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Ms. Flora Greene
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Reference: EPA Contract No. 68-W-02-019; EPA Work Assignment No. R06928: EPA Region 6 RCRA Special Field Investigation; Field Activity Trip Report, Shumaker Naval Ammunition Depot Facility, East Camden, Arkansas; Draft Deliverable Task 11

Dear Ms. Greene:

Enclosed please find the Field Activity Trip Report, Shumaker Naval Ammunition Depot Facility (Trip Report). The Trip Report describes the installation and sampling of groundwater monitoring wells associated with the Shumaker Naval Ammunition Depot (SNAD) facility located near East Camden, Arkansas. Ten shallow and ten deep groundwater monitoring wells were installed, developed, surveyed and sampled by TechLaw, Inc (TechLaw) team members during the period of February 5, 2007 through April 28, 2007. TechLaw performed data validation on the GPL Laboratories analytical data packages which were previously submitted to the EPA as a separate deliverable. The analytical reports and chains-of-custody forms will be submitted to EPA as a separate deliverable at a later date.

Sample results were compared to the EPA Region 6 Human Health Medium-Specific Screening Levels (MSSL) and the EPA Region III Risk-Based Concentrations (RBCs).. The analytical results of the groundwater samples obtained in both the shallow and deep monitoring wells indicate low-level detections of perchlorate, mercury and organic compounds, and exceedances of the MSSL and RBC screening criteria for arsenic, lead and bis (2-ethylhexyl) phthalate.

For your convenience, a copy of this Trip Report on CD is also being provided. If you have any questions, please contact me at (214) 572-0069.

Sincerely,

Wally O'Rear
Regional Project Manager

cc: R. Ehrhart, EPA Region 6 WAM
T. Brown-Derocher, TechLaw Central Files
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TechLaw Dallas Files (R06928)

**FIELD ACTIVITY TRIP REPORT
SHUMAKER NAVAL AMMUNITION DEPOT FACILITY
EAST CAMDEN, ARKANSAS**

Submitted to:

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June 18, 2007

**FIELD ACTIVITY TRIP REPORT
SHUMAKER NAVAL AMMUNITION DEPOT FACILITY
EAST CAMDEN, ARKANSAS**

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DISCLAIMER

TechLaw, Inc. in fulfillment of Contract No. 68-W-02-019, Work Assignment No. R06928, prepared this report for the United States Environmental Protection Agency (EPA), Region 6. Any opinions, findings or conclusions expressed herein are those of the contractor, not necessarily those of EPA or cooperating agencies. The mention of any company or product names is not to be considered an endorsement by EPA.

This report is intended to assist EPA personnel in documenting any contamination at the Shumaker Naval Ammunition Depot (SNAD) located in East Camden, Arkansas. Sampling activities took place on February 5, 2007 through April 28, 2007.

**FIELD ACTIVITY TRIP REPORT
SHUMAKER NAVAL AMMUNITION DEPOT FACILITY
EAST CAMDEN, ARKANSAS**

1.0 INTRODUCTION

The United States Environmental Protection Agency (EPA) requested TechLaw, Inc. (TechLaw) to assess groundwater flow and analytically evaluate the current nature and extent of groundwater contamination in the vicinity of the former Shumaker Naval Ammunition Depot (SNAD) facility located near East Camden, Arkansas. Lithologic logging, core collection, groundwater well installation, well development and groundwater sampling took place during the period of February 5, 2007 through April 28, 2007. Anderson Engineering Consultants, Inc. of Little Rock, Arkansas provided drilling and installation services for the shallow groundwater monitoring wells (SW). The deep groundwater monitoring wells (DW) were drilled and installed by Layne-Christensen Co. of Mission Woods, Kansas. PSC Consulting Group of Dallas, Texas (PSC) was responsible for the packing and disposal of the investigation derived wastes (IDW). The IDW soil samples were analyzed for perchlorate, explosives and Resource Conservation and Recovery Act (RCRA) metals. Groundwater samples were analyzed for volatile organic compounds (VOC), semi-volatile organic compounds (SVOC), explosives, perchlorate, and RCRA metals. Chemical analysis of the samples was conducted by GPL Laboratories of Frederick, Maryland (GPL).

Ten shallow (alluvial) and ten deep (Sparta Sand) groundwater monitoring wells were installed and sampled at the SNAD facility. TechLaw representatives collected shallow groundwater samples through the use of a Waterra® Foot Valve or a bladder pump. Deep wells were sampled with a bladder pump. Core samples were collected from seven deep well locations.

A copy of the photograph log and field log books are presented as Appendices A (Shumaker Photographs) and B (Shumaker Log Books) of this trip report. Appendices C (Shallow and Deep Groundwater Boring Logs) and D (Shallow and Deep Groundwater Monitor Well Data Sheets) contain documentation specific to the groundwater installation process for both the shallow and deep groundwater wells.

2.0 SITE DESCRIPTION AND HISTORY

The SNAD facility is located in East Camden, Arkansas, at 33 degrees (°), 38 (′) minutes North, and 92°, 42′ West. Figures 2.1 (Site Location Shumaker Naval Ammunition Depot) and 2.2 (Monitoring Well Locations Shumaker Naval Ammunition Depot) show the site location and the groundwater monitoring well locations, respectively. The facility extends into Calhoun and Ouachita counties. The site was operated by the U.S. Navy (Navy) from 1944 until 1957 for the manufacture, testing, storage, distribution, disassembly, reworking, and destruction of ammunition, bombs, and explosives, principally rockets. It was operated by the National Fireworks Ordnance Corporation as a government owned - contractor operated (GOCO) facility under the supervision of Navy personnel. Improvements to the site included an elaborate

railroad track and spurline system, hundreds of reinforced concrete storage magazines, loading dock facilities, headquarters and administration buildings, and an eight mile long rocket test range in addition to production and handling facilities for all types of high explosive admixtures, to include TNT, Composition "B", Ammonium Nitrate, RDX Base and aluminum powder.

