FINAL
REMEDIAL ACTION WORK PLAN
FOR
LHAAP-35B (37), CHEMICAL LABORATORY
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Prepared For:

U.S. Army Corps of Engineers

Prepared By:

AECOM

AECOM Technical Services

June 2013

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AECOM Technical Services, Inc.

Contract No. W912DY-09-D-0059

Task Order No. DS01

June 2013

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

µg/L	micrograms per liter
1,1-DCE	1,1-dichloroethene
AECOM	AECOM Technical Services, Inc.
ARAR	applicable or relevant and appropriate requirements
bgs	below ground surface
CERCLA	Comprehensive, Environmental Response, Compensation, and Liability Act
Cis-1,2-DCE	Cis-1,2-dichloroethene
cm/s	centimeters per second
COC	Chemical of Concern
DHC	Dehalococcoides ethenogens
DO	Dissolved Oxygen
DPT	Direct push technology
ECP	Environmental Condition of Property
ft	feet
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
IDW	Investigation Derived Waste
LHAAP	Longhorn Army Ammunition Plant
LTM	Long-term Monitoring
LUC	Land Use Control
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
NCP	National Oil and Hazardous Substances Contingency Plan
NPL	National Priorities List
ORP	Oxidation-Reduction Potential
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RAOs	Remedial Action Objectives
RAWP	Remedial Action Work Plan
RD	Remedial Design

ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
TAC	Texas Administrative Code
TCE	Trichloroethylene
TCEQ	Texas Commission on Environmental Quality
TOC	Total Organic Carbon
Trans-1,2-DCE	Trans-1,2-dichloroethene
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VC	Vinyl chloride
VOC	Volatile Organic Compounds
WERS	Worldwide Environmental Remediation Services

1 INTRODUCTION

AECOM Technical Services, Inc. (AECOM) has been contracted by the U.S. Army Corps of Engineers (USACE), Tulsa District, to complete the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Action (RA) at the Longhorn Army Ammunition Plant (LHAAP) site LHAAP-35B (37) (Chemical Laboratory), located in Karnack, Texas. The LHAAP is an inactive, government-owned, formerly contractor-operated and maintained industrial facility located in central-east Texas in the northeastern corner of Harrison County. The facility occupies approximately 1,400 of its former 8,416 acres located between State Highway 43 in Karnack, Texas, and the western shore of Caddo Lake as shown in **Figure 1-1**. LHAAP was listed as a National Priorities List (NPL) site on August 9, 1990, due to threatened releases of hazardous substances, pollutants, or contaminants. The United States Environmental Protection Agency (USEPA), the Texas Water Commission (now the Texas Commission on Environmental Quality [TCEQ]), and the U.S. Army signed a Federal Facilities Agreement on December 30, 1991.

In June 2010, a combined Record of Decision (ROD) was signed covering both LHAAP-35B (37) (Chemical Laboratory) and LHAAP-67 (Aboveground Storage Tank Farm) sites due to similarities in site impacts, and because the preferred remedies are similar and concurrent (U.S. Army, 2010). LHAAP-35B (37) is located west-northwest of LHAAP-67 (**Figure 1-2**). A combined Remedial Design (RD) document detailing remedial activities required under the LHAAP-35B (37) and LHAAP-67 ROD was approved by the regulatory agencies in August 2011 (U.S. Army, 2011). This RA Work Plan (RAWP) describes the plan to implement the remedial action required under the ROD and developed by the RD to address risks associated with contaminated groundwater at LHAAP-35B (37). The RAWP for LHAAP-67 has been submitted as a separate document (AECOM, 2012).

The work described in this RAWP will be managed by USACE Tulsa District under Worldwide Environmental Remediation Services (WERS) Contract No. W912DY-09-D-0059 Task Order No. DS01.

1.1 Organization of Work Plan

This work plan is composed of the following sections:

- Section 1: “Introduction” summarizes the site background, proposed remedy including the chemicals of concern (COCs) and their respective cleanup levels, the nature and extent of contamination, the on-going bio-plug field demonstration study, and remedial action objectives (RAOs).
- Section 2: “Land Use Control Plan” describes the proposed scope of work including the implementation of activities associated with the Land Use Control (LUC) component of the remedy.
- Section 3: “Monitored Natural Attenuation” describes the plume refinement activities, groundwater and surface water sampling, health and safety procedures and quality assurance/quality control (QA/QC) procedures associated with the monitored natural attenuation (MNA) component of the remedy.

- Section 4: "Remedy Performance Evaluation and Reporting" describes the MNA performance evaluation reporting, annual long-term monitoring (LTM) reporting, and CERCLA five-year reviews to be performed for the remedy.
- Section 5: "Schedule" describes the proposed implementation schedule for the RA activities.
- Section 6: "References" provides a list of references cited in the document.

The work plan also includes Appendix A supporting the main text.

- Appendix A: Well Installation and Sampling Completion Report (February 2012)
- Appendix B: Sample Annual Land Use Control Compliance Certification Documentation

Activities specified in this work plan will be conducted in accordance with the Installation-Wide Work Plan in place when field work is executed.

1.2 LHAAP-35B (37) Background

The LHAAP-35B (37) site, the former Chemical Laboratory, encompasses approximately 12.2 acres and is located in the north-central portion of LHAAP near the southwest corner of LHAAP-47 and in the northeast quadrant of the intersection of Avenue P and 51th Street (**Figure 1-2**). The site topography is relatively flat. The surface features at LHAAP-35B (37) include a mixture of asphalt-paved roads and parking areas, several administration buildings, the former Chemical Laboratory (Building 29-A), and a mixture of wooded and grassy vegetation-covered areas. The surface drainage flows into Goose Prairie Creek. The creek runs perpendicular to the western border of the site and then turns south through the east-central portion of the site and eventually flows into Caddo Lake.

The Chemical Laboratory was built during the construction of Plant 3 (1953-1955) and was originally used to support the production activities at LHAAP. These support activities included research and testing of materials used in the production processes and quality assurance testing. Also, one waste rack sump was located at the site. In 1998, the site was used as a staging area in support of investigation activities (U.S. Army, 2010).

Field investigations conducted between 1998 and 2007 identified groundwater contamination at LHAAP-35B (37) site and determined its nature and extent. Investigation results indicated that there was no significant contamination in soils (U.S. Army, 2010). The investigation data and the subsequent human health risk assessment (HHRA) indicated that the soil at the LHAAP-35B (37) site does not pose a risk to the environment or to human health under an industrial exposure scenario for a future maintenance worker (U.S. Army, 2010). However, groundwater present within the upper shallow zone posed an unacceptable cancer risk and non-cancer hazard to a future maintenance worker from hypothetical groundwater consumption. There is no groundwater contamination in the lower shallow groundwater zone and the intermediate zone (U.S. Army, 2010). The baseline ecological risk assessment (BERA) concluded that no unacceptable risk was present to the ecological receptors from the site soil and groundwater (U.S. Army, 2010).

The ROD and the RD identified the following COCs in LHAAP-35B (37) site groundwater: trichloroethene (TCE), tetrachloroethene (PCE), and 1,1-dichloroethene (1,1-DCE). The

presence of these COCs in the upper shallow groundwater zone represents the primary driver for remedial action as there are no ecological risks at the LHAAP-35B (37) site. Vinyl chloride (VC) was detected in shallow zone monitoring well 35WW14 (installed in February 2012 after completion of the ROD and the RD) at a concentration above its MCL. Degradation products of PCE and TCE including cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), and VC will be included in the performance monitoring of the groundwater remedy.

Although the HHRA reported that antimony and thallium contributed to groundwater noncarcinogenic hazard, only 2 of the 10 samples detected antimony and thallium in the 1996 investigation (pre remedial investigation) and the detections were J-qualified (i.e. the reported values were estimated values since they were below the reporting limits). The conclusions of the 2002 RI were that antimony and thallium had not been detected in the follow-on 1998 sampling event and that the groundwater at the LHAAP-35B (37) site was not considered to be contaminated with these two metals (Jacobs, 2002).

The RA to be implemented at LHAAP-35B (37) was selected and developed in accordance with the CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and, to the extent practicable, the National Oil and Hazardous Substances Contingency Plan (NCP) (40 Code of Federal Regulations 300). The selected remedy finalized in the ROD was developed based on the industrial land use scenario, which is consistent with the anticipated future use as a national wildlife refuge. A notification will be recorded at the Harrison County Courthouse to indicate that the site is suitable for non-residential use.

1.2.1 Proposed Remedy

Under the Safe Drinking Water Act, maximum contaminant levels (MCLs) have been determined for each of LHAAP-35B (37) COCs, and the MCLs will be used as cleanup levels.

Table 1-1 below presents the cleanup levels for the LHAAP-35B (37) site.

Table 1-1: Cleanup Levels

Chemical of Concern (COC)	Concentration (µg/L)	Basis
Trichloroethylene	5	MCL
Tetrachloroethylene	5	MCL
1,1-Dichloroethylene	7	MCL

Notes and Abbreviations:
µg/L – micrograms per liter
MCL – maximum contaminant level

The degradation products of PCE and TCE such as cis-1,2-DCE, trans-1,2-DCE, and VC will also be monitored and MCLs will be used as cleanup levels for these constituents. In addition, antimony and thallium will be monitored in groundwater during the first sampling event and their respective MCLs (antimony – 6 µg/L, and thallium – 2 µg/L) will be used for comparison with the analytical results to determine if further evaluation is needed.

The remedy for the LHAAP-35B (37) site is intended to protect human health by preventing exposure to contaminated groundwater and preventing contaminated groundwater from migrating into nearby surface water.

The remedy for the LHAAP-35B (37) site will include the following components:

- Land Use Control: LUC in the impacted area will ensure protection of human health by restricting the use of groundwater exceeding cleanup levels to environmental monitoring and testing only. The LUC will remain in effect until such time as the U.S. Army, TCEQ, and USEPA agree that the concentrations of COCs have met cleanup levels.
- Monitored Natural Attenuation: MNA constitutes a passive remedial action that relies on natural biological, chemical, and physical processes that act to reduce the mass and concentrations of groundwater COCs under favorable conditions. A program of MNA will be implemented to establish confidence in attenuation trends and verify that the plume is stable and will not migrate to nearby surface water at levels that may present an unacceptable risk to human health or the environment. Natural attenuation is expected to reduce contaminant concentrations to their respective clean-up levels, and return groundwater to its beneficial use, wherever practicable.

  Performance objectives for the MNA program will be re-evaluated after two years of groundwater monitoring following completion of ongoing bioplug study. During those two years, groundwater monitoring will be performed on a quarterly basis.
- Long-term Monitoring/Five-Year Reviews: LTM will begin at a semiannual frequency after the first two years until the CERCLA five-year review. In subsequent years, LTM will be performed annually until the following CERCLA five-year review. The LTM associated with this remedy will be used to track the continued effectiveness of MNA and will continue at least once every five years until the cleanup levels are achieved. The need for continued monitoring will be evaluated every five years during the CERCLA five-year review.

Based on previously performed groundwater modeling, MCLs are expected to be met through natural attenuation in 28 to 38 years for PCE, 39 to 43 years for TCE, and 16 to 21 years for 1,1-DCE at the LHAAP-35B (37) site (U.S. Army, 2010). Considering the lithologic variability, particularly the lateral and vertical gradations from sand to clay, the times to MCL may range to an order of magnitude greater.

1.2.2 Bio-plug Field Demonstration Pilot Study

A field demonstration pilot study involving the Bio-plug technology was initiated at the LHAAP-35B (37) site in February 2012. The purpose of the pilot study is to determine the feasibility of the bio-plug technology to accelerate remediation of chlorinated organic compounds in groundwater and consequent reduction of long-term remediation costs and land use restrictions. Bio-plugs are small, in-situ immobilized microbe bioreactors installed in an array within the contaminated zone. Each bio-plug well is supplied with air and nutrient distribution system which is expected to cause aerobic co-metabolism of TCE and other chlorinated organic compounds in the groundwater. Per the pilot study schedule, the bio-plug wells will be active for approximately two years from the time the study is initiated (September 2012). The study will be assessed per the following performance criteria:

- Attain MCLs for groundwater contaminants;

- Attain measurable increase in the rate of biodegradation of COCs relative to baseline biodegradation rate models;
- Measurable evidence of TCE-degrading microbial populations distributed throughout the upper shallow groundwater profile relative to baseline microbial populations; and
- No technology-related displacement of COCs outside of existing groundwater plume boundaries.

Figure 1-3 depicts the array of bio-plug points installed across the LHAAP-35B (37) site. The **Figure 1-3** also depicts the clusters of monitoring wells installed for performance monitoring during the bio-plug study.

1.2.3 Nature and Extent of Contamination

The RD document indicated that the center of mass of the TCE plume to be in proximity of shallow monitoring well 35BWW08 and the center of mass of the PCE plume to be in proximity of shallow monitoring well 35BWW04. That information was based on data collected in December 2006 and September 2007. In December 2006, maximum concentrations of TCE, PCE, and 1,1-DCE were detected in monitoring wells LHSMW58, LHSMW59, and 35BWW04 at 166, 30.1, and 3.34 µg/L, respectively. In September 2007, two additional monitoring wells, 35BWW06 and 35BWW08, were installed at the site. Well 35BWW08 was installed as a replacement well for LHSMW59, which was plugged and abandoned. Well 35BWW06 was installed in the lower shallow/intermediate zone. Four VOCs (acetone, cis-1,2-DCE, PCE, and TCE) were detected in well 35BWW08 at concentrations of 6.04, 0.407, 0.981, and 150 µg/L, respectively. No VOCs were detected in well 35BWW06. Monitoring well 35BWW02 has been observed to be dry during the previous events in 2004 and August 2006.

Since completion of the RD document, additional monitoring wells have been installed and sampled as part of the on-going bio-plug study. Wells 35BWW09, 35WW11, and 35WW14 were installed in February 2012. Locations of these wells are depicted in **Figure 1-4**. In February 2012, groundwater samples from wells 35WW04, 35WW08, 35WW09, 35WW11, and 35WW14 were analyzed for VOCs. February 2012 data indicated PCE was detected above its MCL in wells 35BWW04 and 35BWW14, TCE was detected above its MCL in wells 35BWW04, 35BWW08, 35WW09 and 35BWW14, and VC above its MCL in well 35WW14. Cis-1,2-DCE was detected above the laboratory detection limit in well 35BWW14; however, its concentration was below its MCL. 1,1-DCE was detected above the laboratory detection limit in wells 35BWW04, 35BWW08, and 35BWW09; however, the concentrations were below its MCL. No VOCs were detected above their respective MCLs in well 35BWW11. Detected VOC concentrations in wells are depicted in **Figure 1-4**. The Well Installation and Sampling Completion Report, dated February 2012 and prepared by Cherokee Nation, is included in Appendix A.

A baseline monitoring event associated with the bio-plug demonstration study was performed in July 2012 at the site. The baseline event included sampling and analysis of groundwater samples for VOCs from the eleven wells: 35BWW01, 35BWW03, 35BWW04, 35BWW05, 35BWW06, 35BWW07, 35BWW08, 35BWW09, 35BWW11, 35BWW14, and LHSMW58. The VOC data from these wells is depicted in **Figure 1-4** and Appendix C. The July 2012 data indicates TCE exceeding its MCL in wells 35BWW04, 35BWW05, 35BWW08, 35BWW09(located to the west

beyond the site boundary), LHSMW58, and 35BWW14 (located on the east side of the Goose Prairie creek). PCE exceeded its MCL in wells 35BWW04, LHSMW58, and 35BWW14. 1,1-DCE was detected in well 35BWW14 above its MCL.

A performance monitoring event associated with the ongoing bio-plug study was performed in March 2013 at the site. The event included sampling and analysis of groundwater samples for VOCs from the seven wells: 35BWW04, 35BWW05, 35BWW06, 35BWW08, 35BWW09, 35BWW14, and LHSMW58. The VOC data from these wells is depicted in **Figure 1-4** and Appendix C. The March 2013 data indicates TCE exceeding its MCL in wells 35BWW04, 35BWW05, 35BWW08, 35BWW09, and 35BWW14. PCE exceeded its MCL in wells 35BWW04, LHSMW58, and 35BWW14. 1,1-DCE was detected in well 35BWW14 above its MCL.

The February 2012, July 2012, and March 2013 VOC data has been validated and data from the July 2012, where available, was used to revise the TCE and PCE plumes, as defined by their respective MCLs. The data and the TCE and PCE plumes are depicted in **Figure 1-4**. The data from February 2012, July 2012, and March 2013 will be used in evaluation of long-term performance of the remedy. The bioplug study was initiated in September 2012.

Currently, there are no shallow wells to the west/south of well 35BWW09 and to the north/northeast of well 35BWW14. Therefore, additional investigation work is proposed to refine the TCE and PCE plumes at the site.

The MNA evaluation performed by Shaw in 2007 demonstrated that natural attenuation mechanisms, including reductive biodegradation, dilution, dispersion, sorption, and volatilization may all be contributing to the observed reduction in COC concentrations at LHAAP-35B (37) (U.S. Army, 2010). Biodegradation pathways such as cometabolic or oxidative dechlorination may also have contributed to the reduction of COCs at the site (Shaw, 2007).

1.2.4 Site Geology and Hydrogeology

Topsoil at LHAAP-35B (37) site ranges in thickness from 0 to 4 feet and consists of the Quarternary silty clay underlain by alternating layers of clayey sand, silty sand, and poorly sorted sand of the Wilcox Group. The sand layers are laterally discontinuous and separated by silty clay. Groundwater at the site is encountered at 12 to 33 feet below ground surface (bgs) in the upper shallow zone, to 47 feet bgs in the lower shallow zone, and at about 70 feet bgs in the intermediate zone. Groundwater elevation contours for the shallow zone from data collected in July 2012 are included in **Figure 1-4** and indicate that the groundwater flow at the site is to the east-southeast, although the shallow groundwater flow direction may vary locally during high water table conditions due to the influence of Goose Prairie Creek. For the shallow groundwater zone, hydraulic conductivity values in the sand units ranged from a minimum value of 4.3×10^{-4} centimeters per second (cm/sec) in the northwest portion of the site to a maximum value of 7.7×10^{-4} cm/sec east of the site. The average groundwater flow rate is 0.0496 feet/day for LHAAP-35B (37), based on average hydraulic conductivity, hydraulic gradient, and effective porosity (U.S. Army, 2010).

Although not currently indicated by the data, there is a concern that COCs present in shallow groundwater beneath the LHAAP-35B (37) could potentially discharge to surface water in Goose Prairie Creek which flows into Caddo Lake, a drinking water source. The shallow groundwater

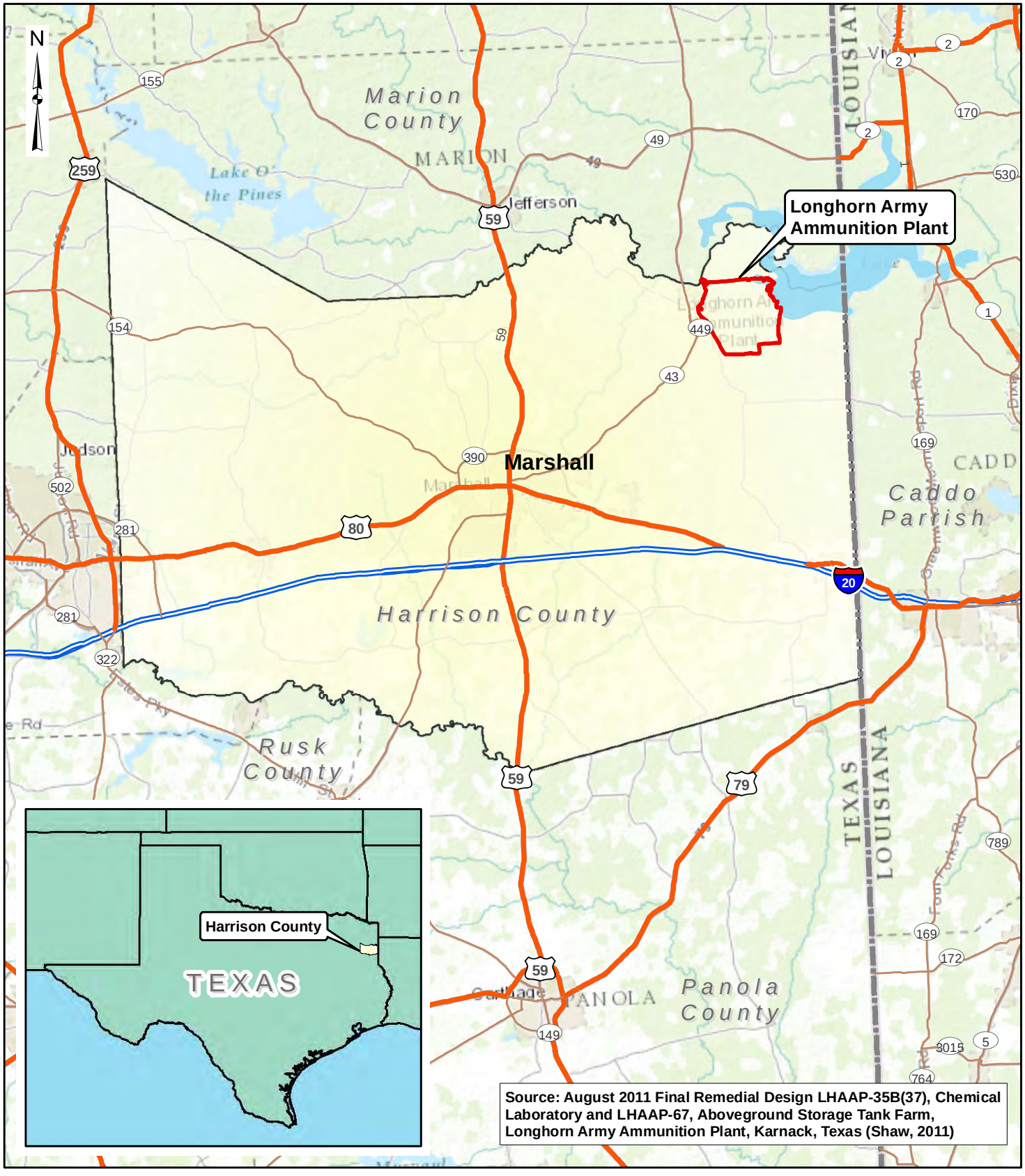
potentiometric surface indicates groundwater from LHAAP-35B (37) has a predominantly east/southeasterly flow direction; although, the overall trend in groundwater flow direction at Longhorn is east-northeast towards Caddo Lake. Data indicates that the shallow zone water table is below the Goose Prairie Creek bed surveyed at 186.86 feet above mean sea level and does not discharge into Goose Prairie Creek during certain times of the year (U.S. Army, 2010). Due to uncertainties regarding the seasonal variations in the water table elevations, shallow groundwater is presumed to discharge into the Goose Prairie Creek when the water table elevations are high enough (U.S. Army, 2010).

1.2.5 Remedial Action Objectives

The RA at the LHAAP-35B (37) site must protect human health and meet applicable or relevant and appropriate requirements (ARARs). There are no ecological risks at the LHAAP-35B (37) site (U.S. Army, 2010). The proposed RA addresses human health risks for a future maintenance worker in an industrial scenario.

The RAOs for the LHAAP-35B (37) site, consistent with the reasonably anticipated future use as a national wildlife refuge, are:

- Ensure protection of human health by preventing exposure to the contaminated groundwater;
- Ensure protection of human health and the environment by preventing contaminated groundwater from migrating into nearby surface water; and,
- Ensure return of groundwater to its potential beneficial use as drinking water, wherever practicable.



