exactly as the other wells are shown. A note has been added to the figure stating that 17WW01	

Comment No.	Section, Page ref.	TCEQ Comment	C, D, E, or X[1]	Response	A or D[2]
				may be added using the same design based on the results of the baseline sampling.	
19.	Figure 5-3	Add radius of influence for 17WW01	C	An estimated radius of influence of 200 feet has been added to Figure 5-3 for 17WW01 assuming a pumping rate of 1.5 gpm.	
20.	Figure 6-1	Please remove 18WW10/18WW11 from the LUC boundary for site 17. This well belongs with 18/24 and we can include it with that LUC. The north boundary of the LUC could go from 17WW15 to MW-18 instead.	C	The LHAAP-17 LUC boundary shown on Figure 6-1 has been redrawn to match a boundary map showing LHAAP-16, -17, and -18/24 LUC boundaries previously submitted by the Army. The wells north and east of the 17WW11/12/20 cluster will be within the LHAAP-18/24 LUC boundary.	
21.	Figure 7-1	Add 17WW01.	C	17WW01 has been added as a possible extraction well as requested.	
22.	Figure 8-1	Include all wells and change the color, symbol, or highlight for MNA wells. Don't hide non-MNA wells.	C	Figure 8-1 has been revised as requested.	
23.	Appendix D	Form will need to be revised to include 17WW01 (if included as extraction well)	C	The form provided is an example that will be updated to meet the needs of the system as installed.	

Draft Final
Remedial Design and Remedial Action Work Plan, LHAAP-17 Burning Ground No. 2 / Flashing Area, Group 2

Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers, Tulsa District
Contracting Division
2488 East 81st Street
Tulsa, Oklahoma 74137-4290

Prepared by

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APTIM

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Contract No. W9128F-13-D-0012
Task Order No. W9128BV17F0150
Project No. 501032
Rev 0
March 2019

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Acronyms and Abbreviations

µg/L	micrograms per liter
AECOM	AECOM Engineering Company
APTIM	Aptim Federal Services, LLC
Bgs	below ground surface
Bhate	Bhate Environmental, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	chemical of concern
COPEC	chemical of potential ecological concern
CY	cubic yards
DCE	dichloroethene
DNT	dinitrotoluene
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
gpm	gallons per minute
GPS	global positioning system
GWTP	groundwater treatment plant
HDPE	high density polyethylene pipe
IWWP	Installation-Wide Work Plan
LHAAP	Longhorn Army Ammunition Plant
LOE	line of evidence
LTM	long-term monitoring
LUC	land use control
mg/kg	milligrams per kilogram
MNA	monitored natural attenuation
MOA	Memorandum of Agreement
NCP	National Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
PDI	Pre-Design Investigation
RA	remedial action
RACR	Response Action Completion Report
RA-O	Remedial Action-Operation
RAOs	remedial action objectives
RAWP	Remedial Action Work Plan
RD	remedial design
ROD	Record of Decision
Shaw	Shaw Environmental, Inc.
TAC	Texas Administrative Code
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin

Acronyms and Abbreviations (continued)

TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TNT	2,4,6-trinitrotoluene
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service

Contract No. W9128F-13-D-0012, Task Order No. W9128BV17F0150 • Draft Final • Rev 0 • March 2019

1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE), Tulsa District, contracted Bhate Environmental, Inc. (Bhate), under the Omaha Multiple Environmental Government Acquisition National Small Business Multiple Award Task Order Contract Environmental Remediation Services with Military Munitions Response Program, Task Order No. W9128BV17F0150 to conduct environmental restoration of LHAAP-17 at Longhorn Army Ammunition Plant (LHAAP). The Bhate Team is comprised of Bhate and Aptim Federal Services, LLC (APTIM). This Remedial Design (RD) and Remedial Action Work Plan (RAWP) was prepared to describe the design elements selected to implement the remedy for LHAAP-17 described in the Final Record of Decision (ROD) (Shaw 2016) and the actions necessary to implement them.

1.1 Site Description

LHAAP is approximately 14 miles northeast of Marshall, Texas and approximately 40 miles west of Shreveport, Louisiana (**Figure 1-1**). The installation occupies approximately 1,300 of its former 8,416 acres between State Highway 43 at Karnack, Texas and the western 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. Department of the Army (U.S. Army), the U.S. Environmental Protection Agency (USEPA), and the Texas Water Commission (now the Texas Commission on Environmental Quality [TCEQ]) entered into a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §120 Federal Facility Agreement (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. LHAAP has been under the administrative control of the Base Realignment and Closure Division of the Army since 2003 and is Defense Environmental Restoration Account funded. 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 (Shaw 2016).

LHAAP-17, an NPL site, known as the Burning Ground No. 2/Flashing Area, is a 3.9-acre site located within a heavily wooded section in the southeastern portion of LHAAP (**Figure 1-2**). The site has two 185 feet by 305 feet cleared areas, separated by a gravel access road. The site is covered with grass and scattered brush, has been graded above the surrounding terrain, and is relatively flat. LHAAP-17 was used as a burning ground from 1959 through 1980 (Plexus 2005). Bulk trinitrotoluene (TNT), photo flash powder, and reject material from Universal Match Corporation operations were burned at LHAAP-17. In 1959, the materials removed

from the former TNT Production Area (LHAAP-29) and the former TNT Waste Disposal Plant (LHAAP-32) during demolition were burned and/or flashed at LHAAP-17. The site was used as a flashing area to decontaminate recoverable metal byproducts until 1980, when it became inactive. Burning trenches were located around the inside perimeter of the previously fenced area and within the open area on the western boundary of the site (**Figure 1-3**). As each trench filled with ash, it was covered and a new trench was dug. The waste residues were reportedly removed from the trenches in 1984, and the site was allowed to revegetate (Jacobs 2001).

The ROD identified chemicals of concern (COCs) for human health and chemicals of potential ecological concern (COPECs), as shown in **Table 1-1**. The remedy selected in the ROD included excavation and off-site disposal of soil, groundwater extraction, monitored natural attenuation (MNA), and land use controls (LUCs) to maintain the remedy and prohibit groundwater use until COC concentrations are reduced to levels supportive of unlimited use and unrestricted exposure. The human health and ecological cleanup levels are shown in **Tables 1-2** and **1-3**, respectively.

Table 1-1
COCs and COPECs for LHAAP-17

Media	Chemicals of Concern (Human Health)	Chemicals of Potential Ecological Concern (COPEC)
Soil	2,4,6-trinitrotoluene (TNT), 2,4-dinitrotoluene (DNT), 2,6-DNT, and perchlorate	Barium, 2,4-DNT, 2,6-DNT, 2,4,6-TNT, and 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD)
Shallow Zone Groundwater	1,1-dichloroethene (DCE), 1,2-dichloroethane, cis-1,2-DCE, trichloroethene (TCE), vinyl chloride, and perchlorate	Not applicable
Intermediate Zone Groundwater	cis-1,2-DCE, TCE, vinyl chloride	Not applicable

1.2 Selected Remedy

The selected remedy was summarized in Section 1.4 of the Final ROD (Shaw 2016) as follows:

- Contaminated soil removal with off-site disposal to protect the hypothetical future maintenance worker and ecological receptors and to eliminate the soil-to-groundwater pathway.

- Extraction and treatment of groundwater until the trigger level of 20,000 micrograms per liter (µg/L) of perchlorate is reached. The trigger level in this ROD is an interim cleanup level. Upon reaching the trigger level, the remedial action (RA) will transition

from the initial measure of groundwater extraction to the primary remedy of MNA. Reduction of the perchlorate concentration to the trigger level is anticipated to expedite MNA.

  - If the 20,000 µg/L of perchlorate level is not reached after approximately 1.5 years, a contingency remedy of in situ bioremediation will be implemented to reduce the perchlorate levels more quickly so the conditions become amenable for trichloroethene (TCE) to attenuate naturally.

- MNA to confirm protection of human health and the environment by documenting that the contaminated groundwater remains localized with minimal migration and that contaminant concentrations are being reduced to cleanup levels.

  - Performance objectives will be evaluated after 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 long-term monitoring (LTM) will be semiannual for three years. In subsequent years, LTM will be annual until the next Five Year Review, and annually thereafter until recommended otherwise by the Five Year Review. The monitoring and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue until recommended otherwise at the Five Year Review.

- The LUC objectives include maintaining the integrity of any current or future remedial or monitoring systems, and preventing the use of groundwater contaminated above cleanup levels as a potable water source. The groundwater treatment and MNA remedial components include a groundwater monitoring system that will be used to characterize the condition of the groundwater during the period the groundwater remedy is in place until the groundwater remediation goals are achieved, and to demonstrate achievement of the groundwater remediation goals when the groundwater remedy is complete. As a part of this groundwater remedy, the Army will maintain the remedial and monitoring systems associated with the groundwater remedies until these components of the remedy are no longer needed to achieve cleanup levels, and cleanup levels have been achieved. During the period of operation of the groundwater remedy, if any of the elements of the remedial and groundwater monitoring systems are damaged, destroyed, or become ineffective, they will be repaired or replaced with suitable components to assure that the remedial and groundwater monitoring systems are able to provide data of the quality necessary to determine the progress of and eventual completion of this component of the remedy. The actions to be taken to implement these LUC objectives and requirements will be provided through modifying

the "Comprehensive Land Use Control (LUC) Management Plan, Former Longhorn Army Ammunition Plant, Karnack, Texas" and detailed in the LUC RD.

- The LUC for prohibition of groundwater use (except for monitoring and testing) shall be implemented and shall remain in place at the Site until the COCs in soil and groundwater remaining at the site are reduced below levels that would support unlimited use and unrestricted exposure. The recordation notification for the Site, to be filed with Harrison County, will include a description of the LUCs.

- The LUC restricting land use to nonresidential shall be implemented until it is demonstrated that surface and subsurface soil and groundwater COCs are at levels that allow for unlimited use and unrestricted exposure.

  - The LUC to maintain the integrity of any current or future remedial or monitoring systems will remain in place until the levels of COCs in groundwater are met.

- CERCLA Five Year Reviews until the levels of COCs in soil and groundwater allow for unlimited use and unrestricted exposure.

1.3 Remedial Action Objectives

The remedial action objectives (RAOs) developed for LHAAP-17 and outlined in the Final ROD (Shaw 2016) are:

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

The above RAOs recognize USEPA's policy to return all groundwater to beneficial uses, based on the non-binding programmatic expectation in the National Contingency Plan (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.

Per the ROD's RAOs, and consistent with the NCP, groundwater will be returned to its beneficial use as drinking water. The cleanup levels for groundwater established in the ROD are shown in **Table 1-2**.

1.4 Document Organization

This document is composed of the following sections:

- **Section 1.0:** "Introduction" summarizes the site background, proposed remedy, and remedial action objectives.
- **Section 2.0:** "Site Characteristics" summarizes the geology and hydrogeology of the site, as well as the nature and extent of contamination.
- **Section 3.0:** "Pre-Design Investigation" summarizes the results of the Pre-Design Investigation (PDI) that form the basis for the design elements described in subsequent sections.
- **Section 4.0:** "Soil Excavation Remedial Design" describes the design basis for the planned excavation of contaminated soil.
- **Section 5.0:** "Groundwater Extraction and MNA Remedial Design" describes the extraction system and MNA design elements.
- **Section 6.0:** "Land Use Control Remedial Design" describes the proposed scope and implementation activities associated with the LUC component of the remedy.
- **Section 7.0:** "Remedial Action Work Plan" describes the tasks to implement the design for soil excavation, groundwater recovery, and MNA RAs.
- **Section 8.0:** "Post-Remedial Monitoring and Reporting" describes monitoring activities that will be used to track progress of the groundwater recovery and MNA RAs.
- **Section 9.0:** "Schedule" provides a list of activities and anticipated durations for the work plan tasks.
- **Section 10.0:** "Operation and Maintenance Procedures" describes the activities to be performed to operate and maintain the groundwater recovery system, monitoring network, and LUCs.
- **Section 11.0:** "References" provides citations for the documents used as references.

This work plan also includes the following appendices supporting the main text.

- **Appendix A** includes the Analytical Data Reports for the August 2018 soil samples collected from locations that were inaccessible during the PDI sampling event conducted in January 2018.
- **Appendix B** includes the Sample Collection Logs from the August 2018 soil sample collection event.
- **Appendix C** includes sample specification sheets for the pumps and tanks to be used as part of the groundwater extraction system.
- **Appendix D** includes a sample weekly tracking form that will be used to document groundwater recovery volumes, pumping rates, and operation and maintenance (O&M) activities for the groundwater recovery system.
- **Appendix E** includes the sample Annual LUC Compliance Checklist and Compliance Certification.

1.5 Deviations from the Installation Wide Work Plan

There are two planned deviations from the Final Installation Wide Work Plan (IWWP) (Bhate 2018b) that are described in more detail later in this document:

- **Excavation Sidewall Confirmation Samples for Small Excavations (Section 4.4)** - For small excavation areas (less than 400 square feet of floor area and sidewall height of less than 6 feet) it is proposed to collect a 4-point composite sidewall sample from such excavations by collecting a grab sample from each of the four sidewalls. The IWWP indicates that a wall samples shall be collected from every 1,000 square feet of excavation floor and from each wall. For the small excavations described, the area of the four sidewalls combined will be less than 480 square feet. If the sidewall composite sample result is above the cleanup levels, then additional grab samples will be collected from each wall to determine which direction to overexcavate. Excavation floor sampling for small excavations will be performed in accordance with the IWWP.
- **Baseline Groundwater Sampling for Perchlorate in 17WW01 and 17WW02 (Section 5.3)** – The pump inlet for the November 2017 sample from 17WW01 was at approximately 20.8 feet, which is the midpoint of the screened interval. The previously collected samples from 17WW01 in 2009 and 2010 used an inlet at 28 feet and 28.5 feet respectively. The pump inlet for the sampling of 17WW02 in 2010 was 20 feet, while an inlet depth of 17 feet was used in 2017. The baseline sample to be collected from 17WW01 prior to the installation of the extraction system will be collected with a pump inlet depth of 28 feet to match the inlet used for the 2009 and 2010 samples and 17WW02 will be sampled using a pump inlet depth of 20 feet to match the 2010 sample. This will be done to ensure consistency with the previous sampling techniques

and to allow comparable results. All other groundwater sampling planned as part of the monitoring described in this work plan will be performed in accordance with the IWWP (Bhate 2018b).

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2.0 SITE CHARACTERISTICS

2.1 Geology and Hydrogeology

The local geology at LHAAP-17 consists of silty, clayey, and sandy units of the Wilcox Group. The uppermost unit consists predominantly of silty clay-to-clay extending to depths ranging from 5 to 30 feet. Underlying this layer is a gray to light brown, fine-grained, silty-sandy unit interbedded with silty clay-to-clay lenses. The clay layers act as an aquiclude separating the Shallow Zone from the Intermediate Zone. Boring 17WW05 was drilled to a total depth of 150 feet below ground surface (bgs). In this boring, a thick, relatively homogeneous fine- to medium-grained sand was encountered from approximately 50 to 150 feet bgs and reflects the geology of the Lower Wilcox Formation.

The Intermediate and Deep Zones comprise the Wilcox Formation, which is separated from the Shallow zone by a Wilcox clay layer. With the exception of two monitoring wells, 17WW05 and 17WW16, which were completed in the Deep Zone (lower Wilcox), the remainder of the monitoring wells at the site have been completed in the Shallow Zone and Intermediate Zone (upper Wilcox). The depth of the Shallow Zone groundwater generally ranges between 10 and 35 feet bgs. The Intermediate Zone (upper Wilcox) extends below the Wilcox clay at approximately 55 feet bgs. The Deep Zone extends below the upper Wilcox to a depth of approximately 150 feet bgs based on information from well 17WW05. Groundwater elevations from two sets of co-located wells measured in November 2017 indicated that the groundwater elevation in the Intermediate Zone is generally lower than the groundwater elevation in the Shallow Zone: the groundwater elevation in Intermediate Zone well 17WW09 was lower by 0.12 foot compared to the groundwater elevation in Shallow Zone well 17WW10; similarly, the groundwater elevation in Intermediate Zone well 17WW07 was lower by 0.46 foot compared to the groundwater elevation in Shallow Zone well 17WW08. These elevations indicate that a slight downward vertical gradient is present at the site. The general groundwater flow direction depicted based on the November 2017 LHAAP-17 potentiometric data in the Shallow Zone and the November 2017 LHAAP-18/24 potentiometric data from the *Draft Quarterly Evaluation Report, 4th Quarter (October-December) 2017* (Bhate 2018a) is to the west (**Figure 2-1**), while the Intermediate Zone flow is predominantly to the north (**Figure 2-2**).

2.2 Nature and Extent of Contamination

Contamination was found in the soil and shallow zone groundwater. The COCs are toxic and, with the exception of perchlorate, carcinogenic. Principal threat waste material was initially thought to be present due to the high concentrations of perchlorate in soil. However, subsequent information confirmed that the concentrations that were present did not constitute

principal threat waste (AECOM 2016). According to the Final ROD (Shaw 2016), the maximum 2,4,6-TNT concentration in the soil is 10,000 milligrams per kilogram (mg/kg). Other explosives, 2,4-dinitrotoluene (DNT) and 2,6-DNT, have maximum concentrations of 4,000 mg/kg and 27.5 mg/kg (2018), respectively. The concentrations of 2,3,7,8-TCDD toxicity equivalence concentration and barium potentially affecting ecological receptors are 1.9×10^{-4} mg/kg and 20,500 mg/kg, respectively.

2.3 Current and Future Land Use

LHAAP is located near the unincorporated community of Karnack, Texas. Karnack is a rural community with a population of approximately 775 people. The incorporated community of Uncertain, Texas, approximate 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) with an access gate that is locked after daylight hours, which restricts public access. The fence now represents the National Wildlife Refuge boundary. The public can access most of the facility during the day, with additional fencing and signage restricting access from some environmental sites.

The reasonably anticipated future use of LHAAP-17 is part of a national wildlife refuge. This anticipated future use is based on a Memorandum of Agreement (MOA) (U.S. Army 2004) between the USFWS and the U.S. Army. That MOA documents the transfer process of the LHAAP acreage to USFWS to become the Caddo Lake National Wildlife Refuge and will be used to facilitate a future transfer of LHAAP-17. Presently the Caddo Lake National Wildlife Refuge occupies approximately 7,100 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 (Shaw 2016).

2.4 Current and Future Surface Water Use

Streams on LHAAP currently support wildlife and aquatic life. While humans may have limited access to some streams during annual hunts, there is no routine human use of streams on LHAAP. The streams do not carry adequate numbers and size of fish to support either sport or subsistence fishing. During the summer months, the streams cease flowing and/or dry up.

The streams flow into Caddo Lake. Caddo Lake is a large recreational area that covers 51 square miles and has a mean depth of 6 feet. The watershed of the lake encompasses approximately 2,700 square miles. It is used extensively for fishing and boating. Caddo Lake is a drinking water supply for multiple cities in Louisiana including Vivian, Oil City, Mooringsport, South Shore, Blanchard, Shreveport, and Bossier City.

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

2.5 Current and Future Groundwater Use

Groundwater in the drinking water aquifer (250 to 430 feet bgs) near LHAAP is currently used as a drinking water source. The drinking water aquifer should not be confused with the Deep Zone groundwater, which extends only to a depth of approximately 151 feet bgs. The Deep Zone groundwater and the drinking water aquifer are distinct from each other, and there is no connectivity between the contaminated zone and the drinking water aquifer. There are five active water supply wells near LHAAP that are completed in the drinking water aquifer (**Figure 2-3**). One well is located in and owned by Caddo Lake State Park. The well is completed to a depth of 315 feet bgs and has been in use since 1935. A second well owned by the Karnack Water Supply Corporation services the town of Karnack and is located approximately two miles southeast of town. This well is completed to approximately 430 feet bgs and has been in use since 1942. The Caddo Lake Water Supply Corporation has three wells located both north and northwest of LHAAP. These wells are identified as Caddo Lake Water Supply Corporation Wells 1, 2, and 3, and all are hydraulically upgradient of LHAAP (Jacobs 2001). These wells are completed deeper than the deepest zone of contamination at LHAAP. Because of this and the large distance between these wells and LHAAP, water removal from these wells is not expected to affect groundwater flow at the site. In addition, there are several livestock and domestic wells located in the vicinity of LHAAP with depths averaging approximately 250 feet bgs.

Three water supply wells are located within the boundary of LHAAP itself. One well is located at the Fire Station; the second well is located approximately 0.35 miles southwest of the Fire Station. The third well is located 30 feet east of the USFWS administration building for the Caddo Lake National Wildlife Refuge, near the main entrance to LHAAP. The distances from these water supply wells to LHAAP-17 are approximately 2.2 miles, 2.1 miles, and 2.6 miles, respectively. The three water supply wells were completed at a depth much greater than the zone of contamination described at LHAAP-17. Two additional wells previously supplied water to the installation, but these have been plugged and abandoned. None of these three wells are currently used for drinking water at LHAAP, although they may supply water for non-potable uses.

Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-17 as a drinking water source, the State of Texas designates all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 Texas Administrative Code (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. The selected remedy for LHAAP-17 includes a LUC preventing groundwater use until COC concentrations are supportive of unlimited use and unrestricted exposure.

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3.0 PRE-DESIGN INVESTIGATION

A PDI was conducted between November 2017 and March 2018 in accordance with the PDI Work Plan (AECOM 2016) to collect information required for the preparation of the RD/RAWP. The Draft Final PDI Report (APTIM 2018) was submitted to the USEPA and TCEQ on September 12, 2018 and was approved with no further comments by both agencies on September 28, 2018.

3.1 Soil Investigation

During January 11-15, 2018, the soil sample collection was completed at 80 of the 93 locations identified in the PDI Work Plan (AECOM 2016). Thirteen locations in the northeastern part of the site were under water and inaccessible for sampling for barium and 2,4-DNT/2,6-DNT. Samples were collected from 12 of the 13 previously inaccessible locations on 8-9 Aug 2018. The sample from the 13th location (17SB01A) was intended to be a 7-9 feet deep vertical delineation sample; however, saturated subsurface conditions prohibited collection of the sample from that location using a hand auger, despite multiple attempts. The excavation around 17SB01A is planned for a depth of 7 feet or to the top of groundwater, whichever is shallower. If groundwater is not encountered above 7 feet, the floor sample from the excavation will take the place of the 7 to 9-foot sample that had been planned for collection. No sample will be collected if saturated conditions are encountered shallower than 7 feet. The soil sample data from the January 2018 sampling event were reported in the Draft Final PDI Report (APTIM 2018). The analytical data from the August 2018 sampling event is provided in **Table 3-1**. Analytical data reports are included as **Appendix A,** and Sample Collection Logs are provided as **Appendix B**.

The PDI identified primarily shallow explosives contamination and limited barium contamination. Areas to the north of Area H (as identified in **Figure 4-1**) in the northwest quadrant and south/east of Areas M and N (as identified on **Figure 4-1**) in the southeastern quadrant were not completely delineated by the samples collected. However, these areas approach the boundaries of the historical operations (burning and flashing pits) where surface contamination would be expected, and any concentrations in those areas exceeding the cleanup levels are unlikely to extend very deep based on the available data from those areas. Therefore, no additional sampling was conducted in these areas, and excavation confirmation sampling will be used to confirm the contaminated soil was removed. **Figure 3-1** shows the locations with concentrations of one or more COC exceeding the cleanup goal that will require excavation and the proposed excavation areas mentioned above are discussed in **Section 4.3** and shown on **Figure 4-1**.

3.2 Aquifer Pumping Test

An aquifer-pumping test was conducted at LHAAP-17 beginning on January 19, 2018 and concluding on January 27, 2018. The aquifer-pumping test was performed following the PDI Work Plan (AECOM 2016) and consisted of 1) installation of three new piezometers; 2) period of ambient monitoring; 3) step-drawdown test; 4) constant-rate test; and 5) recovery test. The aquifer-pumping test was conducted to evaluate aquifer and pumping well properties that will provide a basis for the design (capture area, design pumping rates, piping requirements, etc.) of the groundwater recovery system specified as part the selected remedy in the ROD (Shaw 2016). Monitoring Well 17WW02 was used as the primary pumping well, and wells 17WW01 and 17WW06 were used as supplemental pumping locations at the end of the constant-rate pumping test.

The test was performed to obtain additional data for the RD as described in the PDI Work Plan (AECOM 2016). Previously, a 4-hour pumping test was conducted in 17WW01, 17WW02, and 17WW06 and indicated that the potentially sustainable pumping rates ranged from 0.89 to 1.49 gallons per minute (gpm) (AECOM 2016). The initial step test performed in January 2018 indicated that these rates could not be sustained from 17WW02. The rates in the constant-rate test ranged from 0.25 gpm in 17WW02 to 1.5 gpm in 17WW01 and 17WW06 when they were pumping. The aquifer recovered in less than 24 hours as expected. A detailed description of aquifer testing and conclusions is included in Draft Final PDI (APTIM 2018).

The Transmissivity (T), Hydraulic Conductivity (K), and Storativity (S) values calculated from the recovery tests were very consistent between all three piezometers, and generally within an order of magnitude of the values calculated from the constant-rate test data. The relatively good agreement between the two sets of calculated values provides confidence that the values are representative of the area in the vicinity of 17WW02 and may be extrapolated for use elsewhere at LHAAP-17 based on the pumping data collected from 17WW01 and 17WW06. The values calculated based on the recovery data are more consistent and should provide a good basis for designing the pumping system needed to capture and remove the high concentrations of perchlorate present in groundwater in the vicinity of 17WW06 in accordance with the selected remedy in the ROD. Because the late term pumping data from 17WW06 indicate that it may be capable of producing greater than 1.5 gpm, careful consideration has been given to the design of the pumping system described in **Section 5.0**.

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4.0 SOIL EXCAVATION REMEDIAL DESIGN

The design elements of the excavation are provided in the following sections. The details of the implementation of the design are included in **Section 7.0**.

4.1 Design Criteria

The soil design criteria define the goals to be achieved and are based on the RAOs of protection of human and ecological receptors from contaminated soil and the protection of human health by preventing further potential degradation of groundwater. The ROD identified chemical COCs for human health and COPECs as shown in **Table 1-1**. The soil cleanup levels for Human Health Risk and Ecological Risk in Soil (EcoPRGs) included in the ROD are shown in **Tables 1-2** and **1-3**. The design for soil includes excavation of the contaminated soil until the cleanup levels are attained or groundwater is encountered. If the contamination is present at or below groundwater level, excavation will be terminated at the depth where saturated conditions are encountered.

4.2 Performance Objective

The performance objective is to remove the contaminated soil above the cleanup levels. Confirmation samples will be collected and analyzed for the COCs or COPECs after excavation to verify the contaminated soils were removed and cleanup levels were attained. Soil concentrations in several samples exceeded the cleanup levels for human and/or ecological receptors. The soil samples exceeding the human health and ecological cleanup levels for the COCs and COPECs are shown on **Figure 3-1**.

4.3 Excavation Area

The proposed excavation area to address both human health and ecological receptors is shown on **Figure 4-1**. The excavation area was developed by extending the limit (vertically and horizontally) to sample locations that had results below the COC or COPEC cleanup levels based on the data in the Draft Final PDI Report (APTIM 2018), the August 2018 soil sample results, and the historical data. The estimated horizontal area is depicted on the figures. The excavation depths anticipated to remove the contaminated soil vary from 2 to 7.5 feet bgs at various locations within the footprint of LHAAP-17. The groundwater elevation typically varies from 7 to 9 feet bgs. As discussed in **Section 3.1**, the excavation area is not fully delineated, but approximately 5,300 in-place cubic yards (CY) of soil will be excavated.

In most areas, soil will be excavated from the entire area to a depth of 2.5 feet bgs to 3 feet bgs. Isolated samples had contamination detected deeper than 3 feet, but were clean at 7 feet bgs. In these excavation areas, the excavation floor will be sloped from the 3 foot to the 7 foot

depth. In areas where the sidewall height of the deeper excavation area would be greater than 4 feet, the excavation walls will be benched.

Confirmation samples will be collected to define the final excavation limits. If contamination is present in a confirmation sample, the excavation limits will be extended in increments of 1 foot vertically and 2 to 5 feet horizontally until confirmation samples are below the applicable human health cleanup levels or saturated conditions are encountered. Areas being excavated for ecological exceedances will be terminated at 2 feet bgs vertically because deeper soil will not impact ecological receptors; however, the ecological area excavations will be extended horizontally if wall samples indicate contamination is present above the ecological cleanup levels.

4.4 Confirmation Sampling

Each confirmation sample will be a 5-point composite soil sample collected from every 1,000 square feet of the excavation floor area and of each sidewall, in accordance with the IWWP (Bhate 2018b). However, a deviation from the 5-point composite methodology is proposed to allow the use of existing soil samples to define the excavation limits. The proposed excavation extent shown on **Figure 4-1** has been established to allow the use of the existing soil samples as confirmatory wall or floor samples where possible. **Figure 4-2** shows the existing samples that will be used as confirmation samples for the proposed excavation. **Table 4-1** summarizes the sample locations to be used for each excavation area and the additional confirmation samples from each area that will be collected to provide for adequate sampling of the excavation area floors and sidewalls in accordance with the IWWP (Bhate 2018b).

The following proposed sampling procedure for small excavation areas (less than 400 square feet of floor area and sidewall height of less than 6 feet) is a deviation from the IWWP. It is proposed to collect a 4-point composite sidewall sample from such excavations by collecting a grab sample from each of the four sidewalls. If the sidewall composite sample result is above the cleanup levels, then additional grab samples will be collected from each wall to determine which direction to overexcavate. Excavation floor sampling for small excavations will be performed in accordance with the IWWP.

Based on the initial excavation limits shown on **Figure 4-1** and the sampling summarized on **Table 4-1**, approximately 17 confirmation samples will be collected from the floors, and approximately 26 confirmation samples will be collected from the sidewalls of the excavation areas. If the confirmation sample is above the cleanup level, additional soil will be removed (5 feet laterally and 1 foot vertically). After each over-excavation, additional confirmation samples will be collected from the excavation floor and/or wall(s) as needed. This process of over-excavation and collection of additional confirmation samples will continue until the cleanup level area attained or until groundwater is encountered.

In the event that groundwater is encountered and a floor sample cannot be collected, a linear 5-point composite sample will be collected from each excavation sidewall just above the groundwater interface to represent the floor area above the groundwater. If the linear 5-point composite sidewall sample is above the cleanup level, then additional excavation of the sidewall will be conducted to the groundwater interface depth, and over-excavation step outs and confirmation sampling would continue until the confirmation sample results are below the cleanup levels. The confirmation samples will confirm that the vadose zone soil identified as exceeding the cleanup levels would be removed.

4.5 Waste Characterization and Disposal

The excavated soil will be disposed at an off-site landfill. Waste characterization samples will be collected at a rate of one sample for every 1,000 cubic yards of excavated soil to characterize the waste. It is anticipated that soil will be classified as non-hazardous. Samples will be analyzed for the analytes required by the selected waste disposal facility.

4.6 Backfill and Site Restoration

Following the receipt of clean confirmation samples for a given excavation area, clean fill dirt will be placed in the excavation and compacted with the backhoe/excavator bucket to prevent settling. The fill dirt will be suitable for future vegetation growth. Borrow source material will be considered clean if VOC, explosives, and perchlorate are below the TCEQ RRS2 MSCs for industrial use and metals are below the ecological cleanup levels. Approximately 7,400 CY of fill dirt will be brought on site. Borrow source samples will be collected at a rate of one per 1,000 cubic yards of borrow soil. The site will be reseeded with a native grass and wildflower mix with guidance from USFWS.

