FINAL WORK PLAN

SHEPLEY'S HILL LANDFILL SUPPLEMENTAL INVESTIGATION TO DEMONSTRATE PLUME CAPTURE

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

AUGUST 2017

Prepared for:
U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

Prepared by:
KOMAN Government Solutions, LLC
Contract No.: W912WJ-17-C-0010

SHEPLEY'S HILL LANDFILL SUPPLEMENTAL INVESTIGATION TO DEMONSTRATE PLUME CAPTURE FORMER FORT DEVENS ARMY INSTALLATION DEVENS, MA

August 2017

CERTIFICATION:

I hereby certify that the enclosed Report, shown and marked in this submittal, is that proposed to be incorporated with Contract Number W912WJ-17-C-0010. This Document was prepared in accordance with the U.S. Army Corps of Engineers Scope of Work and is hereby submitted for Government Approval.

Reviewed By:

July 28, 2017

KGS Project Manager **Date**

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USACE Project Manager **Date**

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
Army	U.S Army
bgs	below ground surface
BRAC	Base Realignment and Closure
ºC	Degrees Celsius
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CMR	Code of Massachusetts Regulations
cy	cubic yards
DO	Dissolved Oxygen
DoD	Department of Defense
DQCR	Daily Quality Control Report
DRFTA	Devens Reserve Forces Training Area
EM	Engineer Manual
ESD	Explanation of Significant Differences
FS	Feasibility Study
ft	feet
ft/min	feet per minute
gpm	gallons per minute
HSA	hollow stem auger
ID	Identification
IDW	Investigation-Derived Waste
KGS	KOMAN Government Solutions, LLC
LCS	Laboratory Control Sample
L/min	Liters per minute
LTM	Long Term Monitoring
LTMMP	Long Term Monitoring and Maintenance Plan
MassDEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NIA	Northern Impact Area

NTCRA	Non-Time Critical Removal Action
NTU	Nephelometric Turbidity Units
ORP	Oxidation Reduction Potential
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
PID	Photoionization Detector
PPE	Personal Protection Equipment
PM	Project Manager
PSP	Plow Shop Pond
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QSM	Quality Systems Manual
RAO	Remedial Action Objective
RI	Remedial Investigation
ROD	Record of Decision
SHL	Shepley's Hill Landfill
SOP	Standard Operating Procedure
SP16	Screen Point 16
SI	Site Investigation
UFP	Unified Federal Program
USACE	U.S. Army Corps of Engineers, New England District
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound

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1. INTRODUCTION

1.1 Purpose

This Work Plan describes activities associated with supplemental investigations planned at Shepley's Hill Landfill (SHL) at the Former Fort Devens Army Installation, Devens, Massachusetts. This document constitutes the planning document, addressing specific protocols for subsurface profiling, sample collection, sample handling and storage, chain-of-custody, laboratory and field analyses, data validation, and data reporting. This document is to be used in combination with the Unified Federal Program Generic Quality Assurance Project Plan (UFP QAPP) (H&S Environmental, 2015), with revisions through 2016 (KGS, 2016). The investigations described in this Work Plan were developed to satisfy the requirements of the U.S. Environmental Protection Agency (USEPA) Scope of Work (SOW) described in their letter to the U.S. Army from 24 February 2016.

This Work Plan was prepared by KOMAN Government Solutions, LLC (KGS) on behalf of U.S. Army Corps of Engineers (USACE) New England District, under Contract Number W912WJ-17-C-0010. This Work Plan complies with applicable USACE New England District, USEPA Region 1, and Massachusetts Department of Environmental Protection (MassDEP) requirements, regulations, guidance, and technical standards.

1.2 Background

Fort Devens is located within the towns of Ayer and Shirley in Middlesex County and Harvard and Lancaster in Worcester County, Massachusetts, approximately 35 miles northwest of Boston, Massachusetts. Prior to the official base closure, Fort Devens was divided into the North Post, Main Post, and South Post (**Figure 1**). The SHL site which is the subject of this Work Plan is located within the North Post area. The South Post, generally referenced as the South Post Impact Area, consists of the portion of the South Post that encompasses the training ranges. Route 2 divides the South Post from the Main Post. The Nashua River runs through the North, Main, and South Posts. The area surrounding Fort Devens is largely rural residential property.

Camp Devens was established in 1917 as a temporary training area for soldiers during World War I. Prior to 1917, the area was occupied by residential homes and farmland. In 1932, the site was named Fort Devens and made a permanent installation with the primary mission of commanding, training, and providing logistical support for non-divisional troop units. The installation also supported the Army Readiness Regional and National Guard units in the New England area. Fort Devens was used for a variety of training missions between 1917 and 1990. Pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, Fort Devens was placed on the National Priorities List on November 21, 1989, due to environmental contamination at several sites.

Fort Devens was identified for cessation of operations and closure under Public Law 101-510, the Defense Base Realignment and Closure (BRAC) Act of 1990, and officially closed in March 1996. As part of the Fort Devens BRAC program, portions of the property formerly occupied by Fort Devens were retained by the U.S. Army (Army) for reserve forces training and renamed the Devens Reserve Forces Training Area (DRFTA). Areas not retained as part of DRFTA were, or are in the process of being, transferred to new owners for reuse and redevelopment.

SHL encompasses approximately 84 acres in the northeast corner of the main post of the former Fort Devens (**Figure 1**). The landfill is bordered to the northeast by Plow Shop Pond (PSP), to the west by Shepley's Hill, to the south by recent commercial development, and to the east by land formerly containing a railroad roundhouse. Nonacoicus Brook, which drains PSP, is located north of the landfill in the Northern Impact Area (NIA). The NIA is identified as the area north of the SHL with suspected groundwater contamination associated with the landfill.

SHL was reportedly operating by the early 1940s; however, evidence from test pits within the landfill suggests earlier usage, possibly as early as the mid-nineteenth century. The landfill contains a variety of waste materials including, but not limited to, incinerator ash, demolition debris, asbestos, sanitary wastes, and glass. The maximum depth of the refuse occurs in the central portion of the landfill and is estimated to extend about 40 feet below ground surface (bgs). The volume of waste in the landfill has been estimated at over 1.3 million cubic yards (cy), of which approximately 160,000 cy (11%) is below the water. The saturated wastes appear to be emplaced in a wetland; at least two areas previously mapped as wetlands were filled (Harding ESE, 2002), and the waste has been found to be underlain by peat deposits (Sovereign, 2011).

The Massachusetts Department of Environmental Protection (MassDEP) approved the landfill closure plan in 1985. The landfill was closed in five phases between 1987 and 1993 in accordance with 310 Code of Massachusetts Regulations (CMR) 19.000. Closure consisted of capping the landfill with a 30 to 40-mil polyvinyl chloride (PVC) membrane, covering the cap with soil and vegetation, and installing gas vents. Closure also included installation of wells to monitor groundwater quality around the landfill and construction of drainage swales to control surface water runoff.

Subsequent to closure of the landfill, the Army completed Remedial Investigations (RIs) under CERCLA which evaluated soil, sediment, surface water, and groundwater conditions at and in the immediate vicinity of the landfill. The RIs identified the presence of various compounds, particularly certain inorganics, including arsenic, and volatile organic compounds (VOCs), in groundwater, sediment, and surface water at and adjacent to the SHL. The Army's Feasibility Study (FS) and Record of Decision (ROD) resulted in a Remedial Action requiring long term monitoring, including maintenance of the existing landfill cap and groundwater monitoring.

As described in the ROD (USACE, 1995), the Remedial Action Objectives (RAO) are to:

- Protect potential residential receptors from exposure to contaminated groundwater migrating from the landfill having chemicals in excess of Maximum Contaminant Levels (MCLs); and
- Prevent contaminated groundwater from contributing to the contamination of Plow Shop Pond sediments in excess of human health and ecological risk-based concentrations.

The ROD required the Army to perform groundwater monitoring and five-year reviews to evaluate the effectiveness of the selected remedial action, which at the time relied heavily on the landfill cap to attain groundwater cleanup goals by 2008 and to reduce potential exposure risks. If concentrations in groundwater, primarily arsenic, met risk-based performance standards over time, the ROD did not require further action; however, if goals were not met, the ROD required implementation of a groundwater extraction contingency remedy component. Due to continued arsenic concentrations greater than MCLs, the Army installed and began operating a groundwater extraction and treatment system, also known as the Arsenic Treatment Plant (ATP), in March 2006 as a contingency remedy component to address groundwater contamination emanating from the northern portion of the landfill (CH2M Hill, 2005).

In 2012, the Army installed a low-permeability groundwater barrier wall between the SHL and the Red Cove area of PSP (Area of Concern 72) as part of a Non-Time Critical Removal Action (NTCRA). The barrier wall was installed from August to September 2012 in an effort to mitigate arsenic flux to Red Cove/PSP by groundwater flow from the SHL (**Figure 2**). In 2014, land use controls were implemented pursuant to an Explanation of Significant Differences (ESD) (Sovereign, 2013) to restrict groundwater use and further protect potential receptors in the area located north of the landfill in the NIA (i.e., the groundwater impacted off-site that includes properties in Ayer along West Main Street, north of the landfill). These land use controls were incorporated into the ROD.