Source: August 2011 Final Remedial Design LHAAP-35B(37), Chemical Laboratory and LHAAP-67, Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas (Shaw, 2011)

LHAAP -- Longhorn Army Ammunition Plant

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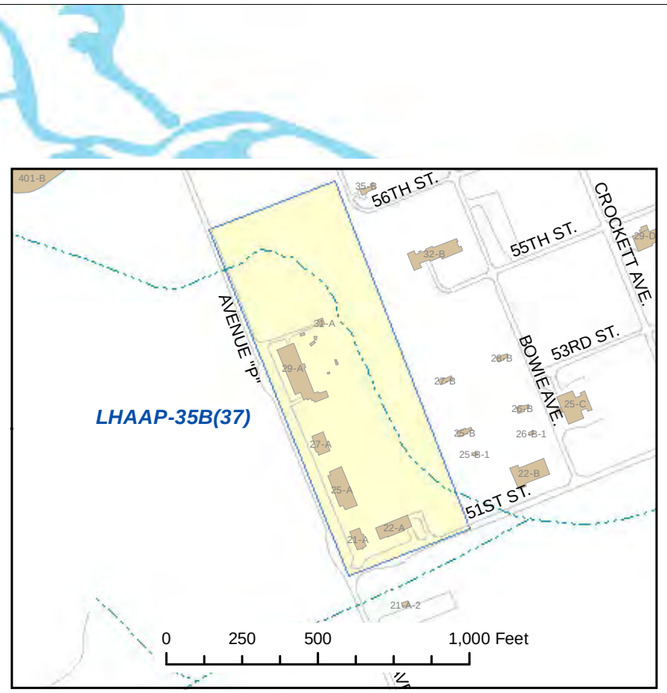
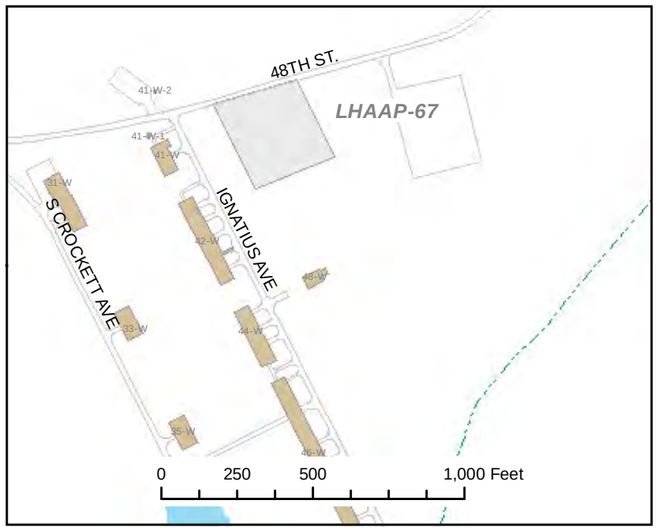
Figure 1-1
Site Area Map
Remedial Action Work Plan
LHAAP-35B(37)
Longhorn Army Ammunition Plant
Karnack, Texas

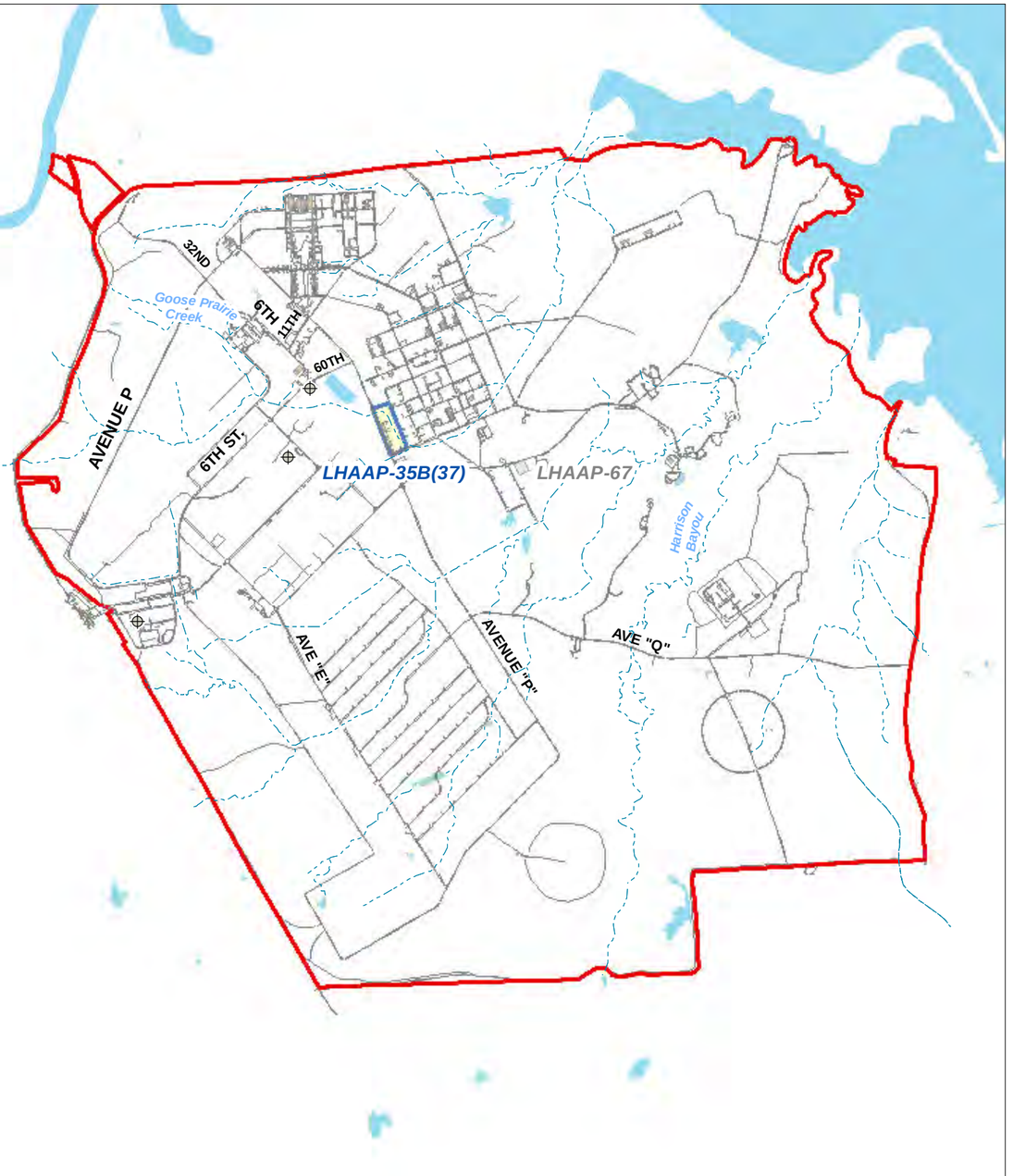
60256135

January 2013

\\usgrn1vfp001\data\group\L:\Group\IT_GIS\GIS Projects\Longhorn\MXDs\LHAAP-37\RAWP\2013-Jan-02\Figure 1-1 LHAAP-37 Site Location Map.mxd







N

Legend

- Water Supply Well
- Streams
- Roads
- LHAAP Boundary
- LHAAP-35B(37) Site Boundary
- LHAAP-67 Site Boundary
- Lake/Pond

Source: August 2011 Final Remedial Design LHAAP-35B(37), Chemical Laboratory and LHAAP-67, Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas (U.S. Army, 2011)

0 1,750 3,500 7,000 Feet

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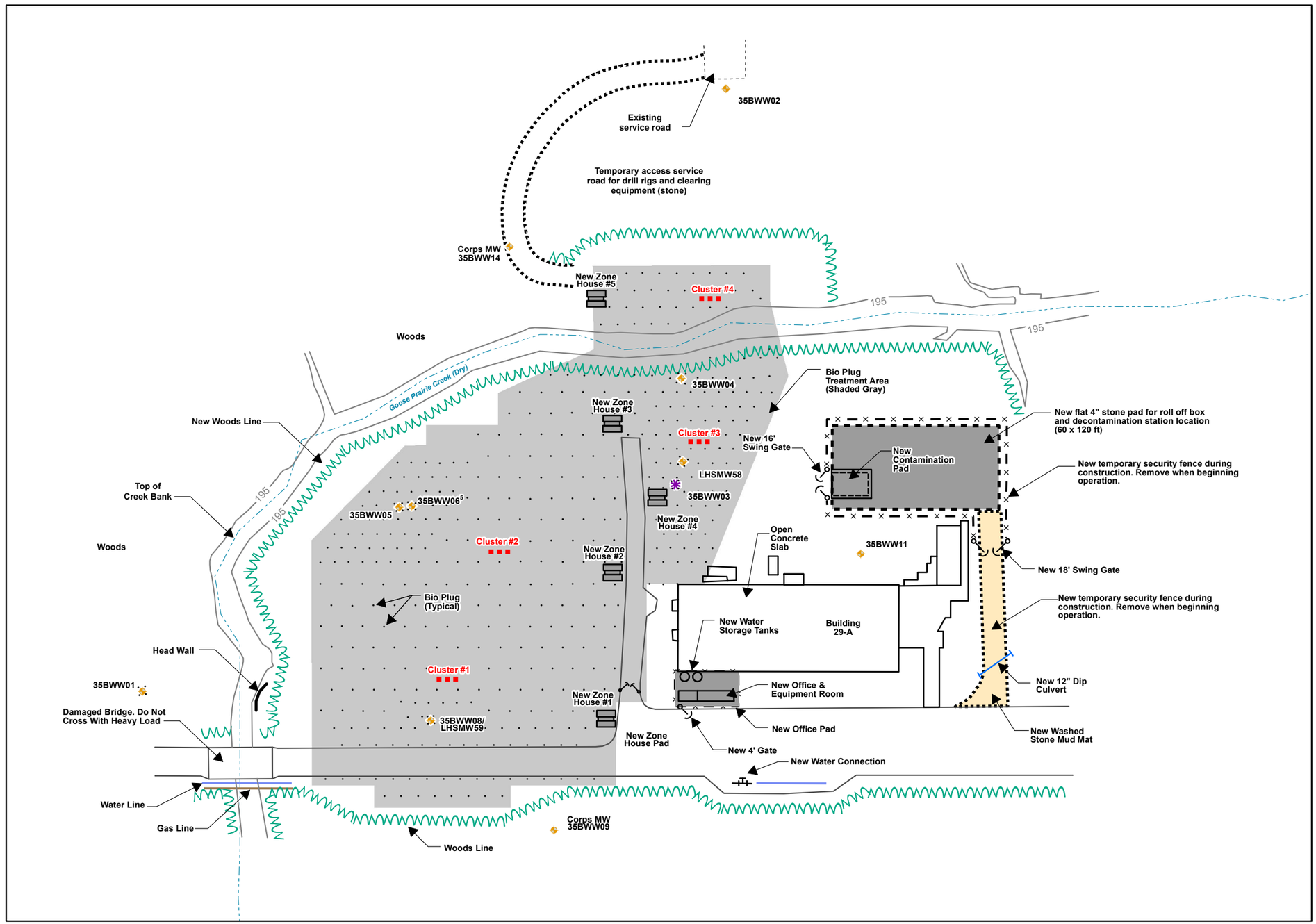
Figure 1-2
Site Location Map
Remedial Action Work Plan
LHAAP-35B(37)
Longhorn Army Ammunition Plant
Karnack, Texas

60256135

January 2013



Legend

- MW Cluster Location
- Bio Plug Locations
- Existing Intermediate Well
- Existing Shallow Well
- Goose Prairie Creek
- Roads
- Mud Mat
- Stonepad

Source: Original map provided by U.S. Army.

Notes:
1. Topography performed by: Landmark Consultants, Inc. Professional Land Surveyors, November, 2011.
2. Locations of groundwater monitoring wells to be selected by DOA project representative.
3. ■■■ represents groundwater monitoring well cluster location.
4. Bio Plug Demonstration Study is performed by a separate contractor for the U.S. Army.
5. Well 35BWW06 is a lower shallow well.

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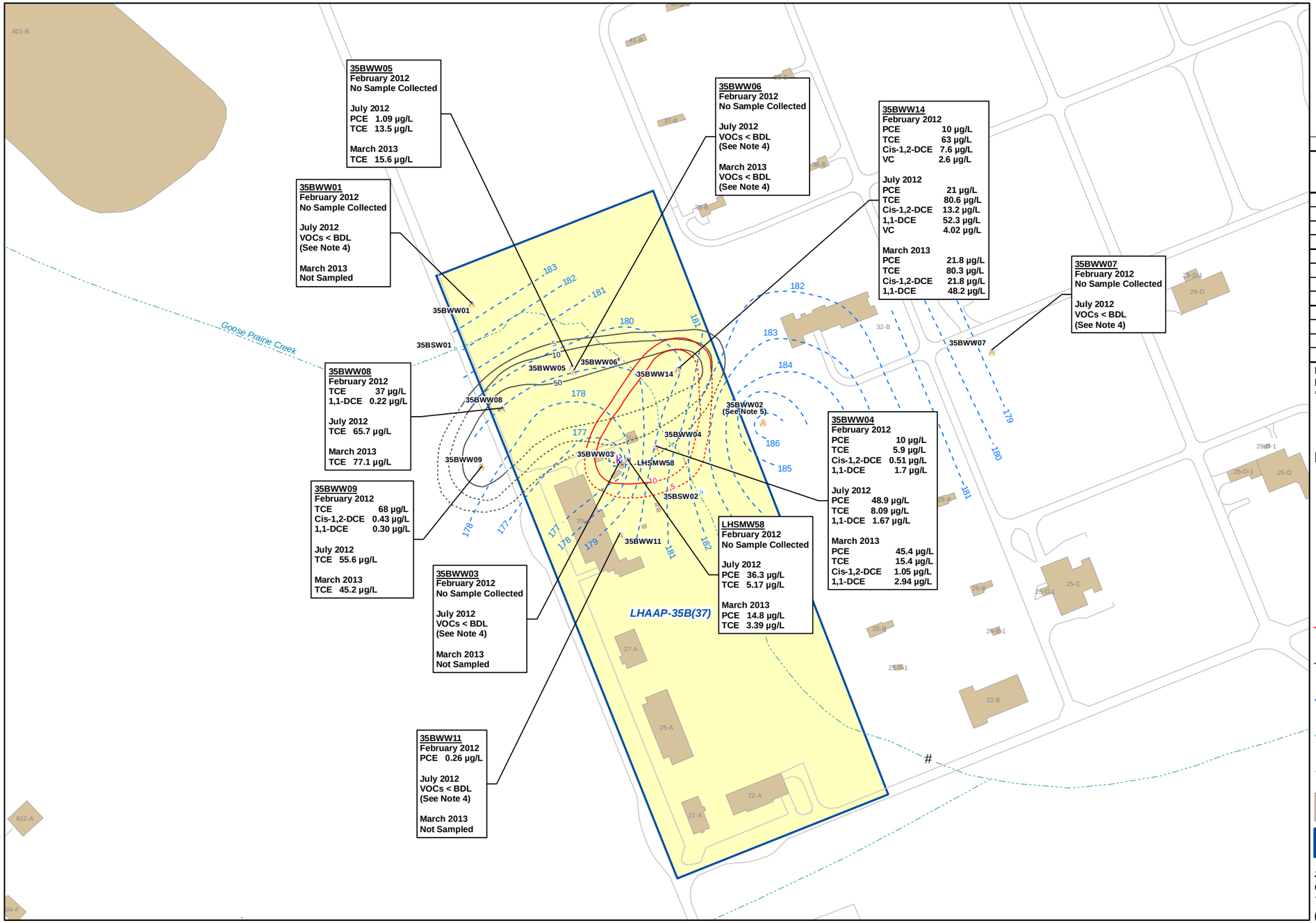
Figure 1-3
Bio-Plug Demonstration Pilot Study
Remedial Action Work Plan
LHAAP-35B(37)
Longhorn Army Ammunition Plant
Karnack, Texas

60256135 April 2013



July 2012 Sampling Event Gauging Data

Well ID	Casing Height (Ft) (above ground surface)	Well Depth (Ft) (to top of casing)	Water Level (Ft) (to top of casing)	Surface Elev. (Ft msl)	Groundwater Elev. (Ft msl)
35BWW01	2.1	21.28	18.45	200.17	183.82
35BWW02	2.35	16.85	16.66	200.82	186.51
35BWW03	2.21	82.5	27	200.36	175.57
35BWW04	3.06	33.18	22.84	199.95	180.17
35BWW05	2.67	37.78	23.31	199.95	179.31
35BWW06	3	53.15	23.92	199.98	179.06
35BWW07	2.65	31.2	26.19	202	178.46
35BWW08	2.42	34.08	24.49	201.06	178.99
35BWW09	2.04	37.03	25.65	202.15	178.54
35BWW11	2.44	37.46	23.54	200.74*	179.65
35BWW14	1.75	37.08	22.3	200.23*	179.69
LHS-MW-58	2.77	35.04	24.06	200.14*	178.86

Notes:
Ft msl - feet above mean sea level
* = Surface elevation at this well is based on Google Earth and not on surveyed data.

Legend

- # — Creek Survey Location
- k — Existing Intermediate Well
- A — Existing Shallow Well
- Surface Water Sampling Location
- PCE Concentration Contour (Dashed Where Inferred)
- TCE Concentration Contour (Dashed Where Inferred)
- Groundwater Elevation Contour (July 2012)
- Goose Prairie Creek
- Roads
- Buildings
- LHAAP-35B(37) Site

Source: August 2011 Final Remedial Design LHAAP-35B(37), Chemical Laboratory and LHAAP-67, Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas (U.S. Army, 2011)

Notes:
1. Concentrations reported in micrograms per liter (µg/L).
2. February 2012, July 2012, and March 2013 sampling events were performed by Cherokee Nation, on behalf of the U.S. Army as part of the bio-plug demonstration study.
3. Concentrations from July 2012 sampling event where available are used to generate concentration contours.
4. VOCs are below laboratory detection limits.
5. Well 35BWW02 was dry in 2004 and 2006. It is not known if the wells with no data were not sampled or if they were dry during sampling event.
6. Well 35BWW06 is a lower shallow well.
8. The groundwater elevation data is from July 2012 sampling event.
9. The surface elevation data at wells 35BWW09, 35BWW11, and 35BWW14 is estimated from Google Earth and is not based on survey information.

0 100 200 400 Feet

TCE - Trichloroethene
PCE - Tetrachloroethene
cis-1,2-DCE - Cis-1,2-Dichloroethene
VC - Vinyl Chloride
1,1-DCE - 1,2-Dichloroethene

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Figure 1-4
Approximate TCE and PCE Plumes in Shallow Groundwater
Remedial Action Work Plan
LHAAP-35B(37)
Longhorn Army Ammunition Plant
Karnack, Texas

60256135 April 2013

2 LAND USE CONTROL PLAN

The U.S. Army or its representatives will be responsible for LUC implementation and certification, reporting and enforcement. 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. The following sections provide a detailed scope of work for the LUC component of the RA.

2.1 Land Use Control Implementation

The objectives of LUC at LHAAP-35B (37) are to prevent human exposure to groundwater contamination presenting an unacceptable risk to a future maintenance worker and ensure that there is no withdrawal or use of groundwater from the site for anything other than environmental monitoring and testing. This groundwater restriction will remain in effect until the levels of the COCs in groundwater allow for unlimited use and unrestricted exposure. Notification of the groundwater use restriction will accompany all transfer documents and will be recorded at the Harrison County Courthouse in accordance with the Texas Administrative Code (TAC) Title 30, §335.566.

The LUC addresses the area of the LHAAP-35B (37) site containing VOC plumes in the shallow groundwater zone. The U.S. Army is responsible for implementing, maintaining, monitoring, reporting on, and enforcing the LUC.

The U.S. Army will undertake the following actions to implement the groundwater restriction LUC for LHAAP-35B (37) site:

- **Define the Area of the Groundwater Use Restriction**

  The estimated LUC boundary is depicted in **Figure 2-1**. The LUC boundary will be finalized after additional data collection as part of plume refinement and MNA evaluation. A buffer may be provided to address uncertainty in the exact location of the plume boundary at all points.

- **Survey the LUC Boundary**

  The proposed LUC boundary will be finalized only after the proposed well installations are complete and all wells are sampled (one round of monitoring data). The proposed boundary will be coordinated with the USEPA and TCEQ, and the LUC boundary will be surveyed by a State-licensed surveyor. A legal description of the surveyed area will be appended to the survey plat. The LUC boundary may be modified if future monitoring data identifies the initial boundary is inaccurate.

- **Record the LUC in Harrison County**

  The LUC plat, legal description and groundwater use restriction language will be recorded in the Harrison County Courthouse in accordance with the TAC Title 30, §335.566.

- **Notify the Texas Department of Licensing and Regulation of the LUC**

  The Texas Department of Licensing and Regulation will be notified of the groundwater restriction which includes the prohibition of water well installation for any purpose other

than environmental monitoring and testing without prior approval from the U.S. Army, USEPA, and the TCEQ. The survey plat, legal boundary, and description of the groundwater restriction, in conjunction with a locator map, will be provided in hard and electronic copy.

The U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of a LUC objective at the site after it has been transferred.

2.2 Site Certification and Reporting

The annual inspections/certifications will be completed in compliance with the LUC objectives. The U.S. Army or the transferee after the transfer will retain the annual LUC inspection/certification documents (Appendix B of this document) in the project files for incorporation into the CERCLA five-year review reports, and these reports will be made available to the USEPA and TCEQ upon request. If any violations are found during the annual certification, the U.S. Army will provide the USEPA and TCEQ a separate written explanation indicating the specific violations found and what efforts or measures have or will be taken to correct the violations. Upon transfer, such responsibilities may shift to the transferee via appropriate provisions placed in the Environmental Condition of Property (ECP) or other environmental transfer document. The need to continue annual inspections/certifications will be revisited during CERCLA five-year reviews.

2.3 Notice of Planned Property Conveyances

The U.S. Army will provide notice to the USEPA and TCEQ when conveying the LHAAP-35B (37) site acreage. The notice will describe the mechanism by which the LUC will continue to be implemented, maintained, inspected, reported, and enforced. Upon transfer, such responsibilities may shift to the transferee via appropriate provisions placed in the ECP or other environmental transfer document. The U.S. Army retains the responsibility for remedy integrity and is responsible for addressing substantive violations of the LUC performance objective that would undermine the U.S. Army CERCLA remedy. The U.S. Army will be responsible for outlining the transferee's LUC obligations in property transfer documents.

2.4 Opportunity to Review Text of Intended Land Use Control

The U.S. Army will provide copies of the groundwater use restriction notification to the TCEQ and USEPA prior to its recordation in Harrison County, and will produce an ECP or other environmental document prior to transfer of the LHAAP-35B (37) site and provide a draft to the USEPA and TCEQ.

2.5 Notification Should Action(s) which Interfere with Land Use Control Effectiveness be Discovered Subsequent to Conveyance

Should the U.S. Army discover any activity on the property inconsistent with the LUC performance objectives after conveyance of the site, USEPA and TCEQ will be notified within 72 hours. The U.S. Army, in conjunction with the USEPA, TCEQ, and the transferee will correct the problem(s) discovered. This reporting requirement does not preclude the U.S. Army from taking immediate action pursuant to its CERCLA authority to prevent any perceived risks to human health and the environment.

2.6 Land Use Control Enforcement

Should the LUC remedy fail, the U.S. Army will coordinate with the USEPA and TCEQ to ensure that appropriate actions are taken to reestablish its protectiveness. The U.S. Army may notify the local agencies with jurisdiction of any LUC violation(s) by future property owners and will work cooperatively with them to restore owner/user compliance with the LUC. Should circumstances warrant, the U.S. Army can choose to exercise its response authorities under CERCLA.

2.7 Modification or Termination of Land Use Control

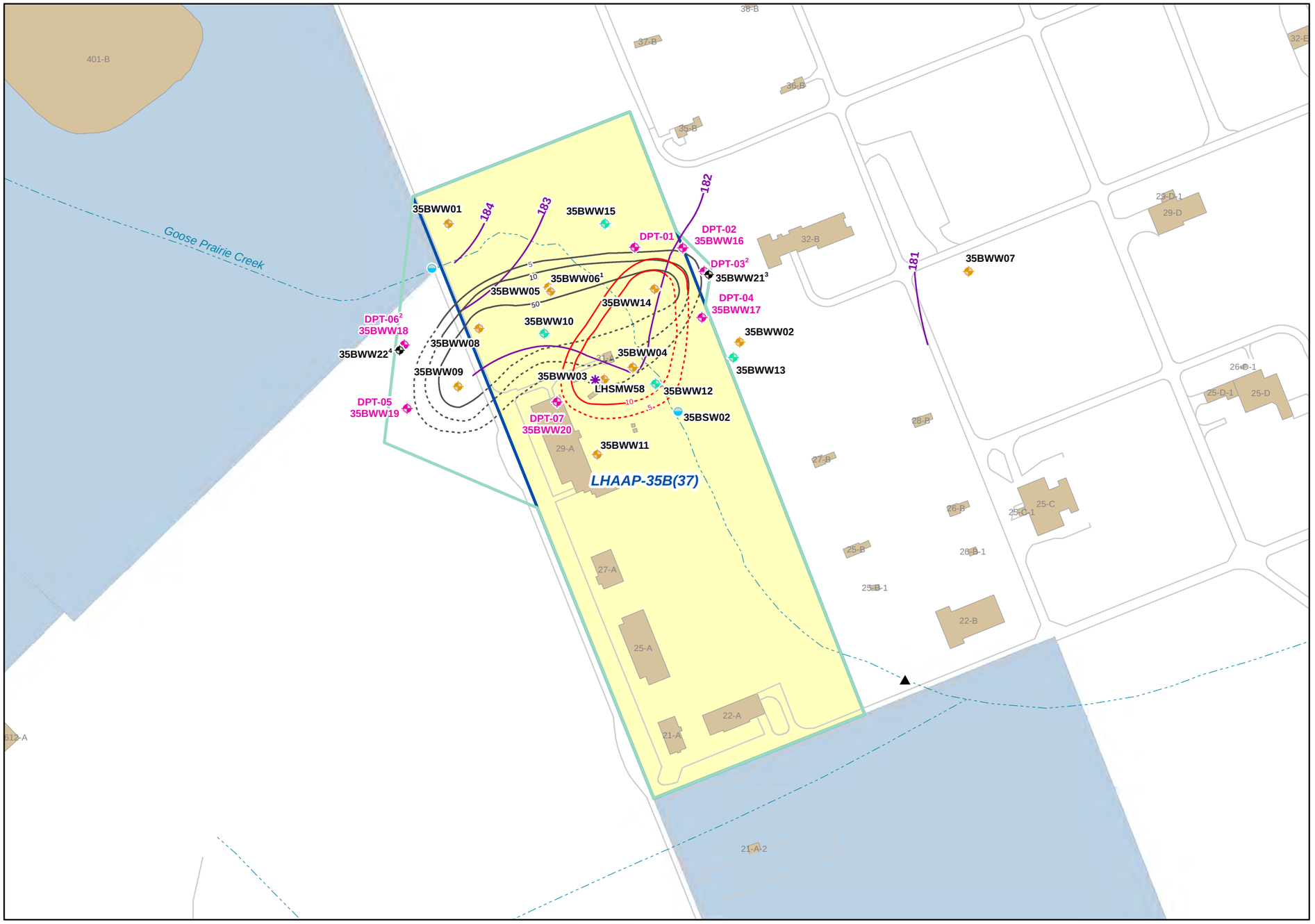
The U.S. Army will only make a significant modification to, or terminate the LUC or make a land use change inconsistent with the LUC objective with USEPA and TCEQ concurrence before commencing actions that may impact remedy integrity.

The LUC will remain in effect until such time as the U.S. Army, TCEQ, and USEPA agree that the concentrations of COCs are at levels that allow for unlimited use and unrestricted exposure. When this occurs, the LUC will be terminated consistent with the NCP process for post-ROD changes. If the property has been transferred and a determination by the U.S. Army, TCEQ and USEPA has been made to terminate the LUC, the U.S. Army shall provide to the owner of the property an appropriate release for recordation pertaining to the site and will also provide timely advice to other local stakeholders of the action.