4.7 Other Design Considerations

Several of the bridges at LHAAP have weight limits. Routes for trucks filled with waste soil as well as for trucks bringing clean soil from borrow sources will be selected with coordination from USFWS. Additional gates may need to be unlocked to allow access to and from LHAAP from another gate besides the main gate in Karnack to avoid bridges where weight limits may be exceeded with loaded trucks.

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5.0 GROUNDWATER EXTRACTION AND MNA REMEDIAL DESIGN

The design elements for the groundwater extraction are provided in the following sections. The details of the implementation of the design are included in **Section 7.0**.

5.1 Design Criteria

The groundwater design criteria define the goals to be achieved and are based on the RAOs of protection of human health from contaminated groundwater, of protection of human health and the environment by preventing contaminated groundwater from migrating into nearby surface water, and if practicable, return groundwater to its potential beneficial use as drinking water. The ROD identified COCs for groundwater, as shown in **Table 1-1**. The groundwater cleanup levels for Human Health Risk from the ROD are shown in **Table 1-2**. The design for groundwater includes extraction, MNA, and a contingency remedy, if needed.

5.2 Performance Objective

The performance objective is to extract contaminated groundwater in the Shallow Zone for 18 months to remove concentrations of perchlorate exceeding 20,000 µg/L. The current concentrations and perchlorate plume in the shallow groundwater zone are shown on **Figure 5-1** and **Table 5-1**. If the perchlorate concentration in each of the wells has dropped below 20,000 µg/L at the end of the 18-month extraction period, MNA will be implemented until the groundwater COCs have attained the cleanup level. If the trigger value has not been obtained after the extraction period, a contingency remedy will be implemented to treat the contaminated groundwater in situ.

5.3 Groundwater Extraction Design

The groundwater extraction system will include groundwater recovery pumps installed in two extraction wells located within the perchlorate and TCE groundwater plumes (17WW02 and 17WW06). Baseline groundwater samples will be collected from 17WW01, 17WW02, and 17WW06 prior to beginning the system construction. The sample from 17WW01 will be collected with a pump inlet depth of 28 feet and 17WW02 will be collected with a pump inlet depth of 20 feet to be consistent with the 2009 and 2010 samples collected from those locations, which contained perchlorate concentrations exceeding 20,000 µg/L. As discussed in Section 1.5, the sample collection at 17WW01 and 17WW02 will be a deviation from the IWWP. The remaining groundwater samples will be collected in accordance with the IWWP (Bhate 2018b). If the perchlorate concentration in well 17WW01 is greater than 20,000 µg/L, 17WW01 will be outfitted with a pump and used as an extraction well along with 17WW02 and 17WW06. The extracted groundwater will be piped to the existing 4-inch conveyance line

from LHAAP-16 to the groundwater treatment plant (GWTP) for treatment, prior to discharge to Harrison Bayou. The design in this document focuses on extracting and conveying the groundwater to the existing line and not on the treatment at the GWTP. The GWTP process is designed to treat groundwater impacted with perchlorate and volatile organic compounds and has the capacity to treat the contaminants from LHAAP-17.

5.4 System Components

The pumps in the extraction wells will be pneumatically operated using compressed air supplied by a compressor to be installed at the site. The decision to use pneumatic pumps was driven by the range of flow rates potentially expected in the two wells, the distance of the site from electrical power lines, and the ability to easily avoid damage to the pumps, which could occur if electric submersible pumps were used and ran dry.

Figure 5-2 is the process flow diagram that depicts the groundwater extraction from two wells. The following subsections provide more details about the pumps and other components selected.

5.4.1 Extraction Pump Selection

The proposed pneumatic pumps are made of fiberglass body and internal parts consisting of stainless steel and polyvinylidene difluoride (PVDF) which are compatible with the COCs present in the groundwater. The pump specifications are included in **Appendix C** of this Plan. The pneumatic pumps operate on compressed air and are capable of extraction rates ranging from 0 to 5 gpm, which will meet the pumping rates expected from these two wells. These pumps expel a known volume of water with each cycle and contain cycle counters to record the quantity of groundwater extracted from each well within a given time period. The existing stickup well boxes will be removed, and the pump controller and connecting piping at each wellhead will be installed in steel well vault measuring approximately 4 feet by 4 feet. A compressor will be connected to an electrical drop near the entrance of the site along Avenue Q, and compressed air lines and water piping will be installed in a trench to the wellheads to operate the pumps. The pump and other equipment installation details are described in **Section 7.0** of this Plan.

The constant rate pumping test performed for the PDI pumped well 17WW02 at a rate of 0.25 gpm for approximately 48 hours. Steady state drawdown levels were achieved in the pumping well (8.72 feet of drawdown), as well as three nearby piezometers prior to initiating pumping in 17WW01 and 17WW06. At the time steady state was achieved, the drawdown at a distance of 90 feet from the pumping well was approximate 0.25 feet, but the drawdown at a well approximately 150 feet from the pumping well could not be distinguished from background fluctuations. Therefore, the radius of influence for pumping 17WW02 at a rate of

0.25 gpm is conservatively estimated at approximately 100 feet. The pumping rate was limited during the pumping test by the need to avoid running the pump dry and the placement of transducers several feet below the pump. The construction of 17WW02 will allow at least five additional feet of drawdown, which will allow a flow rate higher than 0.25 gpm to be sustained. The pneumatic pumps proposed for use cannot be damaged by running the well dry and can fully dewater the well to maximize the cone of depression around it. The calculations shown on **Table 5-2** estimate that 17WW02 will maintain a pumping rate of 0.4 gpm when fully drawn down, and **Figure 5-3** shows a 125 foot estimated radius of influence for the higher pumping rate.

The second proposed extraction well, 17WW06, was operated at a pumping rate of 1.5 gpm near the end of the pumping test, and the final drawdown was 4.09 feet. The pumping of 17WW06 and 17WW01 showed measurable drawdown at piezometer locations 150 to 180 feet from the wells, indicating that the radius of influence when pumping in the 1.25 to 1.5 gpm range was at least 150 feet. The construction of 17WW06 will allow at least another 6.5 feet of drawdown. Therefore, the calculation on **Table 5-2** estimate a pumping rate of 2.5 gpm for 17WW06 and **Figure 5-3** shows an estimate radius of influence of 250 feet.

Monitoring Well 17WW02 may also be used as an extraction well based on the outcome of the baseline sampling. 17WW02 was pumped at a rate of 1.25 gpm at the end of the pumping test and the final drawdown was 11.31 feet. Based on a pumping rate of 1.5 gpm, the radius of influence for 17WW01 is estimated to be 200 feet, as shown on **Figure 5-3**. The calculation on **Table 5-2** uses the estimated pumping rate of 1.5 gpm for 17WW01.

It should be noted that various empirically derived formulae for estimating radius of influence provide significantly higher estimated radii of influence for the wells based on the hydraulic conductivity, storativity, and transmissivity values calculated from the pump test. The radii of influence used for 17WW02 and 17WW06 on **Table 5-2** and **Figure 5-3** are conservatively estimated for this RD based on the observed drawdown measured during the pumping test and will be adequate to capture nearly the full extent of the perchlorate plume exceeding 17 µg/L as depicted on **Figure 5-3**. The aquifer pumping test results were discussed in **Section 3.2** of this document.

5.4.2 Extraction/Discharge Piping and Temporary Storage of Groundwater

The groundwater extracted from the extraction wells will be temporarily stored in a 2,500-gallon high density polyethylene pipe (HDPE), double wall holding tank located at LHAAP-17. The holding tank will be placed and anchored to a concrete pad adjacent to the compressor pad. Details of the holding tank are included in **Appendix C** of this Plan. The 1-inch diameter HDPE extraction piping from the two wells will be connected to the holding

tank. The piping will be buried underground. From the holding tank, 1-inch polyvinyl chloride piping will run above ground to the transfer pump, and this piping will be insulated or heat traced for freeze protection. The 1-inch PVC piping from the transfer pump will be buried and tapped into the existing 4-inch PVC conveyance pipe from LHAAP-16 to the GWTP. If LHAAP-16 is no longer in operation, the conveyance line to the GWTP may be cut and blind flanged. If operation is still ongoing at LHAAP-16, appropriate valves will be installed on the LHAAP-16 conveyance line to prevent any potential backflows. As shown on **Figure 5-2**, the existing high-level sensor in the GWTP equalization tank (currently used to shut down the LHAAP-18/24 wellfield) will be used to trigger shutoff of the transfer pump to avoid overfilling the equalization tank. The holding tank at LHAAP-17 will also be equipped with auto shutoff equipment to shut down pumping from the extraction wells to prevent overfilling the holding tank. The extracted groundwater from the holding tank will be transferred to the GWTP by a transfer pump activated by level sensors. The piping, holding tank, and other appurtenances installation details are described in **Section 7.0**.

5.5 Groundwater Monitoring During Extraction

Remedial Action Operation (RA-O) sampling will commence once extraction begins. Water from 17WW01, 17WW02, and 17WW06 will be sampled and analyzed for perchlorate prior to beginning extraction to determine if 17WW01 will be needed as an extraction well (if the perchlorate concentration exceeds 20,000 µg/L). Sampling of water from 17WW01, 17WW02, 17WW03, 17WW06, and 130, will be conducted monthly for the first 6 months and then quarterly for the next 12 months of the extraction period. Data from the samples collected semiannually from MW-18 and MW-19 as part of the LHAAP-18/24 monitoring will be used to evaluate possible impacts from the extraction on the LHAAP-18/24 plume. The remaining LHAAP-17 network wells will be gauged for the initial baseline elevation and quarterly to allow for evaluation of the capture radius of the extraction system. Once the 18-month extraction period is completed, quarterly MNA monitoring will be initiated as part of the RA-O sampling. Following consultation with the USEPA and TCEQ, the groundwater extraction system will be shut down at the conclusion of the 18-month period.

5.6 Post Extraction MNA Monitoring Design

Upon achieving the target perchlorate concentration in the sampled wells and shutting down the extraction system, the MNA monitoring program will begin with quarterly sampling of monitoring wells selected for the monitoring network for two years. The monitoring network is discussed in **Section 8.2**. Following two years of quarterly monitoring, an MNA evaluation will be performed to determine if the remedy is successful. If so, monitoring will continue semiannually for three years and then annually thereafter. If MNA is unsuccessful, a contingent remedy may be implemented via an Explanation of Significant Differences (ESD) to the ROD.

5.7 Contingency Remedy

If the target perchlorate concentration of 20,000 µg/L is not met in the sampled wells after 18 months of extraction, a contingent remedy may be implemented via an ESD to the ROD.

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6.0 LAND USE CONTROL PLAN

The U.S. Army or its representative will be responsible for LUC implementation and certification, reporting and enforcement. The U.S. Army will address the LUC problems within its control that are likely to impact remedy integrity and will address problems as soon as practicable. Per the Final ROD (Shaw 2016), the LUCs' performance objectives are to:

- Prohibit the use of groundwater contaminated as a potable water source;
- Restrict land use to nonresidential; and
- Maintain the integrity of any current or future remedial or monitoring systems.

The implementation, maintenance, and inspection requirements associated with each of the performance objectives that comprise this LUC RD are described below. The proposed actions to be taken to implement the LUC objectives during the RA phase are described in **Section 8.0**. The implementation activities, as well as ongoing maintenance, monitoring, and reporting requirements will be presented in the Remedial Action Completion Report (RACR), as the final LUC RD. Upon regulatory review and concurrence with the final LUC RD, it will be included as part of the Comprehensive LUC Management Plan.

For portions of the Site subject to land use controls that are not owned by the Army, the Army will monitor and report on the implementation, maintenance, and enforcement of land use controls, and coordinate with federal, state, and local governments and owners and occupants of properties subject to land use controls. The Army retains responsibility for ensuring that the remedy remains protective of human health and the environment.

6.1 LUC Implementation

The actions required to implement the LUCs for LHAAP-17 are described below. The first of these, the initial notice of LUCs was completed on December 8, 2016. The December 8, 2016 notice letters that were sent to relevant officials (U.S. Army 2016) included a preliminary LUC boundary. The proposed LUC boundary for the groundwater use restriction is shown in red on **Figure 6-1**. The LUC boundary for the non-residential site use will be the "Site Boundary" shown in blue on **Figure 6-1**. The following actions will be undertaken to implement the LUCs for LHAAP-17:

- Finalize the boundary for the LUCs as a part of the remedial action.
  - Revise the boundary, if necessary, based on groundwater sampling results. The final boundary of the groundwater LUCs (prevent the use of groundwater contaminated above cleanup levels as a potable water source and prohibit access to the contaminated groundwater except for environmental monitoring and testing

only); the remedial or monitoring system LUCs (maintain the integrity of any current or future remedial or monitoring systems); and the nonresidential land use LUC (restrict land use to nonresidential) will be reviewed during RA activities after an evaluation of the monitoring data has been completed and revised if necessary.

  - Survey the groundwater use and land use restriction LUC boundaries. The boundaries will be finalized after concurrence by USEPA and TCEQ, and will be surveyed by a State-licensed surveyor. A legal description of the surveyed areas will be appended to the survey plat.

- Record the LUCs in Harrison County. The LUC plat, legal description, and LUC restriction language will be recorded in the Harrison County Courthouse in accordance with TAC Title 30, §335.566.
- Notify the Texas Department of Licensing and Regulation of the groundwater LUCs. The Texas Department of Licensing and Regulation will be notified of the groundwater restrictions, which include the prohibition of water well installation for any purpose other than environmental monitoring and testing without prior approval from the Army, the USEPA, and the TCEQ. The survey plat, legal boundary, and description of the groundwater restriction LUCs, in conjunction with a locator map, will be provided in hard and electronic copy.
- Provide notice after finalizing LUC boundary as part of the RA. The notice will consist of a brief description of the contaminants in groundwater and soil, a written description of the LUCs and a figure depicting the revised LUC boundaries. The notices will be sent to federal, state, and local officials including: U.S. Senators, U.S. Congressman, State Senator, State Representative, Harrison County Judge, Harrison County Commissioner Precinct 1, City of Uncertain Mayor, and Karnack Water Supply Corporation Board Members. Notice will also be sent to the Caddo Lake National Wildlife Refuge Manager.
- Periodically transmit the notice to federal, state, and local governments involved at this site and the owners and occupants of the properties subject to those use restrictions and LUCs. The transmittal will coincide with each Five Year Review and will be documented in the report.

6.2 Maintenance and Monitoring Requirements

The LUCs will be maintained in place as follows:

- The LUCs restricting the use of groundwater to environmental monitoring and testing only and the LUC restricting land use to nonresidential will remain in place until the levels of COCs (i.e., including all hazardous substances, pollutants, and contaminants found at the Site at cleanup levels as listed in **Tables 1-2 and 1-3**) in surface and subsurface soil and groundwater allow for unlimited use and unrestricted exposure;

- The LUC to maintain the integrity of any current or future remedial or monitoring systems will remain in place until groundwater cleanup levels of COCs (i.e., including all hazardous substances, pollutants and contaminants found at the Site at cleanup levels as listed in **Table 1-2**) are met; and,

- The LUC prohibiting groundwater use (except for environmental monitoring and testing) as a potable source will remain in place until the levels of COCs (i.e., all hazardous substances, pollutants, and contaminants found at the Site at cleanup levels as listed in **Tables 1-2 and 1-3**) in soil and groundwater allow for unlimited use and unrestricted exposure.

Remedial or Monitoring System LUCs include physical components that require repair and maintenance. These are described in **Section 10.0.** The RAO and Extraction System Inspection and Maintenance Checklists is provided in **Appendix D.**

The administrative maintenance required to ensure the LUCs remain in place and effective until the cleanup levels of the COCs are at levels that allow unrestricted use and unlimited exposure are:

- Annual field inspections of the site to confirm that no violations of the LUCs have occurred. Documentation of the inspection will be included in the Inspection and Maintenance Checklist (see **Appendix D).**

- Annual certifications that no LUC-restricted activities have been authorized and that site conditions and use are consistent with the LUCs. The Certification Form is presented in **Appendix E).**

- Periodic transmittal of a LUC Notice to federal, state, and local authorities and to owners and occupants of LHAAP-17. The notice will include the groundwater and soil (surface and subsurface) contamination and any land use restrictions referenced in the ROD, a written description of the LUCs and a figure depicting the LUC boundaries. The transmittal will coincide with each Five Year Review and will be documented in the report.

- The final LUC RD appendix of the RACR will be added to the Comprehensive LUC Management Plan and the plan will be provided to the owner or occupant of LHAAP-17.

The U.S. Army will address LUC problems within its control that are likely to impact remedy integrity and shall address problems as soon as practicable.

6.3 LUC Inspection and Monitoring

Upon finalization of this LUC RA, the amended LUC boundary map and legal description recordation will be inserted into the Comprehensive LUC Management Plan for LHAAP. The Comprehensive LUC Management Plan figure and table will be updated to reflect the inclusion of LHAAP-17.

Beginning with finalization of this RD/RAWP and approval of the Inspection and Maintenance form and the Annual Certification Form, the U.S. Army will undertake inspections and certify continued compliance with the LUC objectives. The U.S. Army, or the transferee after transfer, will retain the LUC Inspection and Certification documents in the project files for incorporation into the Five Year Review reports, and these documents will be made available to USEPA and TCEQ upon request. In addition, should any violations be found during the certification, the U.S. Army will provide to USEPA and TCEQ, along with the document, a separate written explanation indicating the specific violations found and what efforts or measures have or will be taken to correct those violations. The need to continue inspections and certifications will be revisited at Five Year Reviews.

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7.0 REMEDIAL ACTION WORK PLAN

7.1 Field Activities

This section describes the remedial action field activities planned at the LHAAP-17. Prior to initiation of the field activities performed as part of this RD/RAWP, the regulators will be notified at least 10 days in advance. Site-specific activities are described in associated subsections. The field activities to be conducted under this Work Plan are outlined below:

- Mobilization and Site Setup
- Surveying
- Soil Excavation and Disposal
- Confirmation Soil Sampling
- Backfilling and Site Restoration
- Groundwater Extraction System Installation
- Waste Management
- Decontamination
- Site Restoration

In general, the field activities will be conducted in accordance with the IWWP for LHAAP (Bhate 2018b). To the degree possible, excavation activities and groundwater extraction system construction will occur concurrently. However, because excavation is planned for the area around 17WW02, the groundwater extraction piping and control connections to 17WW02 will not be completed until after the excavation has been backfilled in that area.

7.1.1 Mobilization and Site Setup

Prior to the mobilization of subcontractors to LHAAP sites, work locations for overhead and ground level accessibility will be evaluated. In areas that have excessive vegetation and/or tree growth, a backhoe or other appropriate earthmoving equipment will be used to clear the areas to allow equipment access. After coordinating with underground utility locators for utility clearances, excavation locations and areas that require surface soil removal will be located and staked. Utility location and clearance for intrusive activities will be conducted in accordance with Section 3.1 of the IWWP (Bhate 2018b).

Appropriate personnel, subcontractors, and equipment necessary to perform specific task(s) will be mobilized to the site. A permanent decontamination station is located at the on-site LHAAP-18/24 GWTP and can accommodate large equipment. Temporary decontamination

pads will be constructed as needed at approved on-site locations to decontaminate equipment and prevent cross-contamination between sites. Wash water will be contained and transported to the GWTP for disposal when necessary.

Improvement of the site access road using gravel or other materials to reduce the slopes may be performed to allow trucks and heavy equipment to enter and exit the site safely. USFWS will be consulted regarding any improvements to minimize impact to the surrounding terrain to the degree possible.

7.1.2 Surveying

During the excavation, the locations of soil confirmation samples and limits of excavation will be surveyed using global positioning system (GPS) equipment. Use of GPS equipment will be coordinated with USACE in accordance with Section 3.3 of the IWWP (Bhate 2018b). A professional land surveyor licensed in the State of Texas will survey the final horizontal excavation limits. The new vertical elevations of the top of casing for the wells modified to be used as pumping wells (17WW02 and 17WW06) will be based on the North American Vertical Datum of 1988 and will be surveyed to the nearest 0.01 foot.

7.1.3 Soil Excavation and Disposal

The limits and plans for excavation are described in **Section 4.0** of this Plan. Excavation of the soil generally consists of preparing the site, excavating the soil, transporting and disposing the soil, collecting confirmation samples, surveying the excavation limits, backfilling, and restoring the site. Excavations performed under this remedial action are expected to be less than one acre in size and are not subject to the storm water pollution prevention requirements of Chapter 26 of the Texas Water Code and TCEQ General Permit TXR15000. However, best practices (silt fencing, berms, etc.) will be used where appropriate to prevent excess runoff of sediment from the excavation and stockpile areas.

7.1.3.1 Site Preparation

The areas to initially be excavated will be established prior to mobilization of the excavation personnel. A GPS will be used to delineate and mark the excavation area shown on **Figure 4-1**. The potential limits of excavation will then be physically marked with survey stakes, pin flags, paint, or other appropriate marking. Clearing of the vegetation in the excavation area will largely be conducted using conventional equipment. A temporary decontamination station may be constructed on site as needed.

The southwestern portion of the site will be cleared for construction of a temporary soil staging/stock pile area. A temporary staging area consisting of berm with polyethylene sheeting will be constructed for stockpiling soil prior to collecting waste characterization and off-site transport and disposal.

7.1.3.2 Excavation and Soil Handling

After the initial excavation limits are established, excavation will begin. Areas where the excavation depths will exceed four feet will be benched for safety reasons for the persons entering the excavation area. Vertical excavation will stop if groundwater is encountered.

At excavation areas with sufficient soil analytical results from the Draft Final PDI (APTIM 2018), the selected disposal facility may evaluate the results for characterization of the waste and provide pre-excavation acceptance of the soil from these select areas. Pre-excavation acceptance will allow direct loading of contaminated soil and avoid staging and double-handling of material. In these instances, the soil will be removed from the excavation and placed directly in transport trailers or dump trucks for immediate transport to the disposal facility. Licensed transporters will be used to haul the excavated soil to the pre-approved landfill for non-hazardous disposal. The excavated soil may be staged on plastic sheeting adjacent to the excavation while awaiting loading. The excavated soil stockpile will be protected from rainfall runoff and erosion by covering it with plastic sheeting.

Composite samples will be collected from staged material at a rate of 1 sample per 1,000 CY and analyzed for the necessary analytes to obtain acceptance at the selected disposal facility. Each composite sample will consist of equal parts of five samples collected at evenly spaced locations within the stockpile. The fully-characterized excavation stockpile soil will be loaded onto dump trucks and removed from the site for proper disposal in accordance with state and federal regulations. Loading of trucks will be coordinated with USFWS to ensure that load ratings for bridges along the haul route out of the refuge are not exceeded.

7.1.3.3 Confirmation Soil Sampling

Confirmation soil sampling will be conducted concurrently with excavation and will document that the remaining soil meets the established cleanup levels as shown in **Tables 1-2** and **1-3**. After the initial excavation, confirmation samples will be collected from the sidewalls and floor of the excavation in the areas where existing samples are not available for use as confirmation samples. The confirmation samples will be tested for the ecological or human health contaminants being addressed for each excavation area (**Figure 4-1)**. Excavation will continue until concentrations in the soil are less than the site-specific cleanup levels.

When existing sample data are not available for use as confirmation samples, additional composite samples will be collected to ensure that every 1,000 square feet of floor or each sidewall is representatively sampled. Five-point composite soil samples will be collected in accordance with the IWWP (Bhate 2018b). As described in **Section 4.4**, in small areas a composite wall sample may deviate from the IWWP and will be collected by combining discrete samples collected from each of the four walls.

GPS coordinates of each discrete sample location that comprises the composite confirmation sample will be collected. Vertical wall height will be manually measured and recorded. Each sample location will be numbered sequentially in order of collection, labelled on a map, and identified using the following nomenclature:

17WLXXX-ZZ-MMDDYY or 17FLXXX-ZZ-MMDDYY

The number 17 represents the site (LHAAP-17); WL indicates a sidewall sample, while FL indicates a floor sample; XXX represents the unique sample number; ZZ indicates excavation sidewall height or the average depth below ground surface of the excavation floor; and MMDDYY is the date of sample collection.

If contaminants are detected above their cleanup levels during the confirmation sampling, the area will be over-excavated at least one additional foot deeper or 2 to 5 additional feet sideways. The extent of the over-excavation (2 to 5 feet) will consider the concentrations detected in the sidewall sample, and the floor over-excavation will consider the anticipated depth to groundwater. This will continue until confirmation samples demonstrate the contaminants remaining in the soil are below their cleanup level or until groundwater is encountered. The areas excavated for ecological receptors will not be over-excavated vertically, but may be stepped out horizontally.

In the event that groundwater is encountered and a floor sample cannot be collected, a linear 5-point composite sample will be collected from each excavation sidewall just above the groundwater interface to represent the floor area above the groundwater. If the linear 5-point composite sidewall sample is above the cleanup level, then additional excavation of the sidewall will be conducted to the groundwater interface depth, and over-excavation step outs and confirmation sampling would continue until the confirmation sample results are below the cleanup levels. The confirmation samples will confirm that the vadose zone soil identified as exceeding the cleanup levels would be removed.

7.1.3.4 Backfilling and Site Restoration

The backfill operations will proceed after excavation confirmation samples are clean for a definable area. The excavation areas will be backfilled with fill material that is certified to meet the site-specific cleanup levels. If the soil is unstable due to the moisture from the adjacent tributaries/ditches and saturated soil from rain events, the bottom of the excavation will be stabilized with an appropriate product that will not adversely impact the soil pH prior to placing the backfill. The backfill will be placed in 1-foot lifts to allow proper compaction with a backhoe/excavator bucket. After backfilling is complete, the area will be graded, with a mound approximately one foot above finished grade to allow for some soil settling without creating a depression and positive drainage. The top six inches will have a soil that will be

suitable for vegetative growth. The surface will be reseeded with a native grass and wildflower seed mixture selected in coordination with USFWS.

7.2 Groundwater Extraction System Installation

The groundwater extraction system mainly consists of extraction wells, extraction pumps, extraction piping, holding tank, and discharge lines to GWTP. A power drop from existing electric service lines is planned near the entrance of LHAAP-17. If the power drop is not viable, a diesel power generator would be used. The overall groundwater recovery system is shown on **Figure 5-2**.

7.2.1 Extraction Pump Installation

Prior to the extraction pump placement in the wells, groundwater levels will be measured to determine the depth of installation of the pump to get maximum extraction rate. In general, the bottom of the pump will be set at least two feet from the bottom of the well. The pump will be equipped with cycle counters to measure the amount of groundwater recovered from each well. The wellhead assembly will be housed in a 4-foot by 4-foot steel vault and will be equipped with a sample port to allow collection of a sample directly from water produced by the well. The extraction pumps will be operated by compressed air supplied by a compressor located on site. The air compressor will be housed in a building to protect from the elements. The air compressor will be powered by a generator or an electric drop from the power lines along Avenue Q near the entrance to the site.

7.2.2 Extraction/Discharge Piping

The extraction piping will be of SDR 11 HDPE and will be buried at least 18 inches below ground. A walk behind trencher will be used to lay the piping underground. A certified HDPE pipe welding technician will perform the welding of the pipe. The trenches will be backfilled and compacted once the pipe is placed. The extraction piping from each well will be connected to manifold and to the holding tank. The discharge pipe from the holding tank will be PVC piping and will run above ground to the transfer pump before being buried and connected to the existing conveyance line coming from LHAAP-16 feeding into the LHAAP-18/24 GWTP. Backflow preventers will be installed as needed to prevent cross flow to or from LHAAP-16. The piping layout is shown on **Figure 7-1**.

7.2.3 Holding Tank

The 2,500-gallon dual wall HDPE tank will be installed and anchored to concrete pad approximately 10 feet by 10 feet by 4 inches thick, with two layers of weld mesh. The holding tank will be equipped with an auto shut off system to prevent overflow of the tank. The tank will also have a transfer pump activated by level sensors to transfer water to the GWTP. The location of the tank is shown on **Figure 7-1**.

7.3 Waste Management

Waste generated during the course of the project that include waste water, soil piles, personal protective equipment, sampling equipment, and miscellaneous trash will be managed as per Section 3.7 of the IWWP (Bhate 2018b).

7.4 Decontamination

Decontamination of equipment will be performed as per A1 SOP Appendix A of the IWWP (Bhate 2018b).

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8.0 POST-REMEDIAL MONITORING AND REPORTING

8.1 Groundwater Extraction Monitoring

Following installation of the groundwater extraction system, monitoring wells 17WW01, 17WW02, 17WW03, 17WW06, and 130 will be sampled monthly for the first 6 months and then quarterly for 12 months during the 18-month extraction period. The samples will be analyzed for perchlorate by EPA Method 6850 to evaluate progress of the extraction. Upon completing the 18-month extraction period, the system will be shut down, dismantled, and removed, and the MNA monitoring program described below will begin (if the 20,000 µg/L has been achieved) as part of the RA-O sampling.

8.2 RA-O Monitoring Network

The RA-O monitoring network to be used to evaluate the performance of the LHAAP-17 MNA remedy will be selected based on the initial sampling of the network of wells shown in **Table 8-1**. The wells on **Table 8-1** include 14 shallow wells with detected concentrations of COCs and key unimpacted wells upgradient, cross-gradient, and downgradient from the perchlorate and VOC plume areas. Three intermediate zone wells closest to the plume area are also included to allow detection of vertical migration of COCs. Because intermediate zone contamination was not present in the 2017 sampling and deep zone contamination has not been previously detected, monitoring of the deep zone will not be necessary for the RA-O monitoring program. The two deep zone wells will be sampled for the initial sampling event following completion of the extraction period and for each Five Year Review. Following the initial sampling event, the monitoring network may be modified based on the sampling results with regulatory concurrence. All wells with concentrations of one or more COCs exceeding the cleanup goals will be analyzed for the site COCs (VOCs and perchlorate) as well as MNA parameters as shown in the example network in **Table 8-2** (4 wells based on 2017 analytical results). The remaining wells selected for the network will be analyzed only for the groundwater COCs. The initial monitoring network wells are shown on **Figure 8.1**.

8.3 Groundwater Sampling

Groundwater sampling events performed for LHAAP-17 will consist of the following:

- A baseline monitoring event from all LHAAP-17 COC-impacted wells (17WW01, 17WW02, 17WW03, 17WW06, and 130) conducted prior to the initiation of groundwater extraction and monthly for 6 months, followed by quarterly sampling for the next 12 months

- RA-O/MNA monitoring to be conducted quarterly for two years beginning upon completion of the groundwater extraction and used to evaluate the performance of the MNA remedy

- RA-O monitoring that will be conducted semiannually in years 3 through 5 after completion of extraction, and annually thereafter until the groundwater COC concentrations are below the PCL or the regulators agree that less frequent sampling schedule is more appropriate

Areas around the wells will be cleared of vegetation and biohazards prior to each sampling event to protect the field staff. Low-flow groundwater sampling will be performed in accordance with Section 3.5 of the IWWP. Validated data packages will be provided at the monthly managers meeting as they become available.