1.3 Supplemental Site Investigation

This Work Plan describes the activities for supplemental investigations to be conducted at SHL. The focus of the Work Plan is to redo Phase 1 Tasks 1 through 3 in accordance with the USEPA SOW for Additional Work (or "EPA SOW"). Phase 1 Tasks 4 and 5 are not included in this Work Plan and will be addressed separately. Although the EPA SOW did not require the submission of a Work Plan, EPA agreed in response to the Army's request to amend the EPA SOW Enforceable Milestone Schedule to include submission of this Work Plan in order to help ensure that the data collection effort is consistent with the requirements of the EPA SOW. In addition to the EPA SOW, the Army also plans to install two new piezometers in support of the ongoing groundwater hydraulic monitoring program at SHL.

EPA SOW Investigation

In addition to ongoing data collection for the evaluation of remedial operations and overall remedy performance per the *Updated SHL Long Term Monitoring and Maintenance Plan* (LTMMP) (Sovereign, 2015), the Army will conduct a supplemental investigation at SHL in response to USEPA's SOW (USEPA, 2016) to assist in the determination of whether the selected Remedial Action is protective of human health and the environment over the long term. This Work Plan addresses Phase 1 of the USEPA SOW which is to "demonstrate plume capture" at SHL. As such, the Army will collect sufficient data to demonstrate that the existing groundwater extraction and treatment system, as designed, constructed, and operated, provides sufficient containment/capture of the contamination migrating from SHL. The remaining phases of the USEPA SOW will be addressed under separate cover.

The activities included in the EPA SOW investigation are described in **Section 2.1**.

Groundwater Hydraulic Monitoring Support

The Army will install two new 2-inch diameter piezometers located adjacent to the two existing groundwater extraction wells (EW-1 and EW-4) at the SHL in order to facilitate groundwater hydraulic monitoring in that area as part of the ongoing LTM program. The activities included in this effort are described in **Section 2.2**.

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2. SAMPLING AND ANALYSIS PLAN

This section describes the sampling and analysis plan for supplemental investigation activities at the SHL. The work will be performed in accordance with the project-specific sampling and analysis plan and the guidelines set forth in the USACE Engineer Manual (EM) EM200-1-2, Technical Project Planning Guidance for Hazardous, Toxic, and Radioactive Waste Data Quality Design (USACE, 1995) and USEPA, Region 1, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells (USEPA, Region 1, 2010). Standard Operating Procedures for field sampling and analytical testing tasks are presented in the QAPP (KGS, 2016). Descriptions of field activity methods and procedures are included in **Section 3**.

2.1 EPA SOW Investigation Activities

This section describes investigation activities that are included in Phase 1, Tasks 1 through 3 of EPA SOW for Additional Work (EPA 2016) for demonstrating plume capture. The fieldwork for this supplemental investigation includes the following tasks:

1. Delineate the capture zone based on hydraulic and geochemical data;
2. Delineate the lateral and vertical extent of the contamination upgradient of extraction system; and
3. Delineate the lateral and vertical extent of the contamination downgradient of extraction system along Sculley Road.

Drilling locations for this work plan are shown on **Figure 2**.

EPA SOW Phase 1 Task 1

(Delineate the capture zone based on hydraulic and geochemical data)

In the 24 February 2016 EPA SOW, Task 1 included the installation of five paired piezometers near the extraction wells (Task 1.c) and conducting vertical groundwater profiling in that area (Task 1.d). On 9 March 2017, EPA issued a revised Enforceable Milestone Schedule for the redo of Phase 1 Additional Work which indicated that Task 1.c is not required at this time; therefore, the following procedures pertain to Task 1.d (collecting vertical profile data via direct push to refusal at five locations):

a. Monitoring wells in the immediate vicinity of the boring locations will be gauged prior to drilling to determine the approximate depth to water.

b. The borings will be installed adjacent to and upgradient of the nested wells installed in this area in 2016 (**Figure 3**). Borings will be conducted using a Geoprobe® drill rig utilizing direct push technology to advance each boring to refusal, and groundwater profile samples will be collected at 10-foot intervals from the first vertical sample collected to refusal. Groundwater samples will be collected through the Geoprobe® Screen Point 16 (SP16) Groundwater Sampler (see **Appendix B** for detail about this sampler). The SP16 Groundwater Sampler is a direct push device consisting of a PVC screen (slot size 0.010-inch) that is driven to the targeted depth within a sealed, steel sheath and then deployed for the collection of representative groundwater samples.

To collect a groundwater sample from a specific depth the sampler is threaded onto the leading end of a Geoprobe® probe rod and advanced into the subsurface. When the targeted depth is reached, the tool string is retracted exposing 24 inches of the screen to the surrounding formation allowing formation water to enter the screen.

c. After each depth interval, the tooling will be 1) retracted to the top, 2) sampling screen reset in the sheath and, 3) a new expendable drive point installed.

d. At the same location, the tool string is retracted and tooling reset to the next interval depth and a repeat of Steps E through I (below) will be conducted. The overall process will be repeated until refusal.

e. Purging will be conducted by removing 2-times the tooling volume prior to connecting to flow cell. The tooling volume is the volume of the tubing from the surface to the screen plus the interior of the screen. However, if make-up water *must* be used to prevent formation sand from heaving inside the tooling, a purge of 2-times the tooling volume or make-up volume, whichever is greater, will be performed.

f. The sample tubing or down-hole pump inlet will be placed at the depth of the temporary profiler screen for purging; if required, the purge will also remove accumulated solids within the drill rods to facilitate stabilized conditions.

g. Use of high-capacity, in-line filters (10-micron, 5-micron, 1-micron; singly or in series) prior to flow cell to reduce turbidity below 10 Nephelometric Turbidity Units (NTU) (protects electrodes) will be added to the sample tubing during low flow parameter stabilization period.

h. Use of low-flow stability criteria for flow cell electrodes (with in-line filters in place) prior to collecting sample will be conducted (this is a deviation from low-flow Standard Operating Procedure [SOP]).

i. Collection of groundwater samples filtered using a 0.45-micron filter. If filter clogging occurs before the required bottle volume can be achieved, the sampler will use either 10-, 5-, or 1-micron filters in-line prior to the 0.45-micron filter in order to minimize suspended solids or turbidity.

j. Profile sample locations are summarized in **Table 1**.

k. Groundwater sample acquisition will be performed using either a stainless-steel submersible pump or a peristaltic pump dependent on depth to water table. Sampling and analysis shall be consistent with methods identified above, and in the *SHL LTMMP Update* (Sovereign, 2015). Samples will be submitted for the analytical parameters as listed in **Table 2**. Details regarding these laboratory analyses are included in the QAPP (KSG, 2016).

l. Cross sections of the proposed boring locations and existing wells are presented on **Figure 4** and **Figure 5** and show estimated depths to bedrock.

m. Upon completion of each profile boring the boring will be pressure grouted with a cement/bentonite mixture for borehole abandonment.

On or before December 1, 2017, Army will submit a draft revised Phase 1, Task 1 Technical Memorandum (Task 1.g) to EPA that defines the lateral and vertical extent of the capture zone of the two extraction wells based on hydraulic data collected with the system operating at 50 gallons per minute and that the assessment will build upon the data and methodology developed by EPA in its 2013 capture zone assessment. The Technical Memorandum shall include the hydraulic data collected, a comparison of observed and predicted flow vectors and a map showing the horizontal and vertical extent of the plume capture zone (i.e., Tasks 1.b through 1.f) for the extraction wells based on the hydraulic data collected.