2.8 Comprehensive Land Use Control Management Plan of Land Use Control

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-35B (37).

The Comprehensive LUC Management Plan consists of LHAAP RD documents and a survey plat showing the locations where the LUC being implemented at LHAAP is applied. The purpose of this Comprehensive LUC Management Plan is to ensure all site-specific LUC are compiled into one comprehensive document for both pre-transfer use by the installation and for post-transfer use by the transferee. This document will also be accessible to regulators, the local government, and the public. The Comprehensive LUC Management Plan is located in the Marshall Public Library to accompany LHAAP's Administrative Record. As LUC RD documents for additional environmental sites are approved by USEPA and TCEQ, the U.S. Army shall likewise add those documents and survey plats to the Comprehensive LUC Management Plan as well as update the previous copy of the plan placed in the Marshall Public Library.



Legend

- Creek Survey Location
- Proposed Intermediate Zone Well
- Proposed DPT Locations/Shallow Wells
- Existing Intermediate Well
- Existing Shallow Well
- Proposed Shallow Well
- Surface Water Sampling Location (Proposed)
- Groundwater Elevation Contour December 2007
- PCE Concentration Contour (Dashed Where Inferred)
- TCE Concentration Contour (Dashed Where Inferred)
- Goose Prairie Creek
- Roads
- Buildings
- LHAAP-35B(37) LUC Boundary
- LHAAP-35B(37) Site

Source: August 2011 Final Remedial Design LHAAP-35B(37), Chemical Laboratory and LHAAP-67, Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas (U.S. Army, 2011)

FWS Interest

- Acquired Wildlife Refuge

Source: US Fish and Wildlife Service (FWS) National Wilife Refuge System - December 2012

Notes:
1. Well 35BWW06 is a lower shallow well.
2. DPT-03 and DPT-06 will be advanced into the intermediate zone and if groundwater is encountered, a sample will be collected for analysis of VOCs.
3. Intermediate zone well 35BWW21 will be installed only if groundwater sample could be collected from the intermediate zone DPT-03 point and the VOC analysis of the collected sample depicts COCs exceeding cleanup levels.
4. Intermediate zone well 35BWW22 will be installed only if groundwater sample could be collected from the intermediate zone DPT-06 point and the VOC analysis of the collected sample depicts COCs exceeding cleanup levels.

AECOM

Figure 2-1
Location of Monitoring Wells and Proposed LUC Boundaries
Remedial Action Work Plan
LHAAP-35B(37)
Longhorn Army Ammunition Plant
Karnack, Texas

60256135 April 2013

3 MONITORED NATURAL ATTENUATION

This section discusses the objectives and details of the MNA program under the RA.

COCs are present in the upper shallow groundwater zone at the LHAAP-35B (37) site. No constituents have exceeded their cleanup levels in the intermediate groundwater zone; hence, this zone will not be monitored. The nature and extent of groundwater contamination in the shallow groundwater zone is discussed in section 1.2.2.

Performance monitoring will be conducted to evaluate remedy effectiveness and will include groundwater and surface water monitoring. The groundwater monitoring program is designed to evaluate and monitor natural attenuation of COCs in shallow zone groundwater and the surface water monitoring program is designed to evaluate potential migration of contaminated groundwater to surface water.

The combined monitoring program shall meet the following objectives (USEPA, 1999):

- Demonstrate that natural attenuation is effectively occurring;
- Detect changes in environmental conditions (e.g. geochemical, hydrogeologic, etc.) that may reduce the efficacy of any of the natural attenuation processes;
- Identify potentially toxic and/or mobile transformation products;
- Verify that the plume(s) is not expanding;
- Verify no unacceptable impact to downgradient receptors;
- Detect new releases of contaminants to the environment that could impact effectiveness of the natural attenuation remedy; and,
- Verify attainment of the remediation objectives.

3.1 Plume Refinement Activities

TCE was detected at concentrations exceeding its MCL in wells 35BWW04 (5.9 µg/L), 35BWW08 (37 µg/L), 35BWW09 (68 µg/L), and 35BWW14 (63 µg/L) in February 2012. PCE exceeded its MCL in wells 35BWW04 (17 µg/L), and 35BWW14 (10 µg/L). In addition, VC exceeded its MCL in well 35BWW14 (2.6 µg/L) in February 2012.

In July 2012, TCE exceeded its MCL in wells 35BWW04 (8.09 µg/L), 35BWW05 (13.5 µg/L), 35BWW08 (65.7 µg/L), 35BWW09 (55.6 µg/L), 35BWW14 (80.6 µg/L), and LHSMW58 (5.17 µg/L). PCE exceeded its MCL in wells 35BWW04 (48.9 µg/L), 35BWW14 (21 µg/L) and LHSMW58 (36.3 µg/L) in July 2012 event. 1,1-DCE exceeded its MCL in well 35BWW14 (52.3 µg/L) in July 2012. VC exceeded its MCL in well 35BWW14 (4.02 µg/L) in February 2012.

In March 2013, TCE exceeded its MCL in wells 35BWW04 (15.4 µg/L), 35BWW05 (15.6 µg/L), 35BWW08 (77.1 µg/L), 35BWW09 (45.2 µg/L), and 35BWW14 (80.3 µg/L). PCE exceeded its MCL in wells 35BWW04 (45.4 µg/L), 35BWW14 (21.8 µg/L) and LHSMW58 (14.8 µg/L). 1,1-DCE exceeded its MCL in well 35BWW14 (48.2 µg/L) in March 2013.

Data from July 2012 and March 2013 is included in Appendix C.

Additional monitoring wells are proposed at the LHAAP-35B (37) site to provide additional data for TCE/PCE plume refinement and to assist in evaluation of natural attenuation.

Prior to installation of permanent monitoring wells, discrete groundwater samples will be collected from a minimum of seven temporary borings advanced using direct push technology (DPT) drilling and will be analyzed for VOCs. Approximate locations of the seven temporary borings, DPT-01 through DPT-07 are depicted in **Figure 3-1**. Additionally, two of the borings, DPT-03 and DPT-06, will be advanced into the intermediate zone of the aquifer. Discrete groundwater samples, if groundwater is present, will be collected from the intermediate zone from these two borings and will be analyzed for VOCs.

After collecting VOC data from the temporary borings, permanent shallow monitoring wells will be installed at nine different locations. Proposed locations of the shallow monitoring wells, 35BWW10, 35BWW12, 35BWW13, 35BWW15, 35BWW16, 35BWW17, 35BWW18, 35BWW19, and 35BWW20 are depicted in **Figure 3-1**. Additional DPT points will be installed, if necessary, to the southwest of DPT-07 if results from DPT-07 detect VOCs above applicable standards. The location of the proposed monitoring well 35BWW20 will be adjusted in the field based on VOC results from DPT-07 and if necessary the additional DPT point. Additionally, if the discrete groundwater samples collected from intermediate zone from DPT-03 and DPT-06 indicate VOC data above their respective cleanup levels, permanent groundwater wells 35BWW21 and 35BWW22 will be installed in the intermediate zone near the locations of DPT-03 and DPT-06, respectively. If VOCs in groundwater from these two DPTs are below cleanup levels, no intermediate zone wells will be installed.

Table 3-1 provides the rationale for proposed DPT points and the shallow and intermediate zone monitoring well locations. The exact locations will be adjusted in the field based on site conditions and available data. The additional data, along with sampling and analysis of existing wells, will be used as guidance to optimize placement of proposed new monitoring wells.

The information gathered from the well installations and one round of monitoring data will be used to establish LUC boundaries for the site. As discussed above, the bio-plug study will be ongoing through approximately February 2014, which includes monitoring at site wells. Implementation of groundwater monitoring presented in this workplan will begin following completion of the bio-plug study and related monitoring.

In summary, a minimum of nine additional shallow monitoring wells (and potentially two intermediate zone wells) are proposed at LHAAP-35B (37) site. **Figure 3-1** depicts the approximate expected locations of the proposed monitoring wells, which are subject to change based upon the findings of the discrete groundwater sampling effort. The use of existing wells will be maximized as they provide historic data that can be used for MNA evaluation.

3.2 MNA Implementation

This section describes the field and other activities planned at the LHAAP-35B (37) site that relate to the MNA component of the groundwater remedy. General activities would apply to any site with similar characteristics. Site-specific activities are described in associated subsections.

3.2.1 Pre-mobilization Activities

A pre-construction meeting will be held prior to initiation of field activities.

3.2.2 Preliminary Activities/Mobilization

The field schedule will be finalized with the selected drilling contractor prior to mobilization to the LHAAP-35B (37) site. An on-site project kickoff meeting will be held with the contractor to review the scope of work including the drilling locations, utility clearances, and health and safety issues.

3.2.3 Site/Utility Clearance

The locations of subsurface utilities will be evaluated based on existing utility maps. All proposed borehole locations will be marked, Underground Service Alert (One Call) will be notified at least two working days prior to intrusive work, and the utility clearance standard operating procedure will be followed.

3.2.4 Direct Push Groundwater Sampling

DPT will be used to collect discrete groundwater samples to refine the boundaries of the shallow groundwater zone plume in order to accurately implement the remedy. A minimum of seven shallow DPT well points will be installed to collect discrete groundwater samples. In addition, two of the DPTs (DPT-03 and DPT-06) will be advanced into the intermediate zone and discrete groundwater samples collected from the intermediate zone. Discrete groundwater samples will be collected from DPT points using a Geoprobe SP-15® or equivalent which has a 3.5-foot screen length. The drilling equipment will be decontaminated after each sample is collected to prevent cross-contamination.

The collected groundwater samples will be analyzed for VOCs utilizing USEPA Method 8260B. Sample analyses and analytical results validation will be conducted in accordance with the Installation-Wide Work Plan in place at the time field work is conducted.

3.2.5 Monitoring Well Installation

A minimum of nine new monitoring wells (**Figure 3-1**) are proposed in the shallow groundwater zone. Additionally, a maximum of two monitoring wells may be installed in the intermediate groundwater zone. Monitoring wells will be installed using a hollow-stem auger, mud rotary or sonic drilling techniques as appropriate. Well installation and development will follow the procedures specified in the Installation-Wide Work Plan in place at the time field work is conducted.

3.2.6 Site Survey

After completion of the sampling activities, the monitoring wells will be surveyed by a licensed land surveyor. The survey activities (for location and elevation) will be performed in accordance with the Installation-Wide Work Plan in place at the time field work is conducted.

3.2.7 MNA Program Groundwater Monitoring

As discussed in Section 1.2.2, the bio-plug study will be ongoing through approximately February 2014, which includes monitoring at site wells. Implementation of groundwater monitoring presented in this workplan will begin following completion of the bio-plug study and related monitoring.

Groundwater monitoring will be performed to demonstrate effectiveness of the MNA remedy. Up to 19 shallow zone monitoring wells (**Figure 3-1**) are proposed to be included in the monitoring program for VOCs. These wells have been selected for their placement relative to the VOC plumes to monitor effectiveness of natural attenuation at the LHAAP-35B (37) site as well as to verify the plume extent and the validity of the LUC boundaries. The number of monitoring wells included in the network may be reduced based on results of the initial groundwater data collection activities. In addition, the existing intermediate zone well (35BWW03), the existing lower shallow well (35BWW06), and the two new proposed intermediate zone wells (35BWW21 and 35BWW22), if installed, will be analyzed for VOCs during the baseline event Subsequent monitoring of these four wells (35BWW03, 35BWW06, 35BWW21 and 35BWW22) will be performed once every five years to support the Five-year review. Table 3-2 indicates the wells and the analytes for each well. Table 3-3 lists the analytes, test methods, and other sampling information. Well 35BWW02 has previously been observed dry during the 2004 and 2006 sampling events. If any particular well is dry, no sample will be collected.

Prior to sampling, depth to groundwater measurements will be recorded using an interface probe capable of detecting the presence of free phase (either light or dense non-aqueous phase) hydrocarbons. The depth to water will be measured from a specified location on top of the casing where elevation has been determined. The depth to water will be recorded in the appropriate field forms and the water elevation calculated using the top of casing elevation. These results will be used to construct a potentiometric map for the site.

Prior to sampling groundwater, each well will be purged and general water quality parameters (temperature, pH, specific conductivity, dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity) will be collected. Upon completion of these activities, groundwater samples will be collected and placed into laboratory-provided containers. The containerized samples will be properly labeled, placed within ice-filled coolers, and shipped to the laboratory under chain-of-custody control for analytical testing. All well purging, groundwater sampling, sample labeling and shipping activities will be conducted in accordance with the Installation-Wide Work Plan in place at the time field work is conducted.

The schedule for groundwater monitoring for MNA will be quarterly for two years, which will be initiated following completion of the bio-plug study. Samples from a subset of the monitoring wells (35BWW01, 35BWW04, 35BWW08, 35BWW12, 35BWW14, and LHSMW58) will also be tested for the following biogeochemical parameters: nitrate, nitrite, sulfate, ferrous iron, chloride, methane, ethane, ethene, inorganic and organic carbon, and Dehalococcoides ethenogenes (DHC).

Sample analyses and analytical results validation will be conducted in accordance with the Installation-Wide Work Plan in place at the time field work is conducted.

3.2.7.1 Surface Water Sampling

Surface water samples from two locations (35BSW01 and 35BSW02) in the Goose Prairie Creek (one upgradient and other downgradient of LHAAP-35B (37) site) will be collected on a quarterly basis for the first year and then annually until the next CERCLA five-year review to confirm contaminated groundwater is not migrating into the surface water and the start of surface water sampling will coincide with the start of well sampling. **Figure 3-1** depicts the proposed locations to collect surface water samples. The collected surface water samples will be analyzed

for VOCs. Surface water sampling, sample labeling and shipping activities will be conducted in accordance with the Installation-Wide Work Plan in place at the time field work is conducted.

3.2.7.2 Long-term Monitoring

After the first two years of quarterly groundwater monitoring, which will commence following completion of the bio-plug study, the long-term monitoring frequency will be reduced to semiannual for three additional years, then annually until the next CERCLA five-year review. After the first year of quarterly monitoring, the suite of analyses performed will also be limited to VOC analysis to be used for ongoing confirmation of declining concentration trends. Further reductions in sampling frequency will depend upon results of CERCLA five-year reviews, but sampling will continue at least once every five years until cleanup levels are attained.

3.2.8 Antimony and Thallium Monitoring

Antimony and thallium were detected in groundwater at the LHAAP-35B (37) site prior to the Remedial Investigation conducted in 2002. Antimony and thallium were not included as COCs due to follow-on groundwater samples being non-detect for these metals, their non-detection in soils at the site, and the lack of their historical uses at the site. No subsequent sampling was conducted at the site for antimony and thallium after 2002.

Groundwater samples from the shallow zone wells collected during the first monitoring event will be analyzed for antimony and thallium to confirm the previous decision to exclude these constituents as COCs. After the first sampling and analysis event for antimony and thallium at LHAAP-35B (37), the need for additional monitoring for these constituents will be evaluated.

Sample collection, analyses and analytical results validation will be conducted in accordance with the Installation-Wide Work Plan in place at the time field work is conducted.

3.2.9 Investigation Derived Wastes

Investigation-Derived Waste (IDW) generated during the investigation and monitoring activities will include disposable sampling equipment, purge water, equipment decontamination fluids, and personal protection equipment (PPE). IDW (except PPE and disposable sampling equipment) will be containerized and stored on-site pending analytical results and waste profiling. The IDW management storage and disposal will be performed in accordance with the Installation-Wide Work Plan in place at the time field work is conducted.

3.2.10 Decontamination of Equipment and Personnel

Decontamination of equipment and personnel will be performed as discussed in the Installation-Wide Work Plan in place at the time field work is conducted.

3.3 Health and Safety Procedures

AECOM and its subcontractors will comply with the health and safety procedures specified by the Installation-Wide Work Plan in place when field work is performed. AECOM anticipates field work will be performed in modified Level D PPE that will include a hard hat, safety glasses, steel-toed boots, and nitrile gloves. Additional PPE may include bug spray, Tyvek®

suits, poison oak block, and reflective safety vests depending on the location and type of field activities.

The medical centers associated with this project include Workcare (Occupational Clinic) located at Marshall, Texas. An emergency contact list and emergency route maps will be included in the Installation-Wide HASP.

3.4 Quality Assurance/Quality Control

All work will be done in accordance with the Installation-Wide Work Plan in place when field work is conducted. The Installation-Wide Work Plan provides information on quality assurance/quality control (QA/QC) procedures for this project, identifies personnel, procedures, controls, instructions, tests, verifications, documents, and forms to be used and the types of records to be maintained. The Installation-Wide Work Plan also addresses quality control requirements specific to each major feature of work.

Table 3-1: Rationale for Selection of Proposed DPT Points and Monitoring Well Locations in Shallow Groundwater Zone

Proposed DPT/Well ID	Location relative to the Plume	Rationale/Purpose
DPT-01	Northwest of well 35BWW14	For delineation of TCE plume near well 35BWW14
DPT-02	North of well 35BWW14	For delineation of TCE plume near well 35BWW14.
DPT-03*	Northeast of well 35BWW14	For delineation of TCE plume near well 35BWW14. To collect a discrete groundwater sample from the intermediate zone in this location for analysis of VOCs.
DPT-04	Down gradient of well 35BWW14	For delineation of TCE plume down gradient of well 35BWW14.
DPT-05	Vicinity of well 35BWW09	For delineation of TCE plume west of well 35BWW09; confirmation of LUC boundary.
DPT-06*	Up gradient and in the vicinity of well 35BWW08	For plume delineation and confirmation of LUC boundary. To collect a discrete groundwater sample from the intermediate zone in this location for analysis of VOCs.
DPT-07	Southwest of well LHSMW58	For plume delineation near well LHSMW58 and 35BWW09
Well 35BWW10	Within plume, down gradient of well 35BWW08	MNA evaluation; Long-term monitoring
Well 35BWW12	Down gradient of well 35BWW04	MNA evaluation; Long-term monitoring
Well 35BWW13	Down gradient of well 35BWW04	MNA evaluation; Long-term monitoring
Well 35BWW15	Up gradient and northwest of well 35BWW14	MNA evaluation; Long-term monitoring
Well 35BWW16	Vicinity of DPT-02 and north of well 35BWW14	Refine northeastern plume edge; MNA evaluation; Long-term monitoring
Well 35BWW17	Vicinity of DPT-04 and down gradient of well 35BWW14	MNA evaluation; Long-term monitoring
Well 35BWW18	Vicinity of DPT-06 and up gradient of well 35BWW08	Refine western edge of plume; MNA evaluation; Long-term monitoring
Well 35BWW19	Vicinity of DPT-05 and west of well 35BWW09	Refine western edge of plume; MNA evaluation; Long-term monitoring
Well 35BWW20	Vicinity of DPT-07 and southwest of LHSMW58	Refine plume edge; MNA evaluation; Long-term monitoring
Well 35BWW21**	Vicinity of DPT-03	For confirmation of presence of VOCs in groundwater in the intermediate zone
Well 35BWW22**	Vicinity of DPT-06	For confirmation of presence of VOCs in groundwater in the intermediate zone

Note: Locations of the proposed new monitoring wells will be adjusted as necessary based on the results of the VOC screening from DPT points. Additional DPT points will be installed in the shallow zone if the current DPT points that are being used for confirmation of the LUC boundary detect VOCs above applicable standards.

* - This boring will be advanced into the intermediate zone to collect a discrete groundwater sample, if available, from the intermediate zone, for analysis of VOCs.

** - Wells 35BWW21 and 35BWW22 will be installed in the intermediate zone only if groundwater samples collected from DPT-03 and DPT-06 detect VOCs at concentrations greater than their respective cleanup levels.

Table 3-2: Monitored Natural Attenuation (MNA) Performance Monitoring Wells

Monitoring Well[(1)] ID	VOCs	Field Parameters**	MNA Parameters***
35BWW01	X	X	X
35BWW02[(2)]	X	X	
35BWW03****	X	X	
35BWW04	X	X	X
35BWW05	X	X	
35BWW06****	X	X	
35BWW07	X	X	
35BWW08	X	X	X
35BWW09	X	X	
*35BWW10	X	X	
35BWW11	X	X	
*35BWW12	X	X	X
*35BWW13	X	X	
35BWW14	X	X	X
*35BWW15	X	X	
*35BWW16	X	X	
LHSMW58	X	X	X
*35BWW17	X	X	
*35BWW18	X	X	
*35BWW19	X	X	
*35BWW20	X	X	
35BWW21*****	X	X	
35BWW22*****	X	X	

Notes:

(1) The number of monitoring wells included in the network and the sampling frequency may be adjusted based on results of the initial data collection activities.

(2) Well 35BWW02 has been dry previously during the 2004 and 2006 sampling events. If any well is dry, no sample will be collected.

* - Proposed monitoring wells (shallow zone)

** - Field parameters to be monitored for all wells: pH, temperature, conductivity, turbidity, ORP, DO

*** - MNA parameters include nitrate, nitrite, sulfate, ferrous iron, chloride, methane, ethane, ethene, inorganic and organic carbon, DHC. Additional parameters may be added or existing set of MNA parameters may be modified as needed as data from initial monitoring events is evaluated.

**** - Wells 35BWW03 is completed in the intermediate zone and well 35BWW06 is completed in the lower shallow zone. These two wells will be sampled during the baseline event and then once every five years to support the Five-year review.

***** - Wells 35BWW21 and 35BWW22 will be installed and completed in the intermediate zone only if groundwater samples are collected from DPT-03 and DPT-06 and the VOC data from these samples indicate concentrations exceeding cleanup levels.

These wells, if installed, will be sampled during the baseline event and then once every five years to support the Five-year review.

X - Well will be analyzed for that parameter.

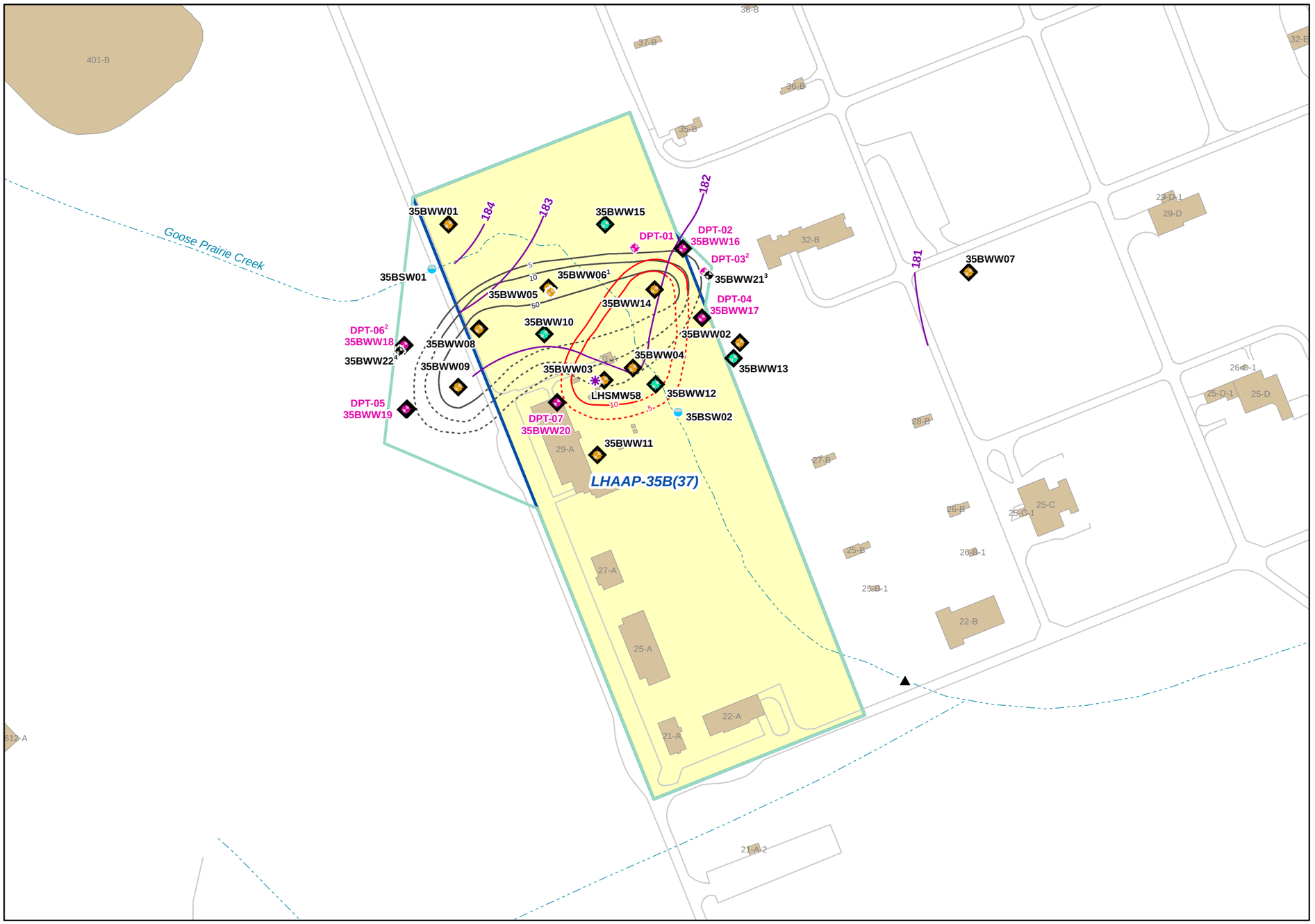
MNA - monitored natural attenuation

VOCs - volatile organic compounds.