International Paper in 1961 bought 40,000 acres of forest at the former naval depot. The Brown family of Texas, later famous for its partnership in the global Brown and Root construction company, bought the remaining 25,000 acres. The purchase included the headquarters buildings, the depot's extensive network of railways, hundreds of warehouses, production facilities and bunkers where the Navy stored explosives and ammunition. Highland Resources Inc., a subsidiary of Brown Engineering, then began operating the depot as an industrial park and defense contractors began taking over the old facilities. The Navy's housing area became the town of East Camden. The depot commander's house became a guest house for visiting consultants, executives and engineers.

3.0 SITE ACTIVITIES

The TechLaw team mobilized to East Camden, Arkansas on February 5, 2007. Well installation and sampling activities were performed February 6, 2007 through April 28, 2007. Daily field activities were recorded in field log books. Copies of the field log books are, presented as Appendix B (Shumaker Log Books) to this trip report.

Various site activities were performed to ensure access to the drilling locations. The deep monitoring well depths were determined based on the soil boring samples with approval from the EPA Project Manager. The shallow well depths were determined based on the soil boring samples with approval of the EPA Project Manager. The number of groundwater monitoring wells was determined by EPA based on the size of the project area and topographical information provided. Analytical parameters were selected based on historical contaminant data. TechLaw team member, Mr. Stephen Phillips, and U.S. EPA representative, Mr. Scott Ellinger, met with local residents and officials to discuss the locations and conditions of the groundwater monitoring wells before the initiation of field activities.

TechLaw team members collected groundwater samples from the 20 groundwater wells. All groundwater monitoring wells were allowed a 24-hour period to stabilize following development activities. Sampling procedures are described in Section 6.0, Sample Collection Activities.

Access

On November 13, 2006, U.S. EPA representative, Mr. Scott Ellinger, met with Arkansas state representatives and TechLaw team member, Mr. Stephen Phillips, to confirm the seven deep and ten shallow groundwater monitoring well locations. Access was acquired only for shallow wells (SW) SW-1, SW-2, SW-3, SW-5, SW-7, SW-8 and SW-10 and deep wells (DW) DW-1, DW-3, DW-4, DW-5, DW-6 and DW-7. On February 5, 2007, Mr. Scott Ellinger met with a local county official to confirm the well locations to be within 25 feet (ft) of gravel roads and 30 ft of paved roads. Access for SW-6 was acquired after Mr. Scott Ellinger, Mr. Stephen Phillips and a

local county official met on February 14, 2007. On February 20, 2007, access for DW-2 and shallow wells SW-4 and SW-9 was acquired by Mr. Scott Ellinger, local landowners and a county official.

Water Access

A stable water source was required for the monitoring well installation activities. On February 7, 2007, Mr. Stephen Phillips obtained a temporary water source, located approximately two (2) miles away from the well installation location, in Harmony Grove. On February 12, 2007, Mr. Stephen Phillips and Mr. Scott Ellinger acquired access for a water source located on the Highlands Industrial Park (HIP) site through a meeting with the Highlands county judge. This water source was located on County Road 5, near SW-8 and DW-3.

Meetings

On February 5, 2007, TechLaw team members verified monitoring well locations with the exception of SW-10, DW-5 and DW-6. On November 14, 2006, Mr. Steve Phillips, United States Geological Survey (USGS) representatives and PSC personnel verified drum delivery and collection locations.

Safety briefings were held with TechLaw team members Mr. Steve Phillips, Mr. Richard Hardy, Mr. Tim Osburn, Mr. Todd Quillen and Ms. Anna Cornelious; U.S. EPA representative, Mr. Scott Ellinger; Anderson Engineering Consultants, Inc. personnel; and Layne-Christensen Co. personnel prior to daily field activities throughout the project.

On March 19, 2007, TechLaw representatives, Mr. Wally O'Rear and Mr. Steven Phillips met with EPA representatives, Ms. Flora Greene, Mr. Rick Ehrhart, Mr. Scott Ellinger, Mr. Ben Benipal and Ms. Cathy Carter to discuss the depths of the screened intervals for DW-2, DW-3 and DW-4. EPA determined that these wells were screened too shallow and requested replacement wells be installed.

On May 23, 2007, Land Point, Inc. representatives surveyed the groundwater well locations. The surveyed locations for the groundwater wells are presented in Table 3.1, Surveyed Well Location Descriptions.

4.0 SHALLOW GROUNDWATER MONITORING WELLS

The installation and development of the shallow groundwater monitoring wells SW-1, SW-2, SW-3, SW-5, SW-6, SW-7, SW-8 and SW-10 began on February 6, 2007, and continued through February 16, 2007. Due to access agreement issues, the installation of SW-4 and SW-9 was not started until March 26, 2007 and the development of these wells was completed March 28, 2007. All monitoring wells were installed and completed in compliance with the Arkansas Water Well Construction Commission Rules and Regulations (January 28, 2006) which references the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD).