EPA SOW Phase 1 Task 2

(Delineate the lateral and vertical extent of the contamination upgradient of extraction system)

Task 2 field work includes the following:

a. Vertical profile sampling shall be performed along the upgradient transect SHL-23 to SHL-21 as shown on **Figures 6** and **7**. The Army shall install three (3) approximately equally-spaced borings at locations between or near SHL-23 and EW-04 and four (4) approximately equally-spaced borings at locations between SHP-05-46 and SHM-10-06A. The locations will be offset approximately 10 feet along the transect from the borings advanced in 2016 and will be hydraulically upgradient from previous borings (in order to avoid potential groundwater quality impacts from grout used in the 2016 borings). Borings will be conducted using a Geoprobe® drill rig utilizing direct push technology. SB-17-06 will have groundwater profile split samples collected by EPA and perform expedited chemical analysis by EPA to determine if a filtered arsenic concentration of 150 µg/L or higher is encountered at one or more vertical profile intervals. If arsenic concentrations are at or above 150 µg/L it will be necessary to conduct an additional profile(s) at a location(s) further west of the currently proposed western extent of the upgradient transect (Figure 7). The upgradient transect and SB-17-06 will be conducted near the beginning of the field effort to help provide sufficient time for preliminary analytical chemistry data from the profile location to facilitate a decision for the need to move further west.

b. Monitoring wells in the immediate vicinity of the boring locations will be gauged prior to drilling to determine the approximate depth to water.

c. Borings will be conducted using a Geoprobe® drill rig utilizing direct push technology to advance each boring to refusal and collect groundwater profile samples at 10-foot intervals from the first vertical sample through to refusal. Groundwater samples will be collected using the Geoprobe® SP16 Groundwater Sampler. The SP16 Groundwater Sampler is a direct push device consisting of a PVC screen (slot size 0.010-inch) that is driven to depth within a sealed, steel sheath and then deployed for the collection of representative groundwater samples. To collect a groundwater sample from a specific depth the sampler is threaded onto the leading end of a Geoprobe® probe rod and advanced into the subsurface. The targeted depth is reached the tool string is retracted exposing 24 inches of the screen to the surrounding formation allowing formation water to enter the screen.

d. After each depth interval, the tooling will be 1) retracted to the top, 2) the sampling screen reset in the sheath and, 3) a new expendable drive point installed.

e. At the same location, the tool string is retracted and tooling reset to the next interval depth and repeat of Steps F through J (below) will be conducted. The overall process will be repeated until refusal.

f. Purging will be conducted by removing 2-times the tooling volume prior to connecting to flow cell. However, if make-up water *must* be used to prevent formation sand from heaving inside the tooling, a purge of 2-times the tooling volume or make-up volume, whichever is greater, will be performed.

g. The sample tubing or down-hole pump inlet will be placed at the depth of the temporary profiler screen for purging; if required, the purge will also remove accumulated solids within the drill rods to facilitate stabilized conditions.

h. Use of high-capacity, in-line filters (10-micron, 5-micron, 1-micron; singly or in series) prior to flow cell to reduce turbidity to less than 10 NTU (protects electrodes) will be added to the sample tubing during low flow parameter stabilization period.

i. Use of low-flow stability criteria for flow cell electrodes (with in-line filters in place) prior to collecting sample will be conducted (this is a deviation from low-flow SOP).

j. Collection of groundwater samples filtered using a 0.45-micron filter. If filter clogging occurs before required bottle volume can be achieved, then the sampler will use either 10-, 5-, or 1-micron filters in-line prior to the 0.45-micron filter in order to minimize suspended solids or turbidity.

k. Profile sample locations are summarized in **Table 1**.

l. Groundwater sample acquisition will be performed using either a stainless-steel submersible pump or a peristaltic pump dependent on depth to water table. Sampling and analysis shall be consistent with methods identified above and in the *SHL LTMMP Update* (Sovereign, 2015). Samples will be submitted for the analytical parameters as listed in **Table 2**. Details regarding these laboratory analyses are included in the Base Wide UFP-QAPP (KGS, 2016).

m. Following sample collection, the profile boring will be pressure grouted with a cement /bentonite mixture to ground surface and the borehole abandoned.

n. Based on the results of this work, the location of permanent monitoring wells shall be determined and will be installed later to monitor the performance of the remedy.

On or before December 1, 2017, Army will submit a draft revised Phase 1, Task 2 Technical Memorandum (Task 2.d) to EPA that includes data from the profile investigation and a map that defines the vertical and horizontal extent of the plume upgradient of the extraction wells based on the data collected and any other relevant data. In addition, the draft Phase 1 Task 2 Technical Memorandum shall compare this delineated plume to the mapped capture zone determined in Phase 1 Task 1.

EPA SOW Phase 1 Task 3

(Delineate the lateral and vertical extent of the contamination downgradient of extraction system along Sculley Road)

Task 3 field work includes the following:

a. Vertical profile sampling will be performed along Sculley Road at six (6) locations along the transect SHM-07-03 and SHM-99-31A/B/C as shown on **Figures 8** and **9**. The locations will be offset approximately 10 feet along the transect from the similar locations conducted in 2016, as feasible based on the available space along Sculley Road and the presence of utilities. Because of the road and utilities, it may not be possible to locate these upgradient of the previous sampling locations.

b. Monitoring wells in the immediate vicinity of the boring locations will be gauged prior to drilling to determine the approximate depth to water.

c. Borings will be conducted using a Geoprobe® drill rig utilizing direct push technology to advance each boring to refusal and collect groundwater profile samples at 10-foot intervals from the first vertical sample through to refusal. Groundwater samples will be collected using the Geoprobe® SP16 Groundwater Sampler. The SP16 Groundwater Sampler is a direct push device consisting of a PVC screen (slot size 0.010-inch) that is driven to depth within a sealed, steel sheath and then deployed for the collection of representative groundwater samples. To collect a groundwater sample from a specific depth the sampler is threaded onto the leading end of a Geoprobe® probe rod and advanced into the subsurface. When the targeted depth is reached, the tool string is retracted exposing 24 inches of the screen to the surrounding formation allowing formation water to enter the screen.

d. After each depth interval, the tooling will be 1) retracted to the top, 2) the sampling screen reset in the sheath and, 3) a new expendable drive point installed.

e. At the same location, the tool string is retracted and tooling reset to the next interval depth and repeat of steps F-J (below) will be conducted. The overall process will be repeated until refusal.

f. Purging will be conducted by removing 2-times the tooling volume prior to connecting to flow cell. However, if make-up water *must* be used to prevent formation sand from heaving inside the tooling, a purge of 2-times the tooling volume or make-up volume, whichever is greater, will be performed.

g. The sample tubing or down-hole pump inlet will be placed at the depth of the temporary profiler screen for purging; if required, the purge will also remove accumulated solids within the drill rods to facilitate stabilized conditions.

h. Use of high-capacity, in-line filters (10-micron, 5-micron, 1-micron; singly or in series) prior to flow cell to reduce turbidity to less than 10 NTU (protects electrodes) will be added to the sample tubing during low flow parameter stabilization period.

i. Use of low-flow stability criteria for flow cell electrodes (with in-line filters in place) prior to collecting sample will be conducted (this is a deviation from low-flow SOP).

j. Collection of groundwater samples filtered using a 0.45-micron filter. If filter clogging occurs before required bottle volume can be achieved, then the sampler will use either 10-, 5-, or 1-micron filters in-line prior to the 0.45-micron filter in order to minimize suspended solids or turbidity.

k. Profile sample locations are summarized in **Table 1**.

l. Groundwater sample acquisition will be performed using either a stainless-steel submersible pump or a peristaltic pump dependent on depth to water table. Sampling and analysis shall be consistent with methods identified above and in the *SHL LTMMP Update* (Sovereign, 2015). Samples will be submitted for the analytical parameters as listed in **Table 2**. Details regarding these laboratory analyses are included in the Base Wide UFP-QAPP (KGS, 2016).

m. Following sample collection, the profile boring will be pressure grouted with a cement /bentonite mixture to ground surface and the borehole abandoned.

n. Based on the results of this work, the location of permanent monitoring wells shall be determined and will be installed later to monitor the performance of the remedy.

On or before December 1, 2017, Army will submit a draft revised Phase 1 Task 3 Technical Memorandum (Task3.d) to EPA that delineates the lateral and vertical extent of contamination downgradient of the extraction system along Sculley Road. In addition, the draft revised Technical Memorandum shall include data from the profile investigation and a map showing the vertical and horizontal extent of the plume along Sculley Road. The map shall be generated using the data from this investigation and any other relevant data.

2.2 <u>Piezometer Installation</u>

The existing stilling wells located at EW-1 and EW-4 are not screened at the same interval as the co-located extraction well. Therefore, to support the ongoing long-term groundwater monitoring program at SHL, two new piezometers will be installed within 5 feet upgradient of EW-1 and EW-4 for LTMMP semi-annual gauging; to refine the SHL groundwater flow model by using more accurate potentiometric surface measurements in this area; and, to serve as surrogate elevation for extraction wells as shown on **Figures 3** and **10**. Borings will be advanced using continuous-flight hollow stem auger (HSA) drill method as follows:

a. Borings will commence within 5 feet and upgradient of the existing extraction wells and advance to depths correlating to the mid-screen of the extraction wells;

b. Downhole drill equipment including a rotary drill head, rods, plug and 4.25-inch inside diameter continuous-flight hollow stem augers will be deployed;
c. No soil samples will be collected during boring advancement;
d. No water will be introduced during drilling operations; however, potable water will be used if conditions require flushing out the inside of augers;
e. Characterization of soil will be performed based on visual observations of soil cuttings at surface only;
f. Containerization of all soil cutting generated from drilling in 55-gallon DOT-approved steel drums will be performed;
g. Installation of 2-inch diameter PVC wells with 0.010-inch slots will be performed;
h. Installation of 6-inch diameter protective casing/guard pipe with locking mechanism will be completed with concrete surface pad;
i. Downhole drilling equipment and auger flights will be steam-cleaned between locations;
j. Well development will be conducted 3 to 7 days after well installation;
k. Surveying of new piezometers will be performed using Massachusetts State Plan Coordinate System of NAD 1983 and vertically on NAVD 1988; and,
l. Documentation of HSA drilling will include:
    - Name and location of job;
    - Names of crew;
    - Type of manufacturer of drilling machine
    - Weather conditions
    - Date and time of start and finish of boring;
    - Boring number and location
    - Surface elevation
    - Method of advancing the boring
    - Depth of water surface and drilling depth
    - Location of strata changes as observed from soil cuttings
    - Materials applied

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3. FIELD METHODS AND PROCEDURES

The following sections provide a more detailed discussion of methods and procedures for collecting and analyzing data described above in **Section 2**. Field sampling and laboratory analytical testing will be conducted in accordance with the QAPP (KGS, 2016).