Table 3-3: Analytical Methods, Containers, and Preservatives

Parameter	Minimum Sample Volume	Holding Time	Preservation	Method
Volatiles	3x40 mL glass vial with PTFE septa cap	14 days	pH < 2 HCl, Cool at 4°C, no headspace	8260B (or latest method)
Thallium	1x250 mL polyethylene bottle	180 days	pH < 2 HNO_3, Cool at 4°C	SW846 3005A/6010C/6020A/7470A/ ME401/ME404/ME600E/ME600G/ME700A
Antimony	1x250 mL polyethylene bottle	180 days	pH < 2 HNO_3, Cool at 4°C	SW846 3005A/6010C/6020A/7470A/ ME401/ME404/ME600E/ME600G/ME700A
DHC	2x1 L amber glass bottles with teflon-lined cap(s)	14 days	Cool at 4°C	Polymerase Chain Reaction (PCR)
Common Anions (chloride, sulfate)	250 mL polyethylene bottle	28 days (Cl/SO_4)	Cool at 4°C	USEPA 300.0
Nitrate/nitrite as N	500 mL polyethylene bottle	28 days	pH < 2 H_2SO_4, Cool at 4°C	USEPA 353.2
Total organic carbon (TOC)	3x40 mL Amber Glass Vials	28 days	pH < 2 H_2SO_4 or HCL, Cool at 4°C	USEPA 415.1
Dissolved gases (methane, ethane, ethene)	3x40 mL glass vial with PTFE septa cap	14 days	Cool at 4°C	RSK 175
Ferrous iron	NA	Immediately in field (with a field kit)	NA	NA

Notes and Abbreviations:
The above listed volumes provide an adequate quantity of samples to analyze a matrix spike (MS) and matrix spike duplication (MSD)
°C – degrees centigrade
H_2SO_4 – sulfuric acid
HCL – hydrochloric acid
HNO_3 – nitric acid
L – liter
mL – milliliter
PTFE – polytetrafluoroethylene
NA – Not applicable
USEPA – United States Environmental Protection Agency



Legend

- Creek Survey Location
- Proposed Intermediate Zone Well
- Proposed DPT Points and New Shallow Monitoring Well Locations
- Existing Intermediate Well
- Existing Shallow Well
- Proposed Shallow Well
- Surface Water Sampling Location (Proposed)
- Wells in the MNA Monitoring Program
- Groundwater Elevation Contour December 2007
- PCE Concentration Contour (Dashed Where Inferred)
- TCE Concentration Contour (Dashed Where Inferred)
- Goose Prairie Creek
- Roads
- Buildings
- LHAAP-35B(37) LUC Boundary
- LHAAP-35B(37) Site

DPT - Direct Push Technology
TCE - Trichlorothene
PCE - Tetrachloroethene

Source: August 2011 Final Remedial Design LHAAP-35B(37), Chemical Laboratory and LHAAP-67, Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas (U.S. Army, 2011)

Notes:
1. Well 35BWW06 is a lower shallow well.
2. DPT-03 and DPT-06 will be advanced into the intermediate zone and if groundwater is encountered, a sample will be collected for analysis of VOCs.
3. Intermediate zone well 35BWW21 will be installed only if groundwater sample could be collected from the intermediate zone DPT-03 point and the VOC analysis of the collected sample depicts COCs exceeding cleanup levels.
4. Intermediate zone well 35BWW22 will be installed only if groundwater sample could be collected from the intermediate zone DPT-06 point and the VOC analysis of the collected sample depicts COCs exceeding cleanup levels.

AECOM

Figure 3-1
Proposed DPT Points and New Monitoring Well Locations
Remedial Action Work Plan
LHAAP-35B(37)

Longhorn Army Ammunition Plant
Karnack, Texas

60256135 April 2013

4 REMEDY PERFORMANCE EVALUATION AND REPORTING

Reporting will consist of formal annual reports, supplemented by the sharing of validated data as it becomes available to shorten the time between sampling and data receipt by the regulators. Annual reports will be prepared for any year in which sampling occurs to document the monitoring program, which will begin following completion of the bio-plug study. The groundwater monitoring will be terminated after the remedy has achieved cleanup levels. The CERCLA five-year reviews will be conducted and reports prepared until levels allowing for unlimited use and unrestricted exposure are achieved. The TCEQ guidance document, 'Monitored Natural Attenuation Demonstrations under TRRP' (TCEQ, RG-366/TRRP-33, revised September 2010) will be used as guideline for evaluation of groundwater data.

4.1 MNA Evaluation

The first year's annual report will include a review of the first four quarters of data, which include natural attenuation parameters and relevant historical data and provide an evaluation for the evidence of MNA as a remedial method and a review of the first year's surface water sample data. The MNA performance criteria are listed in **Table 4-1**. The first annual report will include:

- Figures of the site, wells, and groundwater elevation contours;
- Groundwater and surface water results;
- Plume extent and concentration over time;
- Consideration of the first and second lines of evidence for MNA (see sections 4.1.2 through 4.1.3); and
- An evaluation of the effectiveness of MNA at the site.

For the subsequent annual reports, the data evaluation presented will focus on trend analysis for the COCs.

4.1.1 Migration/Expansion

The MNA evaluation should demonstrate a stable or decreasing plume if the MNA remedy is to be considered favorable at the LHAAP-35B (37) site. A groundwater plume is stable when the pollutant concentrations and plume footprint are relatively unchanged over time. A stable plume shows that pollutant migration in groundwater is under control.

A plume is considered decreasing if its footprint is diminishing. A decreasing plume situation occurs when the attenuation rate of dissolved-phase pollutants exceeds their generation rate from all sources. A decreasing plume supports natural attenuation as a viable remedial alternative.

Monitoring must occur over a period of time sufficient to demonstrate plume stability or decrease under natural conditions. This may take up to several years depending on site-specific conditions, including the monitoring data trend analysis, potential threats to beneficial uses, and other uncertainties. The non-parametric Mann-Kendall statistic will be used to evaluate solute plume stability. If monitoring data do not indicate plume stability/decrease, the remedy will be re-evaluated.

Table 4-1: Monitored Natural Attenuation (MNA) Evaluation Performance Criteria

Performance Criteria	Type	Expected Performance	Commentary
Migration/Expansion	Qualitative	Stable or decreasing plume footprint, stable footprint position	An expanding or migrating plume footprint indicates MNA should not be continued.
Concentrations	Quantitative	Declining concentrations or total CVOC mass in a majority of performance monitoring wells	First Line of Evidence
Aquifer Conditions	Quantitative	Conditions favorable for natural attenuation	Second Line of Evidence
Microcosm Studies or Modeling (if necessary)	Quantitative	Detectable presence of appropriate microorganisms	Third Line of Evidence (if necessary)

4.1.2 First Line of Evidence

The first line of evidence relies upon comparison of current and historical groundwater data from appropriate monitoring or sampling points that demonstrates a trend of stable or decreasing contaminant mass and/or COC concentrations over time or with distance traveled from the source. Decreasing concentrations should not be solely the result of plume migration, so performance wells will be evaluated to determine if the plume is migrating.

COC concentrations in individual wells can be evaluated to calculate a time-based attenuation rate or across multiple wells through the centerline of a plume to calculate distance-based attenuation rate. These calculations will be performed using the methods contained in the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (USEPA, 1998).

Time-based attenuation rates will be calculated for any monitoring well that shows consistent COC concentrations exceeding cleanup levels. Distance-based attenuation rates will be calculated using wells with the highest concentrations parallel to the direction of groundwater flow. Monitoring wells 35BWW04, 35BWW08, LHSMW58, and 35BWW14 are expected to be the primary focus of analysis at the LHAAP-35B (37) site due to high COC concentrations. Thus, data from these wells will be evaluated for meaningful trends indicating decreasing concentrations and/or mass.

4.1.3 Second Line of Evidence

The second line of evidence uses chemical analytical data in mass balance to show that decreases in contaminant and electron acceptor/donor concentrations can be directly correlated to increases in metabolic end-products or daughter compounds. This evidence can be used to show groundwater conditions are sufficiently favorable to natural attenuation so that degradation of chlorinated solvent contaminants can occur.

The second line of evidence evaluates biogeochemical parameters such as nitrates, sulfates, chloride, TOC, etc. The results of these analytes will be interpreted using the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (USEPA, 1998) to determine whether conditions are favorable for continued MNA.

4.1.4 Third Line of Evidence

The third line of evidence, if necessary, consists of predictive modeling studies and other laboratory/field studies that demonstrate an understanding of the natural attenuation processes occurring at the site and their effectiveness in controlling plume migration and decreasing COC concentrations.

For the MNA evaluation, the presence of microorganisms in the groundwater capable of degrading the COCs will be considered the favorable condition supporting continued MNA.

4.2 LTM Annual Reports

An annual report will be prepared at the end of each year of LTM to present groundwater monitoring results, a description of field activities, and to document other relevant information that may be considered useful for the CERCLA five-year review.

Perimeter well data will be evaluated for plume migration while the data from wells within the plume areas will be evaluated for MNA performance.

The annual report will also provide recommendations, if possible, for reducing the number of monitoring wells to be included in the monitoring program and/or frequency of monitoring events.

4.3 Five-Year Review Reports

CERCLA five-year reviews will be performed for the LHAAP-35B (37) site. The five-year review report will present summaries of information from the annual reports, as well as from the five-year review sampling event, and recommend the future course of action. The progress towards cleanup levels will be evaluated in the five-year review report.

5 SCHEDULE

Table 5-1 shows the estimated duration for each major site activity and timeline. This schedule may be adjusted depending upon the outcome of the bio-plug study and related groundwater monitoring. This schedule is considered to be reasonable and achievable. Adverse weather and unknown site conditions could adversely affect this schedule.

Table 5-1: Durations for Major Site Activities

Activities	Duration	Elapsed Time
Additional Delineation Activities and Groundwater Sampling	10 days	
Installation of Monitoring Wells	5 days	-
First Groundwater Sampling Event (includes new wells; will coincide with bio-plug monitoring)(1)	5 days	-
Establish Land Use Control	1 month	2 months
Completion of Bio-plug Demonstration Pilot Study	2 years	2 years 2 months
Year 1 Quarterly MNA Sampling (4 events)(2)	5 days per event	2.5 years
First Annual Report (Final Document)	3 months	2 years and 9 months
Year 2 Quarterly MNA Sampling (4 events)	5 days per event	4 years
Three years of semiannual monitoring and associated annual reporting	3 years	7 years
CERCLA Five-Year Review	6 months	7 years
Annual Sampling (years 5 through 10)	5 years	12 years
Sample once every five years (repeat activity until cleanup levels are achieved)	-	17, 22, 27, 32 years
Achieve Cleanup Levels	-	30 years or greater

Notes:
- Time frame to achieve cleanup levels is estimated based on the ROD (U.S. Army, 2010).
- Schedule revision expected after CERCLA five-year review.

(1) Since the bio-plug monitoring program and the sampling event for MNA will have some common monitoring wells, if feasible, sampling event after installation of new wells will be done along with the bio-plug monitoring event.

(2) Quarterly monitoring for MNA will be initiated after completion of the bio-plug demonstration study.

6 REFERENCES

AECOM, 2012, *Final Remedial Action Work Plan, LHAAP-67, Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas*, December.

Jacobs, 2002, *Final Remedial Investigation Report for the Group 4 Sites, Sites 35A, 35B, 35C, 46, 47, 48, 50, 60, and Goose Prairie Creek, Longhorn Army Ammunition Plant, Karnack, Texas*, January.

Shaw, 2007, *Final Natural Attenuation Evaluation LHAAP-12, LHAAP-35B (37), and LHAAP-67, Longhorn Army Ammunition Plant, Karnack, Texas*, June.

TCEQ, 2010, *Monitored Natural Attenuation Demonstrations under TRRP*, Regulatory Guidance RG-366/TRRP-33, Remediation Division, Austin, Texas.

U.S. Army, 2010, *Final Record of Decision, LHAAP-35B(37), Chemical Laboratory and LHAAP-67,Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas*, June.

U.S. Army, 2011, *Final Remedial Design, LHAAP-35B(37), Chemical Laboratory and LHAAP-67,Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas*, August.

USEPA, 1998, *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*, EPA/600/R-98/128, September.

USEPA, 1999, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, Directive 9200.4-17P, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

APPENDIX A: WELL INSTALLATION AND SAMPLING COLLECTION REPORT (FEBRUARY 2012)

Longhorn Army Ammunition Plant
Well Installation and Sampling

Completion Report

Chemical Laboratory (LHAAP-37)
Karnack, Texas

Contract No.: W912BV-09-D-2022
Task Order No.: 0007

Prepared By:

CHEROKEE NATION™
Cherokee CRC

Tulsa, Oklahoma

Prepared For:

United States Army Corps of Engineers
Tulsa, Oklahoma

April 11, 2012

Table of Contents

APPENDICES

Acronyms and Abbreviations

CCRC	Cherokee CRC, LLC
ID	Identification
ID/IQ	Indefinite Deliverable/Indefinite Quantity
IDW	Investigation Derived Waste
MW	Monitoring Well
HASP	Health and Safety Plan
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
ug/L	Micrograms per Liter
SESOPP	Shaw Environmental Standard Operating Project Procedure
LHAAP	Longhorn Army Ammunition Plant

INTRODUCTION

Cherokee CRC, LLC (CCRC) is a contractor to the United States Army Corps of Engineers (USACE) Tulsa District under an Indefinite Deliverable/Indefinite Quantity (ID/IQ) Contract (W912BV-09-R-2022) and is assigned task orders to provide environmental services. CCRC was tasked under Task Order #7 to provide environmental services at the Longhorn Army Ammunition Plant (LHAAP), chemical laboratory, located in Karnack, Texas a site location map can be found in (**Appendix H**). Task Order #7 requires CCRC to install 3 monitoring wells (MW) 35BWW14, 35BWW11, and 35BWW09, and collect groundwater samples from five monitoring wells (MW) 35BWW14, 35BWW11, 35BWW09, 35BWW08, and 35BWW04.

SUMMARY

The CCRC team conducted a clearing operation to remove trees and vegetation around the well sites on 01/23/2012. Jones Tree Service was onsite at 0830 hours to clear an area around the well sites large enough for the drill rig to operate. All well sites were cleared by 1200 hours. Prior to commencement of work, the CCRC team performed a tailgate safety meeting (**Appendix A**) as stated in the Shaw Environmental project Health and Safety Plan (HASP) contained in the Shaw Environmental Final Installation-Wide Work Plan (Shaw2006).

Drilling operations began on 01/24/2012. Mohawk Drilling personnel Ryan Thompson and Alan Brantley were the drillers installing the MWs. Drilling began on MW 35BWW14 on 01/24/2012 at approximately 0905 hours and the well was completed on 01/26/2012 at approximately 0945 hours. Installation of MW 35BWW11 began on 01/24/2012 and was completed on 01/26/2012 at approximately 1110 hours. Installation of MW 35BWW09 began on 01/25/2012 and was completed on 01/26/2012 at approximately 1240 hours. During well installation John Freise of Cherokee CRC logged the borings and classified the cuttings according to the Unified Soil Classification System (USCS). CCRC followed the Shaw Environmental Standard Operating Project Procedure (SESOPP) for LHAAP for Well Installation. One exception from the Shaw procedure was implemented. The cure time for the bentonite pellets was changed to 1-hour in lieu of the 8-hour cure time called for in the SESOPP. This change was agreed upon by the USACE. The justification for this change was to accelerate the well installation process and the 1-hour cure time is standard operating procedure for Mohawk Drilling. The boring logs, well completion forms, and the Texas well reports are located in (**Appendix B)**. The field logbook entries are located in (**Appendix C**). The geographic positions of the new wells are as follows:

Well ID	Latitude: Decimal Degrees	Longitude: Decimal Degrees
35BWW09	32.67981810° N	94.14565970° W
35BWW11	32.67943120° N	94.14482640° W
35BWW14	32.68028130° N	94.14443340° W

Development of MW 35BWW09 began on 01/27/2012 by John Freise at approximately 0750 hours and the well was sufficiently developed by 1215 hours. Development of MW 35BWW14 began on 02/08/2012 by John Freise and Dwayne Beavers of Cherokee CRC at approximately 1305 hours and the well was sufficiently developed by 1444 hours. Development of MW 35BWW11 began on 02/08/2012 by John Freise and Dwayne Beavers

at approximately 1535 hours and the well was sufficiently developed by 1758 hours. The wells were developed following the SESOPP for LHAAP for Well Development. The well development field forms are located in (**Appendix D**). The field logbook entries are located in (**Appendix C**).

Sampling activities began on 02/09/2012 by John Freise and Dwayne Beavers. Prior to sampling, CCRC measured static water levels and purged each monitoring well utilizing a peristaltic pump and low flow sampling protocols until stabilization parameters were met according to SESOPP for LHAAP for groundwater sampling. Low flow purging began on MW 35BWW14 on 02/09/2012 at approximately 0822 hours. Stabilization criteria were met at 0851 hours and samples were collected at 0900 hours. Low flow purging began on MW 35BWW11 on 02/09/2012 at approximately 0930 hours. Stabilization criteria were met at approximately 1024 hours and samples were collected at 1027 hours. Low flow purging began on MW 35BWW09 on 02/09/2012 at approximately 1044 hours. Stabilization criteria were met at approximately 1120 hours and samples were collected at 1123 hours. A duplicate sample DUP-1 was collected at MW 35BWW09 at 1128 hours immediately following the collection of sample 35BWW09. Low flow purging began on MW35BWW04 on 02/09/2012 at approximately 1144 hours. Stabilization criteria were met at approximately 1221 hours and samples were collected at 1221 hours. Low flow purging began on MW 35BWW08 on 02/09/2012 at approximately 1229 hours. Stabilization criteria were met at approximately 1305 hours and samples were collected at 1308 hours.

All samples were labeled and placed into an ice chest containing wet ice. The Chain of Custody (COC) was filled out for all samples including the duplicate DUP-1, field blank FB1, and the trip blank TB1. Samples were shipped via Fed Ex next day air to the Test America laboratory in Denver, CO on 02/09/2012. The samples were received at the laboratory on 02/10/2012 at a temperature of 2.4° C. The chain of custody and field sampling forms can be found in (**Appendix E**).

The sample results were received by Cherokee CRC from Test America Laboratories on 02/22/2012. The following is a list of all detections from all samples analyzed by the laboratory:

LHAAP SITE 37 Summary of Detections

Sample ID	Analyte	Results	Units
TB1	Methylene Chloride	0.90	ug/L
FB1	Methylene Chloride	0.62	ug/L
35BWW14	1,1-Dichloroethane	2.8	ug/L
	1,1-Dichloroethene	29	ug/L
	Cis-1, 2-Dichloroethene	7.6	ug/L
	Methylene Chloride	1.5	ug/L
	Trans-1, 2-Dichloroethene	0.36	ug/L
	Tetrachloroethene	10	ug/L
	1,2-Dichloroethene, Total	7.9	ug/L
	Trichloroethene	63	ug/L
	Vinyl Chloride	2.6	ug/L

Sample ID	Analyte	Results	Units
35BWW11	Methylene Chloride	0.60	ug/L
	Tetrachloroethene	0.26	ug/L
35BWW09	1,1-Dichloroethene	0.30	ug/L
	Cis-1, 2-Dichloroethene	0.43	ug/L
	Methylene Chloride	1.2	ug/L
	1, 2-Dichloroethene, Total	0.43	ug/L
	Trichloroethene	68	ug/L
Dup-1 (35BWW09)	1,1-Dichloroethene	0.29	ug/L
	Cis-1, 2-Dichloroethene	0.38	ug/L
	Methylene Chloride	1.3	ug/L
	1, 2-Dichloroethene, Total	0.38	ug/L
	Trichloroethene	68	ug/L
35BWW04	1, 1 Dichloroethane	0.57	ug/L
	1, 1 Dichloroethene	1.7	ug/L
	Cis-1, 2-Dichloroethene	0.51	ug/L
	Methylene Chloride	0.62	ug/L
	Tetrachloroethene	17	ug/L
	1, 2-Dichloroethene, Total	0.51	ug/L
	Trichloroethene	5.9	ug/L
IDW-1	1, 1 Dichloroethane	0.90	ug/L
	1, 1 Dichloroethene	7.0	ug/L
	1,2,4-Trimethylbenzene	8.9	ug/L
	1,3,5-Trimethylbenzene	3.7	ug/L
	4-Isopropyltoluene	0.37	ug/L
	Chloroform	0.21	ug/L
	Cis-1, 2-Dichloroethene	2.6	ug/L
	Ethylebenzene	1.6	ug/L
	Isopropylbenzene	0.20	ug/L
	Methylene Chloride	0.56	ug/L
	m-Xylene & p-Xylene	7.2	ug/L
	Napthalene	3.7	ug/L
	n-Butylbenzene	0.32	ug/L
	N-Propylbenzene	0.46	ug/L
	o-Xylene	7.7	ug/L
	Tetrachloroethene	2.6	ug/L
	1, 2-Dichloroethene, Total	2.6	ug/L
	Trichloroethene	33	ug/L
	Vinyl Chloride	0.61	ug/L
	Flashpoint	>160	Degrees F
	pH	7.3	Standard Units
IDW-2	Methylene Chloride	0.95	ug/L
	Tetrachloroethene	2.1	ug/L
	Trichloroethene	0.63	ug/L
	Ignitability	NO	No Unit
	Percent Moisture	21	%

Sample ID	Analyte	Results	Units
IDW-2	pH-soluble	6.7	Standard Units
35BWW08	1, 1 Dichloroethene	0.22	ug/L
	Cis-1, 2-Dichloroethene		ug/L
	Methylene Chloride	0.58	ug/L
	1, 2-Dichloroethene, Total	0.30	ug/L
	Trichloroethene	37	ug/L

A copy of the detected results executive summary from Test America Laboratory can be found in (**Appendix F**).

Investigative Derived Wastes (IDW) which consisted of all soil removed from the borings during well installation, all groundwater removed during well development and sampling, and all water used for decontamination of the drilling augers and sampling and development equipment were placed into 55 gallon drums. The drums were sealed and labeled “Analysis Pending”. There were 17 drums of IDW generated during well installation, development, and sampling. A composite sample was taken from all the drums containing soil and another composite sample was taken from all the drums containing water. IDW-1 was the composite sample of the IDW water and sample IDW-2 was the composite sample of the IDW soil.

The IDW waste profile was completed and the waste was determined to be non-hazardous. The drums were removed from the site by Stericycle on 03/07/2012. A copy of the waste profiles and manifest can be found in (**Appendix G**).

References

Shaw Environmental, 2006, Final Installation-Wide Work Plan, Karnack Texas, Houston, Texas

APPENDIX A

Daily Safety Meeting Log

DAILY SAFETY TRAINING MEETINGS

Date of Training: 01-~~23~~-12

Crew: Jones Tree Service, CCRC Mohawk Drilling	**Craft(s):** Cleaning, Drilling, Env. Sci.

BRIEFLY DESCRIBE SPECIFIC TRAINING TOPICS COVERED

1. Safety Gear, Procedures
2. Health & Safety Plan, Emergency Preparedness,
3.

REMARKS

Total Employees on Crew(s): [redacted]	**Total in Attendance:**

SIGNATURE OF EMPLOYEES ATTENDING

Complete all sections fully and submit to the Project Supervisor or Safety Representative

Supervisor: John Freise	**Job Title:** Env. Scientist

DAILY SAFETY TRAINING MEETINGS

Date of Training: 1-24-12

Crew: CCRC, Mohawk Drilling | **Craft(s):** Drilling

BRIEFLY DESCRIBE SPECIFIC TRAINING TOPICS COVERED

1. PPE
2. Safety Plan
3. Emergency Procedures

REMARKS

Total Employees on Crew(s): | **Total in Attendance:** 6

SIGNATURE OF EMPLOYEES ATTENDING

Ryan Thompson

USACE

Complete all sections fully and submit to the Project Supervisor or Safety Representative

Supervisor: John Freire | **Job Title:** Env. Sc.

DAILY SAFETY TRAINING MEETINGS

Date of Training: 1/25/12

Crew: Mohawk Drilling, CCRC | **Craft(s):** Drilling

BRIEFLY DESCRIBE SPECIFIC TRAINING TOPICS COVERED

1. PPE
2. Safety Plan
3. Emergency Procedures

REMARKS

Total Employees on Crew(s): | **Total in Attendance:**

SIGNATURE OF EMPLOYEES ATTENDING

Roy Long USACE

Complete all sections fully and submit to the Project Supervisor or Safety Representative

Supervisor: John Freise CCRC | **Job Title:** Env Sci

DAILY SAFETY TRAINING MEETINGS

Date of Training: 11/26/12	
Crew: Mohawk / CCRC	**Craft(s):** Well Drilling

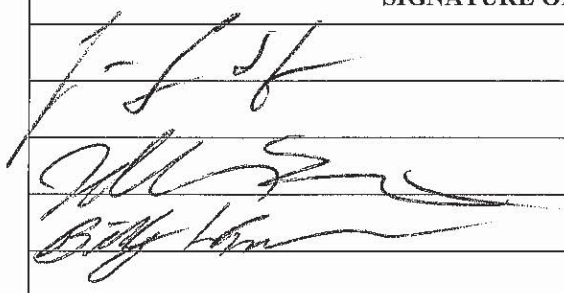
BRIEFLY DESCRIBE SPECIFIC TRAINING TOPICS COVERED

1. PPE
2. Safety Plan
3. Emergency Procedures

REMARKS

Total Employees on Crew(s): 3	**Total in Attendance:** 3

SIGNATURE OF EMPLOYEES ATTENDING



Complete all sections fully and submit to the Project Supervisor or Safety Representative

Supervisor: John Freise	**Job Title:** Env. Sci

APPENDIX B

Well and Boring Logs

Hole No. 35BMW14

DRILLING LOG	DIVISION	INSTALLATION	SHEET OF SHEETS
1. PROJECT CHAAP Site 37		10. SIZE AND TYPE OF BIT 6 5/8 HSA	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY McAnnie Drilling		12. MANUFACTURERS DESIGNATION OF DRILL CME 45C	
4. HOLE NO. (As shown on drawing title and title number)	35BMW14	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER Alan Bentley, Ryan Thom, Jason		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 1/24/12 COMPLETED 1/26/12	
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING	
9. TOTAL DEPTH OF HOLE 35'		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	5		SM, lt Br, WS, Slightly Plastic, Moist			
	10		SM, lt Br, WS not Plastic, dry			
	15		↓ SM, lt Br, w/trace Wfine sand, WS not Plastic, moist			
	20					X Encountered ground water at 19' bgs
	25		SM, lt Br, WS not plastic, moist			
	30		SM, lt Br, WS not plastic, Wet			
	35		Bottom of Bore hole 35' bgs complete @ 1007			

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — PROJECT — HOLE NO.