The shallow monitoring wells were screened in the basal alluvial gravel, which overlays clays of the Cook Mountain or Sparta Sand formations. Penetration into the clay stratum was back filled with ¼ inch (in) bentonite pellets which were then overlain by at least one foot of filter sand prior

to placing the monitoring well screen and casing. Monitoring wells were constructed of 2 in diameter schedule 40 polyvinylchloride (PVC). All screens were 10 ft in length with 0.010 in slots. Filter sand consisted of Custom Aggregates Filter Media, and was 16/30 size. The annulus of each well was grouted with a neat, type-1 Portland cement grout, with approximately 5 percent (%) bentonite added to reduce shrinkage. Steel, concrete-filled bollards were painted yellow to enhance visibility and installed at the corners of each concrete pad except at SW-8, which was located inside a fenced area. All IDW was containerized in 55-gallon drums that were temporarily stored at each well site inside a locked chain link fence.

SW-3, SW-4, SW-5, SW-6, SW-7, SW-9 and SW-10 were adequately developed. Development of the shallow wells involved the use of a whole submersible pump. The wells were surged by periodically moving the pump in a vertical motion. SW-1, SW-2 and SW-8 recharged at a relatively slow pace and never produced clear water. To assist in the production of clear water, shallow wells SW-1 and SW-2 were flushed with potable water to remove accumulated fines but were unsuccessful in developing adequately. For additional information regarding the shallow monitoring well installation procedures, refer to Appendices B, C and D.

Monitoring Well SW-1

Drilling for the installation of monitoring well SW-1 began on February 6, 2007. Appendix A (Shumaker Photographs) Photo Numbers 001 through 011 depict activities at SW-1. Photo Number 004 depicts the Rig set up on shallow well SW-1. Monitoring well installation began on February 7, 2007. The 7 in diameter boring was drilled using 4¼-in inside diameter hollow stem augers to a depth of 55 ft. The boring was backfilled with 7 ft of bentonite pellets to ensure that the bottom of the borehole was sealed at a depth of 48.0 ft. One-foot of filter sand was placed on top the bentonite. A 10 ft section of well screen (with a 6 in bottom cap) was set at a bottom depth of 47 ft. Construction details of SW-1 are included in Table 4.1 (Shallow Groundwater Monitoring Well Summary) and Appendix C (Shallow and Deep Groundwater Boring Logs). The well installation (grouting of the borehole annulus) was completed on February 8, 2007. The well pad and protective casing were constructed and the well completed on February 13, 2007. Monitoring well SW-1 was developed on February 16, 2007 and is shown in Photo Number 008.

Monitoring Well SW-2

Drilling for the installation of monitoring well SW-2 began on February 7, 2007. Appendix A Photo Numbers 012 through 014 depict activities at SW-2. Monitoring well installation began on February 8, 2007. The 7 in diameter boring was drilled using 4¼-in inside diameter hollow stem augers to a depth of 36 ft. The boring was backfilled with 6 ft of bentonite pellets to ensure that the bottom of the borehole was sealed at a depth of 30.0 ft. One-foot of filter sand was placed on top of the bentonite. A 10 ft well screen (with a 6 in bottom cap) was set at a bottom depth of 29 ft. Construction details of SW-2 are included in Table 4.1 and Appendix C. The well installation (grouting of the borehole annulus) was completed on February 9, 2007. The well pad and protective casing were constructed and the well completed on February 13, 2007 and is depicted in Photo Number 012. Monitoring well SW-2 was developed on February 15, 2007.

Monitoring Well SW-3

Drilling and installation of monitoring well SW-3 began on February 9, 2007. Appendix A Photo Numbers 015 through 020 depict activities at SW-3. The 7 in diameter boring was drilled using 4¼-in inside diameter hollow stem augers to a depth of 30 ft. The boring was backfilled with one foot of bentonite pellets to ensure that the bottom of the borehole was sealed at a depth of 29 ft. One-foot of filter sand was placed on top the bentonite. A 10 foot section of well screen (with a 6 in bottom cap) was set at a bottom depth of 28 ft. Construction details of SW-3 are included in Table 4.1 and Appendix C. The well installation (grouting of the borehole annulus) was completed on February 10, 2007 and is depicted in Photo Number 016. The well pad and protective casing were constructed and the well completed on February 12, 2007. The completed pad for shallow well SW-3 is shown in Photo Number 019. Monitoring well SW-3 was developed on February 13, 2007.

Monitoring Well SW-4

Drilling and installation of monitoring well SW-4 began on March 26, 2007. Appendix A Photo Number 021 depict activities at SW-4. The 8 in diameter boring was drilled using 4¼-in inside diameter hollow stem augers to a depth of 22.5 ft. The boring was backfilled with 2 ft of bentonite pellets to ensure that the bottom of the borehole was sealed at a depth of 20.5 ft. One-foot of filter sand was placed on top the bentonite. A ten foot section of well screen (with a 6 in bottom cap) was set at a bottom depth of 19.5 ft. Construction details of SW-4 are included in Table 4.1 and Appendix C. The well installation (grouting of the borehole annulus) was completed on March 27, 2007. The well pad and protective casing were constructed and the well completed on March 28, 2007. Photo Number 021 depicts the completed shallow well SW-4 pad. Monitoring well SW-4 was developed on March 28, 2007.