8.3.1 Baseline Sampling

Monitoring wells 17WW01, 17WW02, 17WW03, 17WW06, and 130 will be analyzed for perchlorate prior to initiating extraction to allow establishment of baseline conditions against which the remedial performance can be evaluated. All network wells will be gauged for groundwater elevation.

8.3.2 Evaluation of Extraction Effectiveness

Groundwater samples from monitoring wells 17WW01, 17WW02, 17WW03, 17WW06, and 130 will be collected monthly for the first 6 months during operation to track the progress of perchlorate reduction. Sampling will be conducted quarterly for the next 12 months. All of the network wells will be gauged for groundwater elevation quarterly to evaluate the capture radius of the extraction system. Extraction will cease upon completion of the 18-month extraction period.

8.3.3 RA-O Monitoring Year 1 and Year 2

A network of wells will be selected to be sampled quarterly following the initial baseline sampling performed following the completion of the extraction period. **Table 8-2** contains an example of the network wells that may be selected and the monitoring planned for each location to monitor the performance of MNA and the long-term stability of the plume. The network shown on **Table 8-2** may change based on the conditions found after the completion of the extraction period. The process of biodegradation results in depletion of dissolved oxygen and oxidation-reduction potential. MNA monitoring will be conducted to evaluate change in geochemical conditions and COC concentrations and to verify that the plume extent is stable or shrinking. For the first two years post-extraction, the wells will be sampled quarterly, with results provided in the monthly managers meetings and summarized more fully in Annual RA-O reports described in **Section 8.5**.

8.3.4 RA-O Monitoring Years 3 through 5

After two years of quarterly performance monitoring and a successful demonstration that MNA is taking place, the monitoring will shift to semiannual RA-O monitoring, and the number of RA-O wells may be reduced based on the MNA monitoring results and recommendations made in RA-O Reports.

8.3.5 RA-O Monitoring Beyond Year 5

RA-O will continue annually after Year 5, if needed, using a monitoring network and analyte list established in the Year 5 RA-O Report based on the ongoing monitoring data. Monitoring will be discontinued with regulator concurrence after COC concentrations in all wells drop below the cleanup level. The need for any additional LTM will be discussed in the next Five Year Review.

8.4 Response Action Completion Report

A RACR will be submitted upon implementation of the groundwater extraction and completion of the excavation to document activities performed to complete the RA. Groundwater monitoring results collected during the extraction system operation will be provided during monthly managers meetings and quarterly memos will document the potentiometric surface data, radius of influence evaluation, extraction rates and perchlorate concentrations, and evaluate trends as appropriate.

8.5 Annual RA-O Reports

An Annual RA-O Report will be prepared at the end of each year to present groundwater monitoring results. During groundwater extraction, the report will summarize the performance of the pumping system and the analytical data collected from the extraction wells. Once monitoring for the MNA remedy begins, wells within the plume areas will be evaluated for effectiveness of MNA, and wells surrounding the plume will be used to evaluate plume stability. The report will provide recommendations, if possible, for reducing the number of monitoring wells to be included in the monitoring program and/or frequency of monitoring events.

8.5.1 MNA Evaluation

A technical evaluation of natural attenuation potential will be performed at the end of the first year and second year of groundwater monitoring. The USEPA guidance, Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (USEPA 1998), will be used as guidance for the natural attenuation evaluation. The USEPA guidance specifies a tiered approach of recommended lines of evidence (LOE) required for demonstrating that MNA is an effective remedy.

There are three LOE according to the USEPA guidance document based on the Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-17 (USEPA 1999), which are described as follows:

- **First Line of Evidence.** Observed reduction in contaminant mass and concentration. Relies on use of historical groundwater data that demonstrate a clear trend of stable decreasing concentrations over time at appropriate monitoring or sampling points.
- **Second Line of Evidence.** Identified and Quantified Natural Attenuation Processes. Uses geochemical indicators to document certain geochemical signatures or "footprints" in the groundwater that demonstrate (indirectly) the type of natural attenuation process(es) occurring at the site and the rate at which such processes will reduce COCs to the cleanup levels (**Table 1-2**) or groundwater medium-specific concentration for industrial use (GW-Ind) levels established by TCEQ.
- **Third Line of Evidence.** Microcosm Studies. Most often consists of predictive modeling studies and other laboratory/field studies that demonstrate the occurrence of natural attenuation process(es) at the site and its ability to degrade the COC.

9.0 SCHEDULE

Table 9-1 shows the estimated duration for each major site activity and timeline. Weather and unknown site conditions could affect this schedule.

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10.0 OPERATION AND MAINTENANCE PROCEDURES

Some components of the final remedy at LHAAP-17 require O&M and those O&M activities are described in this section, along with other routine maintenance activities. The remedy components that require O&M are maintenance of the groundwater extraction system, maintenance of the MNA monitoring system (this would include all wells that serve some purpose) and maintenance of the LUCs. Extraction system O&M will be weekly (**Appendix D**), and the remaining activities will be conducted annually unless recommended otherwise during a Five Year Review.

10.1 Operation and Maintenance of the Groundwater Extraction System

The groundwater extraction system has been designed to require little in the way of direct operation and maintenance. The air compressor installed will be an oil-free design to minimize maintenance and the risk of oil entering the system. The pneumatically driven pumps do not require direct observation or control other than routine checks of their operation and volume extracted. The flow system high/low valves and transfer pump operation will be verified weekly, and flow volumes will be recorded weekly as well. A Weekly Extraction System Tracking and Maintenance Form will be used to record the inspections. The form is included in **Appendix D**.

10.2 Maintenance of the MNA Monitoring System

The MNA monitoring system is comprised of a network of monitoring wells used to implement/measure the progress of the MNA remedy. This system of wells will be inspected and maintained as part of the annual inspection and maintenance program. The monitoring wells will be inspected for the integrity of the pad, bollards, surface casing, and well markings, the presence and accumulation of silt in the well screen, the presence and integrity of a locking mechanism, the presence of encroaching vegetation, such as tree roots and weeds, and the presence of biological hazards, such as ant mounds and bee nests. Maintenance activities will be performed as needed and could include replacement of the pads and well markings, resurfacing/painting the well casing and bollards, and redevelopment of the wells. Photo documentation of well conditions will be collected during inspection and maintenance activities. The annual inspection and maintenance activities will be documented in the Annual RA-O reports.

10.3 LUC Maintenance and Monitoring Requirements

The LUCs will be maintained in place as follows:

- The LUC restricting land use to non-residential will remain in place until the levels of COCs in soil and groundwater allow for unlimited use and unrestricted exposure;
- The LUC to maintain the integrity of any current or future remedial or monitoring systems will remain in place until groundwater cleanup levels of COCs are met; and
- The LUC prohibiting groundwater use as a potable source will remain in place until the levels of COCs in groundwater allow for unlimited use and unrestricted exposure.

The administrative maintenance required to ensure the three LUCs remain in place and effective until the cleanup levels of the COCs are at levels that allow unrestricted use and unlimited exposure is as follows:

- Annual field inspections of the site to confirm that no violations of the LUCs have occurred.
- Annual certifications that no LUC-restricted activities have been authorized and that site conditions and use are consistent with the LUCs. The Certification Form is presented in **Appendix E**).
- Periodic transmittal of a LUC Notice to federal, state, and local authorities and to owners and occupants of LHAAP-17. The notice will include the groundwater contamination and any land use restrictions referenced in the ROD, a written description of the LUCs, and a figure depicting the LUC boundaries. The transmittal will coincide with each Five Year Review and will be documented in the report.
- The final LUC RD appendix of the RACR will be added to the Comprehensive LUC Management Plan, and the plan will be provided to the owner or occupant of LHAAP-17.

The U.S. Army will address LUC problems within its control that are likely to impact remedy integrity and shall address problems as soon as practicable.

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Tables

Table 1-2
Cleanup Levels for Human Health Risk

Medium	Chemical of Concern	Cleanup Level
		MCL (µg/L)
Shallow Zone groundwater	1,1-Dichloroethene	7
	1,2-Dichloroethane	5
	cis-1,2-Dichloroethene	70
	Trichloroethene	5
	Vinyl Chloride	2
		Texas Risk Reduction Program $^{GW}GW_{Ing}$ PCL (µg/L)
	Perchlorate	17
		MCL (µg/L)
Intermediate Zone groundwater	cis-1,2-Dichloroethene	70
	Trichloroethene	5
	Vinyl Chloride	2
		GWP-Ind (mg/kg)
Soil	2,4,6-Trinitrotoluene	5.1
	2,4-Dinitrotoluene	0.042
	2,6-Dinitrotoluene	0.042
	Perchlorate	7.2

Notes:

µg/L - micrograms per liter

GWP-Ind - Texas Commission on Environmental Quality soil medium specific concentration for industrial use based on groundwater protection (30TAC335)

MCL - Safe Drinking Water Act maximum contaminant level

mg/kg - milligrams per kilogram

PCL - protective concentration level (Tier 1 Texas Risk Reduction Program $^{GW}GW_{ING}$)

Table 1-3
Cleanup Levels for Ecological Risk in Soil (EcoPRGs)

Chemical	SS EcoPRG [a] (mg/kg)	TS EcoPRG [a] (mg/kg)	Depth [b]
Barium	222	–	0 - 0.5 feet
	–	520	0 - 3 feet
2,4-Dinitrotoluene	–	12	0 - 3 feet
2,6-Dinitrotoluene	2.7	6.8	0 - 3 feet
2,4,6-Trinitrotoluene	–	4.7	0 - 3 feet
2,3,7,8-TCDD TEC	4×10^{-6}	4×10^{-6}	0 - 3 feet

Notes:

[a] From Baseline Ecological Risk Assessment Table 16-1 (Shaw 2007b).

[b] Depth and locations of remedial action for Waste Sub-Area.

EcoPRG - ecological preliminary remediation goal

mg/kg - milligrams per kilogram

SS - surface soil from 0 to 0.5 feet (applicable to deer mouse)

TCDD - tetrachlorodibenzo-p-dioxin

TEC - toxicity equivalence concentration

TS - total soil from 0 to 3 feet (applicable to short-tailed shrew)

Table 3-1
August 2018 Soil Sample Analytical Results

	Location Code		17SS67		17SS68		17SS69		17SS70	
	Sample ID		17SS67-0.0-0.5		17SS68-0.0-0.5		17SS69-0.0-0.5		17SS70-0.0-0.5	
	Sample Date		8/9/2018		8/9/2018		8/9/2018		8/9/2018	
	Depth									
Analyte	Units	Soil Cleanup Goal [a]	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual
Explosives										
2,4,6-Trinitrotoluene	mg/kg	1.83	NA		NA		NA		NA	
2,4-Dinitrotoluene	mg/kg	0.0125	NA		NA		NA		NA	
2,6-Dinitrotoluene	mg/kg	0.0125	NA		NA		NA		NA	
Metals										
Barium	mg/kg	222	280		4480		252		120	

Notes:

Blue highlighted concentrations in **bold** exceed the ecological SS PRG for Barium.

[a] - The Soil Cleanup Goal for explosives is the human health soil standard from the Final Record of Decision, and the Soil Cleanup Goal for Barium is the ecological surface soil preliminary remediation goal from the Final Record of Decision.

NA - Sample was not analyzed for the analye

U - Undetected: The analyte was analyzed for, but not detected.

mg/kg - milligrams per kilogram

Val Qual - validation qualifier

Table 3-1
August 2018 Soil Sample Analytical Results

	Location Code		17SS71				17SS72		17SS73	
	Sample ID		17SS71-0.0-2.0		17SS71-5.0-7.0		17SS72-0.0-2.0		17SS73-0.0-2.0	
	Sample Date		8/9/2018		8/9/2018		8/9/2018		8/9/2018	
	Depth									
Analyte	Units	Soil Cleanup Goal [a]	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual
Explosives										
2,4,6-Trinitrotoluene	mg/kg	1.83	< 0.0281	U	< 0.0288	U	< 0.029	U	< 0.0282	U
2,4-Dinitrotoluene	mg/kg	0.0125	< 0.0281	U	< 0.0288	U	< 0.029	U	< 0.0282	U
2,6-Dinitrotoluene	mg/kg	0.0125	< 0.0281	U	< 0.0288	U	< 0.029	U	< 0.0282	U
Metals										
Barium	mg/kg	222	NA		NA		NA		NA	

Notes:

Blue highlighted concentrations in **bold** exceed the ecological SS PRG for Barium.

[a] - The Soil Cleanup Goal for explosives is the human health soil standard from the Final Record of Decision, and the Soil Cleanup Goal for Barium is the ecological surface soil preliminary remediation goal from the Final Record of Decision.

NA - Sample was not analyzed for the analye

U - Undetected: The analyte was analyzed for, but not detected.

mg/kg - milligrams per kilogram

Val Qual - validation qualifier

Table 3-1
August 2018 Soil Sample Analytical Results

	Location Code		17SS74				17SS75			
	Sample ID		17SS74-0.0-2.0		17SS74-5.0-7.0		17SS75-0.0-0.5		17SS75-0.0-0.5-FD	
	Sample Date		8/9/2018		8/9/2018		8/8/2018		8/8/2018	
	Depth									
Analyte	Units	Soil Cleanup Goal [a]	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual
Explosives										
2,4,6-Trinitrotoluene	mg/kg	1.83	< 0.0268	U	< 0.0315	U	NA		NA	
2,4-Dinitrotoluene	mg/kg	0.0125	< 0.0268	U	< 0.0315	U	NA		NA	
2,6-Dinitrotoluene	mg/kg	0.0125	< 0.0268	U	< 0.0315	U	NA		NA	
Metals										
Barium	mg/kg	222	NA		NA		78.9		71.3	

Notes:

Blue highlighted concentrations in **bold** exceed the ecological SS PRG for Barium.

[a] - The Soil Cleanup Goal for explosives is the human health soil standard from the Final Record of Decision, and the Soil Cleanup Goal for Barium is the ecological surface soil preliminary remediation goal from the Final Record of Decision.

NA - Sample was not analyzed for the analye

U - Undetected: The analyte was analyzed for, but not detected.

mg/kg - milligrams per kilogram

Val Qual - validation qualifier

Table 3-1
August 2018 Soil Sample Analytical Results

	Location Code		17SS76		17SS77		17SS78	
	Sample ID		17SS76-0.0-0.5		17SS77-0.0-0.5		17SS78-0.0-0.5	
	Sample Date		8/8/2018		8/8/2018		8/8/2018	
	Depth							
Analyte	Units	Soil Cleanup Goal [a]	Result	Val Qual	Result	Val Qual	Result	Val Qual
Explosives								
2,4,6-Trinitrotoluene	mg/kg	1.83	NA		NA		NA	
2,4-Dinitrotoluene	mg/kg	0.0125	NA		NA		NA	
2,6-Dinitrotoluene	mg/kg	0.0125	NA		NA		NA	
Metals								
Barium	mg/kg	222	88.1		90.5		72.8	

Notes:

Blue highlighted concentrations in **bold** exceed the ecological SS PRG for Barium.

[a] - The Soil Cleanup Goal for explosives is the human health soil standard from the Final Record of Decision, and the Soil Cleanup Goal for Barium is the ecological surface soil preliminary remediation goal from the Final Record of Decision.

NA - Sample was not analyzed for the analye

U - Undetected: The analyte was analyzed for, but not detected.

mg/kg - milligrams per kilogram

Val Qual - validation qualifier

Table 4-1
Proposed Excavation Sampling Summary

Excavation Area	Excavation Depth (Feet)	Estimated Total Volume (CY)	Estimated Floor Area (Square Feet)	Existing Sidewall Samples	Existing Floor Samples	Estimated Additional Samples Required [a]
A	2	81	1,094	17SS48, 17SS49, 17SS51	No Floor Samples - 2' Ecological Excavation	1 sidewall (east)
B	2	32	431	17SS75, 17SS76, 17SS77, and 17SS78	No Floor Samples - 2' Ecological Excavation	None
C	2	122	1,641	17SS70	No Floor Samples - 2' Ecological Excavation	3 sidewall samples (east, west, north)
D	7	390	1,504	17SS71 and 17SS74	None	2 sidewall (east and west) and 2 floor
E	2	43	590	17SS52 and 17SS53	No Floor Samples - 2' Ecological Excavation	2 sidewall (east and south)
F	2	31	419	17SS79, 17SS80, 17SS81, and 17SS82	No Floor Samples - 2' Ecological Excavation	None
G	2.5	92	995	17SS99, 17SS100, 17SS101, and 17SS102	COE17-14A (2.5')	None
H	2.5 - 7	2,342	17,217	17SS24 and 17SS89	17SS21A (7'), 17SS22A (3'), 17SS25A (7'), 17SS88 (2.5')	5 sidewall (2 north, east, west, south, and 14 floor)
J	5.5 - 7.5	563	2,586	17SS90	17SB03 (7.5'), 17SS29A (5.5'), and 17SS91 (5.5')	3 wall (north, south, and west)
K	2.5	482	5,204	17SS28 and 17SS109 (17SS83 just beyond northern boundary)	17SS27A (2.5'), 17SS84 (2.5'), 17SS85 (2.5'), 17SS86 (2.5'), 17SS87 (2.5'), and 17WW01A (2.5')	2 wall (south and east)
L	2.5 - 5	537	4,782	17SS97 and 17SS98	17SB04A (5'), 17SS92 (5'), 17SS93 (2.5'), 17SS94 (2.5'), and COE17-08A (2.5')	3 wall (north, west and southwest)
M	2.5 - 7.5	308	2,552	17SS104	17SS103 (2.5'), 17SS105 (2.5'), and 17SB06A (7.5')	4 sidewall (north, west, south, and composite of deeper bench)
N	2.5 - 4	279	2,634	17SS104	COE17-16A (4') and 17SS108 (2.5')	3 sidewall (north, east, and south) and 1 floor
	Estimated Total Volume (CY)	5,302			Total # Samples to be Collected	28 sidewall and 17 floor

Notes:

[a] Based on the depths of the excavation walls, 1,000 square feet of wall represents a longer wall than any single excavation wall anticipated based on Figure 4-1. Therefore, the number of wall samples required was estimated by subtracting the number of existing wall samples from the number of excavation walls.

Table 5-1
Groundwater Analytical Data (2009 to 2018)

Sample Location	Aquifer Zone	Date	Trichloroethene (µg/L)	1,1-Dichloroethene (µg/L)	1,2-Dichloroethane (µg/L)	Perchlorate (µg/L)
120	Shallow	12/14/2017	27,000	250	110	65,000
130	Shallow	3/4/2009	31.1	ND	4.29	1,700
		11/14/2017	2.1	ND	ND	2.5
17WW01	Shallow	3/4/2009	6,090	70	35.8	56,000
		9/10/2010	7,160	84.5	45.9	28,000
		11/14/2017	6,100	240	87	< 4
17WW02	Shallow	3/5/2009	867	6.22	34.5	160,000
		9/10/2010	326	3.82	39.3	122,000
		11/15/2017	6.2	< 1	3.3	2,500
17WW03	Shallow	3/5/2009	12.8	< 0.5	0.26 J	< 0.44
		9/10/2010	15.1	< 0.5	0.381 J	2.71
		11/14/2017	5.3	< 1	< 1	< 4
17WW04	Shallow	3/2/2009	0.914 J	< 0.5	< 0.25	< 0.22
		9/10/2010	1.85	1.1	0.282 J	< 0.1
		11/16/2017	< 1	< 1	< 1	< 4
17WW06	Shallow	3/5/2009	176	8.5	5.68	74,000
		9/10/2010	225	7	6.9	86,100
		11/16/2017	260	7.6	8.4	110,000
17WW08	Shallow	2/25/2009	< 0.25	< 0.5	< 0.25	< 0.22
		9/10/2010	< 0.25	NA	< 0.25	< 0.1
		12/16/2013	< 0.5	NA	< 0.5	< 0.159
		12/1/2015	< 0.5	NA	< 0.5	NA
		6/10/2016	< 0.5	< 1	< 0.5	7.13
		12/6/2016	< 0.5	NA	< 0.5	< 0.2
		6/20/2017	< 0.5	< 1	< 0.5	< 0.2
		11/14/2017	< 1	< 1	< 1	< 4
17WW09	Intermediate	2/26/2009	< 0.25	< 0.5	< 0.25	< 0.11
		9/11/2010	< 0.25	< 0.5	< 0.25	< 0.1
		11/15/2017	< 1	< 1	< 1	< 4
17WW10	Shallow	2/26/2009	< 0.25	< 0.5	< 0.25	< 0.55
		9/10/2010	< 0.25	< 0.5	< 0.25	< 0.1
		11/15/2017	< 1	< 1	< 1	1.6 J
17WW11	Shallow/ Intermediate	2/26/2009	< 0.25	< 0.5	< 0.25	< 0.22
		11/14/2017	< 1	< 1	< 1	< 4
17WW12	Shallow	2/26/2009	< 0.25	< 0.5	< 0.25	290
		3/30/2009	NA	NA	NA	990
		9/11/2010	< 0.25	< 0.5	< 0.25	62.9
		2/15/2018	< 0.5	< 0.5	< 0.5	< 4
17WW13	Shallow	3/3/2009	< 0.25	< 0.5	< 0.25	< 0.55
		9/11/2010	< 0.25	< 0.5	< 0.25	< 0.1
		11/14/2017	1.5	< 1	1.5	< 4
17WW14	Shallow	2/25/2009	< 0.25	< 0.5	< 0.25	< 0.55
		9/11/2010	< 0.25	< 0.5	< 0.25	0.196 J
		11/14/2017	< 1	< 1	< 1	2.5 J
17WW17	Intermediate	3/4/2009	10.8	1.92	0.274 J	< 0.22
		9/11/2010	6.34	0.936 J	< 0.25	< 0.1
		11/15/2017	< 1	< 1	< 1	< 4
17WW18	Intermediate	3/3/2009	< 0.25	< 0.5	< 0.25	< 0.44
		9/11/2010	< 0.25	< 0.5	< 0.25	0.708
		11/15/2017	< 1	< 1	< 1	0.595
17WW19	Shallow	1/15/2018	< 1	< 1	< 1	< 4
17WW20	Shallow	5/8/2018	1.6	< 0.5	< 0.5	< 2
18CPTMW22R	Shallow	6/9/2016	< 0.5	NA	NA	0.917
		12/14/2017	< 1	NA	NA	8.3
18WW10	Shallow	4/1/2009	< 0.25	NA	NA	< 0.11
		9/25/2009	< 0.25	NA	NA	< 0.6
		3/11/2010	< 0.25	NA	NA	< 1.2
		9/8/2010	< 0.25	NA	NA	< 1.2
		3/16/2011	< 0.25	NA	NA	< 0.1
		9/14/2011	< 0.25	NA	NA	< 0.1
		3/9/2012	< 0.25	NA	NA	< 0.1
		9/24/2012	< 0.25	NA	NA	< 0.2
		11/15/2017	< 1	< 1	< 1	52
18WW14	Shallow	3/3/2009	< 0.25	NA	NA	< 0.22
		12/2/2015	< 0.5	NA	NA	NA
		11/16/2017	< 1	< 1	< 1	< 4
C-07	Shallow	11/16/2017	< 1	< 1	< 1	4.4

Table 5-1
Groundwater Analytical Data (2009 to 2018)

Sample Location	Aquifer Zone	Date	Trichloroethene (µg/L)	1,1-Dichloroethene (µg/L)	1,2-Dichloroethane (µg/L)	Perchlorate (µg/L)
MW-7	Shallow	9/20/2011	4,220	NA	NA	49,600
		3/7/2012	4,640	NA	NA	49,300
		9/26/2012	2,130	NA	NA	34,100
		5/14/2013	2,690	NA	NA	37,500
		12/14/2013	2,140	NA	NA	36,700
		8/22/2014	1,680	NA	NA	31,100
		12/17/2014	1,880	NA	NA	32,100
		6/17/2015	1,860	NA	NA	26,800
		12/1/2015	2,730	NA	NA	20,700
		6/24/2016	1,740	NA	NA	22,200
		12/6/2016	1,570	NA	NA	12,300
		6/23/2017	2,230	NA	NA	22,200
		12/13/2017	1,600	< 1	17	15,000
MW-8	Shallow	4/3/2009	1,790	NA	NA	35,000
		9/21/2009	2,200	NA	NA	38,000
		3/9/2010	1,740	NA	NA	34,000
		9/8/2010	1,840	NA	NA	54,000
		3/17/2011	1,140	NA	NA	53,200
		9/15/2011	1,120	NA	NA	64,500
		3/8/2012	1,360	NA	NA	78,000
		9/27/2012	959	NA	NA	72,500
		5/16/2013	907	NA	NA	72,000
		12/19/2013	1,430	NA	NA	63,600
		12/10/2014	1,180	NA	NA	53,200
		6/15/2015	575	NA	NA	40,700
		12/7/2015	487	NA	NA	NA
		6/9/2016	247	NA	NA	8,290
		12/15/2016	245	NA	NA	2,160
		6/16/2017	296	NA	NA	5,320
		12/12/2017	270	< 1	4	5,500
MW-9	Shallow	9/14/2011	5,900	NA	NA	1,780
		3/7/2012	2,240	NA	NA	963
		9/27/2012	5,620	NA	NA	1,340
		5/9/2013	2,400	NA	NA	320
		12/13/2013	1,810	NA	NA	132
		8/21/2014	2,910	NA	NA	1,530
		12/16/2014	3,030	NA	NA	790
		12/1/2015	2,430	NA	NA	NA
		6/22/2016	1,460	NA	NA	263
		12/6/2016	1,250	NA	NA	219
		6/23/2017	661	NA	NA	86.9
		12/11/2017	930	< 1	0.82 J	44
MW-10	Shallow	9/28/2012	0.568 J	NA	NA	< 0.2
		5/8/2013	0.698 J	NA	NA	< 0.2
		12/11/2013	0.554 J	NA	NA	2.74
		6/3/2014	1.01	NA	NA	156
		12/10/2014	0.561 J	NA	NA	< 0.2
		6/11/2015	35.3	NA	NA	3.69
		12/15/2015	4.17	NA	NA	1.26 J
		6/9/2016	0.796 J	NA	NA	0.492
		12/7/2016	0.745 J	NA	NA	< 0.2
		3/20/2017	0.447 J	NA	NA	< 0.2
		6/20/2017	0.701 J	NA	NA	< 0.2
		12/13/2017	< 1	< 1	< 1	< 0.2
MW-16	Shallow	12/8/2017	300	3.6	23	< 0.2
MW-17	Shallow	3/24/2011	0.551 J	NA	NA	0.179 J
		9/15/2011	1.14	NA	NA	< 0.1
		3/9/2012	0.537 J	NA	NA	< 0.1
		9/24/2012	0.943 J	NA	NA	< 0.2
		5/10/2013	0.519 J	NA	NA	< 0.2
		12/16/2013	0.656 J	NA	NA	0.376 J
		6/4/2014	1.69	NA	NA	< 0.2
		12/10/2014	NA	NA	NA	0.143 J
		12/14/2015	NA	NA	NA	24.4 J
		6/20/2016	< 0.5	NA	NA	< 0.2
		12/7/2016	< 0.5	NA	NA	< 0.2
		6/21/2017	< 0.5	NA	NA	< 0.2
		12/11/2017	NA	NA	NA	< 0.2

Table 5-1
Groundwater Analytical Data (2009 to 2018)

Sample Location	Aquifer Zone	Date	Trichloroethene (µg/L)	1,1-Dichloroethene (µg/L)	1,2-Dichloroethane (µg/L)	Perchlorate (µg/L)
MW-18	Shallow	3/3/2009	0.677 J	NA	NA	< 0.11
		7/14/2009	NA	NA	NA	< 4
		9/28/2012	0.5	NA	NA	0.246 J
		5/8/2013	2.57	NA	NA	0.783
		12/18/2013	1.95	NA	NA	< 0.2
		6/13/2014	7.23	NA	NA	0.154 J
		12/23/2014	2.71	NA	NA	< 0.2
		6/22/2015	130	NA	NA	< 2
		12/7/2015	35.9	NA	NA	10.3
		6/17/2016	14.1	NA	NA	< 0.2
		12/15/2016	7.58	NA	NA	< 0.2
		6/21/2017	5.7	NA	NA	< 0.2
		12/11/2017	4.8	< 1	< 1	< 0.2
MW-19	Shallow	7/14/2009	NA	NA	NA	< 3
		9/27/2012	6.07	NA	NA	< 0.2
		5/8/2013	16	NA	NA	< 0.2
		12/17/2013	6.38	NA	NA	< 0.2
		6/13/2014	12.1	NA	NA	0.548
		12/23/2014	31.4	NA	NA	0.229 J
		6/22/2015	31.1	NA	NA	< 2
		12/5/2015	24.6	NA	NA	NA
		6/17/2016	1.82	NA	NA	11.4
		12/21/2016	2.62	NA	NA	< 0.2
		3/22/2017	3.71	NA	NA	< 0.2
		6/20/2017	9.87	NA	NA	< 0.2
		12/12/2017	3.2	< 1	< 1	< 0.2
MW-20	Shallow	4/1/2009	< 0.25	NA	NA	< 0.22
		9/21/2009	< 0.25	NA	NA	< 0.3
		3/8/2010	< 0.25	NA	NA	0.65 J
		9/9/2010	< 0.25	NA	NA	< 0.3
		3/15/2011	0.355 J	NA	NA	< 0.1
		9/13/2011	< 0.25	NA	NA	0.216
		3/7/2012	0.441 J	NA	NA	0.148 J
		6/9/2015	< 0.5	NA	NA	4
		12/6/2016	< 0.5	NA	NA	< 0.2
		12/14/2017	< 1	< 1	< 1	1.9J
MCL / PCL			5	7	5	17

Notes:
µg/L - micrograms per liter
MCL - Safe Drinking Water Act maximum contaminant level (used for trichloroethene, 1,1-dichloroethene, and 1,2-dichloroethane)
PCL - Texas Risk Reduction Program $^{GW}GW_{ING}$ protective concentration level (used for perchlorate)
Concentrations shown in **boldface** type exceed the MCL/PCL
NA - not analyzed
J - concentration shown is estimated

Table 5-2
Estimated Pore Volume and Extraction Volume Calculations

Pore Volume Calculation

Average Saturated Thickness (feet)	12
Plume Area Based on Figure 5-3 17 µg/L contour (feet^2)	58,000
Estimated Porosity (fine sand) (%)	0.35
Estimated Total Pore Volume (Area x Thickness x porosity) (feet^3)	243,600
Estimated Total Pore Volume (Volume in feet^3 x 7.48) (gallons)	1,822,128

Estimated Extraction Volume Calculation

17WW02 Projected Pumping Rate (gallons per minute)	0.4
17WW06 Projected Pumping Rate (gallons per minute)	2.5
Minutes/Day	1,440
Total number of Pumping Days (18 months - 10 days down time)	539
17WW02 Projected Total Extraction Volume (rate x mins/day x days) (gallons)	310,464
17WW06 Projected Total Extraction Volume (rate x mins/day x days) (gallons)	1,940,400
Total Projected Volume Extracted (gallons)	2,250,864
Estimated Pore Volumes Removed by 17WW02 and 17WW06 in 18 Months of Extraction	1.24
17WW01 Projected Pumping Rate (gallons per minute)	1.5
Minutes/Day	1,440
Total number of Pumping Days (18 months - 10 days down time)	539
17WW01 Projected Total Extraction Volume (rate x mins/day x days) (gallons)	1,164,240
Estimated Pore Volumes Removed by 17WW01, 17WW02, and 17WW06 in 18 Months of Extraction	1.87

Table 8-1
Proposed MNA Monitoring Network Locations

Location ID	Aquifer Zone	Northing	Easting	Ground Surface Elevation	Top of Casing Elevation
130	Shallow	6952823.84	3315814.59	174.94	177.73
17WW01	Shallow	6952637.54	3315690.63	176.62	179.01
17WW02	Shallow	6952784.79	3315651.12	174.34	177.21
17WW03	Shallow	6952651.91	3315789.22	176.39	179.2
17WW04	Shallow	6952536.34	3315473.48	177.29	180.21
17WW06	Shallow	6952718.3	3315475.11	176.82	179.36
17WW08	Shallow	6952492.98	3315991.09	176.76	179.94
17WW09	Intermediate	6952843.2	3315374.47	178.4	181.43
17WW10	Shallow	6952842.29	3315390.11	178.38	181.55
17WW11	Shallow/ Intermediate	6952970.73	3315572.84	177.51	180.95
17WW13	Shallow	6952679.23	3315986.44	175.9	179.14
17WW14	Shallow	6952609.79	3315323.86	178.83	181.9
17WW17	Intermediate	6952646.74	3315700.8	176.23	178.81
17WW18	Intermediate	6952976.4	3315886.53	176.03	178.68
17WW19	Shallow	6952718.36	3315313.67	180.08	176.63
17WW20	Shallow	6952980.24	3315580.24	180.02	177.13
MW-18	Shallow	6953262.29	3315771.7	177.27	178.58

Table 8-2

Proposed MNA Monitoring Network Analytes and Frequency

Monitoring Locations	Well Description	Years 1 & 2 (Quarterly)						Year 3-5 (Semiannual)					
		Perchlorate (314.0)	VOCs [a] (SW8260B)	Field Parameters [b]	TOC (EPA 415.1/ SW9060A/SM 5310C)	Anions [c] (SW9056A)	Methane/Ethane/ Ethene/CO2 (RSK-175)	Perchlorate (314.0)	VOCs [a] (SW8260B)	Field Parameters [b]	TOC (EPA 415.1/ SW9060A/SM 5310C)	Anions [c] (SW9056A)	Methane/Ethane/ Ethene/CO2 (RSK-175)
17WW01	Shallow well, COC > Cleanup level	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
17WW02	Extraction well, COC > Cleanup level	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
17WW03	Shallow well, COC > Cleanup level	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
17WW04	Shallow well, all COC < Cleanup level	✓	✓	✓				✓	✓	✓			
17WW06	Extraction well, COC > Cleanup level	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
17WW08	Shallow well, all COC < Cleanup level	✓	✓	✓				✓	✓	✓			
17WW10	Shallow well, all COC < Cleanup level	✓	✓	✓				✓	✓	✓			
17WW11	Shallow/intermediate well, all COC < Cleanup level	✓	✓	✓				✓	✓	✓			
17WW13	Shallow well, all COC < Cleanup level	✓	✓	✓				✓	✓	✓			
17WW14	Shallow well, all COC < Cleanup level	✓	✓	✓				✓	✓	✓			
17WW19	Shallow well, all COC < Cleanup level	✓	✓	✓				✓	✓	✓			
17WW20	Shallow well, all COC < Cleanup level	✓	✓	✓				✓	✓	✓			
130	Shallow well, all COC < Cleanup level	✓	✓	✓				✓	✓	✓			
17WW09	Intermediate well, all COC < cleanup level	✓	✓	✓				✓	✓	✓			
17WW17	Intermediate well, all COC < cleanup level	✓	✓	✓				✓	✓	✓			
17WW18	Intermediate well, all COC < cleanup level	✓	✓	✓				✓	✓	✓			

Notes:

[a] Volatile organic compounds (VOCs) include 1,1-dichloroethene (DCE), 1,2-dichloroethane, cis-1,2-DCE, trichloroethene (TCE), vinyl chloride.