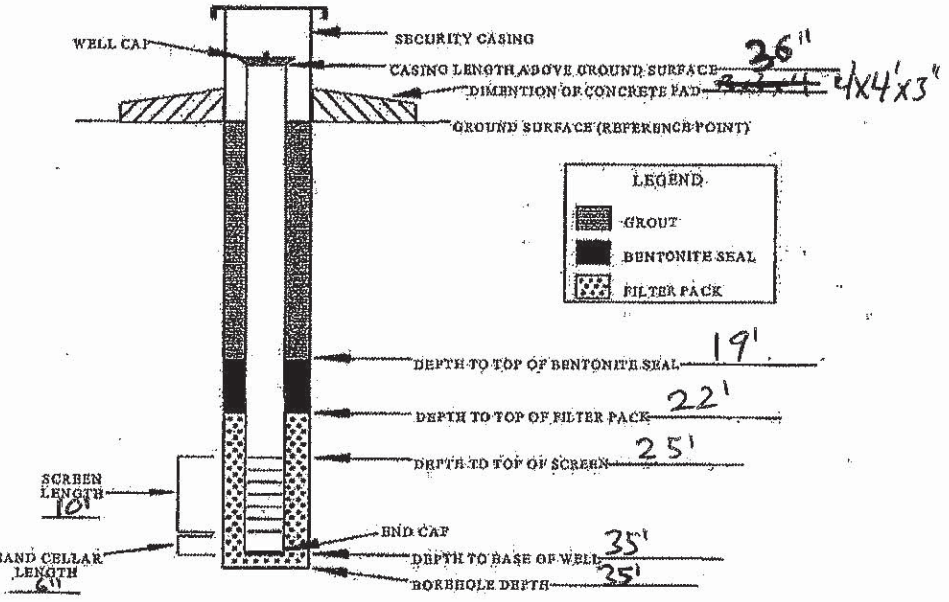
ATTACHMENT B

WELL COMPLETION FORM (Stickup or Above Grade Completion Well)

FIELD REPRESENTATIVE: John Freire
DRILLING CONTRACTOR: Mohawk Drilling
DRILLING TECHNIQUE: HSA
AUGER SIZE AND TYPE:
BOREHOLE IDENTIFICATION: 35BWW14
BOREHOLE DIAMETER: 11"
WELL IDENTIFICATION: 35BWW14
WELL CONSTRUCTION START DATE: 1/24/12
WELL CONSTRUCTION COMPLETE DATE:
SCREEN MATERIAL: Sch 40 PVC
SCREEN DIAMETER: 4"
STRATUM-SCREENED INTERVAL (FT): ~~0-10~~ 10'
CASING MATERIAL: Sch 40 PVC
CASING DIAMETER: 4"

TYPE OF FILTER PACK: 20-40 FilterSil Sand
GRADIATION:
AMOUNT OF FILTER PACK USED: 10 bags
TYPE OF BENTONITE: PDS Well Plug
AMOUNT BENTONITE USED: 3 bags
TYPE OF CEMENT: Portland Cement / BenSeal
AMOUNT CEMENT USED:
GROUT MATERIALS USED: Portland Cement
BenSeal Powdered Bentonite
DIMENSIONS OF SECURITY CASING: 8" diameter
TYPE OF WELL CAP: 4" J-Plug
TYPE OF END CAP: PVC Cone
COMMENTS:

SPECIAL CONDITIONS (describe and draw)



INSTALLED BY: Alan Bantley
INSTALLATION OBSERVED BY: John Freire, CRC
DISCREPANCIES:

Hole No. 35BWW11

DRILLING LOG	DIVISION	INSTALLATION	SHEET OF SHEETS

1. PROJECT: LHAAP Site 37
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: Mohawk Drilling
4. HOLE NO. (As shown on drawing title and title number): 35BWW11
5. NAME OF DRILLER: Alan Brantley, Ryan Thompson
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 35'
10. SIZE AND TYPE OF BIT: 11" OD 6 5/8" ID HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURERS DESIGNATION OF DRILL: CME 45C
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED: UNDISTURBED:
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 1/24/12 COMPLETED 1/26/12
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING:
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			ML, lt Br, WS, slightly plastic, moist			
	5		ML, Gr, Clay w/ lt Br fine Sand, WS, slightly plastic, moist			
	10		SC, lt Br, WS, Sandy Clay slightly plastic, moist			
	15		SC, lt Br, Fine Sand, WS not-plastic, moist			
	20		SC, lt Br, Clay & Sand WS, slightly plastic moist			* Encountered Ground water @ 23' bgs
	25		SC, lt Br, Clay Sand w/ Gr Clay mottled, WS moist			
	30		Bottom of borehole 35' bgs complete @ 1533			
	35					

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — PROJECT — HOLE NO.

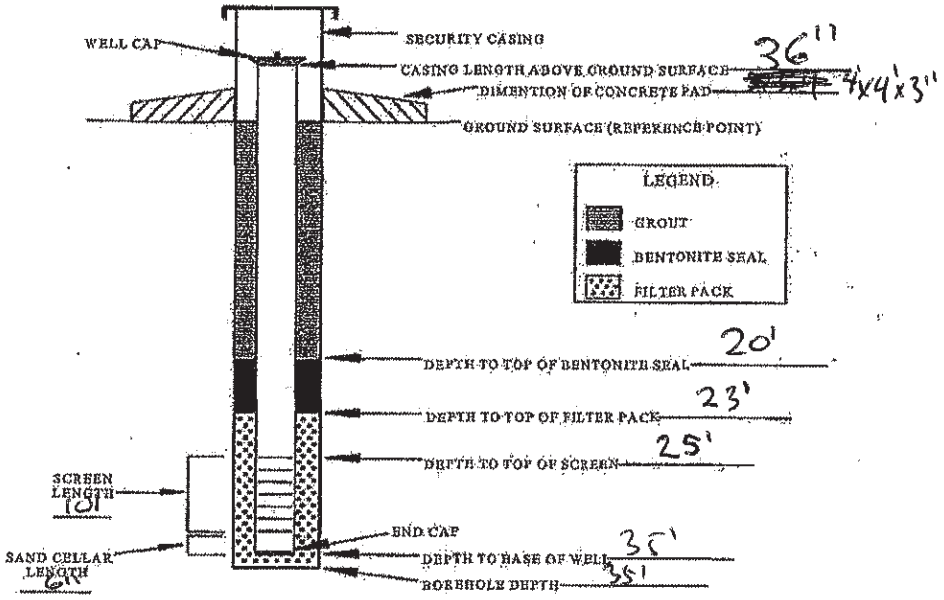
ATTACHMENT B

WELL COMPLETION FORM (Stickup or Above Grade Completion Well)

FIELD REPRESENTATIVE: John Freise CCRC
DRILLING CONTRACTOR: Mohawk Drilling
DRILLING TECHNIQUE: HSA
AUGER SIZE AND TYPE: 11" HSA Oilfield Auger
BOREHOLE IDENTIFICATION: 35 BMW 11
BOREHOLE DIAMETER: 11"
WELL IDENTIFICATION: 35 BMW 11
WELL CONSTRUCTION START DATE: 1/24/12
WELL CONSTRUCTION COMPLETE DATE: 1/26/12
SCREEN MATERIAL: Sch 40 PVC
SCREEN DIAMETER: 4"
STRATUM-SCREENED INTERVAL (FT): 10'
CASING MATERIAL: Sch 40 PVC
CASING DIAMETER: 4"

TYPE OF FILTER PACK: 20-40 Filter Sil Sand
GRADIATION:
AMOUNT OF FILTER PACK USED: 15 bags
TYPE OF BENTONITE: PDS Wellplug
AMOUNT BENTONITE USED: 3 bags
TYPE OF CEMENT: Portland Cement / BenSeal
AMOUNT CEMENT USED:
GROUT MATERIALS USED: Portland Cement BenSeal Powdered Bentonite
DIMENSIONS OF SECURITY CASING: 8"
TYPE OF WELL CAP: 4" J-Plug
TYPE OF END CAP: PVC cone
COMMENTS:

SPECIAL CONDITIONS (describe and draw)



NOT TO SCALE

INSTALLED BY: Alan Brantley
INSTALLATION OBSERVED BY: John Freise, CCRC
DISCREPANCIES:

Hole No. 35BWW09

DRILLING LOG	DIVISION	INSTALLATION	SHEET OF SHEETS

1. PROJECT: LHAAP- Site 37
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: Mohawk Drilling
4. HOLE NO. (As shown on drawing title and title number): 35BWW09
5. NAME OF DRILLER: Alan Brantley, Ryan Thompson
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE: 35'
10. SIZE AND TYPE OF BIT: 11" OD, 6 5/8" ID HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURERS DESIGNATION OF DRILL: CME 45C
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE STARTED: 1/25/12 COMPLETED: 1/26/12
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING:
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SC, lt Br, Sandy Clay, slightly plastic, WS, moist, some sl lt dk br			
	5		SC, lt Br, Hard Sandy Clay, not plastic, WS, dry, becoming less sandy			
	10		CL, dk Br, hard, PS, Silty clay, low plastic, dry			
	15		CL, lt Br, hard, WS low plastic, moist			
	20		becomes slightly plastic			
	25		SC, lt Br, Sandy Clay WS, low plastic, moist +			* Groundwater encountered @ 25' bgs
	30					
	35		bottom of boring @ 35' Complete @ 0932			

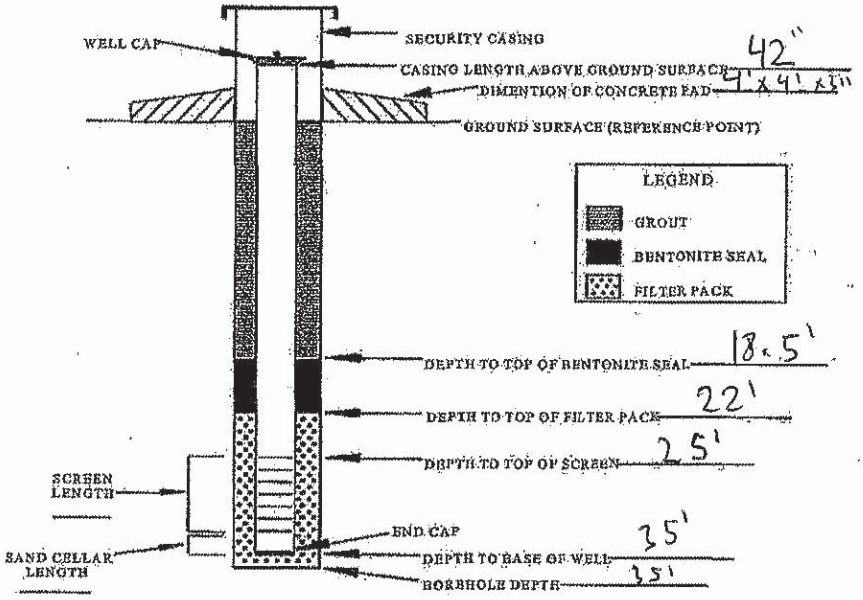
ATTACHMENT B

WELL COMPLETION FORM (Stickup or Above Grade Completion Well)

FIELD REPRESENTATIVE: John Freize
DRILLING CONTRACTOR: Mohawk Drilling
DRILLING TECHNIQUE: HSA
AUGER SIZE AND TYPE: 11" HSA
BOREHOLE IDENTIFICATION:
BOREHOLE DIAMETER: 11"
WELL IDENTIFICATION: 35NWW09
WELL CONSTRUCTION START DATE: 11/25/12
WELL CONSTRUCTION COMPLETE DATE: 11/26/12
SCREEN MATERIAL: Sch 40 PVC
SCREEN DIAMETER: 4"
STRATUM-SCREENED INTERVAL (FT): 10
CASING MATERIAL: Sch 40 PVC
CASING DIAMETER: 4"

TYPE OF FILTER PACK: Filter Sil Sand
GRADATION: 20-40
AMOUNT OF FILTER PACK USED: 15 bags
TYPE OF BENTONITE: PDS well plug
AMOUNT BENTONITE USED: 3 bags
TYPE OF CEMENT: Portland / Ben Seal
AMOUNT CEMENT USED:
GROUT MATERIALS USED: Portland Cement, Ben Seal powdered bentonite
DIMENSIONS OF SECURITY CASING: 8"
TYPE OF WELL CAP: 4" J-Plug
TYPE OF END CAP: PVC Cone
COMMENTS:

SPECIAL CONDITIONS (describe and draw)



NOT TO SCALE

INSTALLED BY: Alan Brantley INSTALLATION OBSERVED BY: John Freize, CCRL

DISCREPANCIES:

Attention Owner:
Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation

Water Well Driller/Pump Installer Section
P.O. Box 12157 Austin, Texas 78711 (512)463-7880 FAX (512)463-8616
Toll free (800)803-9202
Email address: water.well@license.state.tx.us Web address: www.license.state.tx.us

This form must be completed and filed with the department and owner within 60 days upon completion of the well.

WELL REPORT

A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER

Name:	Address:	City:	State:	Zip:
Corps of Engineers	1645 S. 101st E. Ave.	TULSA	OK	74128

2) WELL LOCATION

Well # or # of wells drilled	County:	Physical Address:	City:
35BWW09	Harrison	Former Army Ammo Plant	Karnack, TX.

Lat.	Long.	Grid #
32.6798181	94.1456597	

3) Type of Work
☒ New Well ☐ Reconditioning ☐ Replacement ☐ Deepening

4) Proposed Use (check) ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Extraction ☐ Frac ☐ Industrial ☐ Irrigation ☐ Injection ☐ Closed-Loop Geothermal ☐ De-watering ☐ Test well ☐ Rig Supply ☐ Stock ☐ Public Supply – If Public Supply, were plans approved? ☐ Yes ☐ No

5) N↑

6) Drilling Date
Started 01/25/12
Completed 01/26/12

Diameter of Hole

Dia.(in)	From (ft)	To (ft)
11"	Surface	35

7) Drilling Method (check)
☐ Driven ☐ Air Rotary ☐ Mud Rotary ☐ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☒ Hollow Stem Auger ☐ Reverse Circulation ☐ Other

From (ft)	To (ft)	Description and color of formation material
0	5	SC, light brown, sandy clay
5	10	SC, light brown, Hard Sandy clay
10	15	CL, dark brown, Hard tight Clay
15	20	CL, light brown, Hard
20	25	CL, light brown, clay
25	30	SC, light brown, Sandy Clay
30	35	SC, light brown, Sandy Clay

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion ☐ Open Hole ☐ Straight Wall ☐ Under-reamed ☒ Gravel Packed ☐ Other
Gravel packed interval from: 22 ft. to: 35 ft. Size: 20/40

Casing, Blank Pipe, and Well Screen Data

Dia. (in.)	New Or Used	Steel, Plastic, etc. Perf., Slotted, etc Screen Mfg., if commercial	Setting (ft) From	Setting (ft) To	Gage Casing	Gage Screen
4	new	PVC Riser	0	25	sch 40	
4	new	PVC 010 Screen	25	35		sch 40

9) Annular Seal Data: i.e. (from 0 ft to 100 ft #sacks & material 13 cement)
from 19 ft. to 22 ft. #sacks & material 3 - Bentonite
from 2 ft. to 19 ft. #sacks & material 6 - Portland
from ____ ft. to ____ ft. #sacks & material ____
Method Used Thru Augers Performed By Driller
Distance to septic field or other concentrated contamination ____ ft.
Distance to Property Line ____ ft
Method Verified: ____ Approved by Variance # ____

10) Surface Completion (If steel cased, leave blank)
☒ Surface Slab Installed ☐ Surface Sleeve Installed ☐ Pitless Adapter Used ☐ Alternative Procedure Used

11) Water Level
Static level ____ ft.below surface Date: __/__/__
Artesian Flow ____ gpm

12) Packers:

Type	Depth	Type	Depth

13) Plugged ☐ Well plugged within 48 hour
Casing left in well: ____ Cement/Bentonite placed in well: ____

From (ft)	To (ft)	From (ft)	To (ft)	# Sacks & Material Used

14) Type Pump
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

15) Water Test
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

16) Water Quality
Type of water ____ Depth of Strata: ____ Was a chemical analysis made? ☐ Yes ☐ No
Did you knowingly penetrate a strata which contains undesirable constituents? ☐ Yes ☐ No If yes, Continue:
Check One: ☐ Naturally poor-quality groundwater – type ____ ☐ Hydrocarbons (i.e. gas, oil, etc.)
☐ Hazardous material/waste contamination encountered ☐ Other (describe) ____

☐ *I certify that while drilling, deepening, or otherwise altering the above described well, undesirable water or constituents was encountered and the landowner was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.*

By signing this well report, I certify that I drilled or supervised the drilling of this well and that each and all of the statements herein are true and correct.

Company & Individual's Name: (type or print)		Lic. No.:
Mohawk Drilling, Inc.		54689
Address: 10010 E. 16th Street	**City:** Tulsa	**State:** OK **Zip** 74128
Signature:	2/16/12	**Signature:**
Licensed Driller/Pump Installer	Date	Apprentice	Apprentice Reg. Number

TDLR FORM 001WWD / 11-10 — TDLR (Original) — Landowner (copy) — Driller/Pump Installer (copy)

Attention Owner: Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation

Water Well Driller/Pump Installer Section
P.O. Box 12157 Austin, Texas 78711 (512)463-7880 FAX (512)463-8616
Toll free (800)803-9202
Email address: water.well@license.state.tx.us Web address: www.license.state.tx.us

This form must be completed and filed with the department and owner within 60 days upon completion of the well.

WELL REPORT

A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER

Name:	Address:	City:	State:	Zip:
Corps of Engineers	1645 S. 101st E. Ave.	TULSA	OK	74128

2) WELL LOCATION

Well # or # of wells drilled	County:	Physical Address:	City:
358WW11	Harrison	Former Longhorn Army Ammo Plt	Karnack TX.
	Lat. 32.6794312	Long. 94.1448264	Grid #

3) Type of Work
[X] New Well [ ] Reconditioning [ ] Replacement [ ] Deepening

4) Proposed Use (check) [X] Monitor [ ] Environmental Soil Boring [ ] Domestic [ ] Extraction [ ] Frac [ ] Industrial [ ] Irrigation [ ] Injection [ ] Closed-Loop Geothermal [ ] De-watering [ ] Test well [ ] Rig Supply [ ] Stock [ ] Public Supply – If Public Supply, were plans approved? [ ] Yes [ ] No

5) NT

6) Drilling Date
Started 01/24/12
Completed 01/26/12

Diameter of Hole

Dia.(in)	From (ft)	To (ft)
11"	Surface	35'

7) Drilling Method (check)
[ ] Driven [ ] Air Rotary [ ] Mud Rotary
[ ] Bored [ ] Air Hammer [ ] Cable Tool
[ ] Jetted [X] Hollow Stem Auger
[ ] Reverse Circulation
[ ] Other

From (ft)	To (ft)	Description and color of formation material
0	5	ML, light brown, clayey silt
5	10	ML, Gray Clay, w/ light brown sand
10	15	SC, light brown, Sandy Clay
15	20	SC, light brown, fine sand
20	25	SC, light brown, Clayey Sand
25	30	SC, light brown, Clayey Sand
30	35	SC, light brown, Clayey Sand w/ gray clay, mottled

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion [ ] Open Hole [ ] Straight Wall [ ] Under-reamed [X] Gravel Packed [ ] Other
Gravel packed interval from: 22 ft. to: 35 ft. Size: 20/40

Casing, Blank Pipe, and Well Screen Data

Dia. (in.)	New Or Used	Steel, Plastic, etc. Perf., Slotted, etc Screen Mfg., if commercial	Setting (ft) From	Setting (ft) To	Gage Casing Screen
4	new	PVC Riser	0	25	sch 40
4	new	PVC .010 Screen	25	35	sch 40

9) Annular Seal Data: i.e. (from 0 ft to 100 ft. #sacks & material 13 cement)
from 19 ft. to 22 ft. #sacks & material 3-Bentonite
from 2 ft. to 19 ft. #sacks & material 6-Portland
from ____ ft. to ____ ft. #sacks & material ____
Method Used Thru Augers Performed By Driller
Distance to septic field or other concentrated contamination ____ ft.
Distance to Property Line ____ ft
Method Verified: ____ Approved by Variance # ____

13) Plugged [ ] Well plugged within 48 hour
Casing left in well: Cement/Bentonite placed in well:

From (ft)	To (ft)	From (ft)	To (ft)	# Sacks & Material used

10) Surface Completion (If steel cased, leave blank)
[X] Surface Slab Installed [ ] Surface Sleeve Installed
[ ] Pitless Adapter Used [ ] Alternative Procedure Used

14) Type Pump
[ ] Turbine [ ] Jet [ ] Submersible [ ] Cylinder
[ ] Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

11) Water Level
Static level ____ ft. below surface Date: ___/___/___
Artesian Flow ____ gpm

12) Packers:

Type	Depth	Type	Depth

15) Water Test
Type test [ ] Pump [ ] Bailer [ ] Jetted [ ] Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

16) Water Quality
Type of water ____ Depth of Strata: ____ Was a chemical analysis made? [ ] Yes [ ] No
Did you knowingly penetrate a strata which contains undesirable constituents? [ ] Yes [ ] No If yes, Continue:
Check One: [ ] Naturally poor-quality groundwater – type ____ [ ] Hydrocarbons (i.e. gas, oil, etc.)
[ ] Hazardous material/waste contamination encountered [ ] Other (describe) ____

[ ] *I certify that while drilling, deepening, or otherwise altering the above described well, undesirable water or constituents was encountered and the landowner was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.*

By signing this well report, I certify that I drilled or supervised the drilling of this well and that each and all of the statements herein are true and correct.

Company & Individual's Name: (type or print)	Mohawk Drilling, INC.	Lic. No.:	54689M
Address: 10010 E. 16th Street	City: TULSA	State: OK	Zip 74128
Signature: Licensed Driller/Pump Installer	Date: 2/16/12	Signature: Apprentice	Apprentice Reg. Number:

TDLR FORM 001WWD / 11-10 TDLR (Original) Landowner (copy) Driller/Pump Installer (copy)

Attention Owner: Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation

Water Well Driller/Pump Installer Section
P.O. Box 12157 Austin, Texas 78711 (512)463-7880 FAX (512)463-8616
Toll free (800)803-9202
Email address: water.well@license.state.tx.us Web address: www.license.state.tx.us

This form must be completed and filed with the department and owner **within 60 days** upon completion of the well.

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A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER

Name:	Address:	City:	State:	Zip:
Corps of Engineers	1645 S. 101st E. Ave.	Tulsa	OK	74128

2) WELL LOCATION

Well # or # of wells drilled	County:	Physical Address:	City:
35 BWW 14	Harrison	Former Longhorn Army Ammo Plant	Karnack, TX.

Lat. 32.6802813 Long. 94.1444334 Grid #

3) Type of Work
☒ New Well ☐ Reconditioning ☐ Replacement ☐ Deepening

4) Proposed Use (check) ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Extraction ☐ Frac ☐ Industrial ☐ Irrigation ☐ Injection ☐ Closed-Loop Geothermal ☐ De-watering ☐ Test well ☐ Rig Supply ☐ Stock ☐ Public Supply – If Public Supply, were plans approved? ☐ Yes ☐ No

5) N↑

6) Drilling Date
Started 01 / 24 / 12
Completed 01 / 26 / 12

Diameter of Hole

Dia.(in)	From (ft)	To (ft)
11"	Surface	35'

7) Drilling Method (check)
☐ Driven ☐ Air Rotary ☐ Mud Rotary ☐ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☒ Hollow Stem Auger ☐ Reverse Circulation ☐ Other

From (ft)	To (ft)	Description and color of formation material
0	5	SM, light brown
5	10	SM, light brown
10	15	SM, light brown
15	20	SM, light brown w/ trace white sand
20	25	SM, light brown w/ trace fine white sand
25	30	SM, light brown
30	35	SM, light brown

(Use reverse side of Well Owner's copy, if necessary)

8) Borehole Completion ☐ Open Hole ☐ Straight Wall ☐ Under-reamed ☒ Gravel Packed ☐ Other
Gravel packed interval from: 22 ft. to: 35 ft. Size: 20/40

Casing, Blank Pipe, and Well Screen Data

Dia. (in.)	New Or Used	Steel, Plastic, etc. Perf., Slotted, etc Screen Mfg., if commercial	Setting (ft) From	Setting (ft) To	Gage Casing Screen
4	new	Plastic Riser	0	25	sch. 40
4	new	PVC .010 screen	25	35	sch. 40

9) Annular Seal Data: i.e. *(from 0 ft to 100 ft #sacks & material 13 cement)*
from 19 ft. to 22 ft. #sacks & material 3 - Bentonite
from 2 ft. to 19 ft. #sacks & material 6 - Portland
from ____ ft. to ____ ft. #sacks & material ____
Method Used Thru Augers Performed By Driller
Distance to septic field or other concentrated contamination ____ ft.
Distance to Property Line ____ ft
Method Verified: ____ Approved by Variance # ____

10) Surface Completion (If steel cased, leave blank)
☒ Surface Slab Installed ☐ Surface Sleeve Installed ☐ Pitless Adapter Used ☐ Alternative Procedure Used

11) Water Level
Static level ____ ft. below surface Date: ___/___/___
Artesian Flow ____ gpm

12) Packers:

Type	Depth	Type	Depth

13) Plugged ☐ Well plugged within 48 hour
Casing left in well:

From (ft)	To (ft)

Cement/Bentonite placed in well:

From (ft)	To (ft)	# Sacks & Material used

14) Type Pump
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other ____
Depth to pump bowls, cylinder, jet, etc., ____ ft.