Monitoring Well SW-5

Drilling and installation of monitoring well SW-5 began on February 11, 2007. Appendix A Photo Numbers 022 through 024 depict activities at SW-5. The 7 in diameter boring was drilled using 4¼-in inside diameter hollow stem augers to a depth of 26.5 ft. The boring was backfilled with one-foot of bentonite pellets to ensure that the bottom of the borehole was sealed at a depth of 25.5 ft. One-foot of filter sand was placed on top the bentonite. A ten foot section of well screen (with a 6 in bottom cap) was set at a bottom depth of 24.5 ft. Construction details of SW-5 are included in Table 4.1 and Appendix C. The well installation (grouting of the borehole annulus) was completed on February 12, 2007. The well pad and protective casing were constructed and the well completed on February 13, 2007. Photo Number 022 depicts the completed shallow well SW-5 pad. Monitoring well SW-5 was developed on February 15, 2007.

Monitoring Well SW-6

Drilling and installation of monitoring well SW-6 began on February 14, 2007. Appendix A Photo Numbers 025 through 026 depict activities at SW-6. The 7 in diameter boring (subsequently reamed and washed to approximately a 12 in diameter at the surface) was drilled using 4¼-in inside diameter hollow stem augers to a depth of 30 ft. Flowing sands were encountered in this boring and despite several efforts to ream and wash the well with potable water the bentonite pellets could not be placed in the bottom of this boring to seal it. A 10 ft section of well screen (with a 6 in bottom cap) was set at a bottom depth of 27 ft, resting on

formation sands. Construction details of SW-6 are included in Table 4.1 and Appendix C. The well installation (grouting of the borehole annulus) was completed on February 15, 2007. The well pad and protective casing were constructed and the well completed on February 16, 2007. Photo Number 025 depicts the completed shallow well SW-6 pad. Monitoring well SW-6 was developed on February 16, 2007 before installation of the well pad.

Monitoring Well SW-7

Drilling and installation of monitoring well SW-7 began on February 10, 2007. Appendix A Photo Numbers 027 through 028 depict activities at SW-7. The 7 in diameter boring was drilled using 4¼-in inside diameter hollow stem augers to a depth of 29 ft. The boring was backfilled with one-foot of bentonite pellets to ensure that the bottom of the borehole was sealed at a depth of 28.0 ft. One-foot of filter sand was placed on top of the bentonite. A 10 ft section of the well screen (with a 6 in bottom cap) was set at a bottom depth of 27 ft. Construction details of SW-7 are included in Table 4.1 and Appendix C. The well installation (grouting of the borehole annulus) was completed on February 11, 2007. The well pad and protective casing were constructed and the well completed on February 12, 2007. Photo Number 028 depicts the completed shallow well SW-7 pad. Monitoring well SW-7 was developed on February 13, 2007.

Monitoring Well SW-8

Drilling and installation of monitoring well SW-8 began on February 10, 2007. Appendix A Photo Numbers 029 through 031 depict activities at SW-8. The 7 in diameter boring was drilled using 4¼-in inside diameter hollow stem augers to a depth of 29 ft. The boring was backfilled with one-foot of bentonite pellets to ensure that the bottom of the borehole was sealed at a depth of 28.0 ft. One-ft of filter sand was placed on top of the bentonite. A 10 ft section of well screen (with a 6 in bottom cap) was set at a bottom depth of 27 ft. Construction details of SW-8 are included in Table 4.1 and Appendix C. Drilling activities at shallow well SW-8 are shown in Photo Number 030. The well installation (grouting of the borehole annulus) was completed on February 11, 2007. The well pad and protective casing were constructed and the well completed on February 12, 2007. Monitoring well SW-8 was developed on February 16, 2007.

Monitoring Well SW-9

Drilling and installation of monitoring shallow well SW-9 began on March 26, 2007. Appendix A Photo Number 032 depicts activities at SW-9. The 7 in diameter boring was drilled using 4¼-in inside diameter hollow stem augers to a depth of 28 ft. The boring was backfilled with one-foot of bentonite pellets to ensure that the bottom of the borehole was sealed at a depth of 27.0 ft. One and a half ft of filter sand was placed on top of the bentonite. A 10 ft section of well screen (with a 6 in bottom cap) was set at a bottom depth of 25.5 ft. Construction details of SW-9 are included in Table 4.1 and Appendix C. The well installation (grouting of the borehole annulus) was completed on March 27, 2007. The well pad and protective casing were constructed and the well completed on March 28, 2007 and is depicted in Photo Number 032 of the selected photographs. Monitoring well SW-9 was developed on March 28, 2007.

Monitoring Well SW-10

Drilling and installation of monitoring well SW-10 began on February 11, 2007. Appendix A Photo Numbers 033 through 036 depict activities at SW-10. The 7 in diameter boring was

drilled using 4¼-in inside diameter hollow stem augers to a depth of 28.5 ft. The boring was backfilled with one and half ft of bentonite pellets to ensure that the bottom of the borehole was sealed at depth of 27.0 ft. One-foot of filter sand was placed on top of the bentonite. A 10 ft section of well screen (with a 6 in bottom cap) was set at a bottom depth of 26 ft which is depicted in Photo Number 033. Construction details of SW-10 are included in Table 4.1 and Appendix C. The well installation (grouting of the borehole annulus) was completed on February 12, 2007. The well pad and protective casing were constructed and the well completed on February 13, 2007. The completed pad for shallow well SW-10 is shown in Photo Number 034. Monitoring well SW-10 was developed on February 15, 2007.