3.1 Pre-Sampling Methods and Procedures

Equipment and Supplies

The following equipment and supplies will be utilized in the collection of low-flow groundwater samples:

- Dedicated and non-dedicated variable speed, submersible bladder pump or peristaltic pump pending depth to water below ground surface
- Water level indicator
- Dissolved oxygen (DO), pH, specific conductance, oxidation reduction potential (ORP) and temperature probes (within a single unit) and appropriate calibration solutions recorded via probes in flow-through cell; a turbidity meter (separate meter from the above unit), with samples collected using a "T" valve prior to flow through cell
- Timing device
- Disposable nitrile gloves
- Certified clean, preserved sample containers, equipped with Teflon®-lined lids or septa
- Decontamination supplies, which include methanol, deionized water, and detergent
- Deionized water, obtained from the subcontracted laboratory for equipment rinse blanks
- 500-milliliter (mL) graduated cylinder
- 5-gallon buckets for purge water
- Plastic sealable bags
- 10-, 5-, or 1-micron filters plus 0.45-micron in-line filters
- Well keys
- Field logbook and field sampling forms
- Chain of custody forms and seals
- Cooler with packing material and ice to cool all samples to 4 degrees Celsius (ºC), +/-2 ºC
- Trip blanks (VOCs only) and temperature blanks
- Polyethylene sheeting
- Paper towels
- 55-gallon drums for IDW as needed

Site Location, Security, and Access

SHL is a fenced area and existing monitoring wells/piezometers are bolted or locked shut. Additional security measures may be enacted for the wells/piezometers if evidence of tampering or suspicious damage is noted. Damage observed at sampling locations will be reported to the Army for appropriate action. Information to be reported will include a written description and photograph of each damaged sample location. Arrangements will be made to coordinate LTM activities at any groundwater monitoring wells that are located in areas whose ownership has been transferred from the Army to another entity in an effort to ensure that LTM activities are conducted in a timeframe that is acceptable to all stakeholders and the property owner.

Initial Well Opening and Inspection

Olfactory and visual observations will be made upon opening the well casing protective cap. Observations, such as any odors, will be documented in the logbook and on a Groundwater Monitoring Form included in **Appendix A**. The general condition of the protective cover, its associated concrete apron, well casing protective cap, and the well casing will be inspected and noted in the logbook. Any damage, evidence of tampering, or immediately necessary repairs will be communicated to the USACE-NAE Project Manager (PM) within 24 hours.

Water Level Measurements

Water level measurements will be collected at each groundwater monitoring well before purging and sampling activities are performed and recorded on low-flow sampling forms. Water level measurements will be collected on the marked side of the riser pipe and will be accurate to the nearest 0.01 ft. Water level measurements will be collected on the north side of any riser pipe that has not been previously marked. Every effort will be made to minimize the physical disturbance of water in the monitoring wells. The water level probe end and tape will be decontaminated using the method described in **Section 3.3** before use in the first well, between each well, between sample locations, and at the conclusion of sample activities. Total well depth measurements will be recorded per location.

3.2 <u>Field Procedures</u>

Piezometer Installation

Two non-EPA SOW piezometers will be installed by the extraction wells shown on **Figure 3** and **Figure 10** for hydraulic monitoring. At each location, a borehole will be drilled using HSA method and a 5-foot well screen will be set in each borehole near the center of the screen of each corresponding extraction well. No groundwater profiling will be performed at these two piezometer locations. To ensure the proper installation and completion of the piezometer to the desired depth the following general procedures will be used.

Well casing and screen material shall be assembled and installed with sufficient care to prevent damage to the sections and joints. Sections of well casing and screen each 2-inch in diameter, must be connected by a mechanical method, such as flush threading, to prevent introducing contaminants, such as glue or solvents, into the well. Prior to installing the section(s) of well screen into the well boring, an end cap must be placed at the bottom of the well screen. A sand filter pack of 18- to 24-inch thickness will be installed below the end cap prior to screen installation. A completed well shall be sufficiently straight to allow passage of pumps or sampling devices. The sand filter pack will be installed 18 to 24 inches above the top of the screen. Three feet of bentonite chips shall be emplaced from above the filter pack. The seal material above the well screen in the saturated zone must be emplaced using a tremie pipe when possible to prevent the possibility of bridging. The amount of water added to the cement/bentonite mixture must be as stated in the manufacturer's specifications. The water added to the bentonite for hydration or to mix slurry shall be from an approved source, of suitable quality, free of pollutants and contaminants; and the volume added must be documented in the field logbook. In areas where the borehole does not collapse, such as the dry zone above the water table, grout will be pressure injected to the ground surface. An outer protective casing will be placed over the piezometers and completed within a concrete pad/apron.

Upon completion of the well installation, the piezometer shall be properly surveyed and the measurements documented. In any type of surface completion, there must be a surface seal of concrete around the protective well casing filling the upper annular space.

Piezometer Development

Piezometers will be developed using surging and pumping techniques utilizing a Waterra® pump (tubing and a foot valve) to remove any accumulated silt. The tubing and foot valve are surged through the screened interval of the wells. Before and after depth to bottom measurements and turbidity measurements of extracted groundwater are collected to assess the effectiveness of the redevelopment activities. If the foot valve becomes clogged, piezometers will be developed by surging and over-pumping using a peristaltic pump. Purge water from development will be containerized.

Equipment Calibration

Field equipment that will be used during the groundwater monitoring, including a YSI water quality meter and a Lamotte 2020 turbidity meter, will require periodic calibration to ensure optimum performance. This equipment will be calibrated in accordance with manufacturer's instructions before its initial use at the site and at the beginning of each work day thereafter. The equipment calibration also will be checked at the conclusion of each work day. Calibrations and the end of the day drifts will be documented on log sheets.

Groundwater Profiling

Vertical groundwater profile samples will be collected at 10-foot intervals starting at the water table to refusal or bedrock from proposed locations along the upgradient and downgradient transects. The Geoprobe® SP16 Groundwater Sampler will be deployed to collect each vertical profile groundwater sample at 10-foot intervals starting from the water table and continuing until refusal.

Low-Flow Well Purging

Each vertical profile groundwater sample will be purged in accordance with the USEPA Region 1 Guidance Document entitled, "Low Stress (low-flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells" (USEPA, Region 1, 2010), prior to sampling. The goal of low-flow purging and sampling is to remove stagnant water from the well and collect representative samples at near ambient conditions. A dedicated or properly decontaminated, submersible, low-flow (bladder) pump or Geotech peristaltic pump will be used to purge the wells. Dedicated Teflon™-lined tubing will be used during purging and sampling activities.

The depth to water will be measured with a water level indicator prior to installing the submersible pump in the well. Caution will be exercised to minimize disturbance of the well water. The submersible bladder pump or sample tubing from a peristaltic pump will be placed into the well gently such that the intake will be located in the middle or slightly below the middle of the screened interval to ensure that most of the water will be pumped directly from the formation.

A properly calibrated water quality parameter probe will be fitted into the flow-through cell provided with the instrument with the included mounting hardware. The line from the in-well submersible pump will be attached to the barbed hose fitting on the bottom of the flow through cell. A spigot will be attached to the line from the in-well submersible pump prior to the flow through cell for the purpose of collecting turbidity samples. A drain line will be attached to the top fitting of the flow-through cell to direct the effluent to a bucket. The depth to water will be re-measured to account for any water level variations caused by the placement of the submersible bladder pump. The pre- and post-pump placement measurements will be recorded on the field sampling form and in the field logbook. Flow rates of 0.1 to 0.5 liters per minute (L/min) will be used for purging. The pump will be operated at a flow rate where minimal drawdown occurs during purging. The goal of low-flow purging is for the drawdown to be less than or equal to 0.3 ft. Water level measurements will be made concurrent with stabilization parameters.