15) Water Test
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

16) Water Quality
Type of water ____ Depth of Strata: ____ Was a chemical analysis made? ☐ Yes ☐ No
Did you knowingly penetrate a strata which contains undesirable constituents? ☐ Yes ☐ No If yes, Continue:
Check One: ☐ Naturally poor-quality groundwater – type ____ ☐ Hydrocarbons (i.e. gas, oil, etc.) ☐ Hazardous material/waste contamination encountered ☐ Other (describe) ____

☐ *I certify that while drilling, deepening, or otherwise altering the above described well, undesirable water or constituents was encountered and the landowner was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.*

By signing this well report, I certify that I drilled or supervised the drilling of this well and that each and all of the statements herein are true and correct.

Company & Individual's Name: (type or print)	Mohawk Drilling, Inc.	Lic. No.:	54689M
Address: 10010 E. 16th Street	City: Tulsa	State: OK	Zip 74128
Signature: Lee A. Brewster	2 / 16 / 12	Signature:	
Licensed Driller/Pump Installer	Date	Apprentice	Apprentice Reg. Number

TDLR FORM 001WWD / 11-10 TDLR (Original) Landowner (copy) Driller/Pump Installer (copy)

APPENDIX C

Field Notebook Entries

Wx Sunny, Clear 01/23/2012

LHAAP-37 Well Installation, Karnack, TX

* Dozer service Lytt Jones w/ Jone Tree service on site @ 0830 to clear well sites.
* CCRC personnel, John Freise, Env. Sci. went over safety guidelines and procedures.
- All well sites clear @ 1200 hrs. by Jones Tree Service

1/24/12 WX: Clear cool 48°F

0830 CCRC, ~~[illegible]~~ Mohawk Drilling
Mobilizing to well site 35PWW14

Materials for Well Construction
- x PDS Wellplug bentonite plug (50 lb)
- x Filtersil Quartz Filter Sand 20-40 (50 lb)
- x CME 45C track rig
- x 6 5/8 ID HS Augers 11" OD

*Portland Cement
*Ben Seal Bentonite Powder
} grout

Drillers Ryan Thompson (Mohawk)
Alan Brantley

Over hole @ 0905, Classify Cuttings
0-5 SM, lt Br, WS, slightly plastic, moist
5-10 SM, lt Br, WS, not plastic, dry
10-15 SM, lt Br, WS, not plastic, moist
15-20 SM, lt Brw trace white fine sands, WS, not plastic moist
20-25, SM, lt Br w/trace W fine sand, R mottled, WS, not plastic, moist
25-30 SM, lt Br, WS, not plastic, moist
30-35 SM, lt Br, WS, not plastic, wet
Bottom of Boring 35' bgs @ 1007, Installation of 10' 0.010 4" PVC screen and 4" PVC riser @ 1050, Installation of filter pack 10 bags to a depth of 22' bgs, @ 1150
Installation of bentonite holeplug 3 bags to a depth of 19' bgs, @ 1204

*Verified augers were decon'ed
*Ground water @ 28'
Filter Pack, Bentonite emplaced in through Augers
35PWW14

1/24/12
35BWW14 installation Cont:
Grout installation, 95% Portland Cement, 5% Ben-
Seal bentonite powder, grouting began @1625, grout
up to 3' bgs @1646

1/26/12 Surface completion of 35BWW14 started pouring
pad ~~3@ 3'x3'x4'~~ 4x4x3 and setting well protector 8" Steel Pipe and
~~Steel~~ bollards @0745 completed @0945
3" steel

1/24/12 LHAAP 37

Installation of well 35BWW11 over well @1430

drilling @ 1434, * Drillers hit object @ 4' bgs may be abandoned sewer line, Moving well location 4' NE of GPS coordinates over new location @1442, Drilling @1445

Classify Cuttings

0-5 ML lt Br, WS, ~~Medium~~ slightly plastic, moist

5-10 ML Gr Clay, w lt Br fine Sand, WS, slightly plastic, moist

10-15 SC lt Br, WS, Sandy Clay, Slightly plastic moist

15-20 SC lt Br, fine Sand, WS, Not-Plastic, moist

20-25 SC lt Br Clayey Sand, WS, ~~Medium~~ slightly X Plastic, moist

*23' GW

25-30 SC lt Br, Clayey Sand, WS, Slight plasticy, moist

30-35 SC lt Br, Clay Sand, w Gray Clay mottled, WS, moist+

Bottom of boring is 35', @ 1533

Well String 6" End Cap, 10' 4" PVC .010 screen, 30' 4" riser installed @ 1538, Filter pack ~~20~~ 15 bags, top of filter 23' bgs installed @ 1613, Bentonite Seal 3 bags, top of seal 20' bgs installed @ 1620, Grouting began @ 0845 on 1/25/12, 95% portland cement, 5% Ben Seal powdered bentonite, grout to 2' bgs @ 0915, Installation of surface completion, 4x4x3 concrete pad, 8" steel well protector, 4, 3" steel bollards began @ 1000 completed @ 1110 on 1/26/12

* Vertical Augers were decommed

1/25/12 Wx Cloudy and warm 58°F

Installation of 35BWW09 overwell @ 0720
began drilling @ 0746
Classify Cuttings @ 0747
0-5 SC, ltBr, Sandy Clay, slightly plastic, WS, moist, some silt dk Br
5-10 SC, ltBr, Hard Sandy Clay, not plastic, WS, dry, becoming less Sandy
10-15 CL, dk Br, Hard, PS, silty clay, low plastic dry
15-20 CL, ltBr, Hard, WS, low plastic, moist
20-25 CL, ltBr, WS, (sandy clay), slightly plastic, moist
25-30 ~~CL~~ SC, ltBr, WS, low plastic, moist+
30-35 SC, ltBr Sandy Clay, WS, low plastic, moist+
bottom of boring 35' bgs @ 0932
Installation of filter pack began @ 0954, Filter pack up to 22' bgs, 2 bags of sand. Completed @ 1040, Installation of Bentonite Seal started @ 1041, 3 bags to 18.5' bgs, completed @ 1046, Grout installation began @ 1430 w/ 75% portland cement - 5% KenSeal powdered bentonite, grout to 2' bgs, completed @ 1500, Surface completion of 4'x4'x3" concrete pad, 8" steel well protector, and 3" steel bollards x4 started on 1/26/12 @ 1115, completed @ 1240

* verified Augers were decon'd

GW @ 25' bgs

1/27/12 Partly cloudy Cool 34°F

Well Development 35 Burrough began @ 0750
TD 38.5 DTW 25.7, well volume = 2.32 gal @ 0802
removed 3 bailers of water for initial evaluation
Pumping from bottom of well to remove heavy sediments
@ 0810, pumped 3.5 gal from bottom of well
then surged the well with a Quater 4' surging
disc entire length of screen proceeding to remove
~~4 bailers~~ more sediment by pumping removed @ 0905
5 gallons, Measured water Quality parameters
see Well Development record, Surged the
well, and pumped out 8.5 gal., proceeded
to evaluate parameters @ 1005, surging the
well another cycle @ 1015, starting to pump to
evacuate sediment @ 1030, pumped 8.5 gal,
surged another cycle complete @ 1100, evacuating
sediment by pumping @ 1105, Evaluating
* water quality @ 1115, surging @ 1120, pumping
@ 1145 ~~[illegible]~~ SF to evaulate and remove sediment. Field
parameters stabilized @ 1145, Pumping 3
well volumes to confirm and finish developing
well. Well Developed @ 1215 total volume
pumped 68 gal.

2/8/12 1300

Well Development 35BWW14 @1305
TD 38.7 ft DTW ~~22.15~~ 22.15 ft Well Volume 10.75 gal
Removed 3 bailers of water for initial evaluation
Surged & Pumped 1 cycle pumped out 15 gal
@ 1330 and evaluated. Starting 2nd Surge
& pump cycle @ 1335 removed 16 gals (removed with gravity)
3rd Surge & pump begin 1355 removed 15 gals
evaluating water for stabilization @ 1410,
pumped a total of 63.5 gal.
stabilized @ 1444 on 2/8/12

2/8/12

Well Development

On well 25BWW11 @ 1535 for development TD 89.1 DTW 23.4 Well Volume 19.2 gal removed 3 bailers full for initial evaluation @ 1544 Proceeding to surge & pump started 1st cycle @ 1547 pumped 10 gals, evaluated water pumped 25 gals, Started 2nd Surge & pump cycle @ 1618, pumped 10 gals evaluated water @ 1640, Started 3rd Surge & pump cycle @ 1648, pumped 10 gal, *Readings stabilized @ 1640, Pumped 35 gals @ 1715 Turbidity began clearing @ 1735 and proceeded to stabilize @ 1758

Well Developed @ 1758

* Pumped 15 gals to evacuate sediment from bottom @ 1545

2/9/12

Sampling B5BMW14

Overwell @ 0820, began low flow sampling @ 0822,

DTW 22.25' TD 38.3, Flow rate 150mL/min

Temp	Time	DTW	PH	SPCond	ORP	DO	Turb
10.23	0829	22.25	6.79	0.541	168	3.06	131
11.08	0831	22.25	7.03	0.528	151	3.04	127
11.34	0834	22.23	6.80	0.502	167	2.96	121
11.75	0837	22.25	7.12	0.569	157	2.92	107
11.77	0840	22.25	7.29	0.524	175	2.76	102
12.03	0843	22.25	7.40	0.573	157	2.71	96
12.11	0846	22.21	7.45	0.594	159	2.63	91
12.23	0849	22.24	7.40	0.584	163	2.71	89
12.28	0851	22.24	7.43	0.579	173	2.52	87
	0854						
	0857						

Sampled @ 0900

Total purged 1.8 gal.

Final DTW 22.25'

2/9/12

Final Depth 23.75

Sampling Well 35BMW11, one well volume

0920, low flow pumping started, 0930

DTW 23.50 TD 39.1 Initial Flow Rate 130 mL/min

*decreased Flow Rate to 80 mL/min

Sampled @ 1027 purged 0.6 gal

°F °C Temp	Time	DTW	pH	mS/cm Cond	ORP	DO	Turb
13.38	0934	23.64	6.28	1.13	35	3.25	283
12.73	0937	23.68	6.32	1.21	33	2.11	>1000
11.64	0940	23.70	6.31	1.29	24	1.24	>1000
12.54	0943	23.72	6.31	1.27	22	1.52	231
11.82	0946	23.75	6.37	1.20	21	2.36	275
12.00	0949	23.80*	6.55	0.971	21	2.92	290
12.23	0951	23.78	6.53	0.875	22	3.46	262
12.13	0954	23.78	6.56	0.752	22	3.33	260
12.17	0957	23.78	6.59	0.674	22	3.67	245
12.05	1000	23.78	6.59	0.641	24	3.58	243
12.22	1003	23.78	6.59	0.625	26	3.62	239
12.36	1006	23.78	6.54	0.600	35	3.87	270
12.25	1009	23.78	6.61	0.584	39	4.47	>1000
11.54	1012	23.78	6.91	0.381	25	7.57	>1000
11.41	1015	23.78	6.77	0.579	39	5.77	>1000
11.23	1018	23.75	6.70	0.573	41	5.63	>1000
11.16	1021	23.75	6.72	0.570	43	5.45	>1000
11.15	1024	23.75	6.70	0.569	43	5.65	>1000

2/9/12

Sampling 35BMW09, Dry well @ 1040

Low Flow pumping @ 1044,

DTW 25.5 TD 38.5 Flow Rate 120 ml/min

Sampled @ [redacted]SC 1128 Volume purged 1.0 gal

Dup-1 collected @ 1128 from 35BMW09

time	DTW	Temp	pH	SCond	ORP	DO	Turb
1050	25.70	10.33	6.89	1.48	104	1.60	66.0
1053	25.68	10.82	6.94	1.47	93	1.54	56.4
1056	25.65	11.55	6.96	1.47	84	1.34	47.4
1059	25.65	12.02	6.97	1.47	79	1.15	34.1
1102	25.65	12.41	6.98	1.46	76	1.12	27.0
1105	25.65	12.49	6.99	1.46	73	1.08	19.3
1108	25.65	12.66	6.99	1.45	70	1.04	17.5
1111	25.65	12.97	6.99	1.46	65	0.93	7.1
1114	25.65	13.01	6.99	1.45	62	0.91	6.0
1117	25.65	13.07	6.99	1.44	60	0.90	5.7
1120	25.65	13.05	6.99	1.42	60	0.89	5.9

2/9/12

Sampling B5BMW04, overwell @ 1140 ;
low-flow pumping @ 1144, Flow Rate 130 mL/min
DTW 22.85 TD 35.8
Sample time 1225 Volume purged .5 gal

* slowed flow rate to 80 mL/min @ 1157

Time	DTW	Temp °C	pH	SCond	ORP	DO	Turb
1151	23.04	15.18	6.87	0.347	133	5.13	77.3
1154	23.09	15.57	6.81	0.349	130	7.14	70.0
1157	23.10*	15.48	6.82	0.351	130	7.46	62.2
1200	23.10	15.57	6.82	0.350	130	6.99	52.2
1203	23.10	15.50	6.81	0.349	129	6.98	55.6
1206	23.10	15.48	6.82	0.351	129	6.97	45.9
1209	23.10	15.43	6.81	0.349	130	6.90	45.8
1212	23.10	15.41	6.81	0.348	131	6.93	42.4
1215	23.10	15.40	6.81	0.349	131	6.92	41.2
1218	23.10	15.39	6.81	0.348	130	6.99	41.5
1221	23.10	15.39	6.81	0.350	130	6.97	41.4

2/9/12

Sampling 35 Burrough, overwell @ 1225
low flow pumping @ 1229, Flow Rate 160 mL/min
DTW 24.50 TD 34.6
Sampled @ 1308

Total Volume purged 0.75 gal

time	DTW	Temp C	pH	Scond	ORP	DO	Turb
1238	24.50	14.86	7.58	0.819	168	2.94	0.0
1241	24.55	15.08	6.71	0.818	215	2.38	0.0
1244	24.50	15.18	6.75	0.808	229	2.29	0.0
1247	24.50	15.30	6.73	0.811	232	2.08	0.0
1250	24.50	15.45	6.75	0.810	247	1.77	0.0
1253	24.50	15.52	6.73	0.838	234	1.61	0.0
1256	24.50	15.55	6.79	0.811	246	1.35	0.0
1259	24.50	15.74	6.70	0.838	253	1.35	0.0
1302	24.50	15.81	6.70	0.829	253	1.31	0.0
1305	24.50	16.10	6.70	0.837	251	1.30	0.0

Samples Shipped Fed EX
on 2/9/12 @
Tracking # 8757 0826 0722

APPENDIX D

Well Development Forms

Figure 1

WELL DEVELOPMENT RECORD

WELL/PIEZOMETER ID 35BWW09
SHEET 1 OF 1

PROJECT NAME: LHAAP PROJECT NO.: DATE: 1/27/12

LOCATION: Karnack, TX DATE INSTALLED: 1/26/12

TOTAL DEPTH (FTOC) 38.5' CASING DIAMETER 4"

METHODS OF DEVELOPMENT

☐ Swabbing ☐ Bailing ☐ Pumping ☒ Surge & Pump

Describe

Equipment decontaminated prior to development ☐ Yes ☐ No

Describe Alconox rinse then 2X De-Ionized H_2O rinse

EQUIPMENT NUMBERS Horiba U-52 multi-meter

pH Meter EC Meter Turbidity Meter Thermometer

CASING VOLUME INFORMATION:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION

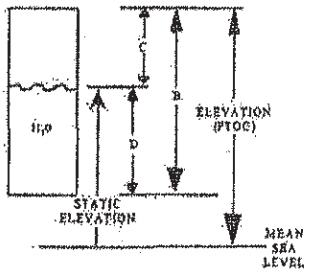
Measured Well Depth B 38.5 ft.

Measured Water Level Depth (C) 25.7 ft.

Length of Static Water Column (D) 38.5 (B) − 25.7 (C) = 12.8

Casing Water Volume (E) 0.65 (A) × 12.8 (D) = 8.32

Total Purge Volume = 8.32 gal



Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC	Temperature F or C	Turbidity/ Sand (ppm)	Comments
1/27	0802	25.7	1 bailer	6.69	1.39	16.61	Overrange	Very Dirty Sandy
1/27	0915	26.8	8.5	7.12	1.17	15.73	Overrange	>1000 NTU
1/27	1005	26.3	8.5	7.08	1.13	17.76	Overrange	>1000 NTU
1/27	1045	26.05	8.5	7.12	1.11	17.52	Overrange	>1000 NTU
1/27	1115	26.05	8.5	7.13	1.10	17.75	Overrange	>1000 NTU
1/27	1145	26.00	8.5	7.11	1.12	17.48	Overrange	>1000 NTU
1/27	1200	26.80	8.5	7.17	1.14	17.47	Overrange	>1000 NTU
1/27	1215	27.52	17	7.16	1.12	17.44	1000 NTU	

Sample 1-2

Figure 1

WELL DEVELOPMENT RECORD

WELL/PIEZOMETER ID 35Bmw11
SHEET _____ OF _____

PROJECT NAME: LHAAP PROJECT NO.: _____ DATE: 2/8/12

LOCATION: 35Bmw11 DATE INSTALLED: 01/26/12

TOTAL DEPTH (FTOC) 39.1 CASING DIAMETER 4"

METHODS OF DEVELOPMENT

Describe Pump & Surge ☐ Swabbing ☐ Bailing ☐ Pumping ☒

Equipment decontaminated prior to development ☒ Yes ☐ No

Describe Wash in Alconox then double rinse in DI water

EQUIPMENT NUMBERS U-52

pH Meter _____ EC Meter _____ Turbidity Meter _____ Thermometer _____

CASING VOLUME INFORMATION:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION

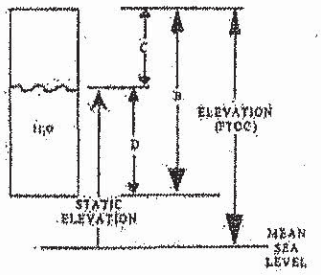
Measured Well Depth B 39.1 ft.

Measured Water Level Depth (C) 23.4 ft.

Length of Static Water Column (D) 39.1 − 23.4 = 15.7

Casing Water Volume (E) 0.65 (A) × 15.7 (D) = 10.2

Total Purge Volume = ~~5~~ 10.2 gal



Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC	Temperature (F or C)	Turbidity/ Sand (ppm)	Comments
2/8	1544	23.4	3 bailers	6.21	1.26	18.53	71000	Cloudy, full of sediment
2/8	1602	29.33	10 gal	6.48	1.13	18.03	71000	Cloudy full of sediment
2/8	1613	29.54	2.5	6.42	1.08	19.52	71000	" " "
2/8	1630	30.10	5	6.40	1.11	18.54	71000	" " "
2/8	1640	31.2	5	6.49	1.09	19.51	71000	" " "
2/8	1653	29.0	2.5	6.47	1.10	19.00	71000	" " "
2/8	1705	29.45	7.5	6.42	1.14	19.36	71000	clearing a little
2/8	1718	29.80	8	6.43	1.11	19.30	71000	" "
2/8	1735	30.3	1	6.49	1.09	19.65	536	clearing
2/8	1743	31.1	1	6.49	1.01	19.01	460	clearing
2/8	1748	31.4	1	6.48	1.16	19.16	428	clearing
2/8	1753	31.8	1	6.47	1.12	19.23	416	clearing
2/8	1758	32.3	1	6.48	1.17	19.17	420	clearing

Stabilized

Stabilized readings

Figure 1

WELL DEVELOPMENT RECORD

WELL/PIEZOMETER ID _____
SHEET _____ OF _____

PROJECT NAME: LHAAP PROJECT NO.: _____ DATE: 2/8/12

LOCATION: 35 BUW 14 DATE INSTALLED: 1/26/12

TOTAL DEPTH (FTOC) 38.7 CASING DIAMETER 4"

METHODS OF DEVELOPMENT

Describe Pump & Surge ☐ Swabbing ☐ Bailing ☐ Pumping ☑

Equipment decontaminated prior to development ☐ Yes ☐ No

Describe Alcono + wash and double rinse in DI water

EQUIPMENT NUMBERS Horiba U52

pH Meter _____ EC Meter _____ Turbidity Meter _____ Thermometer _____

CASING VOLUME INFORMATION:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION

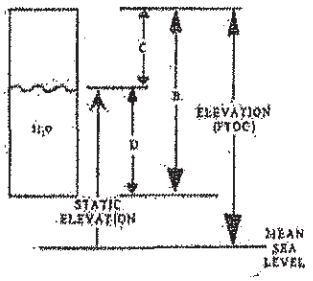
Measured Well Depth B 38.7 ft.

Measured Water Level Depth (C) 22.15 ft.

Length of Static Water Column (D) 38.7 (B) − 22.15 (C) = 16.55

Casing Water Volume (E) 0.65 (A) × 16.55 (D) = _____

Total Purge Volume = 10.75 gal



Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC	Temperature F or C	Turbidity/ Sand (ppm)	Comments
2/8	1305	22.15	5 buckets	7.75	0.944	16.79	>1000	full of sediment
2/8	1330	25.25	15 gal	7.44	0.795	17.38	>1000	full of sediment
2/8	1353	25.00	11 gal	7.10	0.729	18.09	>1000	full of sediment
2/8	1358	25.40	5 gal	7.05	0.686	18.30	>1000	full of sediment
2/8	1410	24.85	5 gal	6.86	0.748	18.03	>1000	starting to clear
2/8	1420	25.64	10 gal	6.86	0.530	18.14	>1000	cloudy
2/8	1427	25.88	5 gal	6.81	0.545	18.25	271	clearing
2/8	1433	26.08	5 gal	6.83	0.515	18.21	255	clearing
2/8	1438	25.14	5 gal	6.85	0.565	18.17	250	clearing
2/8	1444	~~26~~ 26.40	2.5 gal	6.83	0.548	18.01	245	clearing

5 followed

APPENDIX E

Chain of Custody and Field Forms

Chain of Custody Record

Sampler ID _____

Temperature on Receipt 2.4 IR.1 2/10

Drinking Water? Yes ☐ No ☒

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TAL-4124-280 (0508)

Client	Project Manager	Date	Chain of Custody Number
CCRC	Dwayne Beavers	2/9/11	150041
Address	**Telephone Number (Area Code)/Fax Number**	**Lab Number**	**Page 1 of 1**
10838 E Marshall St Suite 220	(918) 431 2912 (918) 583 7948	Lisa Worrell	
City / **State** / **Zip Code**	**Site Contact**	**Lab Contact**	
Tulsa / OK / 74116	Dwayne	303-736-0100	
Project Name and Location (State)	**Carrier/Waybill Number**		
Longhorn Ammunition Plant (LHAAP)	Federal Express		
Contract/Purchase Order/Quote No.			

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	Analysis: VOA	pH	cyanide	Flash Pt.	Sulfide	TCLP Lead	Special Instructions/ Conditions of Receipt
TB1	2/9/12	—		X									X						
FB1	2/9/12	0745		X									X						
35BWW14	2/9/12	0900		X									X						
35BWW11	2/9/12	1027		X									X						
35BWW09	2/9/12	1123		X									X						
DUP-1	2/9/12	1128		X									X						
35BWW04	2/9/12	1221		X									X						
IDW-1	2/9/12	1320		X							X		X	X	X	X	X		
IDW-2	2/9/12	1100				X							X	X	X	X	X	X	
35BWW08	2/9/12	1308		X									X						

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☒ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☒ Disposal By Lab ☒ Archive For 1 Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☒ 21 Days ☒ Other Standard

QC Requirements (Specify)

1. Relinquished By	Date	Time	1. Received By	Date	Time
D L Beaver	2/9/11	1420		2/10/12	0900
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Figure 1

Water Level Measurement/Groundwater Sampling Log Form

Well No. 35BWW11 Date 2/9/12
Sample ID No. 35BWW11
Project ID LHAAP Measured/Sampled By: John Freise
Time: Start 0920 End: 1027

Measuring Point Elevation: Ft. Well Construction Material: 4" PVC
Well Depth Ft: 1) 39.1' 2) 3) 4)
Avg. (of valid measurements*)

Water Depth Ft: 1) 23.50' 2) 3) 4)
Avg. (of valid measurements*)
(*Minimum of three measurements, last two within 0.01 feet.)

Well Internal Diameter: 4 in
Riser Above/Below Pad Elevation Marker: Ft.