5.0 DEEP GROUNDWATER MONITORING WELLS

The installation, completion and development of the deep groundwater monitoring wells DW-1, DW-2, DW-3, DW-4, DW-5, DW-6 and DW-7 began on February 6, 2007 and continued through March 13, 2007.

To obtain groundwater samples from deeper screened intervals, additional monitoring wells DW-2L, DW-3L and DW-4L were installed in April 2007 approximately 10 ft from the original deep well locations DW-2, DW-3 and DW-4. Appendix E contains the State of Arkansas Report on Water Well Construction & Pump Installation forms for all 10 deep wells.

Representatives from USGS geophysically logged monitoring wells DW-3 and DW-6 to a depth of 295 ft and 145 ft below ground surface (bgs) respectively.

Representatives from Century Geophysical Corporation (Century) geophysically logged monitoring wells DW-1 and DW-7 to a depth of 202 ft and 60 ft bgs respectively. The Gamma-Resistivity-Conductivity Logs prepared by Century for wells DW-1 and DW-7 are included in Appendix F.

The Sparta Formation was cored using a “NQ” size wireline core-barrel. This size core-barrel cuts a nominal 2⅛-in core. The cores were logged by a registered professional geologist and placed in wax protected cardboard core boxes for storage at EPA’s warehouse.

All monitoring wells were installed and completed in compliance with the Arkansas Water Well Construction Commission Rules and Regulations (January 28, 2006) which references the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD). The overlying terrace deposits were sealed off by installing 6 or 8 in inside diameter steel casing into the clay stratum underlying the terrace gravels and cement grouting the casing in place. The deep monitoring wells were generally screened in uppermost sand strata of the Sparta Sand Formation encountered while drilling.

The original cored borehole was reamed out to a nominal diameter of 6 or 8 in to approximately 5 ft below the bottom of the screened interval. If needed, the borehole was then back filled with bentonite to within 2 ft of the bottom of the screen that was then overlain by 2 ft of filter sand. Monitoring wells were constructed of 2 in diameter schedule 80 polyvinylchloride (PVC). All screens were PVC, 10 to 20 ft in length with 0.010 in slots. Filter sand consisted of sterilized 20/60 Custom Aggregates Filter Media. Filter sand was placed to a depth of 2 ft above the top of

the screen and then a minimum 2 ft bentonite seal was installed. One to two ft of fine sand was placed above the bentonite seal to prevent the grout from washing through the seal. The annulus of each well was grouted with a neat, type-1 portland cement grout, with approximately 5% bentonite added to reduce shrinkage. Steel bollards were painted yellow to enhance visibility and installed at the corners of each concrete pad except for deep well DW-3 which was located inside a fenced area. All IDW was containerized and drums were temporarily stored at each well site. For additional information regarding the deep monitoring well installation procedures, refer to Appendix B, Appendix C, and Appendix D (Shallow and Deep Groundwater Monitor Well Data Sheets).

Monitoring Well DW-1

Drilling for the installation of monitoring well DW-1 began on February 21, 2007. Appendix A Photo Numbers 037 through 039 depict activities at DW-1. The 12 in (nominal) diameter boring was drilled using 10¼-in inside diameter hollow stem augers to a depth of 28 ft bgs which is depicted in Photo Number 037. An 8-in diameter steel surface casing was set at a bottom depth of 28 ft bgs and grouted in place to isolate the shallow fluvial deposits. NQ wire line core drilling began on DW-1 on February 22, 2007. NQ Coring continued to the termination of the borehole at 233 ft bgs on February 25, 2007.

Monitoring well installation began on March 9, 2007. The previously NQ cored borehole was reamed to an 8 in (nominal) diameter using a modified tricone bit to a depth of 210 ft bgs. The boring was backfilled with bentonite to ensure that the bottom of the borehole was sealed. The bentonite was overlain by 2 ft of filter sand. A 10 ft well screen (with a bottom cap) was set at a bottom depth of 202 ft. Construction details of deep well DW-1 Table 5.1 (Deep Groundwater Monitoring Well Summary) and Appendix C. The well pad and protective casing were constructed and the well was completed on March 12, 2007. Monitoring well DW-1 was developed on March 13, 2007.

On March 16, 2007, the USGS performed down-hole geophysical logging of monitoring well DW-1. Photo Number 038 depicts a completed view of DW-1.

Monitoring Well DW-2

Drilling for the installation of monitoring well DW-2 began on March 6, 2007. Appendix A Photo Numbers 040 through 042 depict activities at DW-2. Photo Number 040 shows the drill rig set up at deep well DW-2. The 12 in (nominal) diameter boring was drilled using 10¼-in inside diameter hollow stem augers to a depth of 29.5 ft bgs. An 8 in diameter steel surface casing was set at a bottom depth of 31.5 ft bgs and grouted in place. NQ wire line core drilling began on deep well DW-2 on March 7, 2007. NQ Coring continued to the termination of the borehole at 299 ft bgs on March 9, 2007.

Monitoring well installation began on March 9, 2007. The previously NQ cored borehole was reamed to an 8-in (nominal) diameter using a modified tricone bit to a depth of 53 ft bgs. The boring was backfilled with bentonite to ensure that the bottom of the borehole was sealed. The bentonite was overlain by 2 ft of filter sand. A 10 ft well screen (with a bottom cap) was set at a bottom depth of 51 ft bgs. Construction details of DW-2 are included in Table 5.1 and Appendix C. The well pad and protective casing were constructed and the well was completed on March

11, 2007. Monitoring well DW-2 was developed on March 12, 2007 and is depicted in Photo Number 042.