Water quality measurements will be used as the basis for establishing the stabilization of the well water. Well stabilization parameters will include pH, specific conductance, temperature, ORP and turbidity. Turbidity samples must be collected from a spigot placed on the sample tubing prior to the flow-through cell and measured with a stand-alone meter. The parameters will be measured every 3 to 5 minutes until stabilization of all parameters is achieved. Stabilization has been reached when pH measurements remain constant within 0.1 standard unit, specific conductance is constant within 3 percent (%), the temperature is constant within 3%, ORP is constant within 10 millivolts and the turbidity is either constant within 10% for values above 5 NTU, or below 5 NTUs for three consecutive readings. All measurements will be tabulated for comparison on the Groundwater Field Sampling Data Sheet. Observations such as odors, water color or the appearance of soil particles or iron floc will also be recorded on the Groundwater Field Sampling Data Sheet.

If the water level drops more than the goal of 0.3 feet during purging, additional measures such as reducing the purge flow rate, will be enacted to reduce drawdown. These activities will be documented. Purging will continue until groundwater parameters stabilize, the water level drops to the screened interval for wells with shorter screened intervals, or until the water level drops to the top of the pump for wells with longer screened intervals that encompass the pre-purging groundwater level. If the water level drops to the top of the pump or the screened interval, purging will be stopped and up to 24 hours will be allowed to pass for the well to recharge. The well will then be sampled after at least 24 hours has passed. All purge water will be containerized in 55-gallon approved drums.

Sample Containers and Preservatives

Laboratory-provided sample containers will be used during groundwater monitoring. Sample containers will not be reused. The laboratory will supply pre-preserved sample containers as appropriate for the analysis to be performed. Field personnel will conduct a visual check to ensure that pre-preserved sample containers contain preservative. A summary of the sample containers, preservation, and holding times for water samples are presented in Worksheets #19 and #30 of the QAPP (KGS, 2016).

Groundwater Sample Collection

Dedicated and non-dedicated variable speed submersible bladder pumps or peristaltic pumps will be used to collect groundwater samples during boring advancement and vertical profiling. The objectives and methods for this procedure are described in USEPA's Region 1 Guidance Document entitled, "Low Stress (low-flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells", (USEPA, Region 1, 2010). The goal of vertical profile groundwater sampling is to provide groundwater quality data that is representative of actual aquifer conditions with minimal alteration caused by inappropriate or variable sampling techniques. Typically, flow rates of 0.1 to 0.5 L/min are used; however, this is dependent on site-specific hydrogeology (USEPA, 2010).

Once groundwater quality parameters have stabilized, groundwater samples will be collected directly from the tubing connected to the pump. The sampling flow rate will be the same flow rate that was used during the purging process to maintain equilibrium between the well and the formation. The flow-through cell will be bypassed or disconnected during the collection of samples. Sample containers will be filled by allowing water from the pump to gently enter the containers with minimal disturbance. Once full, containers will be stored in a cooler and placed on ice immediately. All samples will be labeled as described in **Section 3.2.6** and immediately placed in a cooler with ice to maintain a sample temperature of approximately 2 to 6^{o} C.

During vertical profiling of groundwater, samples collected for dissolved metals (including arsenic), will be field filtered using in-line 0.45-micron filters. Additional 10-, 5- or 1-micron filters in-line prior to 0.45-micron filter will be used if necessary based on turbidity stabilization.

Sample Identification (ID)

Each sample will be assigned a unique sample identifier. Field personnel will generate a label for each sample container that will contain the sample identifier, date, and time of sample collection, the sampler's initials, analytical parameters, and type of preservation used. The sampler will initial any change in the label information prior to the sample collection. A sample numbering system will be used to identify each sample collected and submitted for analysis. The purpose of the numbering system is to assist in the tracking of samples and to facilitate retrieval of analytical results. The sampling number will be used on sample labels, sample tracking forms, chain of custody forms, field logbooks, and for other applicable documentation. The field sample numbering system will follow the format used for previous sampling events. The sample ID for groundwater profile sampling will be the name of the particular soil boring. The sample ID for samples collected from boreholes will include the depth interval where the sample was collected.

Examples:

Sample Location:	Sample ID:
Borehole SB-17-06 sample from 35-39 ft bgs	SB-2017-01A-35-39
Blind Duplicate sample from SB-17-06	SHP-Dup1-YYYYMMDD (date)

QA/QC Control Samples

Quality assurance (QA)/QC samples will be collected during each groundwater monitoring event. Every effort will be made to collect representative QC samples at different depths and different concentrations. However, the collection of planned QC samples at specific depths may be limited based on recovered sample volumes. The following subsections specify the type and quantity of samples to be collected for QA/QC purposes and are summarized in **Table 3**.

- **Field Duplicate Samples**

  Field duplicate samples will be collected and submitted for analysis in conjunction with all analyses associated with primary field samples. Field duplicates are additional samples subjected to the same collection methods, preparation, and analysis as the original sample but are identified with a unique identification number so that they are blind to the laboratory. These samples will be used to evaluate the precision of sample collection, field sample preparation, and laboratory analysis. Blind field duplicates will be collected and analyzed at a frequency of 10% (1 duplicate per 10 samples) for all parameters (dissolved arsenic, iron and manganese as well as alkalinity, chloride sulfate and DOC). Locations will be determined in the field and duplicate samples will be collected concurrently with field samples.

- **Rinsate Blanks**

  Sampling methods called for in this Work Plan include the use of both dedicated and non-dedicated sampling equipment. Therefore, some sampling equipment will be used in more than one well and will require decontamination between uses. In these cases, rinsate blanks will be prepared and submitted for analysis to determine the potential for cross-contamination from the sampling equipment. One rinsate blank will be prepared from non-dedicated sampling equipment, as needed. Rinsate blank samples will be collected at a frequency of one per week during the drilling program. Rinsate blanks are prepared by decontaminating the field equipment as described in **Section 3.3**, followed by pumping de-ionized water through the submersible pump and capturing the rinsate water in a sample bottle.

- **Matrix Spike/Matrix Spike Duplicates**

  Matrix spike (MS)/matrix spike duplicate (MSD) samples will be submitted for all analyses in conjunction with primary field samples and should be a separate sample from the field duplicate sample. Results from MS/MSD samples will be used to evaluate the potential for sample matrix interferences versus laboratory analytical errors as well as to assess the accuracy of the analysis. MS/MSD samples will be collected at a frequency of 5% (1 MS/MSD sample per 20 samples) for all parameters (dissolved arsenic, iron and manganese as well as chloride sulfate and DOC). MS/MSD are not analyzed for alkalinity. Samples from MS/MSD locations will have a total of three times the standard volume collected.

Direct Push Technology Drilling

A Geoprobe® rig will be used to conduct the direct push technology drilling. The direct push technology uses both static force and percussion to advance tooling, such as core barrels and borehole casing, into the subsurface. A Geoprobe® rig will be used to advance borings during groundwater profiling. After advancing the tooling, the tool string is then retracted exposing 24 inches of screen while the screen is held in place with the extension rods. Groundwater sampling will be conducted using the Geoprobe® SP16 Groundwater Sample method, as described below. Down-hole tooling will be steam-cleaned between holes or as necessary.

Borehole locations are planned to be adjacent to borehole locations conducted in 2016. The presence of grout introduced from the 2016 boreholes has the potential to impact water quality around the boreholes. Therefore, the 2017 boring locations will be offset by 10 feet upgradient from the 2016 transects (as feasible, based on site conditions) due to potential grout impacts to groundwater. Monitoring of pH and specific conductivity will be performed during low flow purging to assess whether grout from nearby past boreholes is compromising water chemistry conditions.

If boring refusal is encountered before expected depths to bedrock at a specified location[1], then the borehole will be attempted again with an approximate 10-foot offset from the original boring location. Up to two (2) offsets will be advanced at up to 5 of the 18 target boring locations specified under the Phase 1 USEPA SOW. If drilling continues to reach refusal before the expected depth, then the borehole will not be advanced further and the final groundwater sample will be collected.

If heaving or running sands are encountered during boring advancement such that the target depth cannot be achieved without the addition of make-up water, then the boring advancement will be discontinued and the final groundwater sample will be collected. However, if only one groundwater sample has been collected from a vertical profiling borehole before encountering the running sands, then the borehole may be further advanced with the addition of make-up water. Drilling without make-up water is preferred, but if make-up water *must* be used to prevent formation sand from heaving inside the drill tooling, then a purge of 2-times the tooling volume or make-up volume, whichever is greater, will be performed prior to sampling.

After sampling has been completed (as described below), the boreholes will be abandoned by knocking out the grout plug and pressure grouting to the surface using a cement/bentonite mixture.

Geoprobe® Screen Point 16 Groundwater Sampler

A description of the Geoprobe® SP16 Groundwater Sampler is included in **Appendix B**. The SP16 Groundwater Sampler is a direct push device consisting of a PVC 10 slot screen that is driven to depth within a sealed, steel sheath and then deployed for the collection of representative groundwater samples. The sampler is threaded onto the leading end of a Geoprobe® probe rod and advanced into the subsurface. When the desired sampling interval is reached, extension rods are sent downhole until the leading rod contacts the bottom of the sampler screen. The tool string is then retracted to expose approximately 24 inches of the screen while the screen is held in place with the extension rods. A groundwater sample will then be collected using either a stainless-steel submersible pump or a peristaltic pump (depending on

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[1] Approximate bedrock depths are known based on previous drilling events at the site in 2016.

depth). Sample collection methods, storage, and handling should follow procedures described above.