Pad Elevation: Ft.
Sampling Equipment Used:
Horiba U52, Cole-Parmer Peristaltic Pump, Teflon tubing

Equipment Numbers: U52 # BJ2C3AVR
pH Meter EC Meter Turbidity Meter Thermometer

Casing Volume Information:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

Purging Information:
Measured Well Depth (B): 39.1 Ft.
Measured Water Level Depth (C): 23.5 Ft.
Length of Static Water Column (D): 39.1 (B) - 23.5 (C) = 15.6 ft.
Casing Water Volume (E): 0.65 (A) x 15.6 (D) = 10.14 gal.
Total Purge Volume = 0.6 (gal) (minimum of three casing volumes)

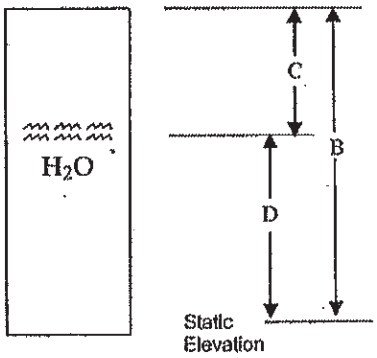


Figure 1 (*continued*)

Water Level Measurement/Groundwater Sampling Log Form (Continued)

Field Indicator Parameter Measurements During Purging:

pH	6.77	6.70	6.72	6.70	
Temp.°C	~~PB~~ 11.41	11.23	11.16	11.15	
Specific Conductance: ~~µmhos~~ mS/cm		0.579	0.573	0.570	0.569
Turbidity: NTU		>1000	>1000	>1000	>1000
Visual Appearance of Water:		Cloudy	Cloudy	Cloudy	Cloudy

Comments:

Field Indicator Parameter Measurements After Sampling:

pH	6.71			
Temp.°C	11.28			
Specific Conductance: ~~µmhos~~ mS/cm	0.571			
Turbidity: NTU	>1000			
Visual Appearance of Water:	Cloudy			

Comments:

Laboratory Analysis Requested:

Sample ID No.	Parameter	Method	Preservation	Duplicate	No. of Containers
35BWW11	VOC	8260B	HCl	N	3

These standard project procedures are applicable to all members of Shaw Environmental, Inc.

Figure 2

Shaw Environmental & Infrastructure, Inc.	WATER SAMPLE FIELD COLLECTION REPORT	Project Number: _____ Project Name: _____ Site Location: LHAAP

Sample ID Number	35BWW11	Date Collected	2/9/12
Sample Location[7]	35BWW11	Time Collected	1027
Diameter of Well	4 (in.)	Sampler	I.D. # SF
Depth to Bottom of Well	39.1 (ft.)	Casing Stick Up	4.1'
Static Water Level	23.50 (ft.)	Measured From[1]	TOC (ft.)
Well Volumes Purged		Purging Method[2]	Pumped
Type of Sample[3]	Well	Sampling Method[4]	Low-flow Pumping
Depth of Sample	34. (ft.)	Measured From[1]	TOC
Sample Collection Order			

FIELD SCREENING AND TEST RESULTS

Water Temperature 11.15 °C pH 6.70 Units

Specific Conductance 0.569 ~~umho~~ mS/cm at 11.15 °C

OVA ☐ HNU PID ☐ Reading _____ PPM

Photovac GC (P/GC) Probable Compound _____ Reading _____ PPM

METER CALIBRATION

pH STD	METER READING	SP. COND. STD	METER READING	_____/STD (8)	METER READING

SAMPLE TYPES COLLECTED

CONTAINER #	TYPE (5)	CONTAINER TYPE	VOLUME	FILTERED	
	VOA	P☐ G☒	40 mL	Y☐ N☒	Y☐ N☐
		P☐ G☐		Y☐ N☐	Y☐ N☐
		P☐ G☐		Y☐ N☐	Y☐ N☐
		P☐ G☐		Y☐ N☐	Y☐ N☐
		P☐ G☐		Y☐ N☐	Y☐ N☐

WEATHER CONDITIONS: TEMP. 50 °F CLEAR☒ CLOUDY☐ RAIN☐ SNOW☐ WINDY☐

(1) T.O.C. = Top of Protective Casing; T.O.W. = Top of Well Casing; G.S. = Ground Surface
(2) Bailed, Pumped, Air Lift, Etc.
(3) Stream, Pond, Spring, Well, Seep, Supply, Etc.
(4) Bailer, Kemmerer, Grab, Pump, Etc.
(5) General Chem., Metal, VOA, Organics, Etc.
(6) HNO^3, NaOH, H^2SO^4, $Na^2O^3S^2$, Etc.
(7) If Well, give Well I.D. Number.
(8) OVA, PID, P/GC or Other.

Figure 1

Water Level Measurement/Groundwater Sampling Log Form

Well No. 35BWW09 Date 2/9/12
Sample ID No. 35BWW09
Project ID LHAAP Measured/Sampled By: John Freise
Time: Start 1040 End: 1128

Measuring Point Elevation: Ft. Well Construction Material: 4" PVC
Well Depth Ft: 1) 38.5 2) 3) 4)
Avg. (of valid measurements*)

Water Depth Ft: 1) 25.5 2) 3) 4)
Avg. (of valid measurements*)
(*Minimum of three measurements, last two within 0.01 feet.)

Well Internal Diameter: 4 ~~Ft~~ In.
Riser Above/Below Pad Elevation Marker: Ft.

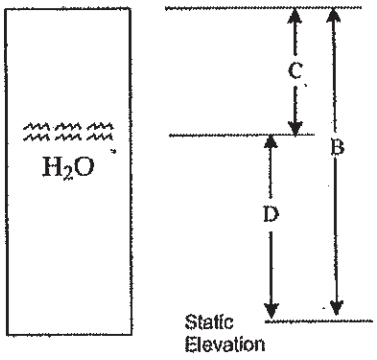
Pad Elevation: Ft.
Sampling Equipment Used:
Horiba U-52, Cole-Parmer Peristaltic Pump, Teflon Tubing

Equipment Numbers: U-52 HBJ2C3AVR
pH Meter _____ EC Meter _____ Turbidity Meter _____ Thermometer _____

Casing Volume Information:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

Purging Information:
Measured Well Depth (B): 38.5 Ft.
Measured Water Level Depth (C): 25.5 Ft.
Length of Static Water Column (D) 38.5 : (B) − 25.5 (C) = 13 ft.
Casing Water Volume (E): 0.65 (A) x 13 (D) = 8.45 gal.
Total Purge Volume = 1.0 (gal) (minimum of three casing volumes)



These standard project procedures are applicable to all members of Shaw Environmental, Inc.

Figure 1 (*continued*)

Water Level Measurement/Groundwater Sampling Log Form (Continued)

Field Indicator Parameter Measurements During Purging:

pH	6.99	6.99	6.99	6.99	
Temp.°C	12.97	13.01	13.09	13.05	
Specific Conductance: ~~µmhos~~ mS/cm		1.46	1.45	1.44	1.42
Turbidity: NTU		7.1	6.0	5.7	5.9
Visual Appearance of Water:		Clear	Clear	Clear	Clear

Comments:

Field Indicator Parameter Measurements After Sampling:

pH	6.99			
Temp.°C	13.01			
Specific Conductance: ~~µmhos~~ mS/cm	1.44			
Turbidity: NTU	5.5			
Visual Appearance of Water:	Clear			

Comments:

Laboratory Analysis Requested:

Sample ID No.	Parameter	Method	Preservation	Duplicate	No. of Containers
35BWW09	VOC	8260B	HCl	Y	6*

*3 for Sample
3 for Dup

These standard project procedures are applicable to all members of Shaw Environmental, Inc.

Figure 2

Shaw Environmental & Infrastructure, Inc.	WATER SAMPLE FIELD COLLECTION REPORT	Project Number: _____ Project Name: _____ Site Location: LHAAP

Sample ID Number	35BWW09	Date Collected	2/9/12
Sample Location[7]	35BWW09	Time Collected	1123 | 1128
Diameter of Well	4 (in.)	Sampler	I.D. # JF
Depth to Bottom of Well	38.5 (ft.)	Casing Stick Up	3
Static Water Level	25.5 (ft.)	Measured From[1]	TOC (ft.)
Well Volumes Purged		Purging Method[2]	Pump
Type of Sample[3]		Sampling Method[4]	Low Flow Pumping
Depth of Sample	33 (ft.)	Measured From[1]	TOC
Sample Collection Order			

FIELD SCREENING AND TEST RESULTS

Water Temperature 13.05 °C pH 6.99 Units

Specific Conductance 1.42 ~~umhos~~ mS/cm at 13.05 °C

OVA ☐ HNU PID ☐ Reading _____ PPM

Photovac GC (P/GC) Probable Compound _____ Reading _____ PPM

METER CALIBRATION

pH STD	METER READING	SP. COND. STD	METER READING	_____/STD (8)	METER READING

SAMPLE TYPES COLLECTED

CONTAINER #	TYPE (5)	CONTAINER TYPE	VOLUME	FILTERED			
	VOA	P ☐ G ☒	40 mL	Y ☐ N ☒	Y		N ☐
Dup-1	VOA	P ☐ G ☐	40 mL	Y ☐ N ☐	Y		N ☐
		P ☐ G ☐		Y ☐ N ☐	Y		N ☐
		P ☐ G ☐		Y ☐ N ☐	Y		N ☐

WEATHER CONDITIONS: TEMP. 50 °F CLEAR ☒ CLOUDY ☐ RAIN ☐ SNOW ☐ WINDY ☐

(1) T.O.C. = Top of Protective Casing; T.O.W. = Top of Well Casing; G.S. = Ground Surface
(2) Bailed, Pumped, Air Lift, Etc.
(3) Stream, Pond, Spring, Well, Seep, Supply, Etc.
(4) Bailer, Kemmerer, Grab, Pump, Etc.
(5) General Chem., Metal, VOA, Organics, Etc.
(6) HNO^3, NaOH, H^2SO^4, $Na^2O^3S^2$, Etc.
(7) If Well, give Well I.D. Number.
(8) OVA, PID, P/GC or Other.

Figure 1

Water Level Measurement/Groundwater Sampling Log Form

Well No. 35BWW08 Date 2/9/12
Sample ID No. 35BWW08
Project ID LHAAP Measured/Sampled By: John Freise
Time: Start 1225 End: 1308

Measuring Point Elevation: Ft. Well Construction Material: 2" PVC
Well Depth Ft: 1) 34.6 2) 3) 4)
Avg. (of valid measurements*)

Water Depth Ft: 1) 24.5 2) 3) 4)
Avg. (of valid measurements*)
(*Minimum of three measurements, last two within 0.01 feet.)

Well Internal Diameter: 2 ~~Ft~~ In
Riser Above/Below Pad Elevation Marker: Ft.

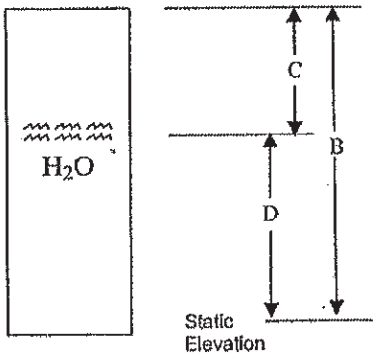
Pad Elevation: Ft.
Sampling Equipment Used:
Horiba U-52 Multi-Meter, Cole-Parmer Peristaltic Pump, Teflon tubing

Equipment Numbers: U-52 #BJ2C3AVR
pH Meter EC Meter Turbidity Meter Thermometer

Casing Volume Information:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

Purging Information:
Measured Well Depth (B): 34.6 Ft.
Measured Water Level Depth (C): 24.5 Ft.
Length of Static Water Column (D) 34.6 : (B) 24.5 - (C) = 10.1 ft.
Casing Water Volume (E): 0.16 (A) x 10.1 (D) = 1.6 gal.
Total Purge Volume = 0.75 (gal) (minimum of three casing volumes)



These standard project procedures are applicable to all members of Shaw Environmental, Inc.

Figure 1 (*continued*)

Water Level Measurement/Groundwater Sampling Log Form (Continued)

Field Indicator Parameter Measurements During Purging:					
pH	6.79	6.70	6.70	6.70	
Temp.°C	15.55	15.74	15.81	16.10	
Specific Conductance: ~~µmhos~~ mS/cm		0.811	0.838	0.839	0.837
Turbidity: NTU		0	0	0	0
Visual Appearance of Water:		clear	clear	clear	clear

Comments:

Field Indicator Parameter Measurements After Sampling:				
pH	6.70			
Temp.°C	16.11			
Specific Conductance: µmhos/cm	0.830			
Turbidity: NTU	0			
Visual Appearance of Water:	Clear			

Comments:

Laboratory Analysis Requested:

Sample ID No.	Parameter	Method	Preservation	Duplicate	No. of Containers
35BWW08	VOC	8260B	HCl	N	3

These standard project procedures are applicable to all members of Shaw Environmental, Inc.

Figure 2

Shaw Environmental & Infrastructure, Inc.	WATER SAMPLE FIELD COLLECTION REPORT	Project Number: _____ Project Name: _____ Site Location: LHAAP

Sample ID Number	35BWW08	Date Collected	2/9/12
Sample Location[7]	35BWW08	Time Collected	1308
Diameter of Well	2 (in.)	Sampler	I.D. # JF
Depth to Bottom of Well	34.6 (ft.)	Casing Stick Up	3
Static Water Level	24.5 (ft.)	Measured From[1]	TOC (ft.)
Well Volumes Purged		Purging Method[2]	Pump
Type of Sample[3]	Well	Sampling Method[4]	Low-Flow Pumping
Depth of Sample	29. (ft.)	Measured From[1]	TOC
Sample Collection Order			

FIELD SCREENING AND TEST RESULTS

Water Temperature 16.10 °C pH 6.70 Units

Specific Conductance 0.837 ~~umho~~/cm at 16.10 °C

OVA ☐ HNU PID ☐ Reading _____ PPM

Photovac GC (P/GC) Probable Compound _____ Reading _____ PPM

METER CALIBRATION

pH STD	METER READING	SP. COND. STD	METER READING	_____/STD (8)	METER READING

SAMPLE TYPES COLLECTED

CONTAINER #	TYPE (5)	CONTAINER TYPE	VOLUME	FILTERED	
	VOA	P ☐ G ☒	40 mL	Y ☐ N ☐	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐

WEATHER CONDITIONS: TEMP. 50 °F CLEAR ☒ CLOUDY ☐ RAIN ☐ SNOW ☐ WINDY ☐

(1) T.O.C. = Top of Protective Casing; T.O.W. = Top of Well Casing; G.S. = Ground Surface
(2) Bailed, Pumped, Air Lift, Etc.
(3) Stream, Pond, Spring, Well, Seep, Supply, Etc.
(4) Bailer, Kemmerer, Grab, Pump, Etc.
(5) General Chem., Metal, VOA, Organics, Etc.
(6) HNO^3, NaOH, H^2SO^4, $Na^2O^8S^2$, Etc.
(7) If Well, give Well I.D. Number.
(8) OVA, PID, P/GC or Other.

Figure 1

Water Level Measurement/Groundwater Sampling Log Form

Well No. 35BWW04 Date 2/9/12

Sample ID No. 35BWW04

Project ID LHAAP Measured/Sampled By: John Freise

Time: Start 1140 End: 1221

Measuring Point Elevation: Ft. Well Construction Material: 4" PVC

Well Depth Ft: 1) 35.8 2) 3) 4)

Avg. (of valid measurements*)

Water Depth Ft: 1) 22.85 2) 3) 4)

Avg. (of valid measurements*)

(*Minimum of three measurements, last two within 0.01 feet.)

Well Internal Diameter: 4 ~~Ft~~ In.

Riser Above/Below Pad Elevation Marker: Ft.

Pad Elevation: Ft.

Sampling Equipment Used:

Horiba U-52 multimeter, Cole-Parmer Peristaltic Pump, Teflon Tubing

Equipment Numbers: U-52 #BJ2C3AVR

pH Meter EC Meter Turbidity Meter Thermometer

Casing Volume Information:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

Purging Information:

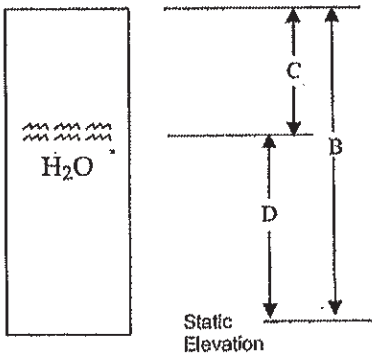
Measured Well Depth (B): 35.8 Ft.

Measured Water Level Depth (C): 22.85 Ft.

Length of Static Water Column (D): 35.8 : (B) 22.85 - (C) = 12.95 ft.

Casing Water Volume (E): 0.65 (A) x 12.95 (D) = 8.4 gal.

Total Purge Volume = 0.5 (gal) (minimum of three casing volumes)



These standard project procedures are applicable to all members of Shaw Environmental, Inc.

Figure 1 (*continued*)

Water Level Measurement/Groundwater Sampling Log Form (Continued)

Field Indicator Parameter Measurements During Purging:

pH	6.81	6.81	6.81	6.81	
Temp.°C	15.41	15.40	15.39	15.39	
Specific Conductance: ~~µmhos~~ mS/cm		0.348	0.349	0.348	0.350
Turbidity: NTU		42.4	41.2	41.5	41.4
Visual Appearance of Water:		Clear	Clear	Clear	Clear

Comments:

Field Indicator Parameter Measurements After Sampling:

pH	6.81			
Temp.°C	15.37			
Specific Conductance: ~~µmhos~~ mS/cm	0.351			
Turbidity: NTU	40.7			
Visual Appearance of Water:	Clear			

Comments:

Laboratory Analysis Requested:

Sample ID No.	Parameter	Method	Preservation	Duplicate	No. of Containers
35BWW04	VOC	8260B	HCl	N	3

These standard project procedures are applicable to all members of Shaw Environmental, Inc.

Figure 2

Shaw Environmental & Infrastructure, Inc.	WATER SAMPLE FIELD COLLECTION REPORT	Project Number: _____ Project Name: _____ Site Location: LHAAP

Sample ID Number	35BWW04	Date Collected	2/9/12
Sample Location[7]	35BWW04	Time Collected	1221
Diameter of Well	4 (in.)	Sampler	I.D. # JF
Depth to Bottom of Well	35.8 (ft.)	Casing Stick Up	3
Static Water Level	22.85 (ft.)	Measured From[1]	TOC (ft.)
Well Volumes Purged		Purging Method[2]	Pump
Type of Sample[3]	Well	Sampling Method[4]	Low-Flow Pumping
Depth of Sample	30. (ft.)	Measured From[1]	TOC
Sample Collection Order			

FIELD SCREENING AND TEST RESULTS

Water Temperature 15.39 °C pH 6.81 Units

Specific Conductance 0.350 ~~umho~~ mS/cm at 15.39 °C

OVA ☐ HNU PID ☐ Reading _____ PPM

Photovac GC (P/GC) Probable Compound _____ Reading _____ PPM

METER CALIBRATION

pH STD	METER READING	SP. COND. STD	METER READING	_____/STD (8)	METER READING

SAMPLE TYPES COLLECTED

CONTAINER #	TYPE (5)	CONTAINER TYPE	VOLUME	FILTERED	
	VOA	P ☐ G ☒	40 mL	Y ☐ N ☒	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐

WEATHER CONDITIONS: TEMP. 50 °F CLEAR ☒ CLOUDY ☐ RAIN ☐ SNOW ☐ WINDY ☐

(1) T.O.C. = Top of Protective Casing; T.O.W. = Top of Well Casing; G.S. = Ground Surface
(2) Bailed, Pumped, Air Lift, Etc.
(3) Stream, Pond, Spring, Well, Seep, Supply, Etc.
(4) Bailer, Kemmerer, Grab, Pump, Etc.
(5) General Chem., Metal, VOA, Organics, Etc.
(6) HNO^3, NaOH, H^2SO^4, $Na^2O^3S^2$, Etc.
(7) If Well, give Well I.D. Number.
(8) OVA, PID, P/GC or Other.

Figure 1

Water Level Measurement/Groundwater Sampling Log Form

Well No. 35BWW14 Date 2/9/12
Sample ID No. 35BWW14
Project ID LHAAP Measured/Sampled By: John Freise
Time: Start 0820 End: 0900

Measuring Point Elevation: Ft. Well Construction Material: 4" PVC
Well Depth Ft: 1) 38.3' 2) 3) 4)
Avg. (of valid measurements*)

Water Depth Ft: 1) 22.25' 2) 3) 4)
Avg. (of valid measurements*)
(*Minimum of three measurements, last two within 0.01 feet.)

Well Internal Diameter: 4 ☒ in
Riser Above/Below Pad Elevation Marker: Ft.

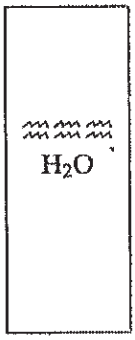
Pad Elevation: Ft.
Sampling Equipment Used:
Horiba U-52 Multimeter, Cole-Parmer Peristaltic Pump, teflon tubing

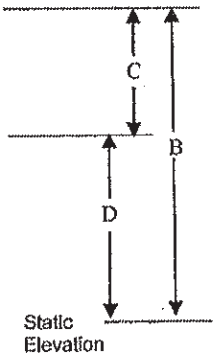
Equipment Numbers: U-52 #BJ2C3AVR
pH Meter EC Meter Turbidity Meter Thermometer

Casing Volume Information:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

Purging Information:
Measured Well Depth (B): 38.3 Ft.
Measured Water Level Depth (C): 22.25 Ft.
Length of Static Water Column (D): 38.3 (B) - 22.25 (C) = 16.05 ft.
Casing Water Volume (E): 0.65 (A) x 16.05 (D) = 10.4 gal.
Total Purge Volume = 1.8 (gal) (minimum of three casing volumes)





These standard project procedures are applicable to all members of Shaw Environmental, Inc.

Figure 1 (*continued*)

Water Level Measurement/Groundwater Sampling Log Form (Continued)

Field Indicator Parameter Measurements During Purging:

pH	7.40	7.45	7.40	7.43	
Temp.°C	~~23.8~~ 12.03	12.11	12.23	12.28	
Specific Conductance: ~~µmhos~~ mS/cm		0.573	0.594	0.584	0.579
Turbidity: NTU		96	91	89	87
Visual Appearance of Water:					

Comments:

Field Indicator Parameter Measurements After Sampling:

pH	7.43			
Temp.°C	12.30			
Specific Conductance: ~~µmhos~~ mS/cm	0.581			
Turbidity: NTU	80			
Visual Appearance of Water:				

Comments:

Laboratory Analysis Requested:

Sample ID No.	Parameter	Method	Preservation	Duplicate	No. of Containers
35BWW14	VOC	8260B	HCl	N	3

These standard project procedures are applicable to all members of Shaw Environmental, Inc.

Figure 2

Shaw Environmental & Infrastructure, Inc.	WATER SAMPLE FIELD COLLECTION REPORT	Project Number: _____ Project Name: _____ Site Location: LHAAP

Sample ID Number	35BWW14	Date Collected	2/9/12
Sample Location(7)	35BWW14	Time Collected	0900
Diameter of Well	4 (in.)	Sampler	I.D. # SF
Depth to Bottom of Well	38.3 (ft.)	Casing Stick Up	3'
Static Water Level	22.25 (ft.)	Measured From(1)	(ft.)
Well Volumes Purged		Purging Method(2)	Pumped
Type of Sample(3)	Well	Sampling Method(4)	Low Flow Pump
Depth of Sample	33 (ft.)	Measured From(1)	TOC
Sample Collection Order			

FIELD SCREENING AND TEST RESULTS

Water Temperature 12.28 °C pH 7.43 Units

Specific Conductance 0.579 ~~umho~~ mS/cm at 12.28 °C

OVA ☐ HNU PID ☐ Reading _____ PPM

Photovac GC (P/GC) Probable Compound _____ Reading _____ PPM

METER CALIBRATION

pH STD	METER READING	SP. COND. STD	METER READING	_____/STD (8)	METER READING

SAMPLE TYPES COLLECTED

CONTAINER #	TYPE (5)	CONTAINER TYPE	VOLUME	FILTERED	
	VOA	P ☐ G ☒	40 mL	Y ☐ N ☒	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐
		P ☐ G ☐		Y ☐ N ☐	Y ☐ N ☐

WEATHER CONDITIONS: TEMP. 40 °F CLEAR ☒ CLOUDY ☐ RAIN ☐ SNOW ☐ WINDY ☐

(1) T.O.C. = Top of Protective Casing; T.O.W. = Top of Well Casing; G.S. = Ground Surface
(2) Bailed, Pumped, Air Lift, Etc.
(3) Stream, Pond, Spring, Well, Seep, Supply, Etc.
(4) Bailer, Kemmerer, Grab, Pump, Etc.
(5) General Chem., Metal, VOA, Organics, Etc.
(6) HNO^3, NaOH, H^2SO^4, $Na^2O^3S^2$, Etc.
(7) If Well, give Well I.D. Number.
(8) OVA, PID, P/GC or Other.