[b] Field parameters for all wells include pH, temperature, conductivity, turbidity, oxidation-reductions potential (ORP), dissolved oxygen (DO), and ferrous iron.

[c] Anions include nitrate, sulfate, and chloride.

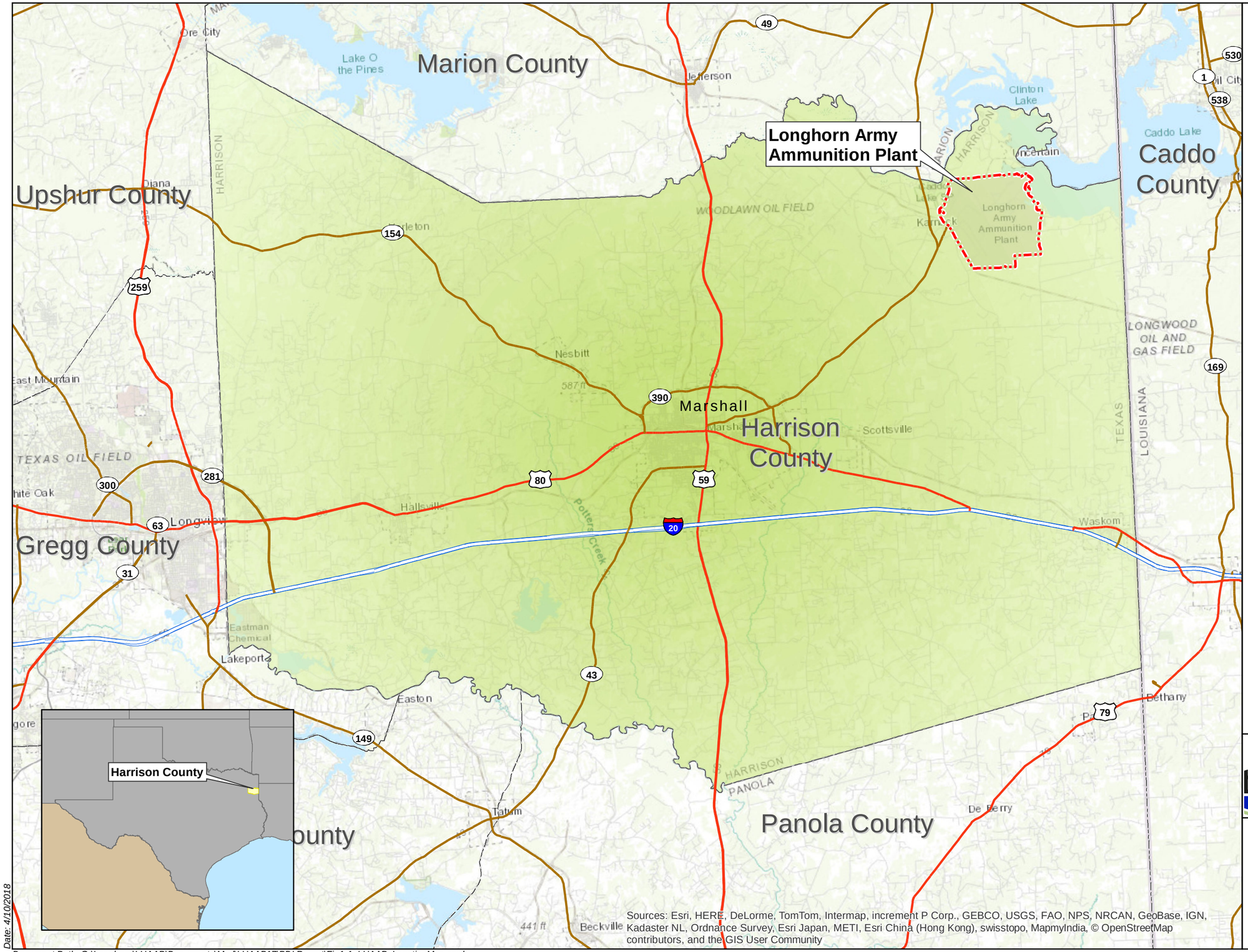
✓ Indicates that sample will be collected and analyzed for the listed analyte.

TOC Total Organic Carbon

Table 9-1
Schedule for Major Site Activities

Activities	Duration
Site Preparation and Mobilization	15
Baseline Sampling and Gauging	3
Utility Clearance	1
Excavation	15
Characterization and Confirmation Sampling	10
Loading Stockpiled Soil, T&D, Over-excavation, Confirmation Sampling	40
Site Backfill and Restoration	10
Groundwater Extraction System Construction	15
Surveying	5
Demobilization	3
Total No. of days	**117**

Figures



N

0 2 4 Miles

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Figure 1-1

LHAAP Location Map
Remedial Design / Remedial Action Work Plan
LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 4/10/2018

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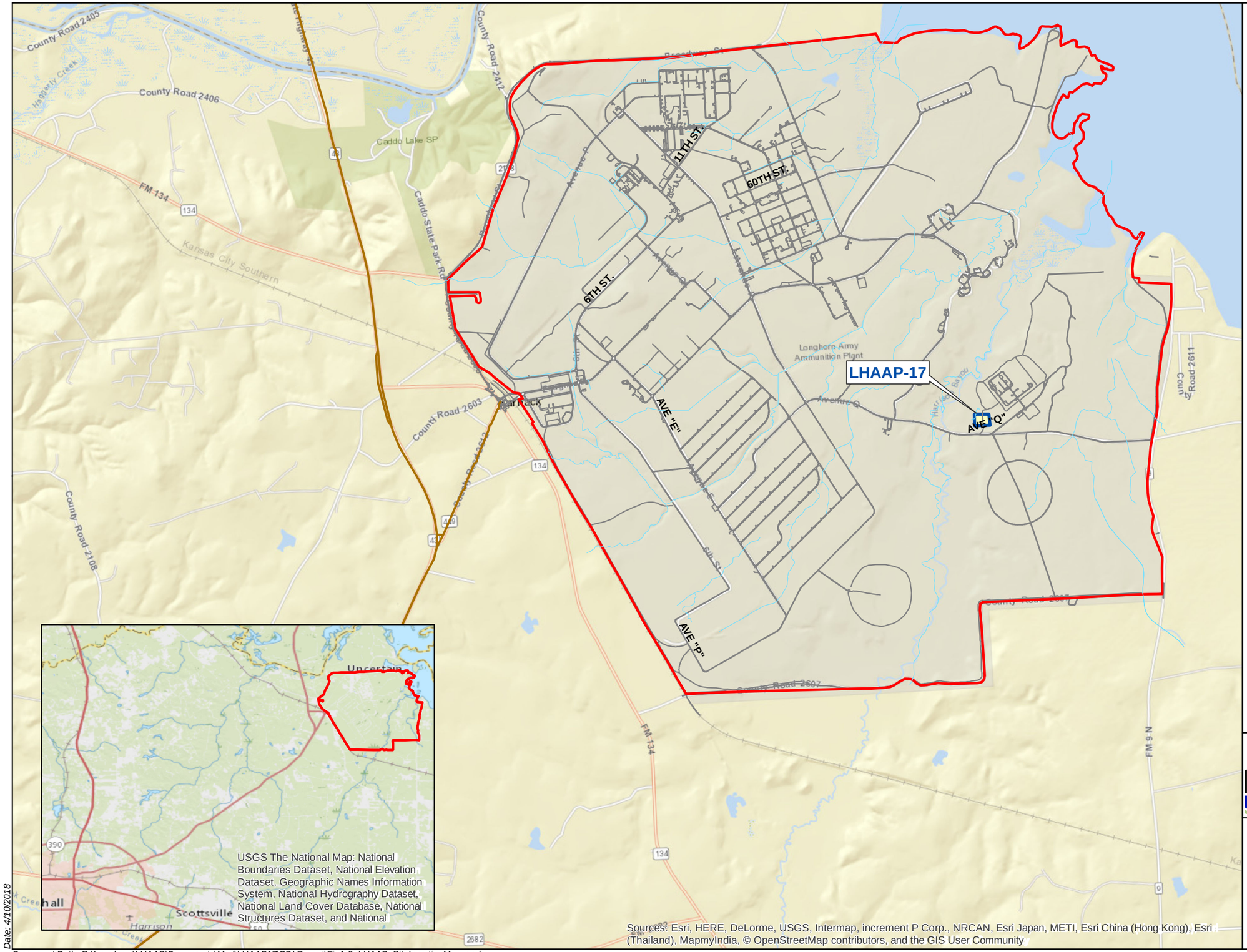

Stream
Road
LHAAP Boundary
LHAAP-17 Site Boundary

N

0 1,500 3,000
Feet

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Figure 1-2

LHAAP-17 Location Map

Remedial Design / Remedial Action Work Plan

LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Date: 4/10/2018

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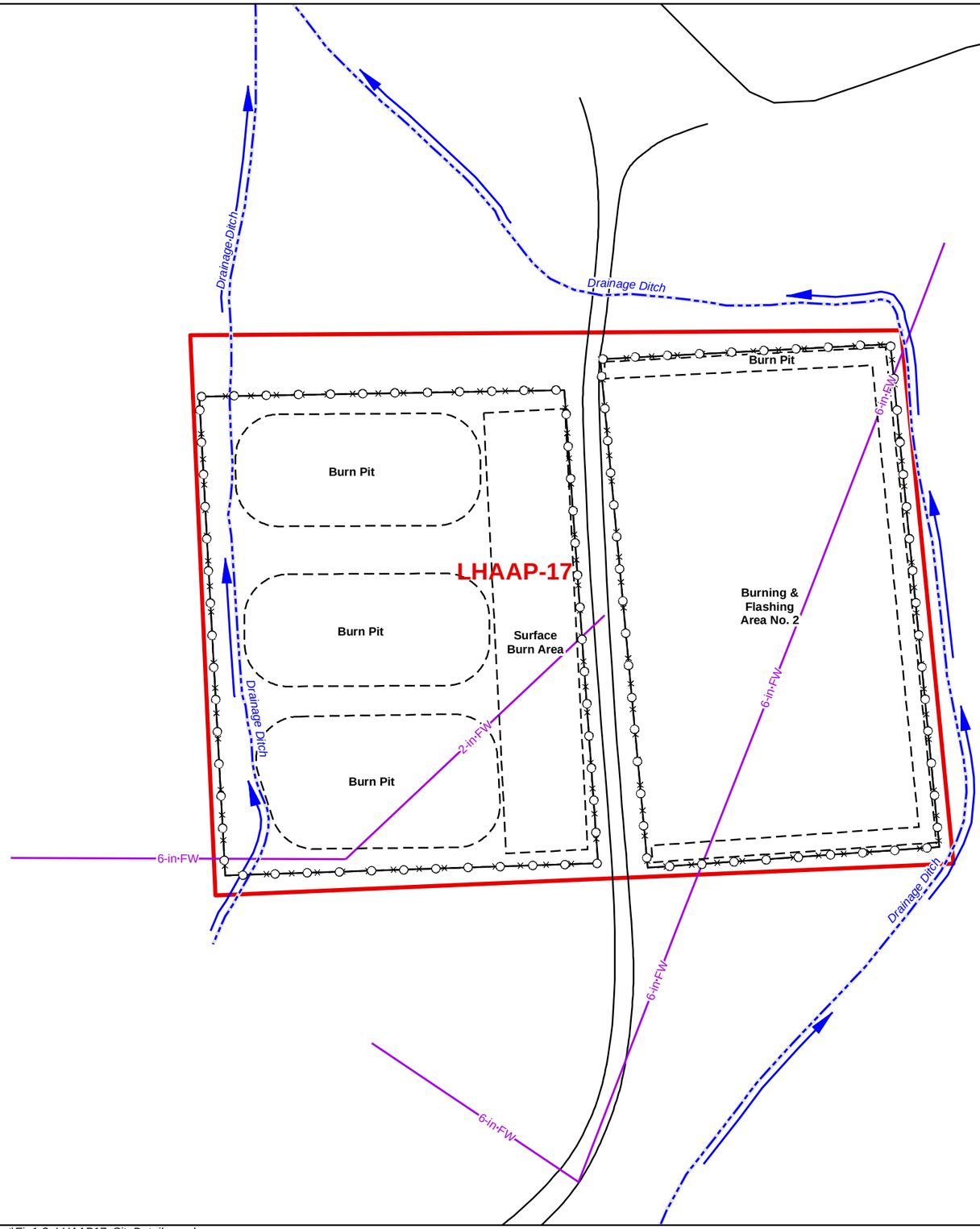

Fence Line

Surface Water Flow Direction

Drainage Ditch

2 inch (in) and 6 inch Diameter
Fire Water (FW) Line (Respectively)

Site Boundary

N

0 40 80 Feet

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Figure 1-3

LHAAP-17 Site Details

Remedial Design / Remedial Action Work Plan
LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 4/10/2018

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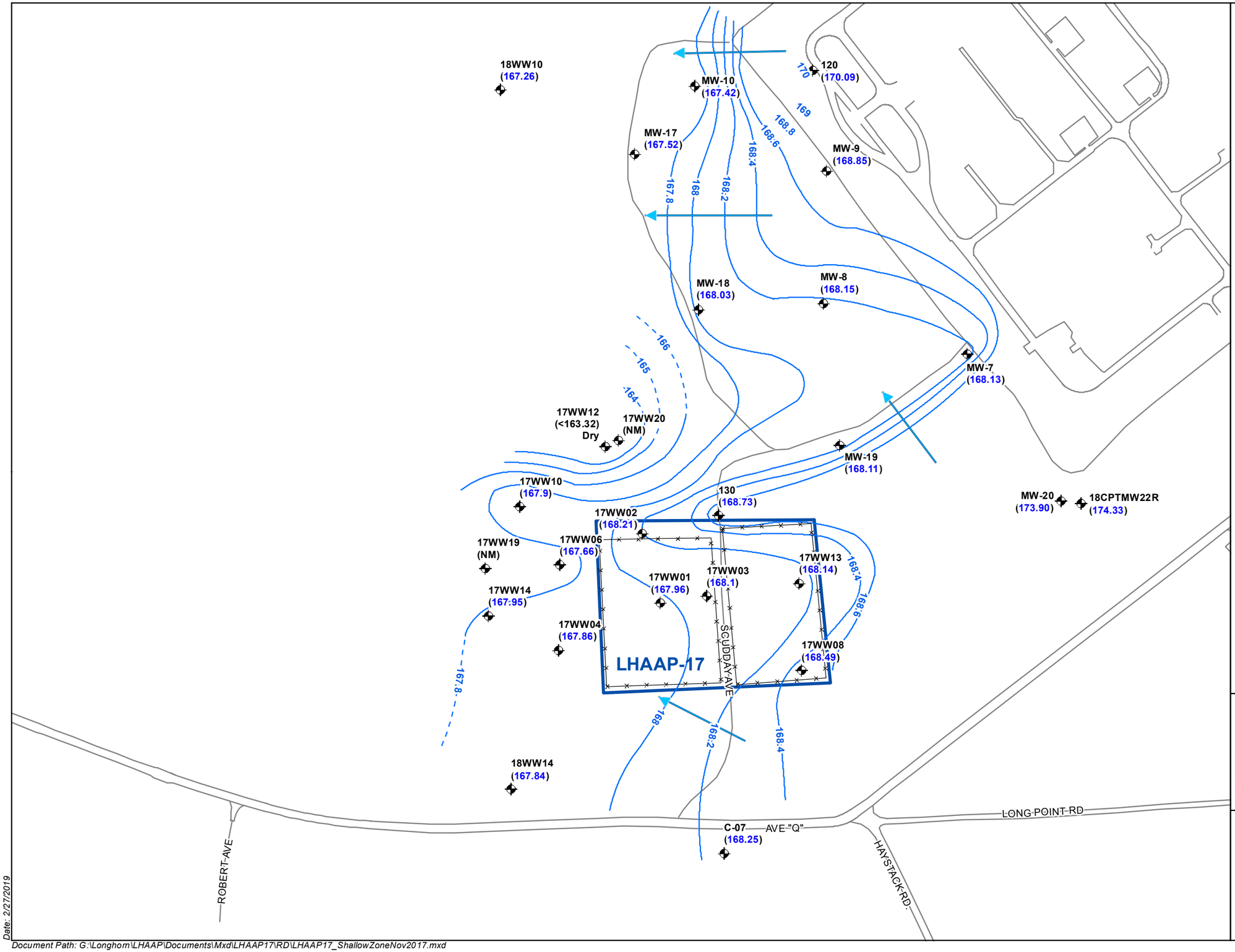

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Figure 2-1

Shallow Zone Potentiometric Surface
(November 2017)
Remedial Design/Remedial Action Work Plan, LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 2/27/2019

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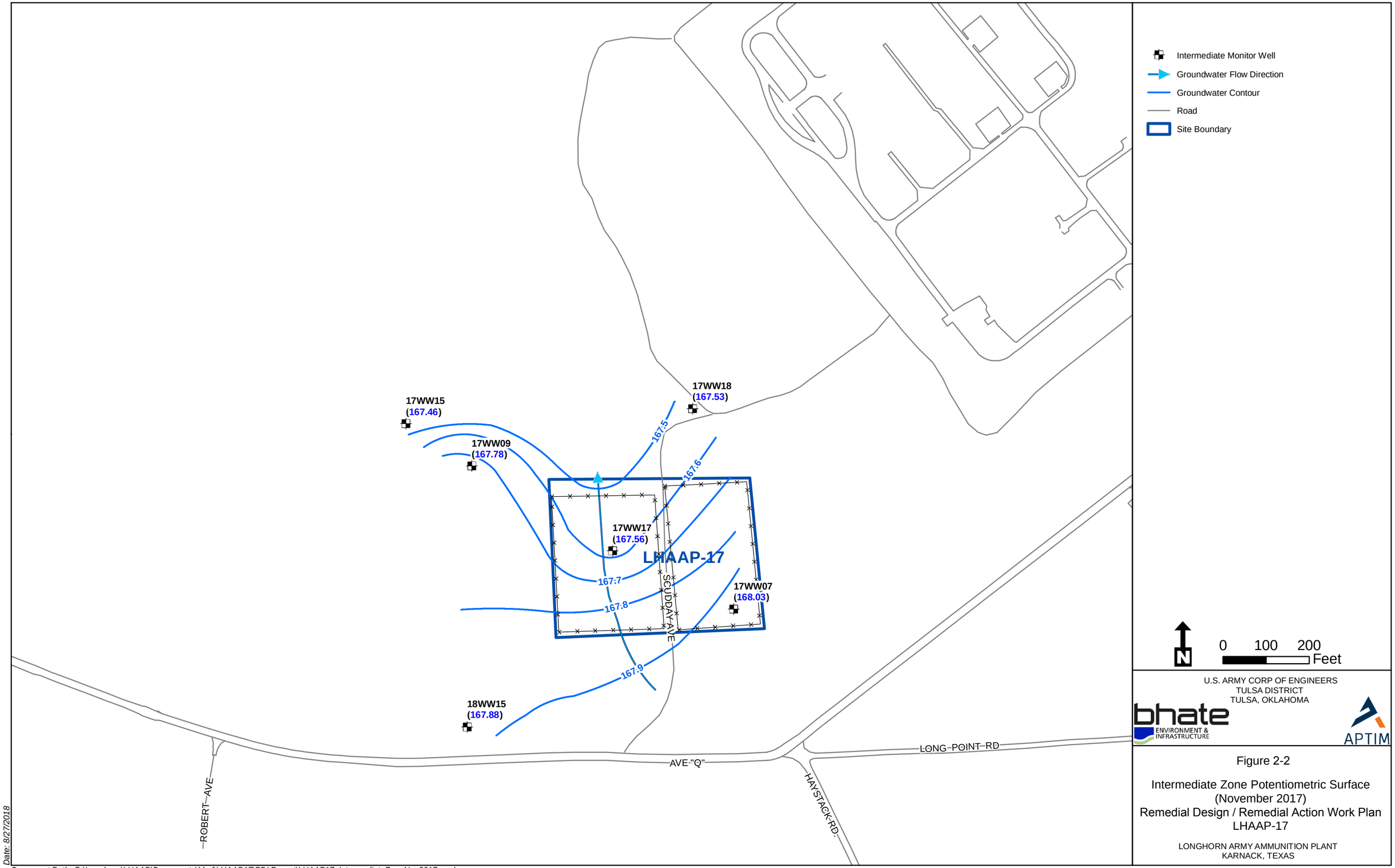

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Figure 2-2

Intermediate Zone Potentiometric Surface
(November 2017)
Remedial Design / Remedial Action Work Plan
LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 8/27/2018

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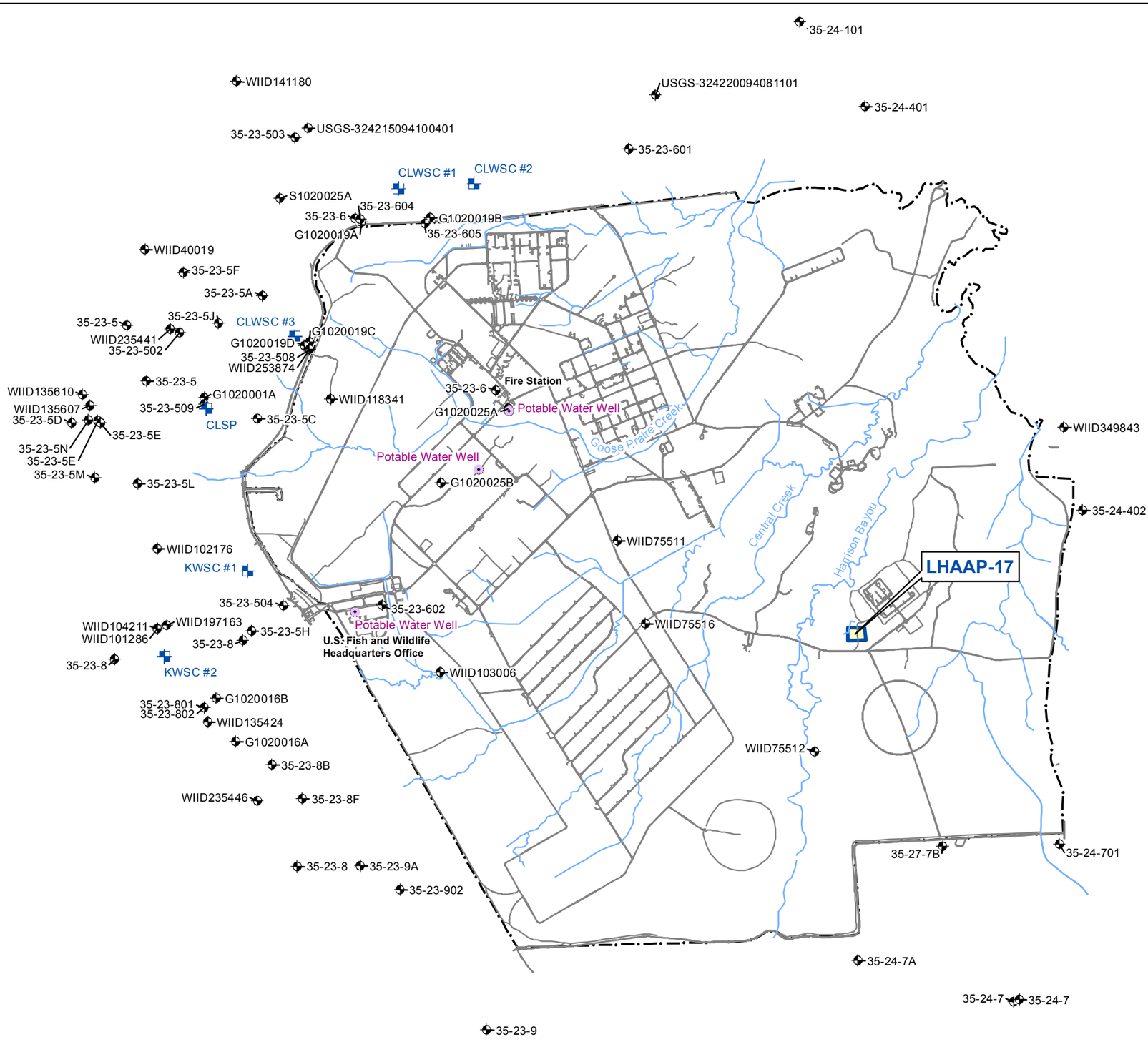

Public Water Supply Well Location
Groundwater Well
Water Supply Well
Stream
Road
LHAAP Boundary
LHAAP-17 Site Boundary

N

0 1,500 3,000 Feet

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Figure 2-3

Drinking Water Supply Well Location Map
LHAAP-17
Remedial Design/Remedial Action Work Plan
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 2/27/2019

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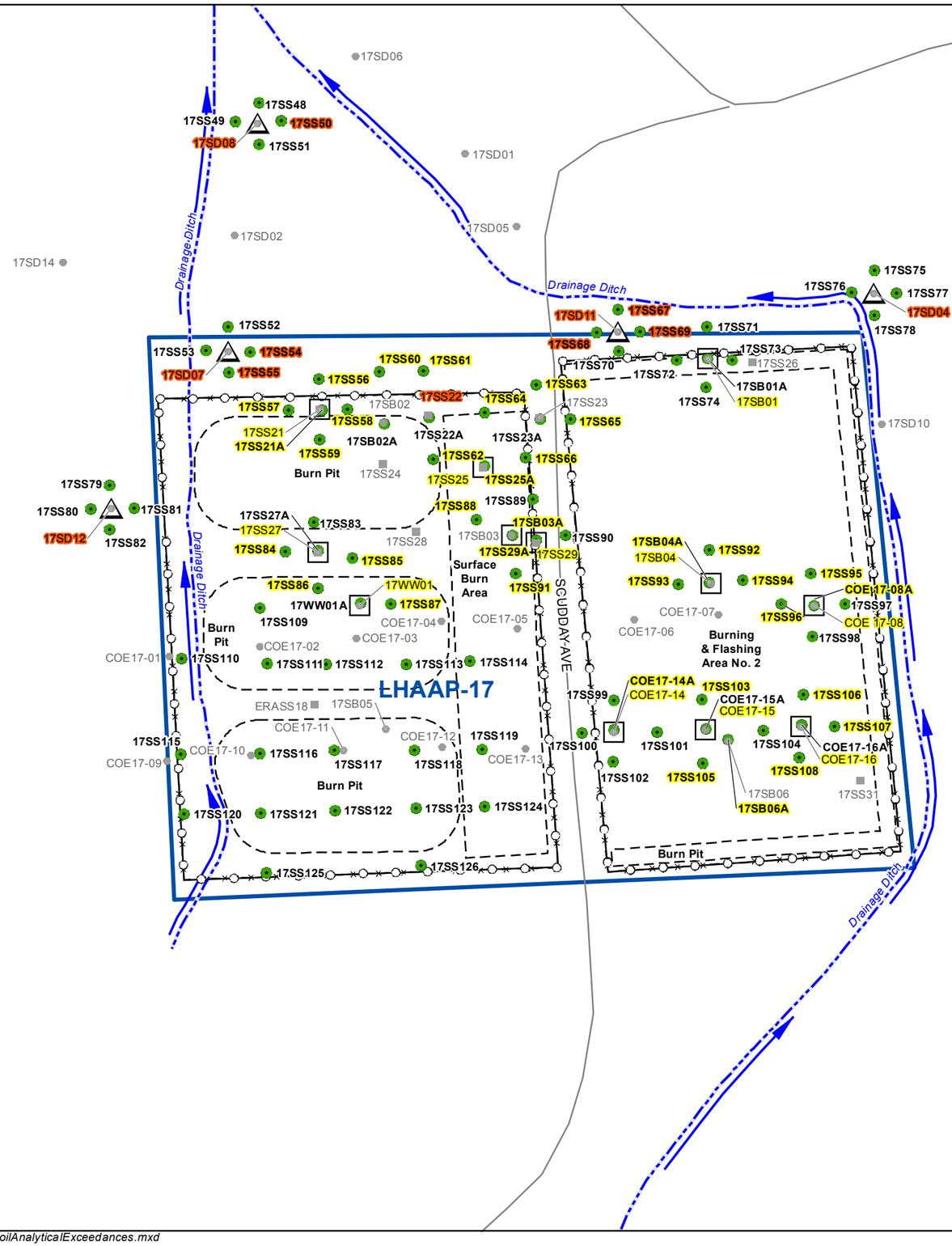

Hstorical Soil Sample Location

Historical Surface Soil/Sediment Location

2018 PDI Soil Sample Location

Historical Sample location with contamination that poses Ecological Risk.