Geoprobe® Groundwater Sampling

Groundwater samples shall be collected using the following procedure:

- Install ¼-inch polyethylene tubing through the tooling to the center of the screen interval;
- Attach tubing to either a peristaltic pump or bladder pump and purge at a minimum flow rate of 100 milliliters (mL) of groundwater;
- After achieving stabilization parameters collect groundwater sample by filling sample containers directly from sample tubing;
- Remove tubing and/or bladder pump from the borehole followed by the direct-push tooling (rods and SP16 sampler) and decontaminate sampler equipment with Alconox and de-ionized water; dispose of tubing in accordance with IDW protocols described in **Section 3.3**;
- After each depth interval reset sampling screen in sheath and install new expendable drive point;
- At same location, drive tooling to next interval depth and repeat steps; repeat overall process until refusal; and, Repeat the steps above until all groundwater samples have been collected at the location.

Piezometer Installation and Development

As described in **Section 2.2**, two new piezometers to be installed by extraction wells EW-1 and EW-4 will be constructed with 5-foot well screens located at the center of the extraction well screened interval at approximately 85 feet bgs. Each piezometer will be constructed with 2-inch diameter, #10 slotted well screen, 2-inch diameter riser pipe, and a 6-inch protective casing. Well screens and casings will be Schedule 40 polyvinyl chloride (PVC). A sand filter pack consisting of No. 1 silica sand will be placed around the well screen to a height of approximately 2 feet above the top of screen. A 2-foot thick layer of fine sand (choker sand) will be placed above the filter pack, and a 3-foot thick bentonite seal will be placed above the sand. The borehole annulus above the shallow well seal (bentonite chips) will be grouted to the surface with cement-bentonite grout tremied in place. Wells should be protected at the ground surface with a 2-foot by 2-foot concrete pad as necessary and terminate inside either a flush-mount road box or a steel stick-up protective casing. Completed piezometers will be sufficiently straight to allow passage of pumps and sampling devices.

The purpose of well development is to establish a good connection between the piezometer and the formation by removing fine particles from the filter pack and surrounding native soil. Development will restore the permeability of the formation that may have been lost due to disturbance or creation of fine particles during drilling. The piezometers will be developed by a combination of purging and surging the well to suspend and remove fine particles. Development shall be performed using Waterra pumps equipped with foot valves. The effluent water from the development shall be monitored for turbidity and conductance at regular intervals of approximately 10 minutes of pumping. Turbidity will be measured with a Lamotte 2020™ or equivalent. Specific conductivity may also be measured with a Beta Tech HYDAC Meter or equivalent. The wells will be developed until the turbidity is constant for at least 20 minutes of pumping at less than 5 NTUs. If 5 NTUs cannot be achieved, development shall be considered complete when turbidity readings become stable for 20 minutes or the well has been developed for a minimum of one hour. Piezometers will be surveyed using Massachusetts State Planar Coordinate System NAD83 for horizontal datum and NAVD88 for vertical datum.

3.3 Post-Sampling Activities

Chain of Custody

Sample custody will be maintained at all times. A sample is considered to be in custody under the following situations:

- The sample is directly in your possession
- The sample is clearly in your view
- The sample is placed in a locked location
- The sample is in a designated secure area

If an overnight courier is used, adhesive custody seals will be used to demonstrate that the samples and coolers have not been tampered with during shipment. The custody seals will be placed across the cooler lids in such a manner that they will be visibly disturbed upon opening of the cooler. The seals will be initialed and dated by field personnel when affixed to the container and cooler.

Documentation of the chain of custody of the samples is necessary to demonstrate that the integrity of the samples has not been compromised between collection and delivery to the laboratory. A chain of custody record will accompany each sample cooler to document the transfer of custody from the field to the laboratory. All information requested in the chain of custody record will be completed. If samples are shipped by an overnight courier, the air bill number assigned by the overnight courier will be listed on the chain of custody record or the general logbook. One copy of the custody form will be retained by the samplers and placed in the project records file. The remaining pages will be sealed in a plastic bag and placed inside the cooler. Upon receipt at the laboratory, the chain of custody forms will be completed. It is the responsibility of the laboratory to document the condition of custody seals and sample integrity upon receipt.

Sample Delivery/Shipment to Laboratory

Sample containers will be placed inside sealed plastic bags as a precaution against cross-contamination caused by leakage or breakage. Bagged sample containers will be placed in insulated coolers with bubble wrap or other wrapping to eliminate the chance of breakage during delivery or shipment. Ice in plastic bags will be placed in the coolers to keep the samples between 2 and 6 ºC throughout storage and shipment. Sample delivery or shipment will be performed in strict accordance with all applicable U.S. Department of Transportation regulations. The samples will be transported from the site to the laboratory by laboratory personnel or shipped to the laboratory by an overnight courier service.

Arrangements will be made between the field team and the contract laboratory point-of contact for samples that are to be delivered to a laboratory on a weekend so that holding times and cooler temperatures are not compromised.

Equipment Decontamination

Equipment or supplies that cannot be effectively decontaminated will be disposed of after sampling. Gauging/sampling equipment will be decontaminated at the site before use, between sampling locations, and after its last use at the site. Decontamination of field equipment will be noted in the project logbook. If it is necessary to make decontamination procedural changes in the field, the changes will be noted in the logbook. Otherwise, a notation will be made each day that decontamination was conducted as specified in the project documents. Procedures for decontaminating sampling equipment that may be used at the Fort Devens site will be conducted in accordance with guidance in USEPA Region 1, 2010, "Low Stress (low-flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells" and is summarized below.

Groundwater gauging equipment and non-dedicated sampling equipment and materials (including the SP16 sampler) will be decontaminated using the following procedure:

- Physical removal, rinse with tap water immediately after use.
- Detergent scrub with brushes (Alconox) immediately after use. The solution will be changed periodically.
- Rinse with tap water to remove all detergent solution.
- Rinse well with de-ionized water.
- Light spray down with isopropyl alcohol, if needed.
- Air dry.
- Rinse with deionized water.
- Cover with aluminum foil (if not to be used immediately).

The water level probe and tape will be decontaminated by the above referenced procedure, substituting air drying with drying the probe tape with a clean paper towel. Equipment that cannot be adequately cleaned will be discarded.

Bladder pumps that are used for groundwater sampling will be taken apart and the steel pump parts will be decontaminated by the procedures above. The plastic bladder will be discarded and a new plastic bladder will be used at each location.

Investigation-Derived Waste

This section identifies the methodology for the handling and disposal of investigation-derived waste (IDW). IDW will be handled in a manner consistent with USACE and USEPA guidance for managing IDW and applicable Federal and state regulations.

Possible sources of IDW include drilling fluid used during drilling, well purge water, decontamination water, personal protective equipment (PPE), and HSA drill cuttings from the installation of the piezometers by the extraction wells. Visual and olfactory observations will serve as the initial screening of well purge water for possible contamination.

Decontamination fluids containing methanol or nitric acid will be containerized, labeled, sealed with a custody seal, and removed for disposal per applicable hazardous and/or non-hazardous waste generation procedures. Drill cuttings for the piezometers will be containerized, characterized, and properly disposed offsite. Other potential wastes generated during sampling activities (e.g., purge water from groundwater sampling) will be returned to the ground at the point of collection, consistent with USEPA and MassDEP requirements.

Data Validation

The objective of the data validation is to assess the performance associated with the analysis in order to determine the quality of the data, which will be accomplished by evaluating whether the collected data comply with the project requirements and by comparing the collected data with established criteria. The same data validation procedures will be used to review all analytical parameters collected in support of this Supplemental Investigation. All types of data, including screening data and definitive data, are relevant to the usability assessment. The data verification and validation process are described in detail in UFP-QAPP Worksheets #34, #35, and #36 (KGS, 2016).

The KGS Project Chemist will review all final validation of the project data for compliance with the method-specific QA/QC guidelines for precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) as defined in the QAPP Worksheet #37.