Monitoring Well DW-2L

Drilling for the installation of monitoring well DW-2L began on April 21, 2007. Appendix A Photo Numbers 043 through 045 depict activities at DW-2L. The 10 in (nominal) diameter boring was drilled using 10³/₄-in inside diameter hollow stem augers to a depth of 29 ft bgs. A 6 in diameter steel surface casing was set at a bottom depth of 29 ft bgs and grouted in place. Mud rotary drilling techniques were used to drill to a depth of 139 ft bgs on April 22, 2007.

Monitoring well installation began on April 22, 2007. A 20 ft well screen (with a bottom cap) was set at a bottom depth of 139 ft bgs. Construction details of DW-2L are included in Table 5.1 and Appendix C. Monitoring well DW-2L was developed on April 23, 2007. The well pad and protective casing were constructed on April 25, 2007.

Monitoring Well DW-3

Drilling for the installation of monitoring well DW-3 began on February 12, 2007. Appendix A Photo Numbers 046 through 064 depict activities at DW-3. The 12 in (nominal) diameter boring was drilled using 10¹/₄-in inside diameter hollow stem augers to a depth of 33.5 ft bgs. An 8 in diameter steel surface casing was set at a bottom depth of 35 ft bgs and grouted in place to isolate the shallow fluvial deposits. NQ wire line core drilling began on deep well DW-3 on February 12, 2007 at approximately 33 ft bgs. NQ Coring continued to the termination of the borehole at 298 ft bgs on February 21, 2007. Photo Number 050 depicts the coring process for deep well DW-3.

On February 21 2007, the USGS performed down-hole geophysical logging of DW-3. The Logging was conducted to a depth of 293 ft bgs.

Monitoring well installation began on February 23, 2007. The previously NQ cored borehole was reamed to an 8 in (nominal) diameter using a modified tricone bit to a depth of 56 ft bgs. The boring was backfilled with bentonite to ensure that the bottom of the borehole was sealed. A view showing the air rig at DW-3 is depicted in Photo Number 051. The bentonite was overlain by 2 ft of filter sand. A 10 ft well screen (with a bottom cap) was set at a bottom depth of 50 ft bgs. Construction details of deep well DW-3 are included in Table 5.1 and Appendix C. The well pad and protective casing were constructed and the well completed on March 6, 2007. Monitoring well DW-3 was developed on March 7, 2007. Photo Number 064 shows a final view of DW-3.

Monitoring Well DW-3L

Drilling for the installation of monitoring well DW-3L began on April 18, 2007. Appendix A Photo Numbers 065 through 068 depict activities at DW-3L. The 10 in (nominal) diameter boring was drilled using 10³/₄-in inside diameter hollow stem augers to a depth of 33 ft bgs. A 6 in diameter steel surface casing was set at a bottom depth of 32.5 ft bgs and grouted in place. Mud rotary drilling techniques were used to drill to approximately 140 ft bgs on April 19, 2007.

Monitoring well installation began on April 20, 2007. A 20 ft well screen (with a bottom cap) was set at a bottom depth of 138 ft bgs. Construction details of DW-3L are included in Table 5.1 and Appendix C. Monitoring well DW-3L was developed on April 23, 2007.

Monitoring Well DW-4

Drilling for the installation of monitoring well DW-4 began on March 10, 2007. Appendix A Photo Numbers 069 through 077 depict activities at DW-4. The 12 in (nominal) diameter boring was drilled using 10¼-in inside diameter hollow stem augers to a depth of 30 ft bgs. An 8 in diameter steel surface casing was set at a bottom depth of 31 ft bgs and grouted in place to isolate the shallow fluvial deposits. NQ wire line core drilling began on DW-4 on March 7, 2007 at approximately 30 ft bgs. NQ Coring continued to the termination of the borehole at 300 ft bgs on March 13, 2007.

Monitoring well installation began on March 9, 2007. The previously NQ cored borehole was reamed to an 8 in (nominal) diameter using a modified tricone bit to a depth of 64 ft bgs. Photo Number 069 depicts a view of the tricone drill bit. The boring was backfilled with bentonite to ensure that the bottom of the borehole was sealed. The bentonite was overlain by 2 ft of filter sand. A 10 foot well screen (with a bottom cap) was set at a bottom depth of 51 ft bgs. Construction details of deep well DW-4 are included in Table 5.1 and Appendix C. The well pad and protective casing were constructed and the well completed on March 13, 2007. Monitoring well DW-4 was developed on March 13, 2007 and is shown in Photo Numbers 073 and 077.

Monitoring Well DW-4L

Drilling for the installation of monitoring well DW-4L began on April 22, 2007. Appendix A Photo Numbers 078 and 079 depict activities at DW-4L. The 10 in (nominal) diameter boring was drilled using 10¾-in inside diameter hollow stem augers to a depth of 30 ft bgs. A 6 in diameter steel surface casing was set at a bottom depth of 29 ft bgs and grouted in place. Mud rotary drilling techniques were used to drill to approximately 30 ft bgs on April 23, 2007. NQ Coring continued to the termination of the borehole at 135 ft bgs on April 23, 2007.