Historical Sample location with contamination that poses Human Health Risk (for soil to groundwater).

Fence Line

BURN_PITS

Surface Water Flow Direction

Drainage Ditch

Road

Site Boundary

17SS64 = Sample location where explosive concentrations in samples from one or more depths exceeded the human health cleanup level from the Final ROD (AECOM 2016)

17SS50 = Sample location where the barium concentration exceeded the cleanup levels for ecological risk in surface soil from the Final ROD (AECOM 2016)

Note: The soil sample analytical results for the highlighted locations shown on the map are provided on **Table 3-1**.

N

0 40 80 Feet

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Figure 3-1

Soil Sample Locations with Concentrations Exceeding the Cleanup Levels
LHAAP-17
Remedial Design/Remedial Action Work Plan

Longhorn Army Ammunition Plant
KARNACK, TEXAS

Date: 2/27/2019

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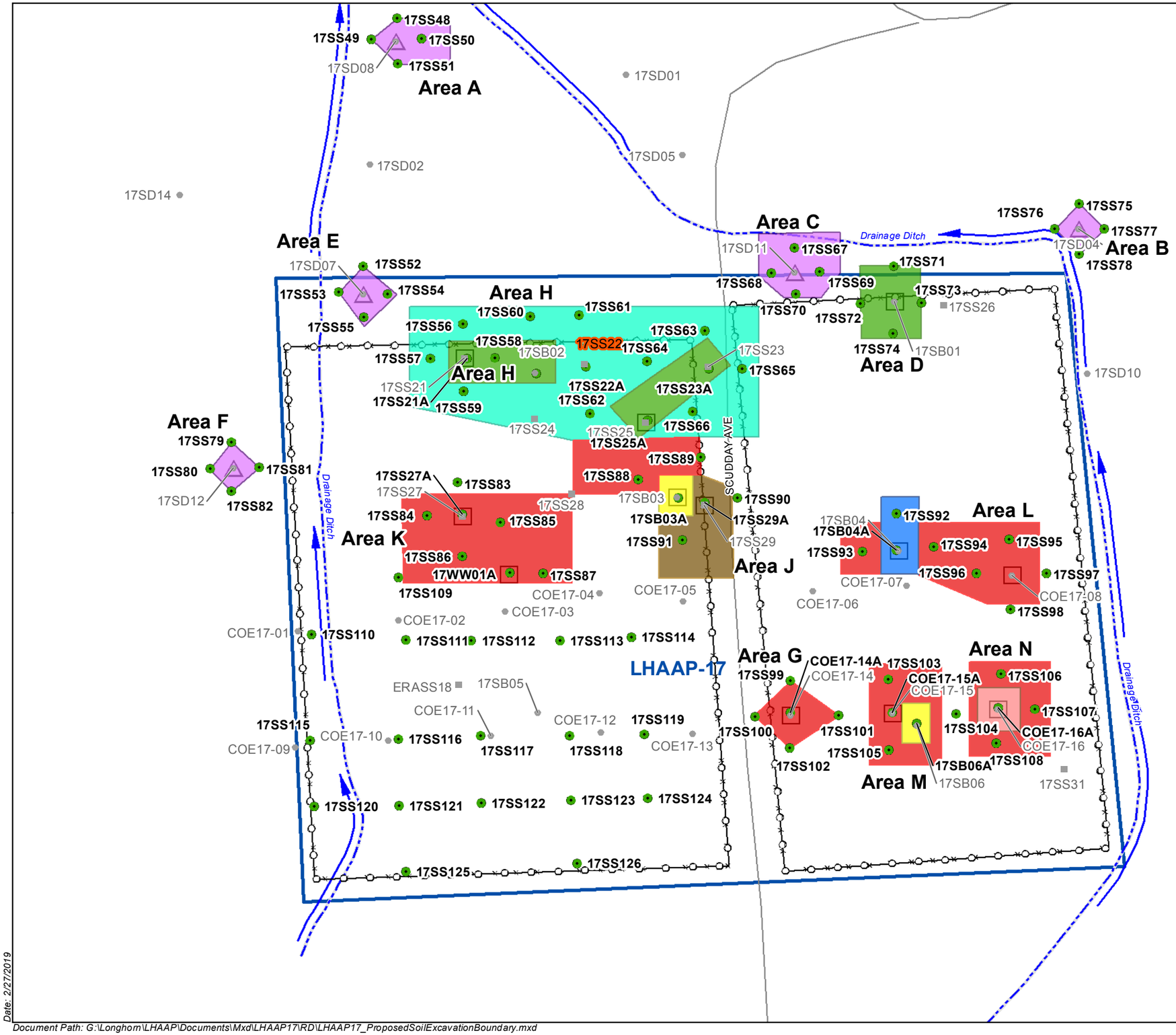

Hstorical Soil Sample Location

Historical Surface Soil/Sediment Location

2018 PDI Soil Sample Location

Excavation Area

- 2 ft (5 Areas, 309.3 cu yd)
- 2.5 ft (7 Areas, 1510.1 cu yd)
- 3 ft (1 Area, 1320 cu yd)
- 4 ft (1 Area, 93.2 cu yd)
- 5 ft (1 Area, 187.5 cu yd)
- 5.5 ft (1 Area, 427.4 cu yd)
- 7 ft, or shallower if groundwater encountered (3 Areas, 1211.2 cu yd)
- 7.5 ft, or shallower if groundwater encountered (2 Areas, 242.7 cu yd)

Historical Sample location with contamination that poses Ecological Risk.

Historical Sample location with contamination that poses Human Health Risk (for soil to groundwater).

Fence Line

Surface Water Flow Direction

Drainage Ditch

Road

Site Boundary

Note:
1. Areas A, B, C, E and F are excavations for ecological receptors and will not go deeper than two feet bgs.

2. Areas G, J, K, L, and M excavation areas have the vertical extent of the excvation defined and existing samples will be used as floor confirmation samples.

3. Portions of Area H (7 foot areas) and Area N (4 foot areas) have the vertical extent defined, and existing samples will be used as floor confirmation samples. Additionally the deeper areas in Areas H and N will have sloped walls because the height difference between the surrounding floor excavation and these areas is less than 4 feet.

N

0 30 60 Feet

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Figure 4-1

Proposed Soil Excavation Boundary
Remedial Design/Remedial Action Work Plan, LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 2/27/2019

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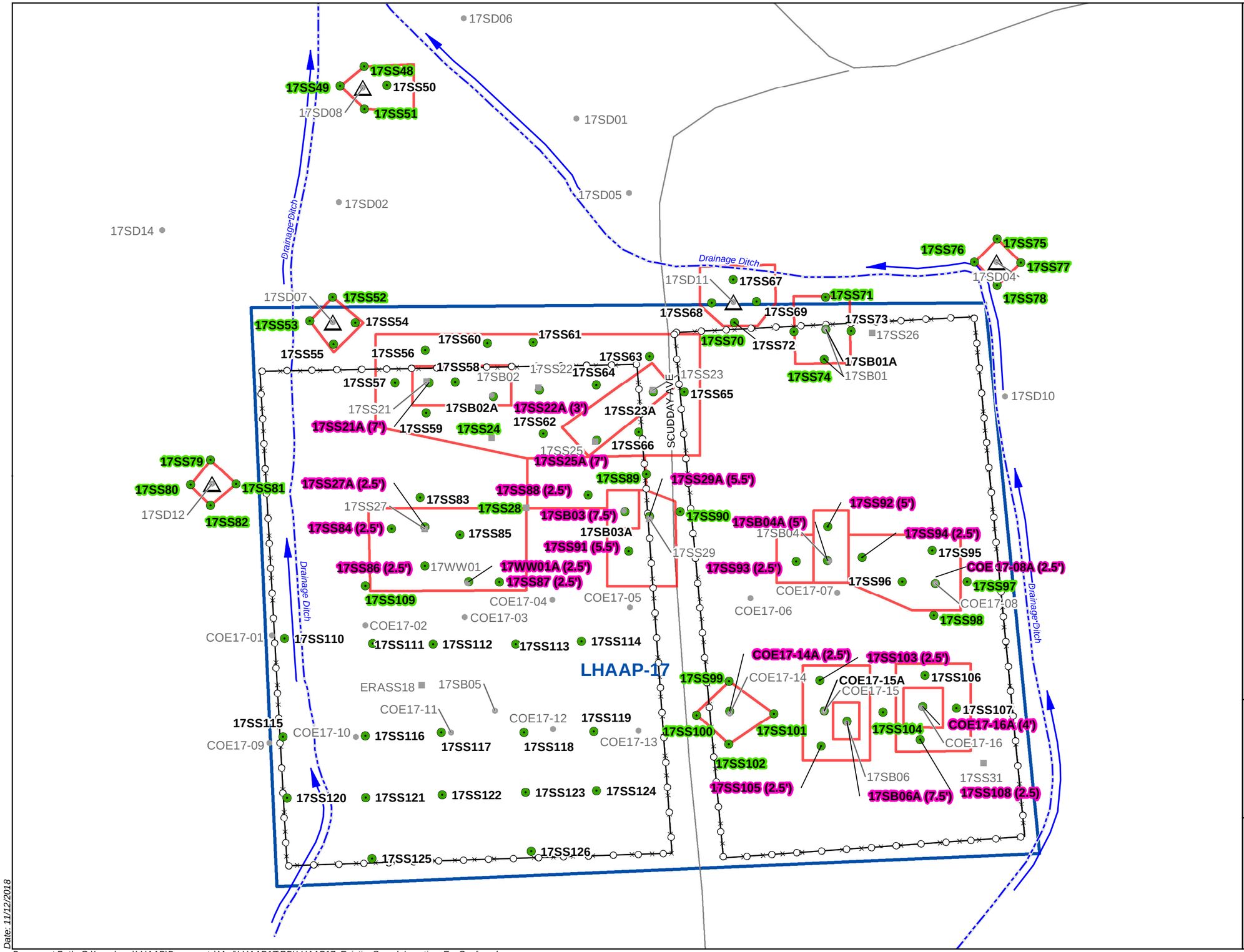

Hstorical Soil Sample Location

Historical Surface Soil/Sediment Location

2018 PDI Soil Sample Location

Historical Sample location with contamination that poses Ecological Risk.

Fence Line

Surface Water Flow Direction

Drainage Ditch

Road

Site Boundary

Excavation Area

17SS92 = Existing samples to be used for vertical excavation limits and confirmation samples

17SS97 = Existing samples to be used for lateral excavation limits and confirmation samples

N

0 30 60 Feet

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Figure 4-2

Existing Sample Locations for Excavation Confirmation

Remedial Design/Remedial Action Work Plan, LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 11/12/2018

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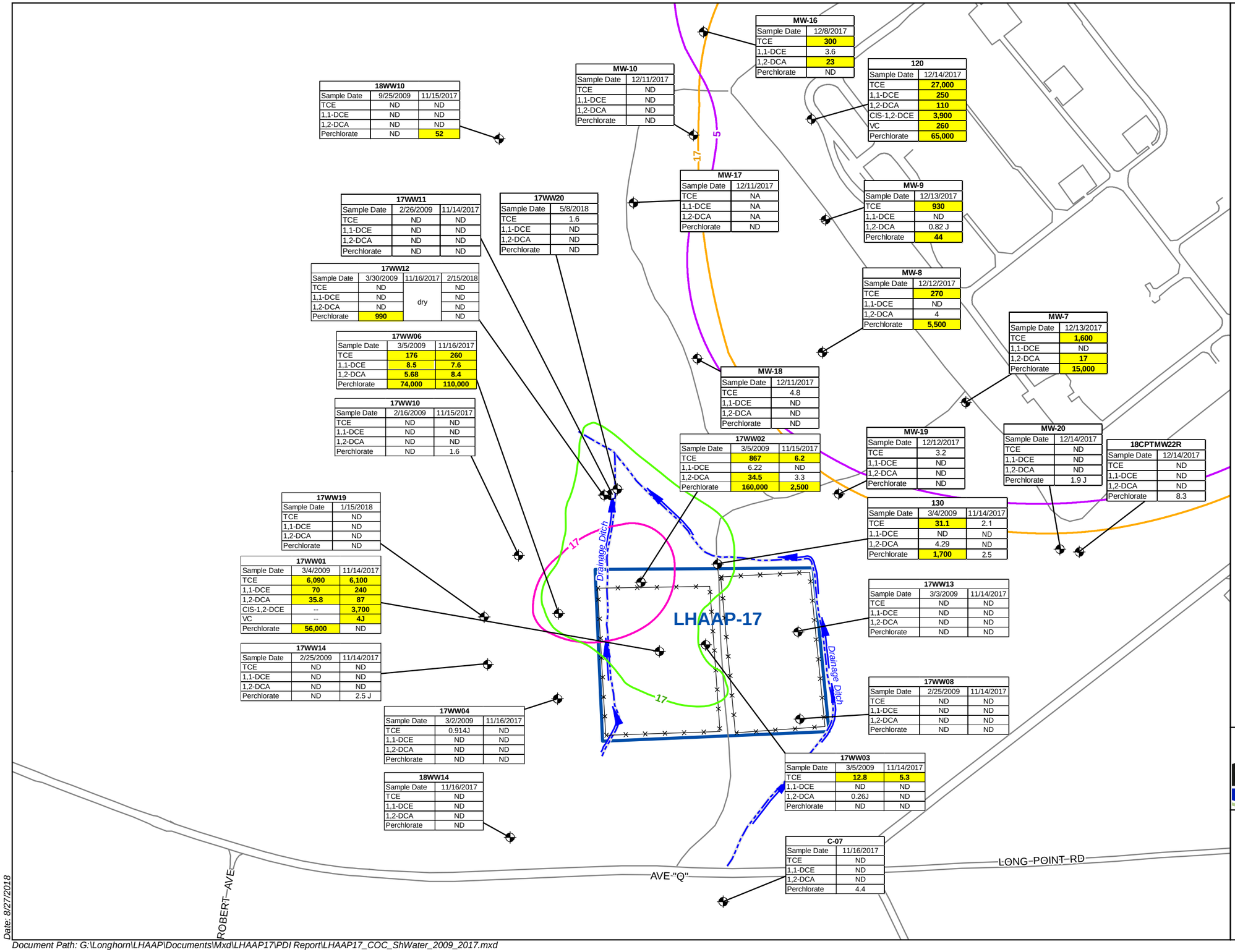

Shallow Monitoring Well

Shallow/Intermediate Monitoring Well

LHAAP-17 2009 Perchlorate Contour (PCL = 17 µg/L)

LHAAP-17 2017-2018 Perchlorate Contour (PCL = 17 µg/L)

LHAAP-18/24 December 2017 Perchlorate Contour (PCL = 17 µg/L) (Bhate 2018a)

LHAAP-18/24 December 2017 TCE Contour (MCL = 5 µg/L) (Bhate (2018a)

Road

Surface Water Flow Direction

Drainage Ditch

Site Boundary

Notes:
1. All concentrations are reported in microgram per liter (µg/L).
2. ND - non detect; detection limit below MCL/PCL
   NA - not analyzed
3. Highlighted concentrations indicate levels above cleanup
4. TCE - trichloroethene (MCL = 5 µg/L)
5. 1,1-DCE - 1,1-dichloroethene (MCL = 7 µg/L)
6. 1,2-DCA - 1,2-dichloroethane (MCL = 5 µg/L)
7. cis-1,2-DCE - cis-1,2-dichloroethene (MCL = 70 µg/L)
8. VC - Vinyl Chloride (MCL = 2 µg/L)
9. PCL - Texas Risk Reduction Program Protective Concentration Level
10. MCL - Safe Drinking Water Act Maximum Contaminated Level
11. The LHAAP-17 2017-2018 Perchlorate contour is based on data collected between November 2017 and May 2018.
12. The LHAAP-18/24 December 2017 TCE and Perchlorate contours are from the Draft Quarterly Evaluation Report, 4th Quarter (October-December) 2017 (Bhate 2018a).

N

0 100 200 Feet

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Figure 5-1

COC Concentrations Detected in Shallow Groundwater - 2009 and 2017

Remedial Design / Remedial Action Work Plan
LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 8/27/2018

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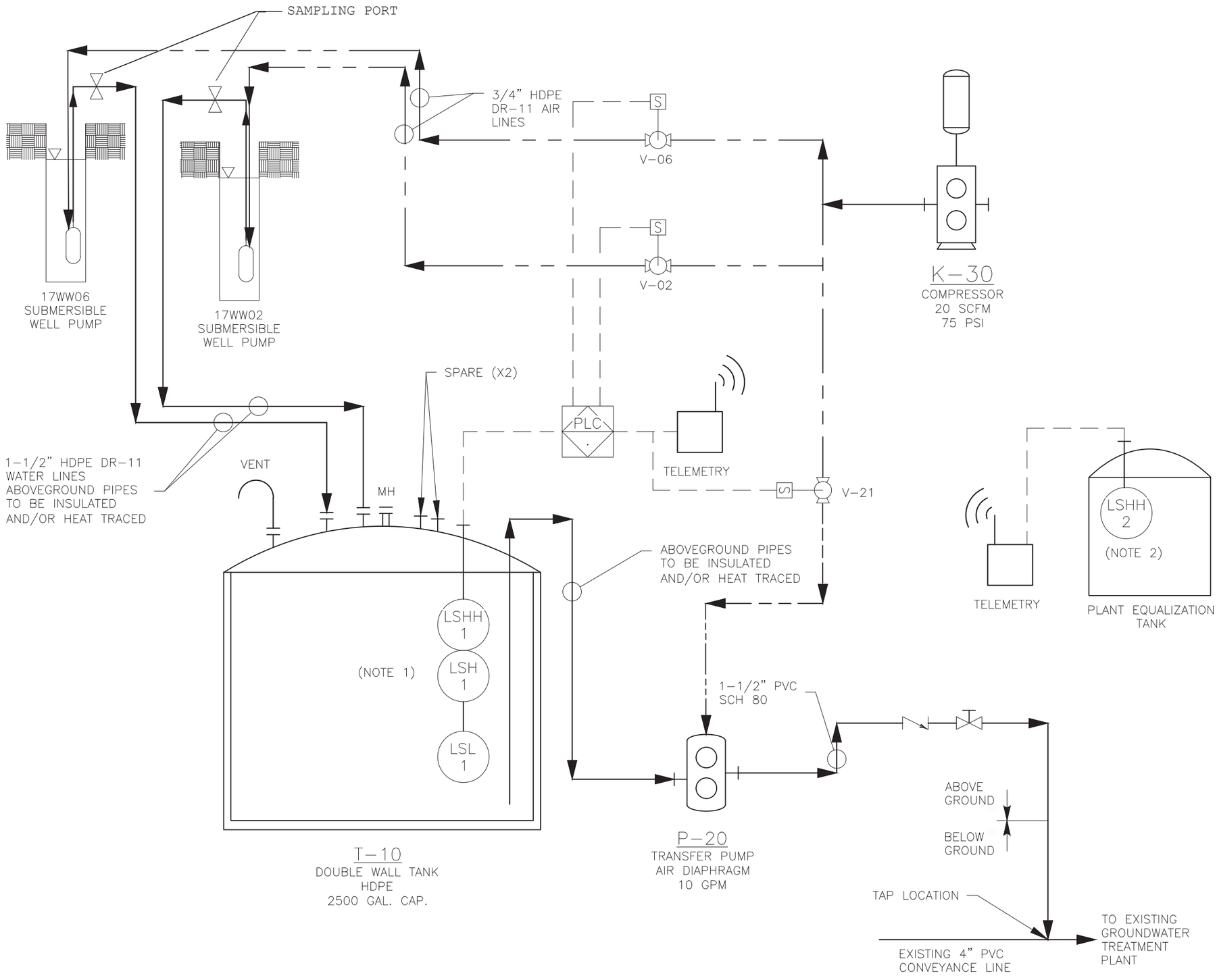

LEGEND:

- WATER LINE
- AIR LINE
- SIGNAL/COMMUNICATION LINE
- S — SOLENOID VALVE
- HAND VALVE
- CHECK VALVE
- LSHH X — LEVEL SWITCH HIGH-HIGH
- LSH X — LEVEL SWITCH HIGH
- LSL X — LEVEL SWITCH LOW

HDPE	HIGH DENSITY POLYETHYLENE
PVC	POLYVINYL CHLORIDE
SCFM	STANDARD CUBIC FEET PER MINUTE
PSI	POUNDS PER SQUARE INCH
GPM	GALLONS PER MINUTE
MH	MANHOLE

NOTES:

1. LSHH1 CLOSES V-02 AND V-06
   LSH1 OPENS V-21
   LSL1 CLOSES V-21
2. LSHH2 CLOSES V-21
3. 17WW01 WILL BE ADDED AS AN EXTRACTION WELL USING THE SAME DESIGN AS 17WW02 AND 17WW06 IF THE BASELINE SAMPLE PERCHLORATE CONCENTRATION EXCEEDS 20,000 MICROGRAMS PER LITER

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FIGURE 5-2

Groundwater Extraction Process Flow Diagram
Remedial Design / Remedial Action Work Plan
LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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Plot Date/Time: Nov 09, 2018 - 10:39am
Plotted By: samantha.bentley

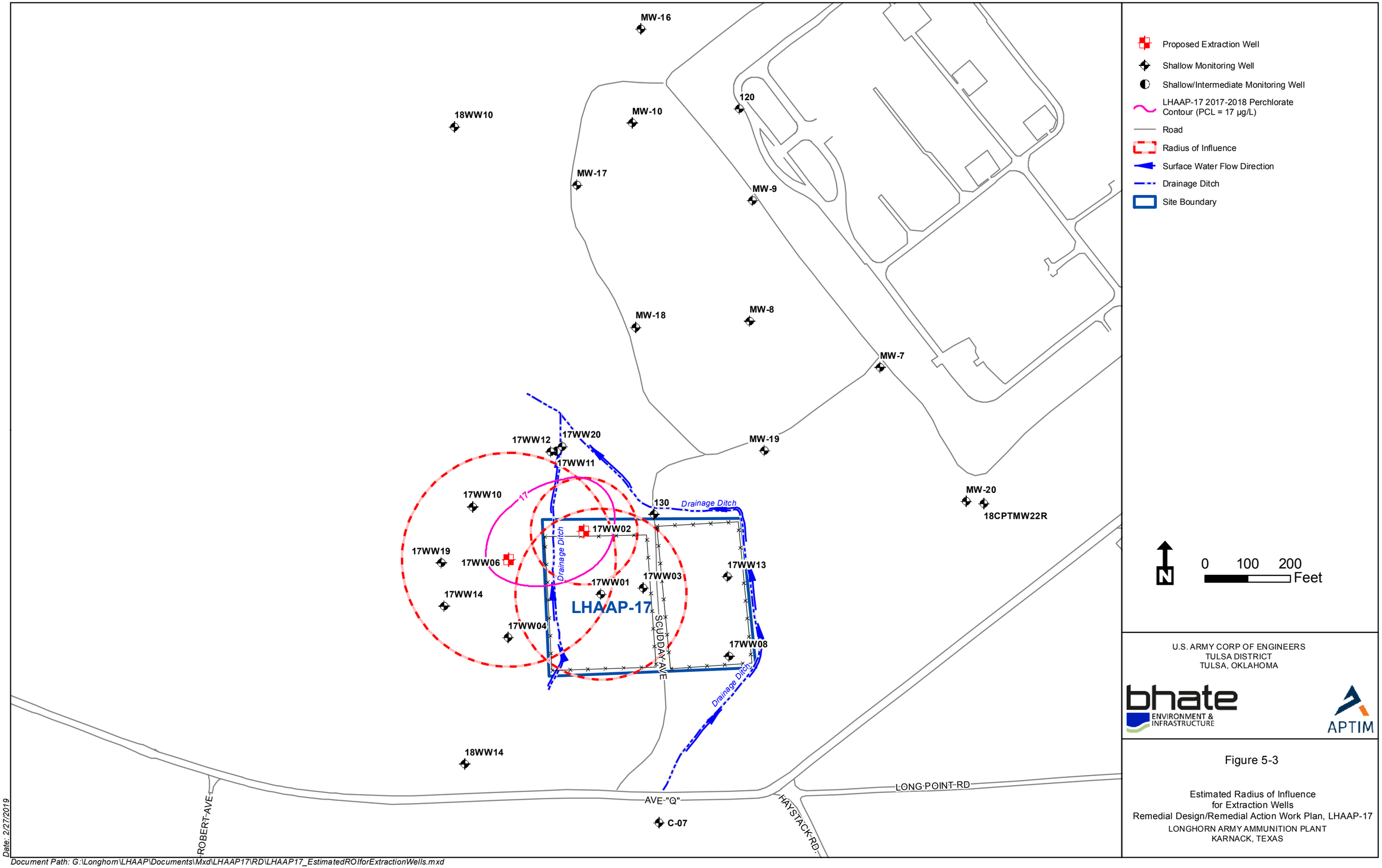

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Figure 5-3

Estimated Radius of Influence
for Extraction Wells
Remedial Design/Remedial Action Work Plan, LHAAP-17
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 2/27/2019

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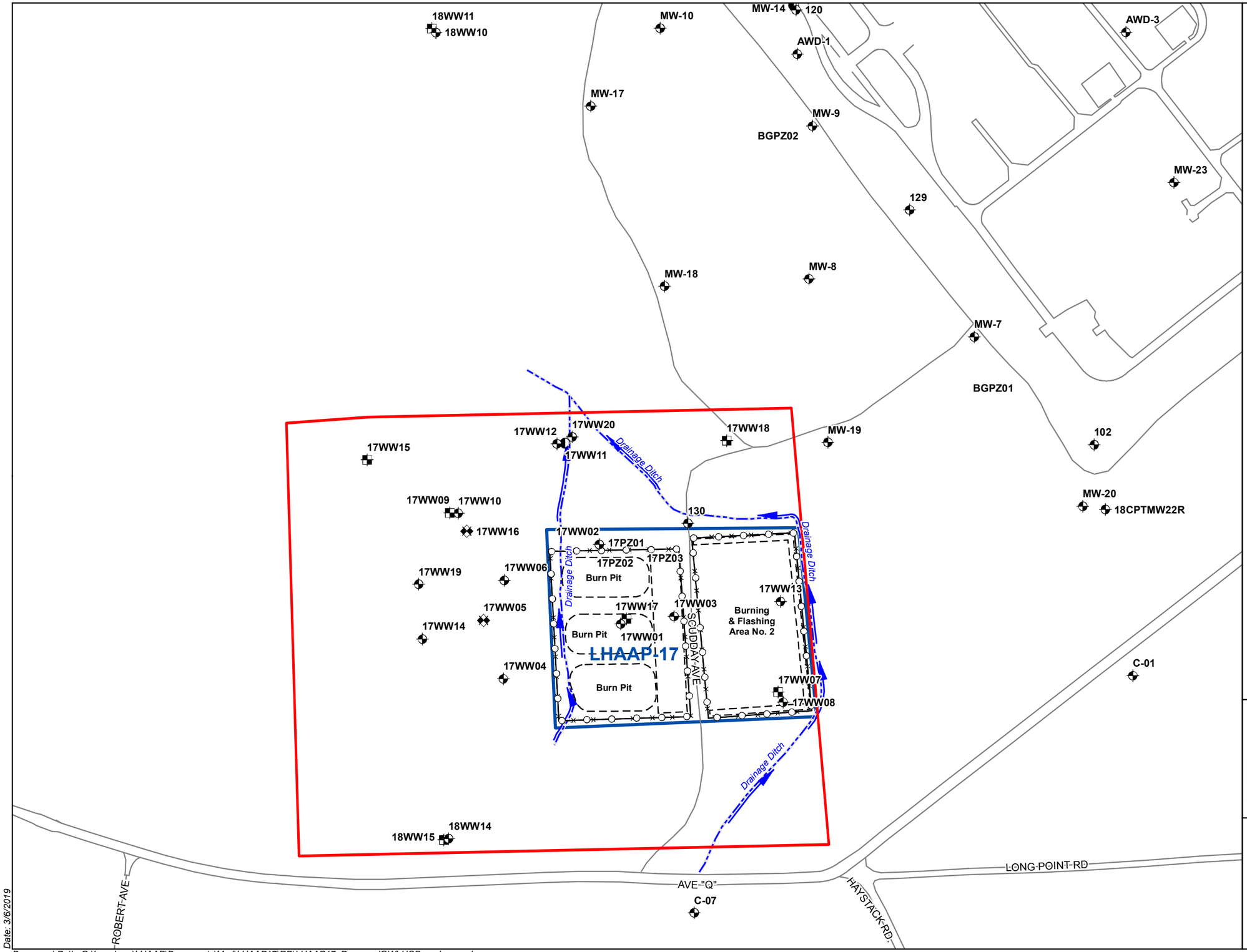

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Figure 6-1

Proposed Groundwater LUC Boundary Map
Remedial Design/Remedial Action Work Plan, LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 3/6/2019

Document Path: G:\Longhorn\LHAAP\Documents\Mxd\LHAAP17\RD\LHAAP17_ProposedGWLUCBoundary.mxd

Note:
17WW02 and 17WW06 are the planned extraction wells, but 17WW01 may be added as an extraction well based on the results of the baseline sampling discussed in Section 5.5

N

0 80 160 320
Feet

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

APTIM

bhate ENVIRONMENT & INFRASTRUCTURE

FIGURE 7-1

GROUNDWATER EXTRACTION SYSTEM LAYOUT

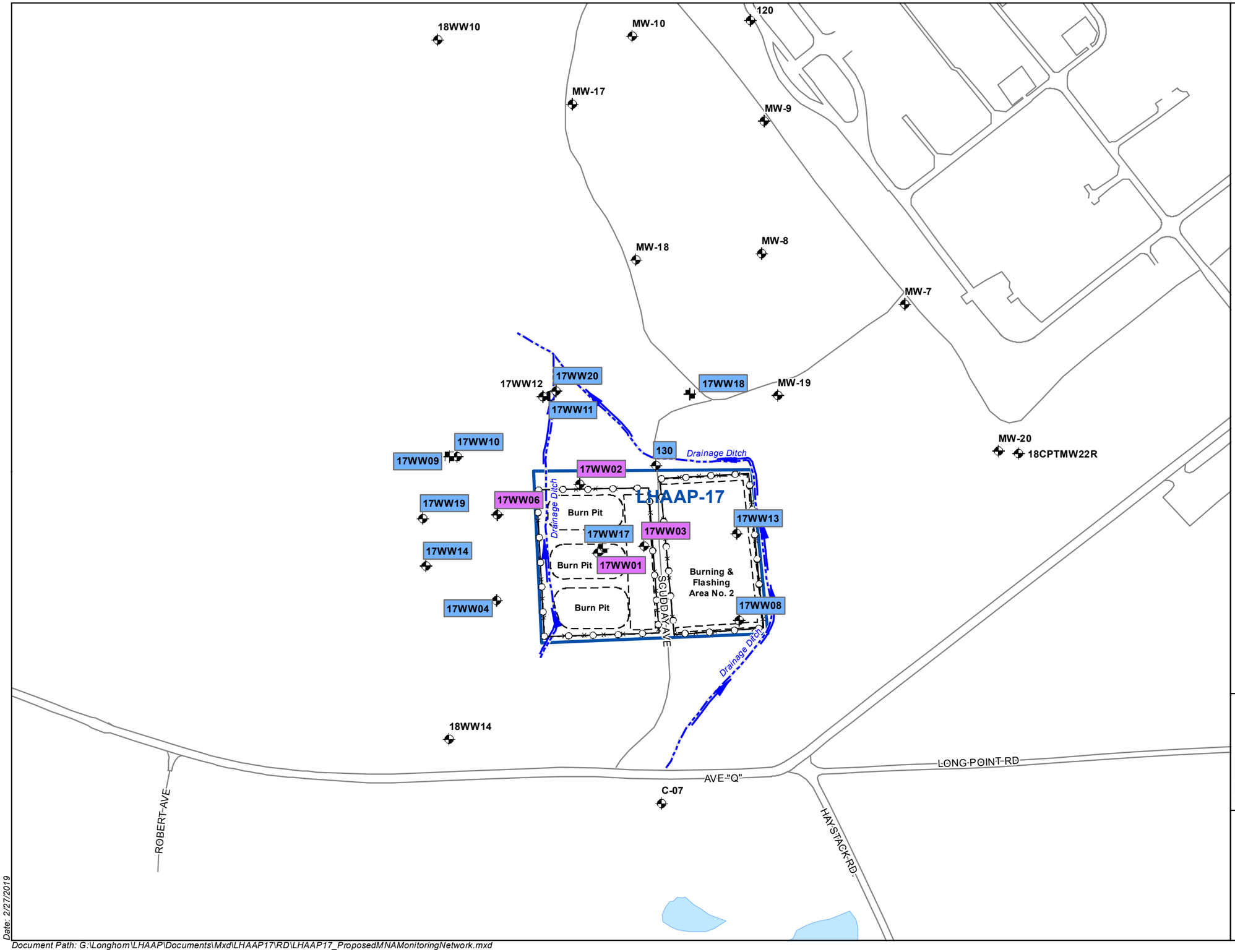
REMEDIAL DESIGN / REMEDIAL ACTION

WORK PLAN

LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

File: 501032-PFD1.dwg
Plot Date/Time: Nov 01, 2018 - 5:14pm
Plotted By: samantha.bentley



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

bhate ENVIRONMENT & INFRASTRUCTURE

APTIM

Figure 8-1

Proposed MNA Monitoring Network

Remedial Design/Remedial Action Work Plan, LHAAP-17

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 2/27/2019

Document Path: G:\Longhorn\LHAAP\Documents\Mxd\LHAAP17\RD\LHAAP17_ProposedMNAMonitoringNetwork.mxd

Appendix A

Analytical Data Reports from August 2018 Soil Samples

10450 Stancliff Rd. Suite 210
Houston, TX 77099
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September 04, 2018

Sharon Pennington
Aptim Environmental & Infrastucture, Inc.
2500 City West Blvd., Suite 1700
Houston, TX 77042

Work Order: **HS18080516**

Laboratory Results for: **Longhorn Army Ammunition Plant LHAAP-17**

Dear Sharon,

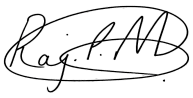
ALS Environmental received 10 sample(s) on Aug 10, 2018 for the analysis presented in the following report.