APPENDIX F

Sampling Results Summary

SAMPLE SUMMARY

Client: Cherokee CRC LLC

Job Number: 280-25498-1

Lab Sample ID	Client Sample ID	Client Matrix	Date/Time Sampled	Date/Time Received
280-25498-1TB	TB1	Water	02/09/2012 0745	02/10/2012 0900
280-25498-2FB	FB1	Water	02/09/2012 0745	02/10/2012 0900
280-25498-3	35BWW14	Water	02/09/2012 0900	02/10/2012 0900
280-25498-4	35BWW11	Water	02/09/2012 1027	02/10/2012 0900
280-25498-5	35BWW09	Water	02/09/2012 1123	02/10/2012 0900
280-25498-6FD	DUP-1	Water	02/09/2012 1128	02/10/2012 0900
280-25498-7	35BWW04	Water	02/09/2012 1221	02/10/2012 0900
280-25498-8	IDW-1	Water	02/09/2012 1320	02/10/2012 0900
280-25498-9	IDW-2	Solid	02/09/2012 1100	02/10/2012 0900
280-25498-10	35BWW08	Water	02/09/2012 1308	02/10/2012 0900

EXECUTIVE SUMMARY - Detections

Client: Cherokee CRC LLC

Job Number: 280-25498-1

Lab Sample ID / Analyte	Client Sample ID	Result	Qualifier	Reporting Limit	Units	Method
280-25498-1TB	**TB1**					
Methylene Chloride		0.90	J	5.0	ug/L	8260B/DoD
280-25498-2FB	**FB1**					
Methylene Chloride		0.62	J	5.0	ug/L	8260B/DoD
280-25498-3	**35BWW14**					
1,1-Dichloroethane		2.8		2.0	ug/L	8260B/DoD
1,1-Dichloroethene		29		2.0	ug/L	8260B/DoD
cis-1,2-Dichloroethene		7.6		2.0	ug/L	8260B/DoD
Methylene Chloride		1.5	J	10	ug/L	8260B/DoD
trans-1,2-Dichloroethene		0.36	J	2.0	ug/L	8260B/DoD
Tetrachloroethene		10		2.0	ug/L	8260B/DoD
1,2-Dichloroethene, Total		7.9		2.0	ug/L	8260B/DoD
Trichloroethene		63		2.0	ug/L	8260B/DoD
Vinyl chloride		2.6	J	3.0	ug/L	8260B/DoD
280-25498-4	**35BWW11**					
Methylene Chloride		0.60	J	5.0	ug/L	8260B/DoD
Tetrachloroethene		0.26	J	1.0	ug/L	8260B/DoD
280-25498-5	**35BWW09**					
1,1-Dichloroethene		0.30	J	2.0	ug/L	8260B/DoD
cis-1,2-Dichloroethene		0.43	J	2.0	ug/L	8260B/DoD
Methylene Chloride		1.2	J	10	ug/L	8260B/DoD
1,2-Dichloroethene, Total		0.43	J	2.0	ug/L	8260B/DoD
Trichloroethene		68		2.0	ug/L	8260B/DoD
280-25498-6FD	**DUP-1**					
1,1-Dichloroethene		0.29	J	2.0	ug/L	8260B/DoD
cis-1,2-Dichloroethene		0.38	J	2.0	ug/L	8260B/DoD
Methylene Chloride		1.3	J	10	ug/L	8260B/DoD
1,2-Dichloroethene, Total		0.38	J	2.0	ug/L	8260B/DoD
Trichloroethene		68		2.0	ug/L	8260B/DoD

EXECUTIVE SUMMARY - Detections

Client: Cherokee CRC LLC

Job Number: 280-25498-1

Lab Sample ID / Analyte	Client Sample ID	Result	Qualifier	Reporting Limit	Units	Method
280-25498-7	**35BWW04**					
1,1-Dichloroethane		0.57	J	1.0	ug/L	8260B/DoD
1,1-Dichloroethene		1.7		1.0	ug/L	8260B/DoD
cis-1,2-Dichloroethene		0.51	J	1.0	ug/L	8260B/DoD
Methylene Chloride		0.62	J	5.0	ug/L	8260B/DoD
Tetrachloroethene		17		1.0	ug/L	8260B/DoD
1,2-Dichloroethene, Total		0.51	J	1.0	ug/L	8260B/DoD
Trichloroethene		5.9		1.0	ug/L	8260B/DoD
280-25498-8	**IDW-1**					
1,1-Dichloroethane		0.90	J	1.0	ug/L	8260B/DoD
1,1-Dichloroethene		7.0		1.0	ug/L	8260B/DoD
1,2,4-Trimethylbenzene		8.9		1.0	ug/L	8260B/DoD
1,3,5-Trimethylbenzene		3.7		1.0	ug/L	8260B/DoD
4-Isopropyltoluene		0.37	J	1.0	ug/L	8260B/DoD
Chloroform		0.21	J	1.0	ug/L	8260B/DoD
cis-1,2-Dichloroethene		2.6		1.0	ug/L	8260B/DoD
Ethylbenzene		1.6		1.0	ug/L	8260B/DoD
Isopropylbenzene		0.20	J	1.0	ug/L	8260B/DoD
Methylene Chloride		0.56	J	5.0	ug/L	8260B/DoD
m-Xylene & p-Xylene		7.2		2.0	ug/L	8260B/DoD
Naphthalene		3.7		1.0	ug/L	8260B/DoD
n-Butylbenzene		0.32	J	1.0	ug/L	8260B/DoD
N-Propylbenzene		0.46	J	1.0	ug/L	8260B/DoD
o-Xylene		7.7		1.0	ug/L	8260B/DoD
Tetrachloroethene		2.6		1.0	ug/L	8260B/DoD
1,2-Dichloroethene, Total		2.6		1.0	ug/L	8260B/DoD
Trichloroethene		33		1.0	ug/L	8260B/DoD
Vinyl chloride		0.61	J	1.5	ug/L	8260B/DoD
Flashpoint		>160		1.00	Degrees F	1010A
pH		7.3	HF	0.10	SU	9040C
280-25498-9	**IDW-2**					
Methylene Chloride		0.95	J	5.6	ug/Kg	8260B/DoD
Tetrachloroethene		2.1	J	5.6	ug/Kg	8260B/DoD
Trichloroethene		0.63	J	5.6	ug/Kg	8260B/DoD
Ignitability		NO			No Unit	7.1.2
Percent Moisture		21		0.10	%	Moisture
Soluble						
pH-Soluble		6.7		0.010	SU	9045D

EXECUTIVE SUMMARY - Detections

Client: Cherokee CRC LLC

Job Number: 280-25498-1

Lab Sample ID / Analyte	Client Sample ID	Result	Qualifier	Reporting Limit	Units	Method
280-25498-10	**35BWW08**					
1,1-Dichloroethene		0.22	J	1.0	ug/L	8260B/DoD
cis-1,2-Dichloroethene		0.30	J	1.0	ug/L	8260B/DoD
Methylene Chloride		0.58	J	5.0	ug/L	8260B/DoD
1,2-Dichloroethene, Total		0.30	J	1.0	ug/L	8260B/DoD
Trichloroethene		37		1.0	ug/L	8260B/DoD

APPENDIX G

Waste Profiles and Manifest

Stericycle
Specialty Waste Solutions

WASTE PROFILE FORM

PROFILE # _____

1. Generator Information		2. Billing Information	
Name	United States Army Corps of Engineers Tulsa District 1645 S. 101st E. Ave. Tulsa, OK 74128	Name	Cherokee CRC 10838 E. Marshall Suite 220 Tulsa, OK 74116
Contact	Aaron Williams	Contact	John Freise
Site	Longhorn Army Ammunition Plant LHAAP-37	Phone/Fax	918-430-3456
Phone	918-669-4915	Email	john.freise@cherokee-crc.com
EPA ID		Generator Status	CESQG ☐ SQG ☐ LQG ☐

3. Waste Description

Common Name of Waste	IDW waste soil								
Process Generating Waste	Monitoring well installation								
Color		Layers		Odor/Strength		State @ 70*	solid		
Free Liquid		% Liquid	21%	% Solids	79%	% Sludge		% Solubility	
% Total Halogens									

4. DOT Shipping Name: (include PG, UN/NA & Haz Class)

Non-Hazardous Waste

None ☐ Lab Pack ☐

*NOS Descriptor			
Quantity	10 55 gal	Frequency	
Shipment Method		Price Units	
EPA Codes			
State Codes			

Specific Gravity		Viscosity	
Flash Point (*F)		pH	6.7
BTUs		PCBs	
Total Cyanides (ppm)	0.3	Total Sulfides (ppm)	0.63

Waste Composition: (List all haz and non-haz. constituents)

	%
	%
	%
	%
	%
	%
	%

5. Regulatory Status (check all that apply)

Hazardous Waste per 40 CFR 261	☐
CESQG per 40 CFR 261.5	☐
Universal Waste per 40 CFR 273	☐
Used Oil per 40 CFR 279	☐
State Regulated Waste	☐
HHW per 40 CFR 261.4(b)(1)	☐
TSCA per 40 CFR 761	☐
Non Hazardous Waste	☑
Other Exempt Waste per 40 CFR 261	☐

Describe:

Form Code | Source Code

6. Hazardous and Chemical Properties

None	☑	Oxidizer	☐
Water Reactive	☐	Ignitable	☐
Shock Sensitive	☐	Medical Waste	☐
Air Reactive	☐	Dioxins	☐
Explosive	☐	Benzene NESHAP	☐
Pyrophoric	☐	Pesticide/Herbicide	☐
Reactive Cyanides	☐	Polymerizable	☐
Reactive Sulfides	☐	Radioactive	☐
Phenols	☐	Asbestos	☐

Customer Disposal Preference (If any):

7. Metals (Inorganic) None ☑ TCLP ☐ SCLP ☐ Generator Knowledge ☐

D004 Arsenic (5mg/l)		D011 Silver (5mg/l)		Manganese	
D005 Barium (100mg/l)		Aluminum		Molybdenum	
D006 Cadmium (1mg/l)		Antimony		Nickel	
D007 Chromium (5mg/l)		Beryllium		Thallium	
D008 Lead (5mg/l)		Cobalt		Tin	
D009 Mercury (0.2mg/l)		Copper		Zinc	
D010 Selenium (1mg/l)		Chromium			

8. Other Compounds (Organic) None ☑ TCLP ☐ SCLP ☐ Totals ☐ Generator Knowledge ☐

D012 Endrin		D023 o-Cresol		D033 Hexachlorobutadiene	
D013 Lindane		D024 m-Cresol		D035 Methyl ethyl ketone	
D014 Methoxychlor		D025 p-Cresol		D036 Nitrobenzene	
D015 Toxaphene		D026 Cresol		D037 Pentachlorophenol	
D016 2,4-D		D027 1,4-Dichlorobenzene		D038 Pyridine	
D017 2,4 5 TP (Silvex)		D028 1,2-Dichloroethane		D039 Tetrachloroethylene	
D018 Benzene		D029 1,1-Dichloroethylene		D040 Trichloroethylene	
D019 Carbon Tetrachloride		D030 2,4-Dinitrotoluene		D041 2,4,5-Trichlorophenol	
D020 Chlordane		D031 Heptachlor (& epoxide)		D042 2,4,6-Trichlorophenol	
D021 Chlorobenzene		D032 Hexachlorobenzene		D043 Vinyl chloride	
D022 Chloroform					

Generator Certification: I hereby certify that I have personally examined and am familiar with the above and attached description. To the best of my knowledge it is complete and accurate. No deliberate or willful omissions of composition or properties exist and all known or suspected hazards have been disclosed.

Name	John Freise	Title	Environmental Scientist
Signature		Date	Friday, March 02, 2012

Stericycle
Specialty Waste Solutions

WASTE PROFILE FORM

PROFILE # _____

1. Generator Information		2. Billing Information	
Name	United States Army Corps of Engineers Tulsa District 1645 S. 101st E. Ave. Tulsa, OK 74128	Name	Cherokee CRC 10838 E. Marshall Suite 220 Tulsa, OK 74116
Contact	Aaron Williams	Contact	John Freise
Site	Longhorn Army Ammunition Plant LHAAP-37	Phone/Fax	918-430-3456
Phone	918-669-4915	Email	john.freise@cherokee-crc.com
EPA ID		Generator Status	CESQG ☐ SQG ☐ LQG ☐

3. Waste Description

Common Name of Waste	IDW waste Water								
Process Generating Waste	Monitoring well installation								
Color		Layers		Odor/Strength		State @ 70°	liquid		
Free Liquid	100%	% Liquid		% Solids		% Sludge		% Solubility	
% Total Halogens									

4. DOT Shipping Name: (include PG, UN/NA & Haz Class)

Non-Hazardous Waste

None ☐ Lab Pack ☐

*NOS Descriptor			
Quantity	5 55 gal	Frequency	
Shipment Method		Price Units	
EPA Codes			
State Codes			

Specific Gravity		Viscosity	
Flash Point (°F)	>160	pH	7.3
BTUs		PCBs	
Total Cyanides (ppm)	0.002	Total Sulfides (ppm)	1.3

Waste Composition: (List all haz and non-haz. constituents)

	%
	%
	%
	%
	%
	%
	%

5. Regulatory Status (check all that apply)

Hazardous Waste per 40 CFR 261	☐
CESQG per 40 CFR 261.5	☐
Universal Waste per 40 CFR 273	☐
Used Oil per 40 CFR 279	☐
State Regulated Waste	☐
HHW per 40 CFR 261.4(b)(1)	☐
TSCA per 40 CFR 761	☐
Non Hazardous Waste	☑
Other Exempt Waste per 40 CFR 261	☐

Describe:

Form Code | Source Code

6. Hazardous and Chemical Properties

None	☑	Oxidizer	☐
Water Reactive	☐	Ignitable	☐
Shock Sensitive	☐	Medical Waste	☐
Air Reactive	☐	Dioxins	☐
Explosive	☐	Benzene NESHAP	☐
Pyrophoric	☐	Pesticide/Herbicide	☐
Reactive Cyanides	☐	Polymerizable	☐
Reactive Sulfides	☐	Radioactive	☐
Phenols	☐	Asbestos	☐

Customer Disposal Preference (if any):

7. Metals (Inorganic) None ☑ TCLP ☐ SCLP ☐ Generator Knowledge ☐

D004 Arsenic (5mg/l)		D011 Silver (5mg/l)		Manganese	
D005 Barium (100mg/l)		Aluminum		Molybdenum	
D006 Cadmium (1mg/l)		Antimony		Nickel	
D007 Chromium (5mg/l)		Beryllium		Thallium	
D008 Lead (5mg/l)		Cobalt		Tin	
D009 Mercury (0.2mg/l)		Copper		Zinc	
D010 Selenium (1mg/l)		Chromium			

8. Other Compounds (Organic) None ☑ TCLP ☐ SCLP ☐ Totals ☐ Generator Knowledge ☐

D012 Endrin		D023 o-Cresol		D033 Hexachlorobutadiene	
D013 Lindane		D024 m-Cresol		D035 Methyl ethyl ketone	
D014 Methoxychlor		D025 p-Cresol		D036 Nitrobenzene	
D015 Toxaphene		D026 Cresol		D037 Pentachlorophenol	
D016 2,4-D		D027 1,4-Dichlorobenzene		D038 Pyridine	
D017 2,4 5 TP (Silvex)		D028 1,2-Dichloroethane		D039 Tetrachloroethylene	
D018 Benzene		D029 1,1-Dichloroethylene		D040 Trichloroethylene	
D019 Carbon Tetrachloride		D030 2,4-Dinitrotoluene		D041 2,4,5-Trichlorophenol	
D020 Chlordane		D031 Heptachlor (& epoxide)		D042 2,4,6-Trichlorophenol	
D021 Chlorobenzene		D032 Hexachlorobenzene		D043 Vinyl chloride	
D022 Chloroform					

Generator Certification: I hereby certify that I have personally examined and am familiar with the above and attached description. To the best of my knowledge it is complete and accurate. No deliberate or willful omissions of composition or properties exist and all known or suspected hazards have been disclosed.

Name	John Freise	Title	Environmental Scientist
Signature		Date	Friday, March 02, 2012

Please print or type
(Form designed for use on elite (12-pitch) typewriter.)

FRIS Contract #HM81

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Waste Tracking Number
N/A	1	800-924-4804	7417-1002985

GENERATOR

5. Generator's Name and Mailing Address

United States Army Corps of Engineers
1645 S 101st East Ave
Tulsa, OK 74128-4637

Generator's Phone: 918-669-4913

Generator's Site Address (if different than mailing address)

United States Army Corps of Engi
Longhorn Army Ammunition Plant
Karnack, TX 75661

6. Transporter 1 Company Name: Stericycle Specialty Waste Solutions, Inc — U.S. EPA ID Number: MNS000110924

7. Transporter 2 Company Name — U.S. EPA ID Number

8. Designated Facility Name and Site Address: Stericycle Specialty Waste Solutions, Inc.
2120 Southwest Blvd
Tulsa, OK 74107

Facility's Phone: (918) 587-9664 Ext — U.S. EPA ID Number: OKD987084060

	9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	
1.	Non-Hazardous Waste soil	12	DM	Est 5151	P	
2.	Non Hazardous, Non-Regulated Liquids (DW Wastewater	4	DM	1730 Est	P	
3.						
4.						

13. Special Handling Instructions and Additional Information: Approval #913-01 C.App #912-01

14. GENERATOR'S CERTIFICATION: I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.

Generator's/Offeror's Printed/Typed Name | Signature | Month | Day | Year

INT'L

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:

Transporter Signature (for exports only): Date leaving U.S.:

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name | Signature | Month | Day | Year

Transporter 2 Printed/Typed Name | Signature | Month | Day | Year

DESIGNATED FACILITY

17. Discrepancy

17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

17b. Alternate Facility (or Generator) — U.S. EPA ID Number

Facility's Phone:

17c. Signature of Alternate Facility (or Generator) | Month | Day | Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name | Signature | Month | Day | Year

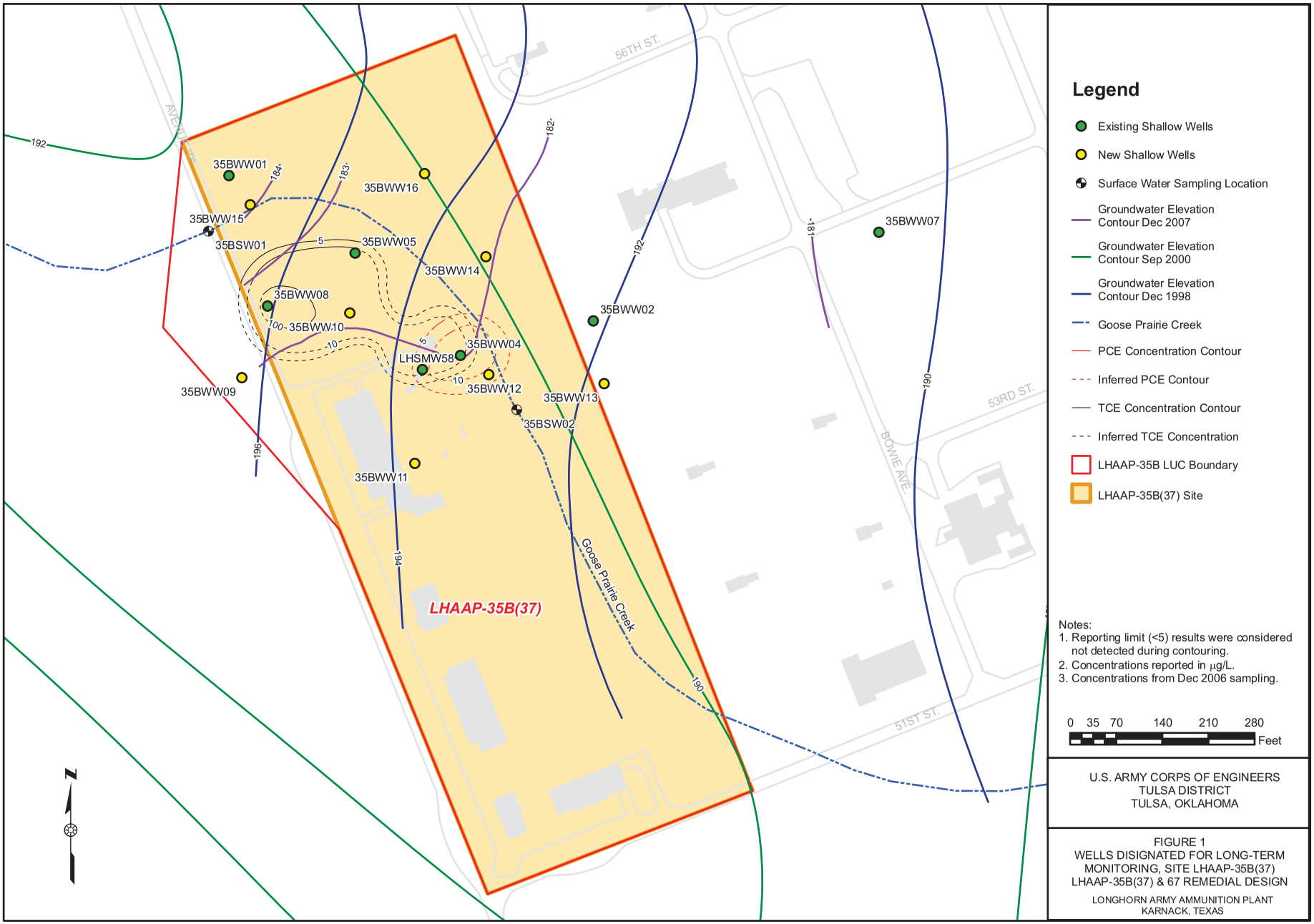
GC Labels • Printed in the USA
1-800-997-6966

GENERATOR'S/SHIPPER'S INITIAL COPY

Reorder Part# MANIFEST-C6NHW
913-897-6966

APPENDIX H

Site Location Map



Legend

- Existing Shallow Wells
- New Shallow Wells
- Surface Water Sampling Location
- Groundwater Elevation Contour Dec 2007
- Groundwater Elevation Contour Sep 2000
- Groundwater Elevation Contour Dec 1998
- Goose Prairie Creek
- PCE Concentration Contour
- Inferred PCE Contour
- TCE Concentration Contour
- Inferred TCE Concentration
- LHAAP-35B LUC Boundary
- LHAAP-35B(37) Site

Notes:
1. Reporting limit (<5) results were considered not detected during contouring.
2. Concentrations reported in µg/L.
3. Concentrations from Dec 2006 sampling.

0 35 70 140 210 280 Feet

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

FIGURE 1
WELLS DISIGNATED FOR LONG-TERM MONITORING, SITE LHAAP-35B(37)
LHAAP-35B(37) & 67 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

LHAAP35BLTM.mxd 08/04/11

APPENDIX I

Photographs

Clearing for MW 35BWW14

Installation of MW 35BWW11

Installation of MW 35BWW09

Surface Completion of MW 35BWW11

Completed MW 35BWW11

IDW from 35BWW14 Pending Analysis

APPENDIX J

Laboratory Report (CD-ROM)

APPENDIX B: SAMPLE ANNUAL LAND USE CONTROL COMPLIANCE CERTIFICATION DOCUMENTATION

Sample Annual Land Use Control Compliance Certification Documentation

In accordance with the Remedial Design dated _____ for LHAAP-35B (37) a certification of site was conducted by _____ [indicate transferee] on _____.

A summary of land use control mechanisms is as follows:

- No residential use or residential development of the property.
- Groundwater restriction - restriction of the use of groundwater to environmental monitoring and
- testing until cleanup levels are met. The restriction against residential use of groundwater will remain in effect until the levels of the COCs in groundwater allow unrestricted use and unlimited exposure (UUUE). [Indicate whether groundwater restrictions are still required at LHAAP-35B (37)]

A summary of compliance with land use and restriction covenants is as follows:

- No residential use or residential development of the property.
- No use of groundwater, installation of new groundwater wells, or tampering with existing wells at LHAAP-35B (37).

I, the undersigned, do document that the certification was performed 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.

APPENDIX C: JULY 2012 AND MARCH 2013 SAMPLING EVENT VOC DATA

Appendix C: Summary of Monitoring Well Sampling VOC Data (July 2012 and March 2013 Sampling Events)
Remedial Action Work Plan for Site 37, Chemical Laboratory
Longhorn Army Ammunition Plant, Karnack, Texas

Location ID: / Date Sampled:	Units	35B WW07 7/18/2012	35B WW14 7/18/2012	35BWW14 3/9/2013	35B WW01 7/17/2012	35B WW03 7/15/2012	35B WW04 7/17/2012	35BWW04 3/12/2013	35B WW05 7/16/2012	35BWW05 3/13/2013	35B WW06 7/16/2012	35BWW06 3/13/2013	35B WW08 7/16/2012	35BWW08 3/10/2013	35BWW08D 3/10/2013	35B WW09 7/16/2012	35BWW09 3/9/2013	35B WW-11 7/17/2012	LHS MW-58 7/15/2012	MW-58 3/12/2013
Volatile Organic Compounds (8260B)																				
1,1-Dichloroethane	ug/L	<0.125 U	*4.95*	*4.89*	<0.125 U	<0.125 U	*0.639* J	*2.11*	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U
1,1-Dichloroethene	ug/L	<0.5 U	***52.3***	***48.2***	<0.5 U	<0.5 U	*1.67*	*2.94*	<0.5 U	<0.5 U	<0.5 U	<0.5 U	<0.5 U	<0.5 U	<0.5 U	<0.5 U	<0.5 U	<0.5 U	*0.656* J	<0.5 U
1,2-Dichloroethane	ug/L	<0.25 U	<0.25 U	*0.285* J	<0.25 U	<0.25 U	*0.256* J	*0.299* J	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U
Benzene	ug/L	<0.125 U	*0.228* J	*0.242* J	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U
Chlorobenzene	ug/L	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	*0.169* J	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U
Chloroform	ug/L	<0.125 U	*0.195* J	*0.153* J	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U	<0.125 U
cis-1,2-Dichloroethene	ug/L	<0.25 U	*13.2*	*12.8*	<0.25 U	<0.25 U	*0.475* J	*1.05*	<0.25 U	*0.255* J	<0.25 U	<0.25 U	*0.305* J	*0.356* J	*0.353* J	*0.38* J	*0.431* J	<0.25 U	<0.25 U	<0.25 U
Tetrachloroethene	ug/L	<0.25 U	***21***	***21.8***	<0.25 U	<0.25 U	***48.9***	***45.4***	*1.09*	*0.998* J	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	***36.3***	***14.8***
trans-1,2-Dichloroethene	ug/L	<0.25 U	<0.25 U	*0.415* J	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U
Trichloroethene	ug/L	<0.25 U	***80.6***	***80.3***	<0.25 U	<0.25 U	***8.09***	***15.4***	***13.5***	***15.6***	<0.25 U	<0.25 U	***65.7***	***77.1***	***78.2***	***55.6***	***45.2***	<0.25 U	***5.17***	*3.39*
Vinyl chloride	ug/L	<0.25 U	***4.02***	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U	<0.25 U

Notes:

1) The analytical data was collected by Cherokee Nation, on behalf of the U.S. Army, as part of the Bio-plug demonstration study.

2) *Italic* numbers represent concentrations of those constituents are detected above the laboratory reporting limits.

3) ***Bold and Italic*** represent concentrations of those constituents exceeding their maximum contaminant levels (MCLs), if available, or TCEQ Tier 1 Protective Concentration Levels (PCLs).

3) J - The concentration is estimated.

4) U - the concentration of that constituent is below the laboratory quantitation limit.