Monitoring well installation began on April 23, 2007. The previously NQ cored borehole was reamed to an 6 in (nominal) diameter using a modified tricone bit to a depth of 136 ft bgs. The boring was backfilled with bentonite to ensure that the bottom of the borehole was sealed. The bentonite was overlain by 2 ft of filter sand. A 20 ft well screen (with a bottom cap) was set at a bottom depth of 135 ft bgs. Construction details of deep well DW-4L are included in Table 5.1 and Appendix C. The well pad and protective casing were constructed and the well completed on April 24, 2007. Monitoring well DW-4L was developed on April 24, 2007.

Monitoring Well DW-5

Drilling for the installation of monitoring well DW-5 began on February 9, 2007. Appendix A Photo Numbers 080 through 088 depict activities at DW-5. The 12 in (nominal) diameter boring was drilled using 10¼-in inside diameter hollow stem augers to a depth of 39 ft bgs. An 8 in diameter steel surface casing was set at a bottom depth of 39 ft bgs and grouted in place. The welded joint surface casing and the tremie pipe placed between the surface casing are shown in Photo Numbers 083 and 084. NQ wire line core drilling began on deep well DW-6 on February 10, 2007. NQ Coring continued to the termination of the borehole at 299 ft bgs on February 12,

2007. Fragments of the Sparta Sands that were cored from deep well DW-5 as well the completed coring process at deep well DW-5 is shown in Photo Numbers 085 and 086 of the selected photographs respectively.

Monitoring well installation began on February 25, 2007. The previously NQ cored borehole was reamed to an 8-in (nominal) diameter using a modified tricone bit to a depth of 86 ft bgs. The boring was backfilled with bentonite to ensure that the bottom of the borehole was sealed. The bentonite was overlain by 2 ft of filter sand. A 10 ft well screen (with a bottom cap) was set at a bottom depth of 81 ft bgs. Construction details of DW-5 are included in Table 5.1 and Appendix C. The well pad and protective casing were constructed and the well completed on March 7, 2007. Monitoring well DW-5 was developed on March 7, 2007 and is shown in Photo Number 088.

Monitoring Well DW-6

Drilling for the installation of monitoring well DW-6 began on February 6, 2007 and is shown in Photo Number 094. Appendix A Photo Numbers 089 through 103 depict activities at DW-6. The 12 in (nominal) diameter boring was drilled using 10¼-in inside diameter hollow stem augers to a depth of 38 ft bgs. An 8 in diameter steel surface casing was set at a bottom depth of 38 ft bgs and grouted in place. The preparation of the grout for DW-6 is shown in Photo Number 093. NQ wire line core drilling began on deep well DW-6 on February 8, 2007. NQ Coring continued to the termination of the borehole at 203.5 ft bgs on February 9, 2007. A completed core box from DW-6 is shown in Photo Number 097.

On February 21 2007, the USGS performed down-hole geophysical logging of deep well DW-6. The Logging was conducted to a depth of 145 ft bgs.

Monitoring well installation began on February 27, 2007. The previously NQ cored borehole was reamed to an 8 in (nominal) diameter using a modified tricone bit to a depth of 172 ft bgs. The boring was backfilled with bentonite to ensure that the bottom of the borehole was sealed. The bentonite was overlain by 2 ft of filter sand. A 20 ft well screen (with a bottom cap) was set at a bottom depth of 168 ft bgs. Construction details of DW-6 are included in Table 5.1 and Appendix C. The well pad and protective casing were constructed and the well completed on March 7, 2007. Monitoring well DW-6 was developed on March 8, 2007. Photo Numbers 090 and 101 show the IDW drums being transferred to the assigned fenced area as well as a view of deep well DW-6 after the pad and casing were completed respectively.

Monitoring Well DW-7

Drilling for the installation of monitoring well DW-7 began on February 25, 2007 and is depicted in Photo Number 104. Appendix A Photo Numbers 104 through 108 depict activities at DW-7. The 12 in (nominal) diameter boring was drilled using 10¼-in inside diameter hollow stem augers to a depth of 34 ft. An 8 in diameter steel surface casing was set at a bottom depth of 34 ft bgs and grouted in place. NQ wire line core drilling began on deep well DW-7 on February 26, 2007. NQ Coring continued to the termination of the borehole at 299.5 ft bgs on March 6, 2007.

Monitoring well installation began on March 8, 2007. The previously NQ cored borehole was reamed to an 8-in (nominal) diameter using a modified tricone bit to a depth of 133 ft bgs. The boring was backfilled with bentonite to ensure that the bottom of the borehole was sealed. The bentonite was overlain by 2 ft of filter sand. A 10 foot well screen (with a bottom cap) was set at a bottom depth of 129 ft bgs. Construction details of DW-7 are included in Table 5.1 and Appendix C. The well pad and protective casing were constructed and the well completed on March 11, 2007. Monitoring well DW- 7 was developed on March 8, 2007 and is shown in Photo Number 108.

On March 16, 2007, the USGS performed down-hole geophysical logging of DW-7. The Logging was conducted to a depth of 60 ft bgs.

6.0 SAMPLE COLLECTION ACTIVITIES

Mr. Stephen Phillips, Mr. Richard Hardy, Mr. Tim Osburn and Mr. Todd Quillen collected, handled, prepared and delivered soil and groundwater samples in accordance with the site-specific Sampling and Analysis Plan (SAP) and the Quality Assurance Project Plan (QAPP). Descriptions of each media specific sampling are included below. All IDW was containerized and properly disposed of off site.