The analytical data provided relates directly to the samples received by ALS Environmental and for only the analyses requested. Results are expressed as "as received" unless otherwise noted.

QC sample results for this data met EPA or laboratory specifications except as noted in the Case Narrative or as noted with qualifiers in the QC batch information. Should this laboratory report need to be reproduced, it should be reproduced in full unless written approval has been obtained by ALS Environmental. Samples will be disposed in 30 days unless storage arrangements are made.

If you have any questions regarding this report, please feel free to call me.

Sincerely,



Generated By: JUMOKE.LAWAL
RJ Modashia
Project Manager

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
Work Order: HS18080516

SAMPLE SUMMARY

Lab Samp ID	Client Sample ID	Matrix	TagNo	Collection Date	Date Received	Hold
HS18080516-01	17SS67-0.0-0.5	Soil		09-Aug-2018 09:45	10-Aug-2018 08:45	☐
HS18080516-02	17SS68-0.0-0.5	Soil		09-Aug-2018 09:55	10-Aug-2018 08:45	☐
HS18080516-03	17SS69-0.0-0.5	Soil		09-Aug-2018 10:05	10-Aug-2018 08:45	☐
HS18080516-04	17SS70-0.0-0.5	Soil		09-Aug-2018 10:15	10-Aug-2018 08:45	☐
HS18080516-05	17SS71-0.0-2.0	Soil		09-Aug-2018 11:10	10-Aug-2018 08:45	☐
HS18080516-06	17SS71-5.0-7.0	Soil		09-Aug-2018 13:20	10-Aug-2018 08:45	☐
HS18080516-07	17SS72-0.0-2.0	Soil		09-Aug-2018 11:20	10-Aug-2018 08:45	☐
HS18080516-08	17SS73-0.0-2.0	Soil		09-Aug-2018 11:30	10-Aug-2018 08:45	☐
HS18080516-09	17SS74-0.0-2.0	Soil		09-Aug-2018 11:40	10-Aug-2018 08:45	☐
HS18080516-10	17SS74-5.0-7.0	Soil		09-Aug-2018 13:30	10-Aug-2018 08:45	☐

Client: Aptim Environmental & Infrastucture, Inc. **CASE NARRATIVE**
Project: Longhorn Army Ammunition Plant LHAAP-17
Work Order: HS18080516

HPLC by Method SW8330

Batch ID: 131497

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

Metals by Method SW6020

Batch ID: 131368

Sample ID: HS18080501-05MS

- MS and MSD are for an unrelated sample

WetChemistry by Method ASTM D2216

Batch ID: R321861

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
Sample ID: 17SS67-0.0-0.5
Collection Date: 09-Aug-2018 09:45

ANALYTICAL REPORT
WorkOrder:HS18080516
Lab ID:HS18080516-01
Matrix:Soil

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
METALS BY SW6020A	**Method:SW6020**					Prep:SW3050A / 10-Aug-2018		Analyst: JDE
Barium	**280**		**0.322**	**1.07**	**5.37**	**mg/Kg-dry**	10	16-Aug-2018 15:46
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**11.5**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	16-Aug-2018 12:06

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
Sample ID: 17SS68-0.0-0.5
Collection Date: 09-Aug-2018 09:55

ANALYTICAL REPORT
WorkOrder:HS18080516
Lab ID:HS18080516-02
Matrix:Soil

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
METALS BY SW6020A	**Method:SW6020**					Prep:SW3050A / 10-Aug-2018		Analyst: JDE
Barium	**4,480**		**3.63**	**12.1**	**60.4**	**mg/Kg-dry**	100	16-Aug-2018 15:48
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**21.3**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	16-Aug-2018 12:06

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
ANALYTICAL REPORT
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder:HS18080516
Sample ID: 17SS69-0.0-0.5
Lab ID:HS18080516-03
Collection Date: 09-Aug-2018 10:05
Matrix:Soil

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
METALS BY SW6020A	**Method:SW6020**					Prep:SW3050A / 10-Aug-2018		Analyst: JDE
Barium	**252**		**0.338**	**1.13**	**5.64**	**mg/Kg-dry**	10	16-Aug-2018 15:50
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**15.5**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	16-Aug-2018 12:06

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
Sample ID: 17SS70-0.0-0.5
Collection Date: 09-Aug-2018 10:15

ANALYTICAL REPORT
WorkOrder:HS18080516
Lab ID:HS18080516-04
Matrix:Soil

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
METALS BY SW6020A	**Method:SW6020**					Prep:SW3050A / 10-Aug-2018		Analyst: JDE
Barium	**120**		**0.0333**	**0.111**	**0.555**	**mg/Kg-dry**	1	16-Aug-2018 15:02
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**13.6**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	16-Aug-2018 12:06

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
ANALYTICAL REPORT
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder:HS18080516
Sample ID: 17SS71-0.0-2.0
Lab ID:HS18080516-05
Collection Date: 09-Aug-2018 11:10
Matrix:Soil

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
EXPLOSIVES BY SW8330B	**Method:SW8330**					Prep:SW8330 / 15-Aug-2018		Analyst: NPI
2,4,6-Trinitrotoluene	28.1	U	5.58	28.1	67.5	ug/Kg-dry	1	16-Aug-2018 11:56
2,4-Dinitrotoluene	28.1	U	4.99	28.1	67.5	ug/Kg-dry	1	16-Aug-2018 11:56
2,6-Dinitrotoluene	28.1	U	12.1	28.1	67.5	ug/Kg-dry	1	16-Aug-2018 11:56
Surr: 1,2-Dinitrobenzene	*77.9*			**0**	*50-150*	*%REC*	*1*	*16-Aug-2018 11:56*
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**12.8**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	16-Aug-2018 12:06

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
ANALYTICAL REPORT
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder:HS18080516
Sample ID: 17SS71-5.0-7.0
Lab ID:HS18080516-06
Collection Date: 09-Aug-2018 13:20
Matrix:Soil

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
EXPLOSIVES BY SW8330B	**Method:SW8330**					Prep:SW8330 / 15-Aug-2018		Analyst: NPI
2,4,6-Trinitrotoluene	28.8	U	5.71	28.8	69.1	ug/Kg-dry	1	16-Aug-2018 12:32
2,4-Dinitrotoluene	28.8	U	5.11	28.8	69.1	ug/Kg-dry	1	16-Aug-2018 12:32
2,6-Dinitrotoluene	28.8	U	12.4	28.8	69.1	ug/Kg-dry	1	16-Aug-2018 12:32
Surr: 1,2-Dinitrobenzene	*76.2*			**0**	*50-150*	*%REC*	*1*	*16-Aug-2018 12:32*
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**16.9**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	16-Aug-2018 12:06

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
ANALYTICAL REPORT
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder:HS18080516
Sample ID: 17SS72-0.0-2.0
Lab ID:HS18080516-07
Collection Date: 09-Aug-2018 11:20
Matrix:Soil

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
EXPLOSIVES BY SW8330B	**Method:SW8330**					Prep:SW8330 / 15-Aug-2018		Analyst: NPI
2,4,6-Trinitrotoluene	29.0	U	5.75	29.0	69.5	ug/Kg-dry	1	16-Aug-2018 13:08
2,4-Dinitrotoluene	29.0	U	5.15	29.0	69.5	ug/Kg-dry	1	16-Aug-2018 13:08
2,6-Dinitrotoluene	29.0	U	12.5	29.0	69.5	ug/Kg-dry	1	16-Aug-2018 13:08
Surr: 1,2-Dinitrobenzene	*70.8*			**0**	*50-150*	*%REC*	*1*	*16-Aug-2018 13:08*
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**15.0**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	16-Aug-2018 12:06

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
ANALYTICAL REPORT
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder:HS18080516
Sample ID: 17SS73-0.0-2.0
Lab ID:HS18080516-08
Collection Date: 09-Aug-2018 11:30
Matrix:Soil

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
EXPLOSIVES BY SW8330B	**Method:SW8330**					Prep:SW8330 / 15-Aug-2018		Analyst: NPI
2,4,6-Trinitrotoluene	28.2	U	5.60	28.2	67.8	ug/Kg-dry	1	16-Aug-2018 13:44
2,4-Dinitrotoluene	28.2	U	5.01	28.2	67.8	ug/Kg-dry	1	16-Aug-2018 13:44
2,6-Dinitrotoluene	28.2	U	12.2	28.2	67.8	ug/Kg-dry	1	16-Aug-2018 13:44
Surr: 1,2-Dinitrobenzene	*73.8*			**0**	*50-150*	*%REC*	*1*	*16-Aug-2018 13:44*
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**11.9**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	16-Aug-2018 12:06

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
Sample ID: 17SS74-0.0-2.0
Collection Date: 09-Aug-2018 11:40

ANALYTICAL REPORT
WorkOrder:HS18080516
Lab ID:HS18080516-09
Matrix:Soil

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
EXPLOSIVES BY SW8330B	**Method:SW8330**					Prep:SW8330 / 15-Aug-2018		Analyst: NPI
2,4,6-Trinitrotoluene	26.8	U	5.32	26.8	64.4	ug/Kg-dry	1	16-Aug-2018 14:19
2,4-Dinitrotoluene	26.8	U	4.76	26.8	64.4	ug/Kg-dry	1	16-Aug-2018 14:19
2,6-Dinitrotoluene	26.8	U	11.6	26.8	64.4	ug/Kg-dry	1	16-Aug-2018 14:19
Surr: 1,2-Dinitrobenzene	*75.1*			**0**	*50-150*	*%REC*	*1*	*16-Aug-2018 14:19*
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**10.4**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	16-Aug-2018 12:06

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
ANALYTICAL REPORT
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder:HS18080516
Sample ID: 17SS74-5.0-7.0
Lab ID:HS18080516-10
Collection Date: 09-Aug-2018 13:30
Matrix:Soil

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
EXPLOSIVES BY SW8330B	**Method:SW8330**					Prep:SW8330 / 15-Aug-2018		Analyst: NPI
2,4,6-Trinitrotoluene	31.5	U	6.25	31.5	75.6	ug/Kg-dry	1	16-Aug-2018 14:55
2,4-Dinitrotoluene	31.5	U	5.59	31.5	75.6	ug/Kg-dry	1	16-Aug-2018 14:55
2,6-Dinitrotoluene	31.5	U	13.6	31.5	75.6	ug/Kg-dry	1	16-Aug-2018 14:55
Surr: 1,2-Dinitrobenzene	*76.3*			**0**	*50-150*	*%REC*	*1*	*16-Aug-2018 14:55*
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**22.9**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	16-Aug-2018 12:06

Note: See Qualifiers Page for a list of qualifiers and their explanation.

WEIGHT LOG

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder: HS18080516

Batch ID: 131368 **Method:** METALS BY SW6020A **Prep:** 3050_I_LOW

SampID	Container	Sample Wt/Vol	Final Volume	Prep Factor
HS18080516-01	1	0.5258	50 (mL)	95.09
HS18080516-02	1	0.5257	50 (mL)	95.11
HS18080516-03	1	0.525	50 (mL)	95.24
HS18080516-04	1	0.5211	50 (mL)	95.95

Batch ID: 131497 **Method:** EXPLOSIVES BY SW8330B **Prep:** 8330_SPR

SampID	Container	Sample Wt/Vol	Final Volume	Prep Factor
HS18080516-05	1	2.04	10 (mL)	4.902
HS18080516-06	1	2.09	10 (mL)	4.785
HS18080516-07	1	2.03	10 (mL)	4.926
HS18080516-08	1	2.01	10 (mL)	4.975
HS18080516-09	1	2.08	10 (mL)	4.808
HS18080516-10	1	2.06	10 (mL)	4.854

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder: HS18080516

DATES REPORT

Sample ID	Client Samp ID	Collection Date	TCLP Date	Prep Date	Analysis Date	DF
Batch ID 131368	**Test Name :** METALS BY SW6020A			**Matrix:** Soil		
HS18080516-01	17SS67-0.0-0.5	09 Aug 2018 09:45		10 Aug 2018 09:51	16 Aug 2018 15:46	10
HS18080516-02	17SS68-0.0-0.5	09 Aug 2018 09:55		10 Aug 2018 09:51	16 Aug 2018 15:48	100
HS18080516-03	17SS69-0.0-0.5	09 Aug 2018 10:05		10 Aug 2018 09:51	16 Aug 2018 15:50	10
HS18080516-04	17SS70-0.0-0.5	09 Aug 2018 10:15		10 Aug 2018 09:51	16 Aug 2018 15:02	1
Batch ID 131497	**Test Name :** EXPLOSIVES BY SW8330B			**Matrix:** Soil		
HS18080516-05	17SS71-0.0-2.0	09 Aug 2018 11:10		15 Aug 2018 11:01	16 Aug 2018 11:56	1
HS18080516-06	17SS71-5.0-7.0	09 Aug 2018 13:20		15 Aug 2018 11:01	16 Aug 2018 12:32	1
HS18080516-07	17SS72-0.0-2.0	09 Aug 2018 11:20		15 Aug 2018 11:01	16 Aug 2018 13:08	1
HS18080516-08	17SS73-0.0-2.0	09 Aug 2018 11:30		15 Aug 2018 11:01	16 Aug 2018 13:44	1
HS18080516-09	17SS74-0.0-2.0	09 Aug 2018 11:40		15 Aug 2018 11:01	16 Aug 2018 14:19	1
HS18080516-10	17SS74-5.0-7.0	09 Aug 2018 13:30		15 Aug 2018 11:01	16 Aug 2018 14:55	1
Batch ID R321861	**Test Name :** MOISTURE - ASTM D2216			**Matrix:** Soil		
HS18080516-01	17SS67-0.0-0.5	09 Aug 2018 09:45			16 Aug 2018 12:06	1
HS18080516-02	17SS68-0.0-0.5	09 Aug 2018 09:55			16 Aug 2018 12:06	1
HS18080516-03	17SS69-0.0-0.5	09 Aug 2018 10:05			16 Aug 2018 12:06	1
HS18080516-04	17SS70-0.0-0.5	09 Aug 2018 10:15			16 Aug 2018 12:06	1
HS18080516-05	17SS71-0.0-2.0	09 Aug 2018 11:10			16 Aug 2018 12:06	1
HS18080516-06	17SS71-5.0-7.0	09 Aug 2018 13:20			16 Aug 2018 12:06	1
HS18080516-07	17SS72-0.0-2.0	09 Aug 2018 11:20			16 Aug 2018 12:06	1
HS18080516-08	17SS73-0.0-2.0	09 Aug 2018 11:30			16 Aug 2018 12:06	1
HS18080516-09	17SS74-0.0-2.0	09 Aug 2018 11:40			16 Aug 2018 12:06	1
HS18080516-10	17SS74-5.0-7.0	09 Aug 2018 13:30			16 Aug 2018 12:06	1

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder: HS18080516

QC BATCH REPORT

Batch ID: 131497 **Instrument: HPLC3** **Method: SW8330**

MBLK Sample ID: **MBLK-131497** Units: **ug/Kg** Analysis Date: **16-Aug-2018 18:30**
Client ID: Run ID: **HPLC3_321848** SeqNo: **4695684** PrepDate: **15-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
2,4,6-Trinitrotoluene	25.0	60.0								U
2,4-Dinitrotoluene	25.0	60.0								U
2,6-Dinitrotoluene	25.0	60.0								U
Surr: 1,2-Dinitrobenzene	*978.6*	*60.0*	*1250*	*0*	*78.3*	*50 - 150*				

MBLK Sample ID: **MBLK-131497** Units: **ug/Kg** Analysis Date: **16-Aug-2018 18:30**
Client ID: Run ID: **HPLC3_321849** SeqNo: **4695693** PrepDate: **15-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
2,4,6-Trinitrotoluene	25.0	60.0								U
2,4-Dinitrotoluene	25.0	60.0								U
2,6-Dinitrotoluene	25.0	60.0								U
Surr: 1,2-Dinitrobenzene	*978.6*	*60.0*	*1250*	*0*	*78.3*	*50 - 150*				

LCS Sample ID: **LCS-131497** Units: **ug/Kg** Analysis Date: **16-Aug-2018 18:53**
Client ID: Run ID: **HPLC3_321848** SeqNo: **4695697** PrepDate: **15-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
2,4,6-Trinitrotoluene	1201	60.0	1250	0	96.1	75 - 125				
2,4-Dinitrotoluene	1200	60.0	1250	0	96.0	82 - 123				
2,6-Dinitrotoluene	1210	60.0	1250	0	96.8	86 - 119				
Surr: 1,2-Dinitrobenzene	*1243*	*60.0*	*1250*	*0*	*99.4*	*50 - 150*				

LCS Sample ID: **LCS-131497** Units: **ug/Kg** Analysis Date: **16-Aug-2018 18:53**
Client ID: Run ID: **HPLC3_321849** SeqNo: **4695698** PrepDate: **15-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
2,4,6-Trinitrotoluene	1201	60.0	1250	0	96.1	60 - 120				
2,4-Dinitrotoluene	1200	60.0	1250	0	96.0	60 - 120				
2,6-Dinitrotoluene	1210	60.0	1250	0	96.8	60 - 120				
Surr: 1,2-Dinitrobenzene	*1243*	*60.0*	*1250*	*0*	*99.4*	*50 - 150*				

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder: HS18080516

QC BATCH REPORT

Batch ID: 131497 **Instrument: HPLC3** **Method: SW8330**

MS Sample ID: **HS18080516-10MS** Units: **ug/Kg** Analysis Date: **16-Aug-2018 15:31**
Client ID: **17SS74-5.0-7.0** Run ID: **HPLC3_321848** SeqNo: **4695680** PrepDate: **15-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
2,4,6-Trinitrotoluene	1271	58.8	1225	0	104	75 - 125				
2,4-Dinitrotoluene	1299	58.8	1225	0	106	82 - 123				
2,6-Dinitrotoluene	1273	58.8	1225	0	104	86 - 119				
Surr: 1,2-Dinitrobenzene	*974.5*	*58.8*	*1225*	*0*	*79.5*	*50 - 150*				

MS Sample ID: **HS18080516-10MS** Units: **ug/Kg** Analysis Date: **16-Aug-2018 15:31**
Client ID: **17SS74-5.0-7.0** Run ID: **HPLC3_321849** SeqNo: **4695689** PrepDate: **15-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
2,4,6-Trinitrotoluene	1271	58.8	1225	0	104	60 - 120				
2,4-Dinitrotoluene	1299	58.8	1225	0	106	60 - 120				
2,6-Dinitrotoluene	1273	58.8	1225	0	104	60 - 120				
Surr: 1,2-Dinitrobenzene	*974.5*	*58.8*	*1225*	*0*	*79.5*	*50 - 150*				

MSD Sample ID: **HS18080516-10MSD** Units: **ug/Kg** Analysis Date: **16-Aug-2018 16:07**
Client ID: **17SS74-5.0-7.0** Run ID: **HPLC3_321848** SeqNo: **4695681** PrepDate: **15-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
2,4,6-Trinitrotoluene	1262	58.0	1208	0	105	75 - 125	1271	0.689	30	
2,4-Dinitrotoluene	1280	58.0	1208	0	106	82 - 123	1299	1.46	30	
2,6-Dinitrotoluene	1237	58.0	1208	0	102	86 - 119	1273	2.86	30	
Surr: 1,2-Dinitrobenzene	*1025*	*58.0*	*1208*	*0*	*84.9*	*50 - 150*	*974.5*	*5.07*	*30*	

MSD Sample ID: **HS18080516-10MSD** Units: **ug/Kg** Analysis Date: **16-Aug-2018 16:07**
Client ID: **17SS74-5.0-7.0** Run ID: **HPLC3_321849** SeqNo: **4695690** PrepDate: **15-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
2,4,6-Trinitrotoluene	1262	58.0	1208	0	105	60 - 120	1271	0.689	30	
2,4-Dinitrotoluene	1280	58.0	1208	0	106	60 - 120	1299	1.46	30	
2,6-Dinitrotoluene	1237	58.0	1208	0	102	60 - 120	1273	2.86	30	
Surr: 1,2-Dinitrobenzene	*1025*	*58.0*	*1208*	*0*	*84.9*	*50 - 150*	*974.5*	*5.07*	*30*	

The following samples were analyzed in this batch: HS18080516-05 HS18080516-06 HS18080516-07 HS18080516-08 HS18080516-09 HS18080516-10

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder: HS18080516

QC BATCH REPORT

Batch ID: 131368 **Instrument: ICPMS04** **Method: SW6020**

MBLK Sample ID: **MBLK-131368** Units: **mg/Kg** Analysis Date: **16-Aug-2018 14:25**
Client ID: Run ID: **ICPMS04_321797** SeqNo: **4695286** PrepDate: **10-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Barium	0.059	0.500								J

LCS Sample ID: **LCS-131368** Units: **mg/Kg** Analysis Date: **16-Aug-2018 14:28**
Client ID: Run ID: **ICPMS04_321797** SeqNo: **4695287** PrepDate: **10-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Barium	9.99	0.500	10	0	99.9	80 - 120				

MS Sample ID: **HS18080501-05MS** Units: **mg/Kg** Analysis Date: **16-Aug-2018 14:48**
Client ID: Run ID: **ICPMS04_321797** SeqNo: **4695296** PrepDate: **10-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Barium	88.29	0.469	9.381	66.31	234	75 - 125				SO

MSD Sample ID: **HS18080501-05MSD** Units: **mg/Kg** Analysis Date: **16-Aug-2018 14:50**
Client ID: Run ID: **ICPMS04_321797** SeqNo: **4695297** PrepDate: **10-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Barium	86.5	0.466	9.314	66.31	217	75 - 125	88.29	2.04	20	SO

PDS Sample ID: **HS18080501-05PDS** Units: **mg/Kg** Analysis Date: **16-Aug-2018 14:53**
Client ID: Run ID: **ICPMS04_321797** SeqNo: **4695298** PrepDate: **10-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Barium	74.61	0.469	9.377	66.31	88.6	75 - 125				O

SD Sample ID: **HS18080501-05SD** Units: **mg/Kg** Analysis Date: **16-Aug-2018 15:44**
Client ID: Run ID: **ICPMS04_321797** SeqNo: **4695307** PrepDate: **10-Aug-2018** DF: **5**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%D	%D Limit	Qual
Barium	66.37	2.34					66.31	0.0901	10	

The following samples were analyzed in this batch: HS18080516-01 HS18080516-02 HS18080516-03 HS18080516-04

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder: HS18080516

QC BATCH REPORT

Batch ID: R321861 **Instrument: Balance1** **Method: ASTM D2216**

DUP Sample ID: **HS18080516-10DUP** Units: **wt%** Analysis Date: **16-Aug-2018 12:06**
Client ID: **17SS74-5.0-7.0** Run ID: **Balance1_321861** SeqNo: **4696162** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Percent Moisture	21.4	0.0100					22.9	6.77	20	

The following samples were analyzed in this batch:

HS18080516-01	HS18080516-02	HS18080516-03	HS18080516-04
HS18080516-05	HS18080516-06	HS18080516-07	HS18080516-08
HS18080516-09	HS18080516-10		

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant LHAAP-17
WorkOrder: **HS18080516**

QUALIFIERS, ACRONYMS, UNITS

Qualifier	Description
*	Value exceeds Regulatory Limit
a	Not accredited
B	Analyte detected in the associated Method Blank above the Reporting Limit
E	Value above quantitation range
H	Analyzed outside of Holding Time
J	Analyte detected below quantitation limit
M	Manually integrated, see raw data for justification
n	Not offered for accreditation
ND	Not Detected at the Reporting Limit
O	Sample amount is > 4 times amount spiked
P	Dual Column results percent difference > 40%
R	RPD above laboratory control limit
S	Spike Recovery outside laboratory control limits
U	Analyzed but not detected above the MDL/SDL

Acronym	Description
DCS	Detectability Check Study
DUP	Method Duplicate
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MBLK	Method Blank
MDL	Method Detection Limit
MQL	Method Quantitation Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PDS	Post Digestion Spike
PQL	Practical Quantitaion Limit
SD	Serial Dilution
SDL	Sample Detection Limit
TRRP	Texas Risk Reduction Program

CERTIFICATIONS,ACCREDITATIONS & LICENSES

Agency	Number	Expire Date
North Carolina	624-2018	31-Dec-2018
Arkansas	88-0356	27-Mar-2019
Texas	T10470231-18-21	30-Apr-2019
North Dakota	R193 2018-2019	30-Apr-2019
Illinois	004438	29-Jun-2019
Louisiana	03087	30-Jun-2019
Dept of Defense	L2231 Rev 3-30-2018	22-Dec-2018
Kentucky	123043 - 2018	30-Apr-2019
Kansas	E-10352 2018-2019	31-Jul-2019
Oklahoma	2018-156	31-Aug-2019

Sample Receipt Checklist

Client Name: CBI-Houston
Work Order: HS18080516

Date/Time Received: **10-Aug-2018 08:45**
Received by: **JRM**

Checklist completed by: *Jared R. Makan* eSignature — 10-Aug-2018 Date

Reviewed by: *RJ Modashia* eSignature — 10-Aug-2018 Date

Matrices: **Soil**

Carrier name: **ALS Courier**

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
TX1005 solids received in hermetically sealed vials?	Yes ☐	No ☐	N/A ☑
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	
Temperature(s)/Thermometer(s):	3.0c/2.6c UC/C	IR11	
Cooler(s)/Kit(s):	43306		
Date/Time sample(s) sent to storage:	08/10/2018 11:35		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	N/A ☑
pH adjusted?	Yes ☐	No ☐	N/A ☑
pH adjusted by:			

Login Notes:

Client Contacted: Date Contacted: Person Contacted:

Contacted By: Regarding:

Comments:

Corrective Action:

APTIM

Page 1 of 1

COC ID: 09-AUG2018-SO-ALSHT-080918 **TURNAROUND TIME:** normal **RUSH:**

PROJECT/CLIENT INFO				LABORATORY				OTHER INFO			
Facility Name	Longhorn AAP			Lab Name	ALS Laboratories			Email Invoice To	FedInvoices@CBIFederalServices.com		
Project Number	501032			Lab Contact	Sonia West						
	LHAAP-17			Email	Sonia.West@alsglobal.com			Email Report To	Sharon.Pennington@CBIFederalServices.com		
Address	1203-B East Grand Avenue			Address	10450 Stancliff Rd., Suite 210			Mail Reports To	Sharon Pennington		
	PMB 202							Address	2410 Cherahala Blvd.		
City	Marshall	State	TX	City	Houston	State	TX	City	Knoxville	State	TN
Postal Code	75670	Country	USA	Postal Code	77099	Country	USA	Postal Code	37932	Country	USA
Phone Number	713.243.7264			Phone Number	281.575.2132 or 281.530.5656						
Project Manager	Praveen Srivastav							Shipping Company	FedEx		

SAMPLE DETAILS									ANALYSIS REQUESTED	
Sample ID	Location	Start Depth	End Depth	Depth Unit	Field Matrix	Date	Time (24hr)	# Of Cont.	Barium in Soil by Method 6020A	2,4-DNT &amp, 2,6-DNT in Soil by Method 8330
17SS67-0.0-0.5	LHAAP-17	0	0.5	FT	SO	8/9/2018	0945	1	X	
17SS68-0.0-0.5	LHAAP-17	0	0.5	FT	SO	8/9/2018	0955	1	X	
17SS69-0.0-0.5	LHAAP-17	0	0.5	FT	SO	8/9/2018	1005	1	X	
17SS70-0.0-0.5	LHAAP-17	0	0.5	FT	SO	8/9/2018	1015	1	X	
17SS71-0.0-2.0	LHAAP-17	0	2	FT	SO	8/9/2018	1110	1		X
17SS71-5.0-7.0	LHAAP-17	5	7	FT	SO	8/9/2018	1320	1		X
17SS72-0.0-2.0	LHAAP-17	0	2	FT	SO	8/9/2018	1120	1		X
17SS73-0.0-2.0	LHAAP-17	0	2	FT	SO	8/9/2018	1130	1		X
17SS74-0.0-2.0	LHAAP-17	0	2	FT	SO	8/9/2018	1140	1		X
17SS74-5.0-7.0	LHAAP-17	5	7	FT	SO	8/9/2018	1330	1		X
17SS74-5.0-7.0-MS	LHAAP-17	5	7	FT	SO	8/9/2018	1330	1		X
17SS74-5.0-7.0-MSD	LHAAP-17	5	7	FT	SO	8/9/2018	1330	1		X

HS18080516

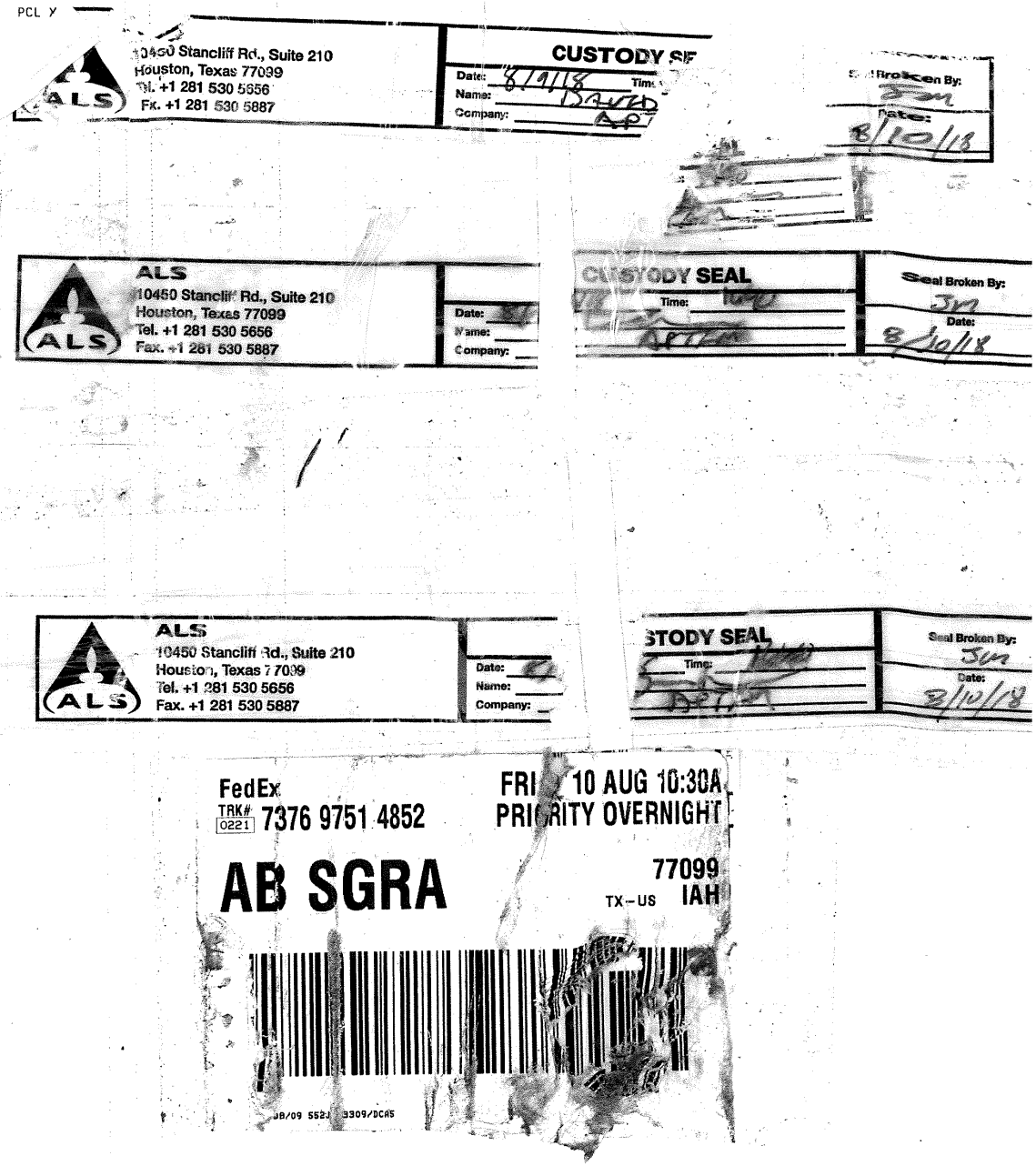
Aptim Environmental & Infrastucture, Inc.