3.4 Field Documentation

Field Logbooks

During all site activities, field logbooks will be maintained to record information related to site activities, health and safety, level of protection worn and any upgrades, visitors to the site, sampling activities/locations and observations. Field logbooks will be bound volumes with sequentially numbered pages. No pages will be removed from the logbooks for any reason. If corrections are necessary, they will be made by drawing a single line through the original entry (so that original entry can still be read) and writing the corrected entry alongside it. The correction will be initialed and dated. Information to be recorded, if appropriate, will include, but is not limited to, the following:

- Project name and number;
- Arrival and departure times;
- Personnel on-site and their affiliation;
- Date and time;
- Tasks for the day;
- Weather conditions;
- Site activities;
- Health and safety meetings and issues;
- Names and affiliations of visitors;
- Sample location and ID (including field sketches, if appropriate);
- Sample depth;
- Sample time;

- Number of aliquots;
- Media type;
- Air monitoring readings and equipment used;
- Sampling personnel present;
- Sampling equipment used;
- PPE level, clothing, and equipment used;
- Analyses requested;
- Sample preservation;
- Associated QC samples;
- Decontamination procedures;
- Field observations;
- Photographic records;
- Other project specific information; and
- Changes or deviations to the project scope or the procedures specified in this Work Plan.

Entries will be in ink with any corrections crossed out with a single line, initialed, and dated. Each page of the logbook will be signed and dated at the bottom by each individual making an entry. At the completion of field activities, copies of the logbook pages will be maintained in the project files.

Field Sample Collection Sheets

Indelible water proof ink will be used to record data and observations on Field Sample Collection Sheets. Field Sample Collection Sheets will be maintained by sampling personnel to supplement the field logbook. Copies of the sample collection field sheets will be hand delivered to the PM for review and distribution at the completion of each sampling event and will be maintained in the permanent project files.

Daily Quality Control Reports

Field data and pertinent QA/QC information will be recorded in Daily Quality Control Reports (DQCR) during all field activities. DQCRs will be prepared, signed, and dated by the field team leader. Copies of the DQCR sheets will be attached to annual LTM reports. If problems are encountered, the KGS PM will be notified by telephone and a copy of the relevant DQCR emailed as soon as possible to USACE's PM.

Photographic Documentation

New photographs will be obtained during EPA SOW events only if needed or site conditions change or new sample locations added. Digital images will be downloaded from the digital media to the digital project files.

Project File

Project files will be maintained by the KGS PM and will include a minimum of the following project records:

- Project plans and specifications, if any;
- Field logbooks and data records;
- Photographs, maps, and drawings;
- Chain of custody records (copies);
- Analytical data packages from the laboratory, including QC documentation;
- Data review reports;
- References and literature;
- Report notes and calculations;
- Progress and technical reports;
- Correspondence and other pertinent information; and
- Authorizations (e.g., property access, well installation forms, etc.).

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4. PROJECT SCHEDULE

This section describes the schedule for the Phase 1, Tasks 1-3 supplemental investigation activities at SHL. Results of the three field investigation tasks for the USEPA SOW will be presented in separate Technical Memoranda. Construction and sampling logs for the two new piezometers by the existing extraction wells will be presented in the 2017 Annual Report for SHL.

- Final Work Plan – 3 August 2017
- Field Work – August through September 2017
- Draft Phase 1, Tasks 1-3 Technical Memoranda – 1 December 2017

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TABLES

Table 1
Shepley's Hill Landfill Profiling Locations
Former Fort Devens Army Installation
Devens, MA

Proposed Location IDs	Matrix	Analyses	Estimated number of Samples	Proposed Well IDs	Proposed Screen Intervals (ft bgs)
Task 1 - Demonstrate Plume Capture – Address Data Gaps near the Extraction Wells					
SB-17-01	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-02	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-03	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-04	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-05	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
Task 2 - Demonstrate Plume Capture – Delineate Lateral and Vertical Extent of Plume upgradient of Extraction System					
SB-17-06	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-07	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-08	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A

Table 1
Shepley's Hill Landfill Profiling Locations
Former Fort Devens Army Installation
Devens, MA

Proposed Location IDs	Matrix	Analyses	Estimated number of Samples	Proposed Well IDs	Proposed Screen Intervals (ft bgs)
SB-17-09	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-10	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-11	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-12	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
Task 3 - Demonstrate Plume Capture – Delineate Lateral and Vertical Extent of Plume downgradient of Extraction System along Sculley Road					
SB-17-13	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-14	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-15	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-16	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-17	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A
SB-17-18	Groundwater Profile	Dissolved Arsenic, Iron, Manganese, chloride, sulfate, alkalinity and DOC	6-10 samples per boring	N/A	N/A

Table 1
Shepley's Hill Landfill Profiling Locations
Former Fort Devens Army Installation
Devens, MA

Proposed Location IDs	Matrix	Analyses	Estimated number of Samples	Proposed Well IDs	Proposed Screen Intervals (ft bgs)
Piezometers for Hydraulic Monitoring					
SHP-17-01	Groundwater	N/A	N/A	SHP-17-01	70 - 75
SHP-17-02	Groundwater	N/A	N/A	SHP-17-02	85 - 90

Groundwater vertical profile samples will be collected at 10-ft intervals to refusal (up to 130-160 ft amsl).
ft bgs = feet below ground surface
N/A-not applicable

Table 2
Profile Sample Analytical Program
Shepley's Hill Landfill Supplemental Investigation
Former Fort Devens Army Installation
Devens, MA

Analytical Parameters	Analytical	Bottle/Preservation Requirements
Dissolved Arsenic (field filtered)	SW6020A	1-250mL poly; HNO3 preserved (combine SW6020 and 6010)
Dissolved Metals Iron and Manganese (field filtered)	SW6010C	
Alkalinity	SM2320B	1-250mL poly
Chloride, Sulfate	SW9056A	1-125mL poly
Dissolved Organic Carbon (DOC) (field filtered)	SW9060	1-500mL amber glass; H2SO4 preserved

Note: All samples must be preserved on ice to 4°C; ±2°C.

Table 3
Shepley's Hill Landfill Profiling Locations with QC Samples
Former Fort Devens Army Installation
Devens, MA

Proposed Location IDs	Matrix	Analyses	Estimated number of Samples**	Field Duplicate Samples (1 per 10 samples) *	MS/MSD Samples (1 set per 20 samples) *	Equipment Blank Samples (1 per week)
Task 1 - Demonstrate Plume Capture – Address Data Gaps near the Extraction Wells						
SB-17-01	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	10 samples per boring	1 per boring (shallow)		1 EB
SB-17-02	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	11 samples per boring	1 per boring (deep)	1 set (mid)	
SB-17-03	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	11 samples per boring	1 per boring (mid)		1 EB
SB-17-04	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	11 samples per boring	1 per boring (shallow)	1 set (mid)	
SB-17-05	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	12 samples per boring	1 per boring (deep)		1 EB
Task 2 - Demonstrate Plume Capture – Delineate Lateral and Vertical Extent of Plume Upgradient of Extraction System						
SB-17-06	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	7 samples per boring	1 per boring (shallow)	1 set (mid)	1 EB
SB-17-07	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	9 samples per boring	1 per boring (deep)		
SB-17-08	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	9 samples per boring	1 per boring (mid)	1 set (mid)	1 EB
SB-17-09	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	7 samples per boring	1 per boring (shallow)		

Table 3
Shepley's Hill Landfill Profiling Locations with QC Samples
Former Fort Devens Army Installation
Devens, MA

Proposed Location IDs	Matrix	Analyses	Estimated number of Samples**	Field Duplicate Samples (1 per 10 samples) *	MS/MSD Samples (1 set per 20 samples) *	Equipment Blank Samples (1 per week)
SB-17-10	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	6 samples per boring	1 per boring (deep)	1 set (mid)	1 EB
SB-17-11	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	7 samples per boring	1 per boring (mid)		
SB-17-12	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	9 samples per boring	1 per boring (shallow)	1 set (mid)	1 EB
Task 3 - Demonstrate Plume Capture – Delineate Lateral and Vertical Extent of Plume Downgradient of Extraction System along Sculley Road						
SB-17-13	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	4 samples per boring	1 per boring (shallow)		
SB-17-14	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	4 samples per boring	1 per boring (deep)	1 set (mid)	1 EB
SB-17-15	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	4 samples per boring	1 per boring (mid)		
SB-17-16	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	7 samples per boring	1 per boring (shallow)	1 set (mid)	1 EB
SB-17-17	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	7 samples per boring	1 per boring (deep)		
SB-17-18	Groundwater Profile	Dissolved Arsenic, Iron, Manganese; chloride, sulfate, alkalinity and DOC	11 samples per boring	1 per boring (mid)	1 set (mid)	1 EB

Table 3
Shepley's Hill Landfill Profiling Locations with QC Samples
Former Fort Devens Army Installation
Devens, MA

Proposed Location IDs	Matrix	Analyses	Estimated number of Samples**	Field Duplicate Samples (1 per 10 samples) *	MS/MSD Samples (1 set per 20 samples) *	Equipment Blank Samples (1 per week)
Piezometers for Hydraulic Monitoring						
SHP-17-01	Groundwater	N/A	N/A			
SHP-17-02	Groundwater	N/A	N/A			

* Every effort will be made to collect representative QC samples at different depths and different expected concentrations.