Lithologic Logging

To determine visible sedimentary characteristics including stratification, texture, coloring, weathering, laminations, grain size and sample efficiency, consolidated soil samples were collected from the seven deep monitoring wells' boreholes by the use of a Shelby® tube. The samples were cored, observed, documented and screened using a photo-ionization detector (PID) which was calibrated daily. The consolidated soil samples were boxed, labeled and prepared for transport to the U.S. EPA representative. Observations of the consolidated soil samples are provided in the Shallow and Deep Groundwater Boring Logs presented in Appendix C.

IDW Soil Samples

Unconsolidated soil samples were collected by using a splitspoon device. Soil samples were placed in 4-oz unpreserved jars for analysis of perchlorate, explosives and RCRA metals. During the sampling activities, appropriate quality control samples were collected in accordance with TechLaw's, U.S. EPA-approved, SAP and QAPP. Disposable sampling equipment was used to minimize contamination. Samples were labeled and then placed on ice. All unconsolidated soil samples were delivered to GPL via FedEx.

Groundwater Samples

Sampling shallow groundwater wells required the use of a Waterra® sampler (SS-10 Micro Flow Foot Valve). The foot valve was screwed into the bottom of the length of polyethylene tubing which was inserted into the well to the middle of the well screen. When the groundwater reached the surface, monitoring for parameters and sample collection took place. A low-flow air operated submersible bladder pump was used to collect the water samples. Packers were used to isolate screened zones if required.

All groundwater samples were collected from the SNAD site by the TechLaw team following the general guidelines set forth in TechLaw's SOP No. 06-04-00, Groundwater Sampling/Monitoring and Analysis-Sampling Activities. Prior to sampling, groundwater parameters were measured using a flow-through cell. Field observations were made for each monitoring well and are listed in Table 6.1, Sample Field Parameters for Shallow Groundwater Well Samples and Table 6.2, Sample Field Parameters for Deep Groundwater Well Samples.

Duplicate samples were collected from the shallow and deep groundwater wells and are denoted with a letter 'D' at the end of the sample identification. Two additional samples, collected from shallow wells SW-7 and SW-8, were analyzed only for volatile organic compounds (VOCs) and are denoted with a letter 'V' at the end of the sample identification.

7.0 ANALYTICAL RESULTS

All analytical results were compared to EPA Region III Risk Based Concentration (RBC) Levels and EPA Region VI Media Specific Screening Levels (MSSL). Sample Information, Table 7.1, provides a summary of the GPL Laboratory analytical activities.

Several quality control samples were collected as proposed in the QAPP. As can be seen in Table 7.2, Summary of Analytical Results for Quality Control Samples, no quality control samples exceeded either the MSSL or RBC screening levels.

Two IDW samples were collected from SW-4 and SW-9 to determine the perchlorate concentration. The perchlorate concentration in these samples was <0.30 ug/L.

Twenty groundwater samples were collected from the ten shallow well locations and were analyzed for RCRA metals, VOCs, SVOCs, total mercury, perchlorate, and explosives. Samples collected from shallow wells SW-1, SW-1D, SW-5, SW-6, SW-7, SW-8 and SW-10 showed arsenic concentrations exceeding both the MSSL and RBC screening levels with a maximum concentration of 29.60 micrograms per liter (ug/L). Lead concentrations exceeded the MSSL screening level with a maximum concentration of 65.90 ug/L and were found in samples from shallow wells SW-5, SW-6, SW-7 and SW-10. Samples collected from shallow wells SW-1, SW-2, SW-3 SW-5, SW-7 and SW-10 exceeded both the MSSL and RBC screening levels for the analyte bis(2-ethylhexyl)phthalate. The maximum concentration observed was 72.00 ug/L. Table 7.3, Summary of Exceedances for Shallow Groundwater Well Samples, provides a general conclusion to the analytical results from the shallow groundwater samples. Table 7.4, Summary of Analytical Results for Shallow Groundwater Well Samples, provides a comparison of the deep groundwater samples with the screening levels.

Thirteen deep groundwater samples were collected from the seven deep water locations and were analyzed for the identical analytical suite as the shallow well groundwater samples. Similar results were observed for the deep well groundwater samples. Arsenic, lead and bis(2-ethylhexyl)phthalate exceeded the screening levels. Deep groundwater samples DW-1, DW-2, DW-2L, DW-2LD, DW-3L, DW-4 and DW-4L exceeded both the MSSL and RBC arsenic screening levels with a maximum concentration of 18.30 ug/L. Deep groundwater samples DW-2, DW-2L, DW-2LD, DW-4, DW-4L exceeded the MSSL lead screening level with a maximum concentration of 65.90 ug/L. Samples collected from deep groundwater samples DW-1, DW-2L,

DW-2LD, DW-3, DW-3L, DW-4, DW-4L, DW-5 and DW-6 exceeded the MSSL and RBC screening levels for bis(2-ethylhexyl)phthalate with a maximum concentration of 9.20 ug/L. Table 7.5, Summary of Exceedances for Deep Groundwater Well Samples, provides a general conclusion to the analytical results from the deep groundwater samples. Table 7.6, Summary of Analytical Results for Deep Groundwater Well Samples, provides a comparison of the deep groundwater samples with the screening levels.

8.0 REFERENCES

[Final](#) Decision Document, Former Shumaker Naval Munitions Site, U.S. Army Corp of Engineers, 2003.

Arkansas Water Well Construction Commission Rules and Regulations (January 28, 2006):
<http://www.accessarkansas.org/awwcc/UPDATED%20RULES%20WITH%20DX%20REVISIONS2005doc.pdf>

FIGURES

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