Longhorn Army Ammunition Plant LHAAP-17

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS	RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
	David Rowan / APTIM	8/9/2018		
	David R	1636	J. MAHAN	8/10/18 08:45

Cooler - 43306 IR 11

Temp - 3.0 CF - 0.4


PCL Y
ALS
10450 Stancliff Rd., Suite 210
Houston, Texas 77099
Tel. +1 281 530 5656
Fax. +1 281 530 5887
CUSTODY SEAL
Date:
Name:
Company:
Seal Broken By:
Date:
8/10/18
ALS
10450 Stancliff Rd., Suite 210
Houston, Texas 77099
Tel. +1 281 530 5656
Fax. +1 281 530 5887
CUSTODY SEAL
Time:
Seal Broken By:
Date:
8/10/18
ALS
10450 Stancliff Rd., Suite 210
Houston, Texas 77099
Tel. +1 281 530 5656
Fax. +1 281 530 5887
Date:
Name:
Company:
Time:
Seal Broken By:
Date:
8/10/18
FedEx
TRK# 0221 7376 9751 4852
FRI 10 AUG 10:30A
PRIORITY OVERNIGHT
AB SGRA
77099
TX-US IAH

10450 Stancliff Rd. Suite 210
Houston, TX 77099
T: +1 281 530 5656
F: +1 281 530 5887

August 20, 2018

Sharon Pennington
Aptim Environmental & Infrastucture, Inc.
2500 City West Blvd., Suite 1700
Houston, TX 77042

Work Order: **HS18080501**

Laboratory Results for: **Longhorn Army Ammunition Plant**

Dear Sharon,

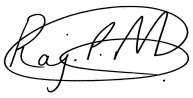
ALS Environmental received 5 sample(s) on Aug 09, 2018 for the analysis presented in the following report.

The analytical data provided relates directly to the samples received by ALS Environmental and for only the analyses requested. Results are expressed as "as received" unless otherwise noted.

QC sample results for this data met EPA or laboratory specifications except as noted in the Case Narrative or as noted with qualifiers in the QC batch information. Should this laboratory report need to be reproduced, it should be reproduced in full unless written approval has been obtained by ALS Environmental. Samples will be disposed in 30 days unless storage arrangements are made.

If you have any questions regarding this report, please feel free to call me.

Sincerely,



Generated By: DAYNA.FISHER
RJ Modashia
Project Manager

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant
Work Order: HS18080501

SAMPLE SUMMARY

Lab Samp ID	Client Sample ID	Matrix	TagNo	Collection Date	Date Received	Hold
HS18080501-01	17SS75-0.0-0.5	Solid		08-Aug-2018 13:30	09-Aug-2018 08:40	☐
HS18080501-02	17SS75-0.0-0.5-FD	Solid		08-Aug-2018 13:30	09-Aug-2018 08:40	☐
HS18080501-03	17SS76-0.0-0.5	Solid		08-Aug-2018 13:40	09-Aug-2018 08:40	☐
HS18080501-04	17SS77-0.0-0.5	Solid		08-Aug-2018 13:50	09-Aug-2018 08:40	☐
HS18080501-05	17SS78-0.0-0.5	Solid		08-Aug-2018 14:00	09-Aug-2018 08:40	☐

Client: Aptim Environmental & Infrastucture, Inc. **CASE NARRATIVE**
Project: Longhorn Army Ammunition Plant
Work Order: HS18080501

Metals by Method SW6020

Batch ID: 131368

Sample ID: 17SS78-0.0-0.5 (HS18080501-05MS)

- The MS and/or MSD recovery was outside of the control; however, the result in the parent sample is greater than 4x the spike amount. Barium.

WetChemistry by Method ASTM D2216

Batch ID: R321965

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

ALS Group Houston, Corp Date: 20-Aug-18

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant
Sample ID: 17SS75-0.0-0.5
Collection Date: 08-Aug-2018 13:30

ANALYTICAL REPORT
WorkOrder:HS18080501
Lab ID:HS18080501-01
Matrix:Solid

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
METALS BY SW6020A	**Method:SW6020**					Prep:SW3050A / 10-Aug-2018		Analyst: JDE
Barium	**78.9**		**0.0310**	**0.103**	**0.516**	**mg/Kg-dry**	1	16-Aug-2018 14:30
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**5.73**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	17-Aug-2018 12:40

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant
Sample ID: 17SS75-0.0-0.5-FD
Collection Date: 08-Aug-2018 13:30

ANALYTICAL REPORT
WorkOrder:HS18080501
Lab ID:HS18080501-02
Matrix:Solid

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
METALS BY SW6020A	**Method:SW6020**					Prep:SW3050A / 10-Aug-2018		Analyst: JDE
Barium	**71.3**		**0.0307**	**0.102**	**0.512**	**mg/Kg-dry**	1	16-Aug-2018 14:32
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**5.54**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	17-Aug-2018 12:40

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Group Houston, Corp Date: 20-Aug-18

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant
Sample ID: 17SS76-0.0-0.5
Collection Date: 08-Aug-2018 13:40

ANALYTICAL REPORT
WorkOrder:HS18080501
Lab ID:HS18080501-03
Matrix:Solid

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
METALS BY SW6020A	**Method:SW6020**					Prep:SW3050A / 10-Aug-2018		Analyst: JDE
Barium	**88.1**		**0.0301**	**0.100**	**0.502**	**mg/Kg-dry**	1	16-Aug-2018 14:35
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**6.97**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	17-Aug-2018 12:40

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant
Sample ID: 17SS77-0.0-0.5
Collection Date: 08-Aug-2018 13:50

ANALYTICAL REPORT
WorkOrder:HS18080501
Lab ID:HS18080501-04
Matrix:Solid

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
METALS BY SW6020A	**Method:SW6020**					Prep:SW3050A / 10-Aug-2018		Analyst: JDE
Barium	**90.5**		**0.0317**	**0.106**	**0.528**	**mg/Kg-dry**	1	16-Aug-2018 14:37
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**9.53**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	17-Aug-2018 12:40

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Group Houston, Corp Date: 20-Aug-18

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant
Sample ID: 17SS78-0.0-0.5
Collection Date: 08-Aug-2018 14:00

ANALYTICAL REPORT
WorkOrder:HS18080501
Lab ID:HS18080501-05
Matrix:Solid

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
METALS BY SW6020A	**Method:SW6020**					Prep:SW3050A / 10-Aug-2018		Analyst: JDE
Barium	**72.8**		**0.0309**	**0.103**	**0.515**	**mg/Kg-dry**	1	16-Aug-2018 14:39
MOISTURE - ASTM D2216	**Method:ASTM D2216**							Analyst: DFF
Percent Moisture	**8.91**		**0.0100**	**0.0100**	**0.0100**	**wt%**	1	17-Aug-2018 12:40

Note: See Qualifiers Page for a list of qualifiers and their explanation.

WEIGHT LOG

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant
WorkOrder: HS18080501

Batch ID: 131368 **Method:** METALS BY SW6020A **Prep:** 3050_I_LOW

SampID	Container	Sample Wt/Vol	Final Volume	Prep Factor
HS18080501-01	1	0.5136	50 (mL)	97.35
HS18080501-02	1	0.5166	50 (mL)	96.79
HS18080501-03	1	0.5349	50 (mL)	93.48
HS18080501-04	1	0.5238	50 (mL)	95.46
HS18080501-05	1	0.5332	50 (mL)	93.77

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant
WorkOrder: HS18080501

DATES REPORT

Sample ID	Client Samp ID	Collection Date	TCLP Date	Prep Date	Analysis Date	DF
Batch ID 131368	**Test Name :** METALS BY SW6020A			**Matrix:** Solid		
HS18080501-01	17SS75-0.0-0.5	08 Aug 2018 13:30		10 Aug 2018 09:51	16 Aug 2018 14:30	1
HS18080501-02	17SS75-0.0-0.5-FD	08 Aug 2018 13:30		10 Aug 2018 09:51	16 Aug 2018 14:32	1
HS18080501-03	17SS76-0.0-0.5	08 Aug 2018 13:40		10 Aug 2018 09:51	16 Aug 2018 14:35	1
HS18080501-04	17SS77-0.0-0.5	08 Aug 2018 13:50		10 Aug 2018 09:51	16 Aug 2018 14:37	1
HS18080501-05	17SS78-0.0-0.5	08 Aug 2018 14:00		10 Aug 2018 09:51	16 Aug 2018 14:39	1
Batch ID R321965	**Test Name :** MOISTURE - ASTM D2216			**Matrix:** Solid		
HS18080501-01	17SS75-0.0-0.5	08 Aug 2018 13:30			17 Aug 2018 12:40	1
HS18080501-02	17SS75-0.0-0.5-FD	08 Aug 2018 13:30			17 Aug 2018 12:40	1
HS18080501-03	17SS76-0.0-0.5	08 Aug 2018 13:40			17 Aug 2018 12:40	1
HS18080501-04	17SS77-0.0-0.5	08 Aug 2018 13:50			17 Aug 2018 12:40	1
HS18080501-05	17SS78-0.0-0.5	08 Aug 2018 14:00			17 Aug 2018 12:40	1

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant
WorkOrder: HS18080501

QC BATCH REPORT

Batch ID: 131368 **Instrument: ICPMS04** **Method: SW6020**

MBLK Sample ID: **MBLK-131368** Units: **mg/Kg** Analysis Date: **16-Aug-2018 14:25**
Client ID: Run ID: **ICPMS04_321797** SeqNo: **4695286** PrepDate: **10-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Barium	0.059	0.500								J

LCS Sample ID: **LCS-131368** Units: **mg/Kg** Analysis Date: **16-Aug-2018 14:28**
Client ID: Run ID: **ICPMS04_321797** SeqNo: **4695287** PrepDate: **10-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Barium	9.99	0.500	10	0	99.9	80 - 120				

MS Sample ID: **HS18080501-05MS** Units: **mg/Kg** Analysis Date: **16-Aug-2018 14:48**
Client ID: **17SS78-0.0-0.5** Run ID: **ICPMS04_321797** SeqNo: **4695296** PrepDate: **10-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Barium	88.29	0.469	9.381	66.31	234	75 - 125				SO

MSD Sample ID: **HS18080501-05MSD** Units: **mg/Kg** Analysis Date: **16-Aug-2018 14:50**
Client ID: **17SS78-0.0-0.5** Run ID: **ICPMS04_321797** SeqNo: **4695297** PrepDate: **10-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Barium	86.5	0.466	9.314	66.31	217	75 - 125	88.29	2.04	20	SO

PDS Sample ID: **HS18080501-05PDS** Units: **mg/Kg** Analysis Date: **16-Aug-2018 14:53**
Client ID: **17SS78-0.0-0.5** Run ID: **ICPMS04_321797** SeqNo: **4695298** PrepDate: **10-Aug-2018** DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Barium	74.61	0.469	9.377	66.31	88.6	75 - 125				O

SD Sample ID: **HS18080501-05SD** Units: **mg/Kg** Analysis Date: **16-Aug-2018 15:44**
Client ID: **17SS78-0.0-0.5** Run ID: **ICPMS04_321797** SeqNo: **4695307** PrepDate: **10-Aug-2018** DF: **5**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%D	%D Limit	Qual
Barium	66.37	2.34					66.31	0.0901	10	

The following samples were analyzed in this batch: HS18080501-01 HS18080501-02 HS18080501-03 HS18080501-04 HS18080501-05

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant
WorkOrder: HS18080501

QC BATCH REPORT

Batch ID: R321965 **Instrument: Balance1** **Method: ASTM D2216**

DUP Sample ID: **HS18080705-08DUP** Units: **wt%** Analysis Date: **17-Aug-2018 12:40**
Client ID: Run ID: **Balance1_321965** SeqNo: **4698026** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Percent Moisture	18.4	0.0100					17.6	4.44	20	

The following samples were analyzed in this batch: HS18080501-01 HS18080501-02 HS18080501-03 HS18080501-04 HS18080501-05

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Aptim Environmental & Infrastucture, Inc.
Project: Longhorn Army Ammunition Plant
WorkOrder: **HS18080501**

QUALIFIERS, ACRONYMS, UNITS

Qualifier	Description
*	Value exceeds Regulatory Limit
a	Not accredited
B	Analyte detected in the associated Method Blank above the Reporting Limit
E	Value above quantitation range
H	Analyzed outside of Holding Time
J	Analyte detected below quantitation limit
M	Manually integrated, see raw data for justification
n	Not offered for accreditation
ND	Not Detected at the Reporting Limit
O	Sample amount is > 4 times amount spiked
P	Dual Column results percent difference > 40%
R	RPD above laboratory control limit
S	Spike Recovery outside laboratory control limits
U	Analyzed but not detected above the MDL/SDL

Acronym	Description
DCS	Detectability Check Study
DUP	Method Duplicate
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MBLK	Method Blank
MDL	Method Detection Limit
MQL	Method Quantitation Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PDS	Post Digestion Spike
PQL	Practical Quantitaion Limit
SD	Serial Dilution
SDL	Sample Detection Limit
TRRP	Texas Risk Reduction Program

CERTIFICATIONS,ACCREDITATIONS & LICENSES

Agency	Number	Expire Date
Oklahoma	2017-088	31-Aug-2018
North Carolina	624-2018	31-Dec-2018
Arkansas	88-0356	27-Mar-2019
Texas	T10470231-18-21	30-Apr-2019
North Dakota	R193 2018-2019	30-Apr-2019
Illinois	004438	29-Jun-2019
Louisiana	03087	30-Jun-2019
Dept of Defense	L2231 Rev 3-30-2018	22-Dec-2018
Kentucky	123043 - 2018	30-Apr-2019
Kansas	E-10352 2018-2019	31-Jul-2019
Oklahoma	2018-156	31-Aug-2019

Date: 20-Aug-18

Sample Receipt Checklist

Client Name: CBI-Houston
Work Order: HS18080501

Date/Time Received: **09-Aug-2018 08:40**
Received by: **JRM**

Checklist completed by: *Pablo Marinez* eSignature — 9-Aug-2018 Date

Reviewed by: *RJ Modashia* eSignature — 10-Aug-2018 Date

Matrices: **SOLID**

Carrier name: **FedEx Priority Overnight**

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
TX1005 solids received in hermetically sealed vials?	Yes ☐	No ☐	N/A ☑
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	
Temperature(s)/Thermometer(s):	3.0C/2.6C UC/C	IR # 11	
Cooler(s)/Kit(s):	2738		
Date/Time sample(s) sent to storage:	8/9/2018 18:30		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	N/A ☑
pH adjusted?	Yes ☐	No ☐	N/A ☑
pH adjusted by:			

Login Notes:

Client Contacted: Date Contacted: Person Contacted:

Contacted By: Regarding:

Comments:

Corrective Action:

APTIM

COC ID: 08-AUG2018-SO-ALSHT-080818 **TURNAROUND TIME:** normal **RUSH:**

PROJECT/CLIENT INFO				LABORATORY				OTHER INFO			
Facility Name	Longhorn AAP			Lab Name	ALS Laboratories			Email Invoice To	FedInvoices@CBIFederalServices.com		
Project Number	501032			Lab Contact	Sonia West						
	LHAAP-17			Email	Sonia.West@alsglobal.com			Email Report To	Sharon.Pennington@CBIFederalServices.com		
Address	1203-B East Grand Avenue			Address	10450 Stancliff Rd., Suite 210			Mail Reports To	Sharon Pennington		
	PMB 202							Address	2410 Cherahala Blvd.		
City	Marshall	State	TX	City	Houston	State	TX	City	Knoxville	State	TN
Postal Code	75670	Country	USA	Postal Code	77099	Country	USA	Postal Code	37932	Country	USA
Phone Number	713.243.7264			Phone Number	281.575.2132 or 281.530.5656						
Project Manager	Praveen Srivastav							Shipping Company	FedEx 737697522677		

SAMPLE DETAILS / **ANALYSIS REQUESTED**

Sample ID	Location	Start Depth	End Depth	Depth Unit	Field Matrix	Date	Time (24hr)	# Of Cont.	ANALYSIS: Barium in Soil by Method 6020A
17SS75-0.0-0.5	LHAAP-17	0	0.5	FT	SO	8/8/2018	1330	1	X
17SS75-0.0-0.5-FD	LHAAP-17	0	0.5	FT	SO	8/8/2018	1330	1	X
17SS76-0.0-0.5	LHAAP-17	0	0.5	FT	SO	8/8/2018	1340	1	X
17SS77-0.0-0.5	LHAAP-17	0	0.5	FT	SO	8/8/2018	1350	1	X
17SS78-0.0-0.5	LHAAP-17	0	0.5	FT	SO	8/8/2018	1400	1	X

HS18080501

Aptim Environmental & Infrastucture, Inc.

Longhorn Army Ammunition Plant

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS	RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
	David Rowan / APTIM	8/8/2018 1530	J. Mullens	8/9/18 08:40

Cooler # 2738 Temp 3.0 2nd 11 CF-0.4

ALS
10450 Stancliff Rd., Suite 210
Houston, Texas 77099
Tel. +1 281 530 5656
Fax. +1 281 530 5887

2738

CUSTODY SEAL
Date: 8/8/18 Time: 1540
Name: B
Company: ALS

Seal Broken By: SM
Date: 08/09/18

2738 AUG 09 2018

ALS
10450 Stancliff Rd., Suite 210
Houston, Texas 77099
Tel. +1 281 530 5656
Fax. +1 281 530 5887

2738

CUSTODY SEAL
Date: 8/8/18 Time: 1540
Name: B
Company: ALS

Seal Broken By: SM
Date: 08/09/18

TO CLIENT SERVICES
ALS LABORATORY GROUP
10450 STANCLIFF ROAD
SUITE 210
HOUSTON TX 77099
(281) 530-5656
REF: LHAA [illegible]-37-RJ

2738

RMA:

FedEx Express

FedEx
TRK# 0221 7376 9752 2677

THU - 09 AUG 10:30A
PRIORITY OVERNIGHT

AB SGRA

77099
TX-US IAH

ALS
10450 Stancliff Rd., Suite 210
Houston, TX 77099
Tel. +1 281 530 5656
Fax. +1 281 530 5887

2735

CUSTODY SEAL
Date: 8/8/18 Time: 1540
Name:
Company: ALS

Seal Broken By: SM
Date: 08/09/18

Appendix B

Sample Collection Logs for August 2018 Soil Samples

Sample Collection Log

Project Name: **Longhorn AAP**

Location ID: **17SS67**

Project No: **501032**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS67-0.0-0.5

DATE/TIME: 8/9/2018 / 09:45

Sample Interval: 0 - 0.5 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes:

Chain of Custody	COC Notes	Analysis Group	Analytic Method
09-AUG2018-SO-ALSHT-080918	None	METALS	SW6020A

Sampler:		David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Location ID: **17SS68**

Project No: **501032**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS68-0.0-0.5

DATE/TIME: 8/9/2018 / 09:55

Sample Interval: 0 - 0.5 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes:

Chain of Custody	COC Notes	Analysis Group	Analytic Method
09-AUG2018-SO-ALSHT-080918	None	METALS	SW6020A

Sampler:		David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS69**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS69-0.0-0.5

DATE/TIME: 8/9/2018 / 10:05

Sample Interval: 0 - 0.5 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes:

Chain of Custody	COC Notes	Analysis Group	Analytic Method
09-AUG2018-SO-ALSHT-080918	None	METALS	SW6020A

Sampler:	David Rowan	David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS70**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS70-0.0-0.5

DATE/TIME: 8/9/2018 / 10:15

Sample Interval: 0 - 0.5 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes:

Chain of Custody	COC Notes	Analysis Group	Analytic Method
09-AUG2018-SO-ALSHT-080918	None	METALS	SW6020A

Sampler:	David Rowan	David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS71**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS71-0.0-2.0

DATE/TIME: 8/9/2018 / 00:00

Sample Interval: 0 - 2 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes:

Chain of Custody	COC Notes	Analysis Group	Analytic Method
09-AUG2018-SO-ALSHT-080918	None	EXPLOSIVES	SW8330

Sampler:		David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS71**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS71-5.0-7.0

DATE/TIME: 8/9/2018 / 13:20

Sample Interval: 5 - 7 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes: No Recovery. Too wet to sample with hand auger, below water table

Chain of Custody	COC Notes	Analysis Group	Analytic Method
09-AUG2018-SO-ALSHT-080918	None	EXPLOSIVES	SW8330

Sampler:		David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS72**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS72-0.0-2.0

DATE/TIME: 8/9/2018 / 11:20

Sample Interval: 0 - 2 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes:

Chain of Custody	COC Notes	Analysis Group	Analytic Method
09-AUG2018-SO-ALSHT-080918	None	EXPLOSIVES	SW8330

Sampler:	David Rowan	David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS72**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS72-5.0-7.0

DATE/TIME: 8/9/2018 / 00:00

Sample Interval: 5 - 7 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes: No Recovery. Hit refusal at 2.5-3'. Retrieved bits of metal, caliche and glass. Assumed to be blocking advancement. Tried multiple locations around orginal point. Same result.

Chain of Custody	COC Notes	Analysis Group	Analytic Method
No COC Specified	None		

Sampler:		David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS72**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS72-7.0-9.0

DATE/TIME: 8/9/2018 / 00:00

Sample Interval: 7 - 9 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes: No Recovery. Hit refusal at 2.5-3'. Retrieved bits of metal, caliche and glass. Assumed to be blocking advancement. Tried multiple locations around orginal point. Same result.

Chain of Custody	COC Notes	Analysis Group	Analytic Method
No COC Specified	None		

Sampler:		David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS73**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS73-0.0-2.0

DATE/TIME: 8/9/2018 / 11:30

Sample Interval: 0 - 2 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes:

Chain of Custody	COC Notes	Analysis Group	Analytic Method
09-AUG2018-SO-ALSHT-080918	None	EXPLOSIVES	SW8330

Sampler:	David Rowan	David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS73**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS73-5.0-7.0

DATE/TIME: 8/9/2018 / 00:00

Sample Interval: 5 - 7 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes: No Recovery. Hit refusal at 2.5-3'.

Chain of Custody	COC Notes	Analysis Group	Analytic Method
No COC Specified	None		

Sampler:		David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS73**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS73-7.0-9.0

DATE/TIME: 8/9/2018 / 00:00

Sample Interval: 5 - 7 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes: No Recovery. Hit refusal at 2.5-3'.

Chain of Custody	COC Notes	Analysis Group	Analytic Method
No COC Specified	None		

Sampler:		David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS74**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS74-0.0-2.0

DATE/TIME: 8/9/2018 / 11:40

Sample Interval: 0 - 2 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes:

Chain of Custody	COC Notes	Analysis Group	Analytic Method
09-AUG2018-SO-ALSHT-080918	None	EXPLOSIVES	SW8330

Sampler:	David Rowan	David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS74**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS74-5.0-7.0

DATE/TIME: 8/9/2018 / 13:30

Sample Interval: 5 - 7 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes: 17SS74-5.0-7.0MS/MSD

Chain of Custody	COC Notes	Analysis Group	Analytic Method
09-AUG2018-SO-ALSHT-080918	None	EXPLOSIVES	SW8330

Sampler:		David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Location ID: **17SS74**

Project No: **501032**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS74-7.0-9.0

DATE/TIME: 8/9/2018 / 00:00

Sample Interval: 7 - 9 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes: No Recovery. Too wet to sample with hand auger, below water table

Chain of Custody	COC Notes	Analysis Group	Analytic Method
No COC Specified	None		

Sampler:		David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS75**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS75-0.0-0.5

DATE/TIME: 8/8/2018 / 13:30

Sample Interval: 0 - 0.5 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes: 17SS75-0.0-0.5-FD

Chain of Custody	COC Notes	Analysis Group	Analytic Method
08-AUG2018-SO-ALSHT-080818	None	METALS	SW6020A

Sampler:	David Rowan	David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS75**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS75-0.0-0.5-FD

DATE/TIME: 8/8/2018 / 13:30

Sample Interval: 0 - 0.5 Ft

Sampling Method: HA

Sample Purpose: FD

Sample Matrix: SO

Sample Notes:

Chain of Custody	COC Notes	Analysis Group	Analytic Method
08-AUG2018-SO-ALSHT-080818	None	METALS	SW6020A

Sampler:		David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS76**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS76-0.0-0.5

DATE/TIME: 8/8/2018 / 13:40

Sample Interval: 0 - 0.5 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes:

Chain of Custody	COC Notes	Analysis Group	Analytic Method
08-AUG2018-SO-ALSHT-080818	None	METALS	SW6020A

Sampler:	David Rowan	David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS77**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS77-0.0-0.5

DATE/TIME: 8/8/2018 / 13:50

Sample Interval: 0 - 0.5 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

Sample Notes:

Chain of Custody	COC Notes	Analysis Group	Analytic Method
08-AUG2018-SO-ALSHT-080818	None	METALS	SW6020A

Sampler:	David Rowan	David Rowan	
QC'ed By:		William Foss	11/12/2018

Sample Collection Log

APTIM

Project Name: **Longhorn AAP**

Project No: **501032**

Location ID: **17SS78**

Sampler(s): **David Rowan**

FIELD CONDITIONS

SAMPLING INFORMATION

Sample No: 17SS78-0.0-0.5

DATE/TIME: 8/8/2018 / 16:20

Sample Interval: 0 - 0.5 Ft

Sampling Method: HA

Sample Purpose: REG

Sample Matrix: SO

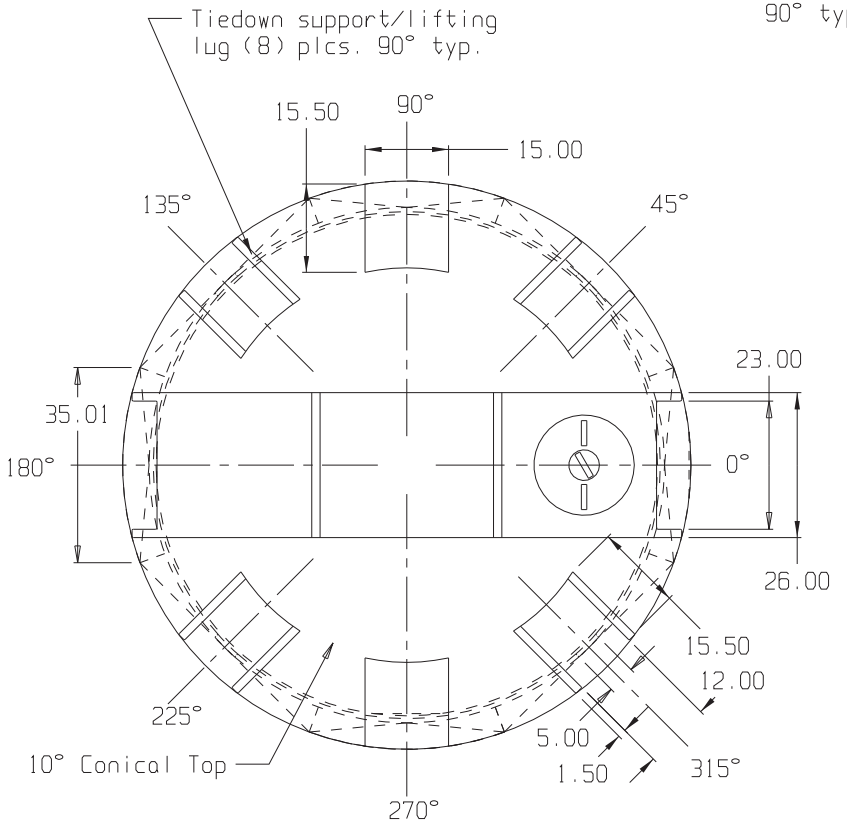
Sample Notes:

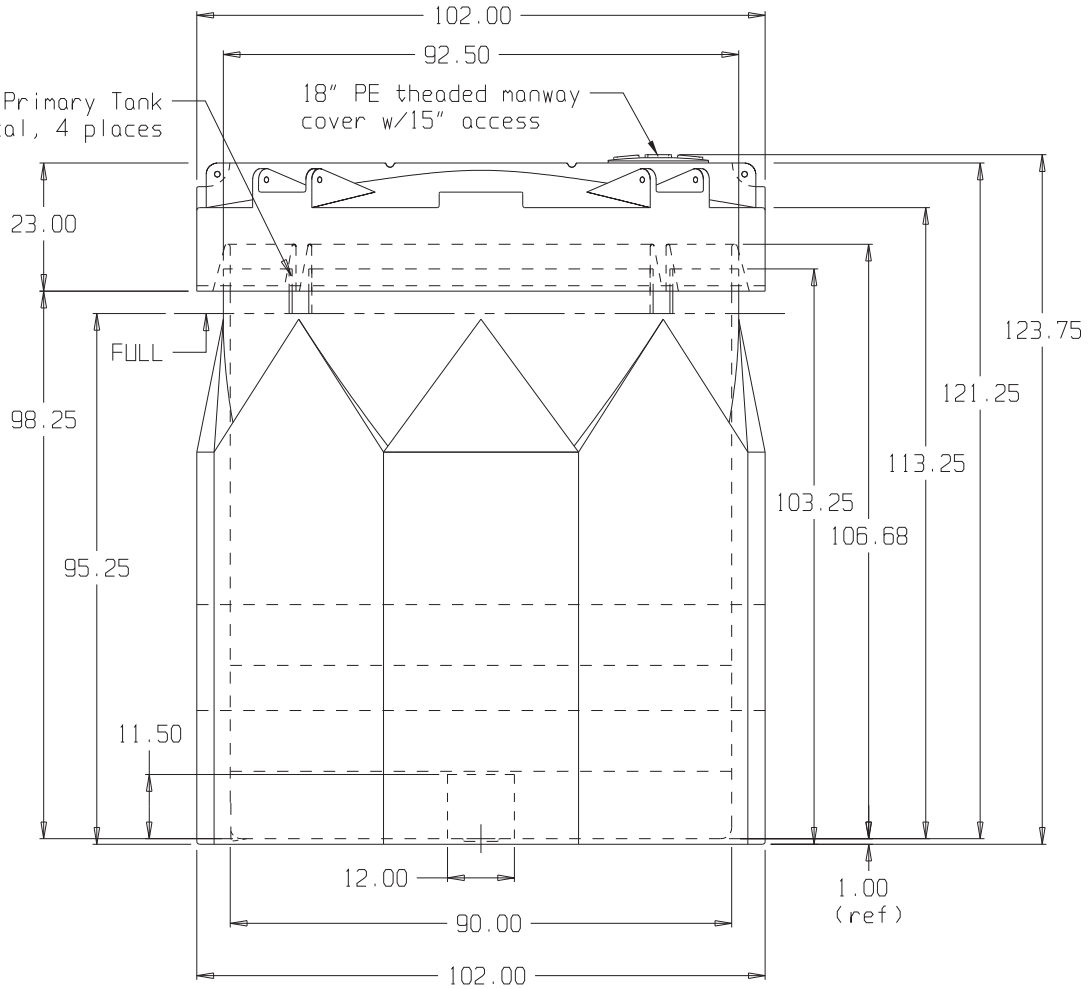
Chain of Custody	COC Notes	Analysis Group	Analytic Method
08-AUG2018-SO-ALSHT-080818	None	METALS	SW6020A

Sampler:	David Rowan	David Rowan	
QC'ed By:		William Foss	11/12/2018

Appendix C

Groundwater Extraction Pump and Holding Tank Specification Sheets





SNYDER INDUSTRIES INC.

(all dimensions in inches)

BASE FITTINGS TO BE LEFT INSTALLED AT TIME OF SHIPMENT PER Sii PROCEDURE

2,500 GALLON CAPTOR CONTAINMENT SYSTEM

PART #	PRIMARY:	5580--
	CONTAINMENT:	5510--
REF#:	0000	07/29/02

Secondary Containment => Double Wall Plastic Tanks

Underground Water Storage Tanks (Cisterns)
Underground Water Tanks
RV Water & Waste Holding Tanks
RV Fresh Water Tanks
RV Holding Tanks
Marine Water & Waste Holding Tanks for Boats
Marine Water Storage Tanks for Boats
Marine Holding Tanks
Marine Fuel Tanks
Water & Liquid Storage Tanks
Plastic Water Tanks
Plastic Storage Tanks
Cone Bottom Tanks
Horizontal Hauling & Storage Tanks
Water Pumps
Low Profile Hauling & Storage Tanks
Flat Bottom Portable Water Tanks
Truck Bed Water Tanks Specials
Rectangular Water & Waste Tanks
Double Wall Tanks
Plastic Stock Tanks - Water Troughs
Elliptical Cradle Tanks
Auto Detailing Tanks
Doorway Water Tanks (29")
PCO Liquid Transport Tanks
Stackable Water Tanks
Brine Storage Tanks
Forkliftable Water Tanks
Stackable Oil Storage Totes
Fuel Tanks
Plastic Open Top Tanks
Open Top Cylindrical Tanks
Open Top Rectangular Tanks
Open Top Cone Bottom Tanks
Plastic Septic Tanks for Sale
Plastic Septic Tanks
Norwesco Bruiser Tanks
Job Shack Holding Tanks
Secondary Containment
Spill Containment Trays
Secondary Containment Basins
Bulkhead Fittings - Lids - Gaskets
Ball Valves
Bulkhead Fittings
Strainer Baskets
Lids
Inspection Lids
Gaskets
Water Tank Float Valves
Siphon Tubes
Baffle Balls - Surgebusters
Pipe Plugs
Heat Blankets
Polypropylene Tanks

2500 Gallon Double Wall Tank

Wrap Option: Select a Wrap Option

Price: $6,899.99 Add to Cart

$190 / month

Part Number:	SII-CCS2500
Mfr. Part Number:	5580000N-45
Capacity:	2500 Gallons
Dimensions:	102" dia. x 123-3/4"H
Weight:	1420 lbs.
Ships From:	NE, WV
USD Shipping:	Call For Shipping Rate 866 310 2556 or Email
PDF Drawing:	View Technical Drawing
Manufacturer:	Snyder Industries
Material:	Polyethylene
Availability:	In Stock *(Stock changes daily please call to confirm)*

Contact Us

Shown With Accessories : Sold Separately

2500 Gallon Captor Double Wall Liquid Storage Tank - 1.9 Specific Gravity

2500 Gallon Snyder Industries Captor Double Wall Liquid Storage Tank Includes:

- 18" Threaded Manway Comes Standard (Bolted and Threaded Manways are available in sizes up to 24" by request.)
- Molded In Tie-Down Lugs (interface with optional cable restraint system to meet seismic and 150 mph wind load requirements.)
- Provides 115%-120% containment of inner tank's capacity.
- Resin complies with U.S. Food and Drug Administration regulation 21 CFR 177.1570 (c) 3.1 and 3.2.
- Through tank fittings available by request.
- Outer containment of the double wall tank complies with federal regulation 40CFR-264.193 capacity requirements.

This tank is made from High Density Linear Polyethylene. It is also made in crosslinked linear polyethylene by request.

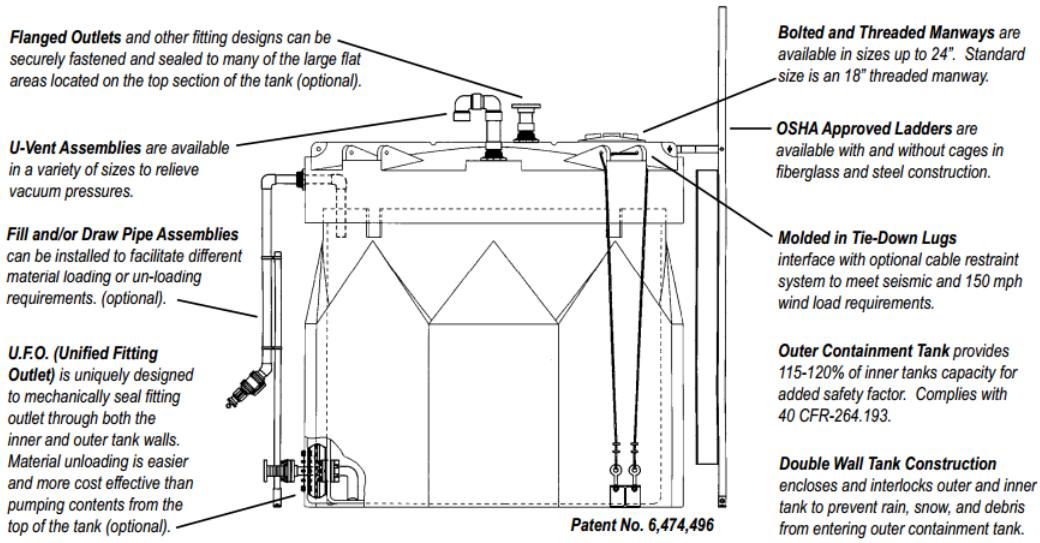
Optional Fittings Include:

- Flanged Outlets (Can be securely fastened and sealed to many of the large flat areas located on the top section of the tank.
- Fill and/or Draw Pipe Assemblies (can be installed to facilitate different material loading or un-loading requirements.)
- U Vent Assemblies (available in a variety of sizes to relieve vacuum pressures.)
- U.F.O. (Unified Fitting Outlet)(uniquely designed to mechanically seal fitting outlet through both the inner and outer tank walls. Material unloading is easier and more cost effective than pumping contents from the top of the tank.)
- OSHA Approved ladders are available with and without cages in fiberglass and steel construction.
- Double Wall Tank Construction encloses and interlocks outer and inner tank to prevent rain, snow, and debris from entering outer containment tank.

Captor Double Wall liquid storage tanks can not be pressurized. This double wall liquid storage tank can hold liquids with a material weight up to 15.83 lbs. per gallon (1.9 specific gravity rating). (Water weighs 8.34 pounds)

Captor Containment System

Protects Bulk Storage Profits
Without Jeopardizing Safety or the Environment



Simplex Part Number: CCS2500-1.9

AP4+B

AutoPump®

Bottom Inlet, Short

Max. Flow	**13 gpm (49 lpm)**
O.D.	**3.6 in. (9.1 cm)**
Length	**39.3 in. (100 cm)**

Description

The AP4+ Bottom Inlet Short AutoPump provides maximum capabilities and flow in a bottom inlet pump for 4" (100 mm) diameter and larger wells with shorter water columns and/or the need to pump down to lower water levels, compared to full-length pumps. It is offered in optional versions to handle even the most severe remediation and landfill pumping applications, and delivers flow rates up to 13 gpm (49 lpm)*. The AP4+ Short Bottom Inlet AutoPump is complemented by the most comprehensive selection of accessories to provide a complete system to meet site-specific requirements. Call QED for prompt, no-obligation assistance on your pumping project needs.

The AutoPump Heritage

The AP4+ Bottom Inlet Short AutoPump is part of the famous AutoPump family of original automatic air-powered pumps, developed in the mid 1980s specifically to handle unique pumping needs at remediation and landfill sites. Over the years they've proven their durability at thousands of sites worldwide. AutoPumps are designed to handle difficult pumping challenges that other pumps can't, such as hydrocarbons, solvents, suspended solids, corrosives, temperature extremes, viscous fluids and frequent start/stop cycles. Beyond just the pump, AutoPump systems offer the most complete range of tubing, hose, connectors, wellhead caps and accessories to help your installation go smoothly. This superior pumping heritage, application experience and support back up every AutoPump you put to work on your project.

Advantages

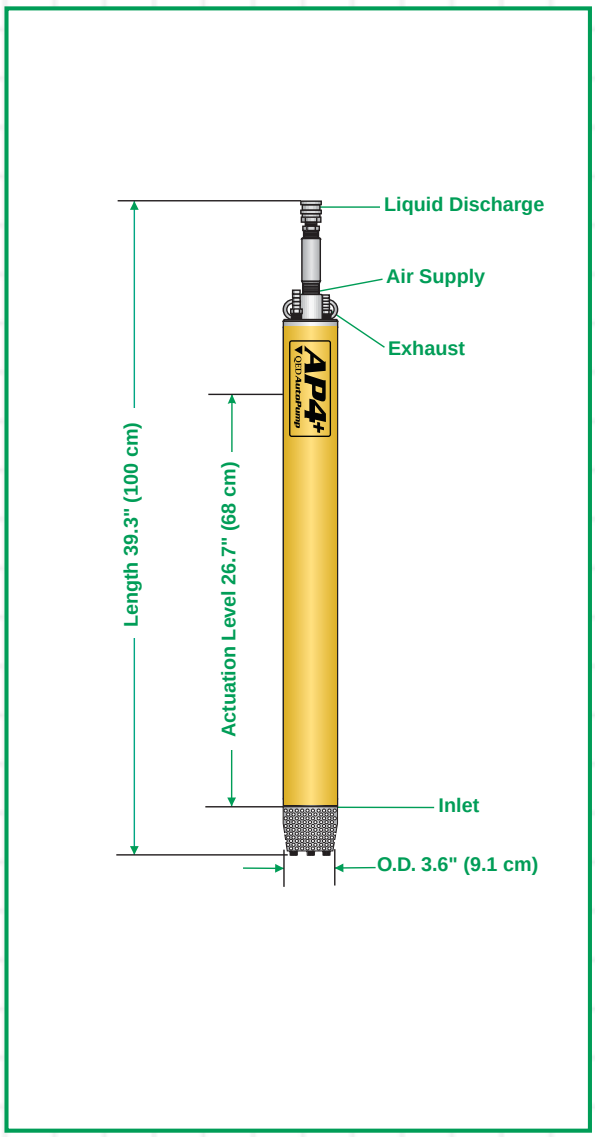
1. **The original automatic air-powered well pump, proven worldwide over 25 years**
2. **The highest flow rates and deepest pumping capabilities in the industry**
3. **Patented, proven design for superior reliability and durability, even in severe applications**
4. **Handles solids, solvents, hydrocarbons corrosive conditions, viscous fluids and high temperatures beyond the limits of electric pumps**
5. **Five-year warranty**

***Consult QED for higher flow requirements**

AutoPump®

Bottom Inlet, Short AP4+B

Pump Dimensions



Specifications & Operating Requirements

Model	**4" - Short AP4+ Bottom Inlet**
Liquid Inlet Location	Bottom
OD	3.6 in. (9.1 cm)
Length Overall (pump & fittings)	39.3 in. (100 cm)
Weight	13 lbs. (5.9 kg)
Max. Flow Rate	13 gpm (49 lpm)* - See Flow Rate Chart
Pump Volume / Cycle	0.22 - 0.36 gal (.83 - 1.36L)
Min. Actuation Level	26.7 in. (68 cm)
Standard Pump	
Max. Depth	250 ft. (76 m)
Air Pressure Range	5 - 120 psi (0.4 - 8.4 kg/cm2)
Air Usage	0.4-1.5 scf / gal. (1.5 - 5.7 liters of air / fluid liter) - See Air Usage Chart
High Pressure Pump	
Max. Depth	425 ft. (130 m)
Air Pressure Range	5 - 200 psi (0.4 - 14.1 kg/cm2)
Min. Liquid Density	0.7 SpG (0.7 g/cm3)
Standard Construction Materials[1]	
Pump Body	Fiberglass or Stainless Steel
Pump Ends	Stainless Steel
Internal Components	Stainless Steel, Viton, PVDF[3]
Tube & Hose Fittings	Brass or Stainless Steel
Fitting Type	Barbs or Quick Connects
Tube & Hose Options	
Tubing Material[2]	Nylon
Sizes - Liquid Discharge	1 in. (25 mm) or 1-1/4 in. (32 mm) OD
Pump Air Supply	1/2 in. (13 mm) OD
Air Exhaust	5/8 in. (16 mm) OD
Hose Material	Nitrile
Sizes - Liquid Discharge	3/4 in. (19 mm) or 1 in. (25 mm) ID
Pump Air Supply	3/8 in. (9.5 mm) ID
Air Exhaust	1/2 in. (13 mm) ID

[1] Material upgrades available
[2] Applies to QED supplied tubing; other tubing sources may not conform to QED fittings.
[3] PVDF - Polyvinylidene Fluoride

Application Limits (Base model)

AP4+ AutoPumps are designed to handle the application ranges described below. For applications outside these ranges, consult QED about AP4 upgrades.

Maximum Temperature: 150°F (65°C)
pH Range: 4-9
Solvents and Fuels: diesel, gasoline, JP1-JP6, #2 heating oils, BTEX, MTBE, landfill liquids

***Consult QED for higher flow requirements**

Long and Short AP4+ AutoPumps are warranted for five (5) years: 100% materials and workmanship.

Low-Drawdown AutoPumps are warranted for one (1) year: 100% materials and workmanship.

2355 Bishop Circle West Dexter, MI 48130 USA **1.800.624.2026** **F 1.734.995.1170** info@qedenv.com www.qedenv.com

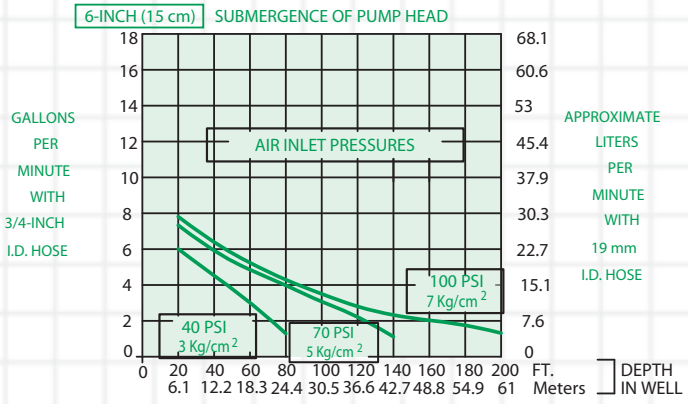
AP4+B

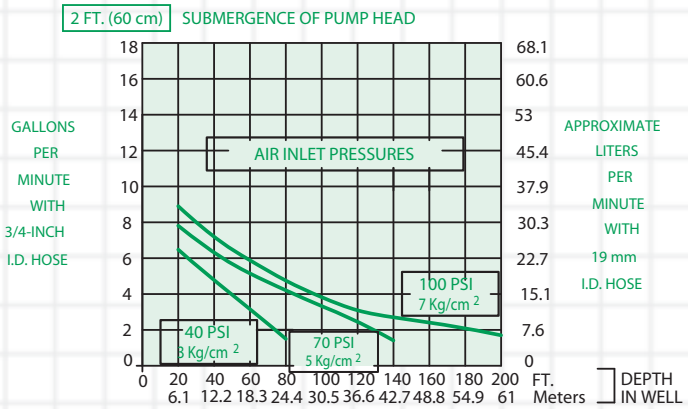
AutoPump®

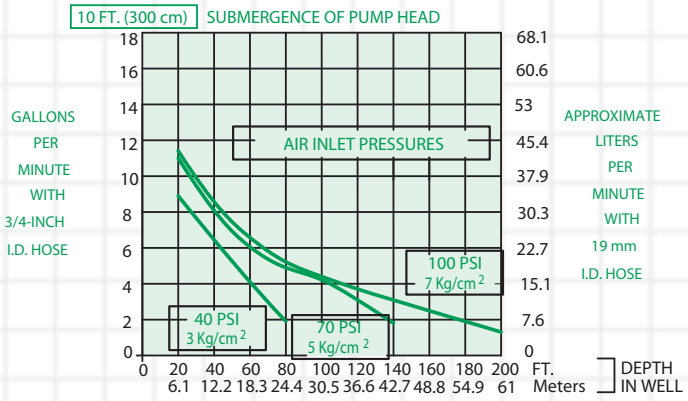
Bottom Inlet, Short

Flow Rates[1]

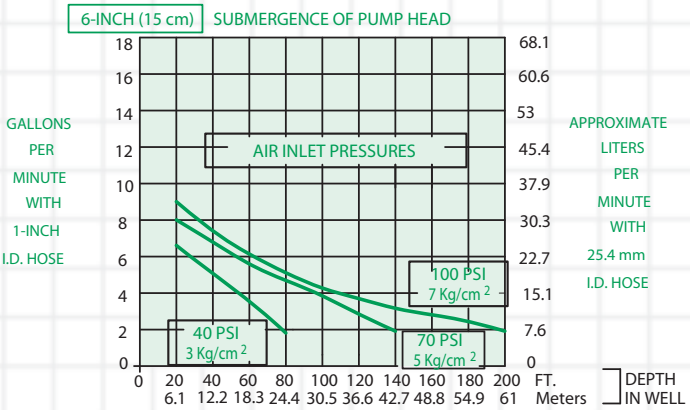
3/4 inch (19 mm) Inside Diameter Discharge Hose
(Equivalent to 1-Inch O.D. Tubing)

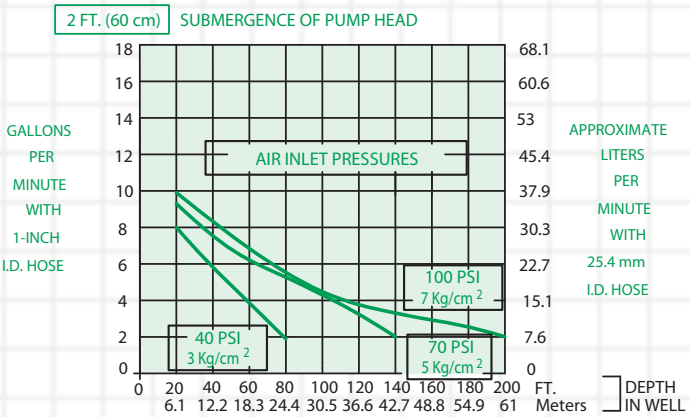


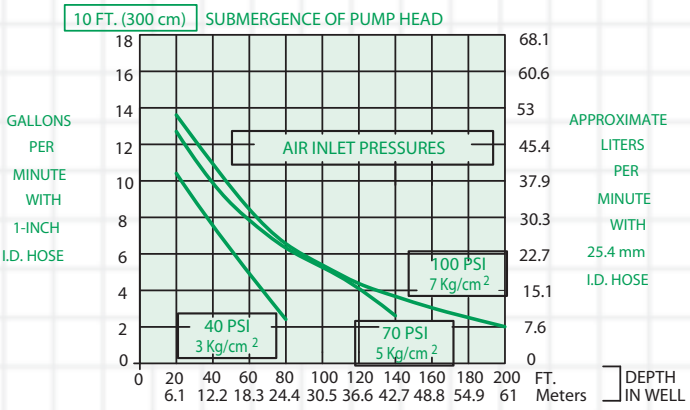




1 inch (25.4 mm) Inside Diameter Discharge Hose
(Equivilant to 1.25-Inch O.D. Tubing)







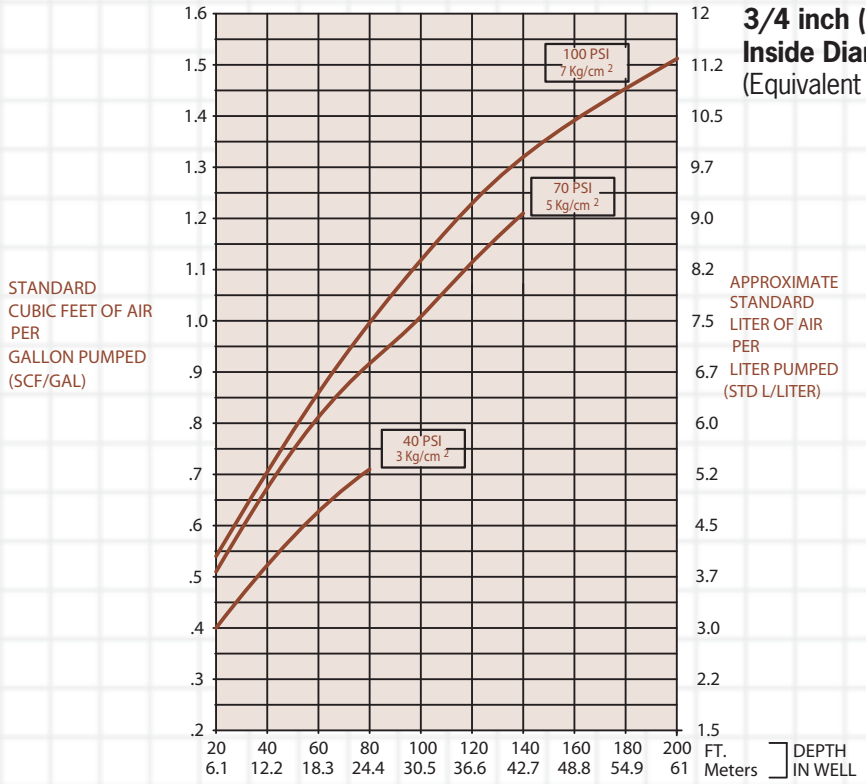
[1]FLOW RATES MAY VARY WITH SITE CONDITIONS. CALL QED FOR TECHNICAL ASSISTANCE.

QED Environmental Systems

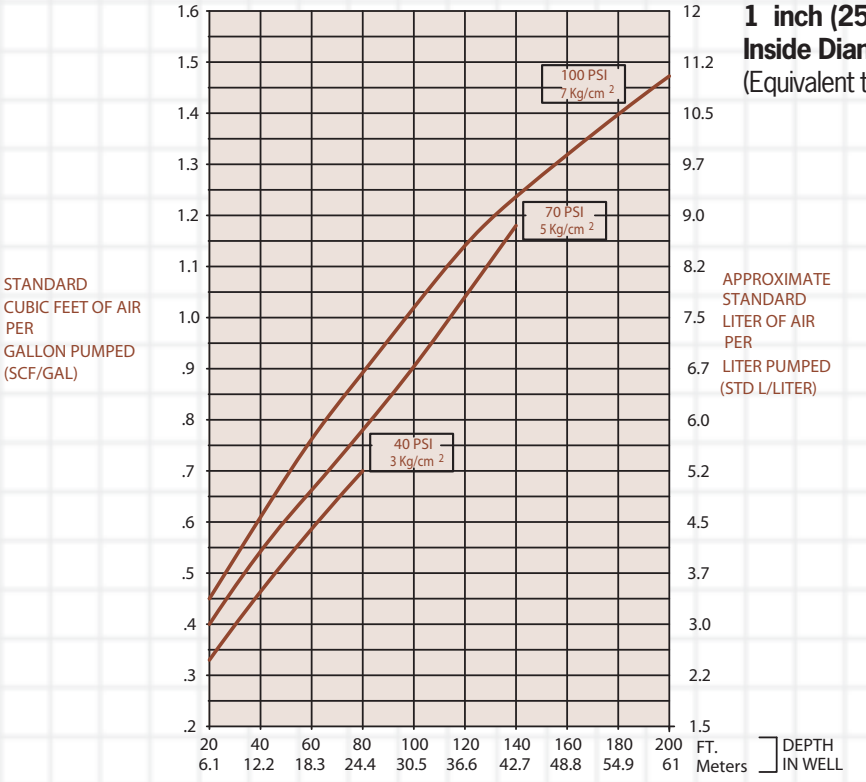
Bottom Inlet, Short AP4+B

Air Consumption

3/4 inch (19 mm)
Inside Diameter Discharge Hose
(Equivalent to 1-Inch O.D. Tubing)



1 inch (25.4 mm)
Inside Diameter Discharge Hose
(Equivalent to 1.25-Inch O.D. Tubing)



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Appendix D

Operation and Maintenance Forms

RAO Inspection and Maintenance Checklist

General Information	
Project Name	RAO Inspection and Maintenance, LHAAP-17, Longhorn Army Ammunition Plant, Karnack, TX
Contractor	
Inspector's Name	
Inspector's Title	
Inspector's Signature	
Inspector's Contact Number	
Inspection Date	
Type of Inspection	☐ Quarterly ☐ Semiannual ☐ Annual ☐ Prior to forecast rain ☐ After a rain event ☐ Other ----------

A. Groundwater Monitoring Wells						
D.1	Are the installed groundwater monitoring wells in poor condition?					
D.2	Is the well cleared of vegetation and accessible?					
D.3	Any other relevant observations?					
D.4	Are there any significant cracks present?					
D.5	Are there any damaged areas?					

LHAAP-17
Weekly Extraction System Tracking and Maintenance Form

Date	Time	Inspector	17WW02 Volume (gallons)	17WW06 Volume (gallons)	Compressor Pressure (PSI)	Well Head Check	Tanks and Transfer Pump	Tank/Compressor/Pump Notes and Maintenance Performed
						Secure Y/N Leaks Y/N	Secure Y/N Leaks Y/N	
						Secure Y/N Leaks Y/N	Secure Y/N Leaks Y/N	
						Secure Y/N Leaks Y/N	Secure Y/N Leaks Y/N	
						Secure Y/N Leaks Y/N	Secure Y/N Leaks Y/N	
						Secure Y/N Leaks Y/N	Secure Y/N Leaks Y/N	
						Secure Y/N Leaks Y/N	Secure Y/N Leaks Y/N	
						Secure Y/N Leaks Y/N	Secure Y/N Leaks Y/N	
						Secure Y/N Leaks Y/N	Secure Y/N Leaks Y/N	

Appendix E

LUC Compliance Certification

Annual Land Use Control Compliance Certification Form

In accordance with the Remedial Design dated _____ for LHAAP-17 an inspection of the site was conducted by _____ [indicate transferee] on _____.

The land use control mechanisms are:

- Groundwater restrictions - prohibit access to the contaminated groundwater except for environmental monitoring and testing only until cleanup goals are met;
- Land use restrictions - restrict land use to nonresidential;
- Integrity of remedial and monitoring systems - maintain the integrity of any current or future remedial or monitoring systems until cleanup goals are met.

No unauthorized activities or uses have occurred. Compliance with land use controls and restrictions is as follows:

- No use of groundwater (other than environmental testing and monitoring), installation of new groundwater wells, or tampering with existing monitoring wells;
- No land use other than nonresidential; and
- No activities that would compromise the integrity of the remedial or monitoring systems.

I, the undersigned, do document that the inspection was conducted as indicated above, and that the above information is true and correct to the best of my knowledge, information, and belief.

Date: _____

Name/Title: _____

Signature: _____

Annual compliance certification forms shall be completed no later than March 1 of each year for the previous calendar year, retained in the file and provided to Army, EPA and TCEQ upon request.