** Based on number of sampling intervals from previous program

Groundwater vertical profile samples will be collected at 10-ft intervals to refusal (up to 130-160 ft amsl).

ft bgs = feet below ground surface

N/A = not applicable

FIGURES

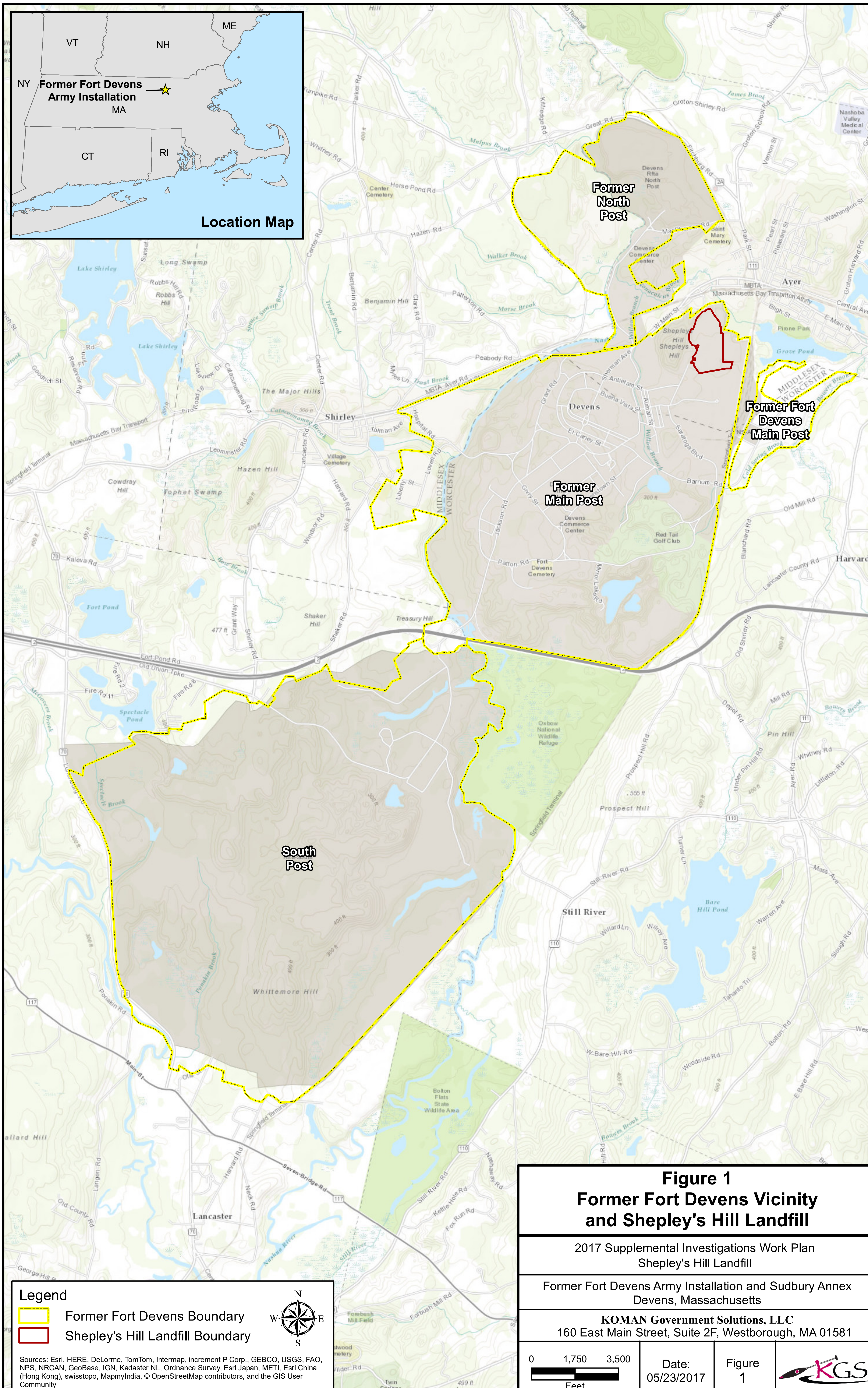


Figure 1
Former Fort Devens Vicinity and Shepley's Hill Landfill

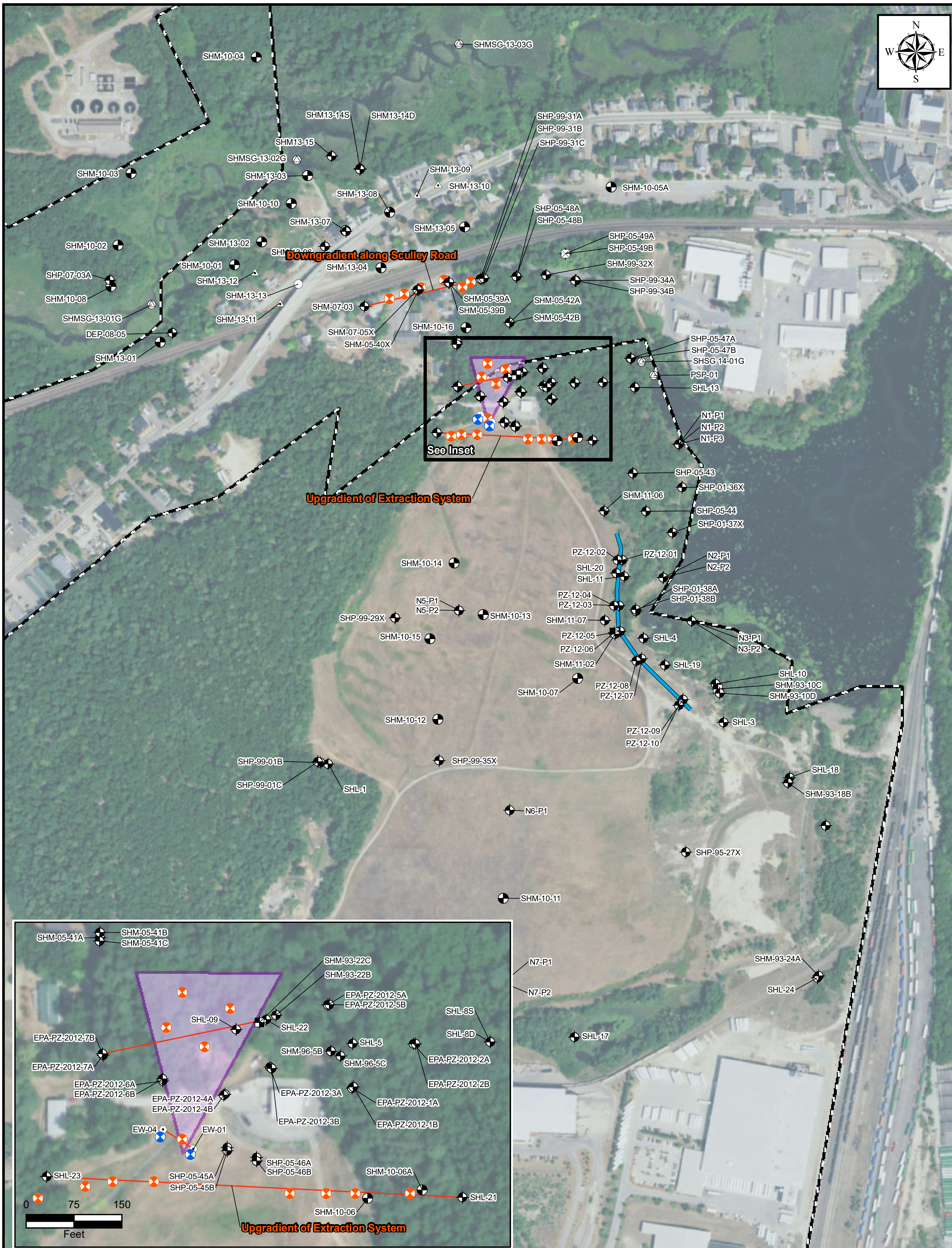
2017 Supplemental Investigations Work Plan
Shepley's Hill Landfill

Former Fort Devens Army Installation and Sudbury Annex
Devens, Massachusetts

KOMAN Government Solutions, LLC
160 East Main Street, Suite 2F, Westborough, MA 01581

Date:	Figure
05/23/2017	1

File: SIWP2017_SHL_FFD_SL.mxd



Legend

New Boring Location	Transect Lines
Overburden Monitoring Well/Piezometer	Barrier Wall
Monitoring Well - Destroyed	Supplemental Capture Zone Investigation Area
Groundwater Profiling Location/Monitoring Well	Former Fort Devens Boundary
Groundwater Profiling Location	
Bedrock Monitoring Well	
Extraction Well	
Soil Boring	
Stream Gauge	
New Piezometer Location	

References: Sovereign/HGL LTMMP 2015

Aerial Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 2
Shepley's Hill Landfill Drilling Locations

2017 Supplemental Investigations Work Plan
Shepley's Hill Landfill

Former Fort Devens Army Installation and Sudbury Annex
Devens, Massachusetts

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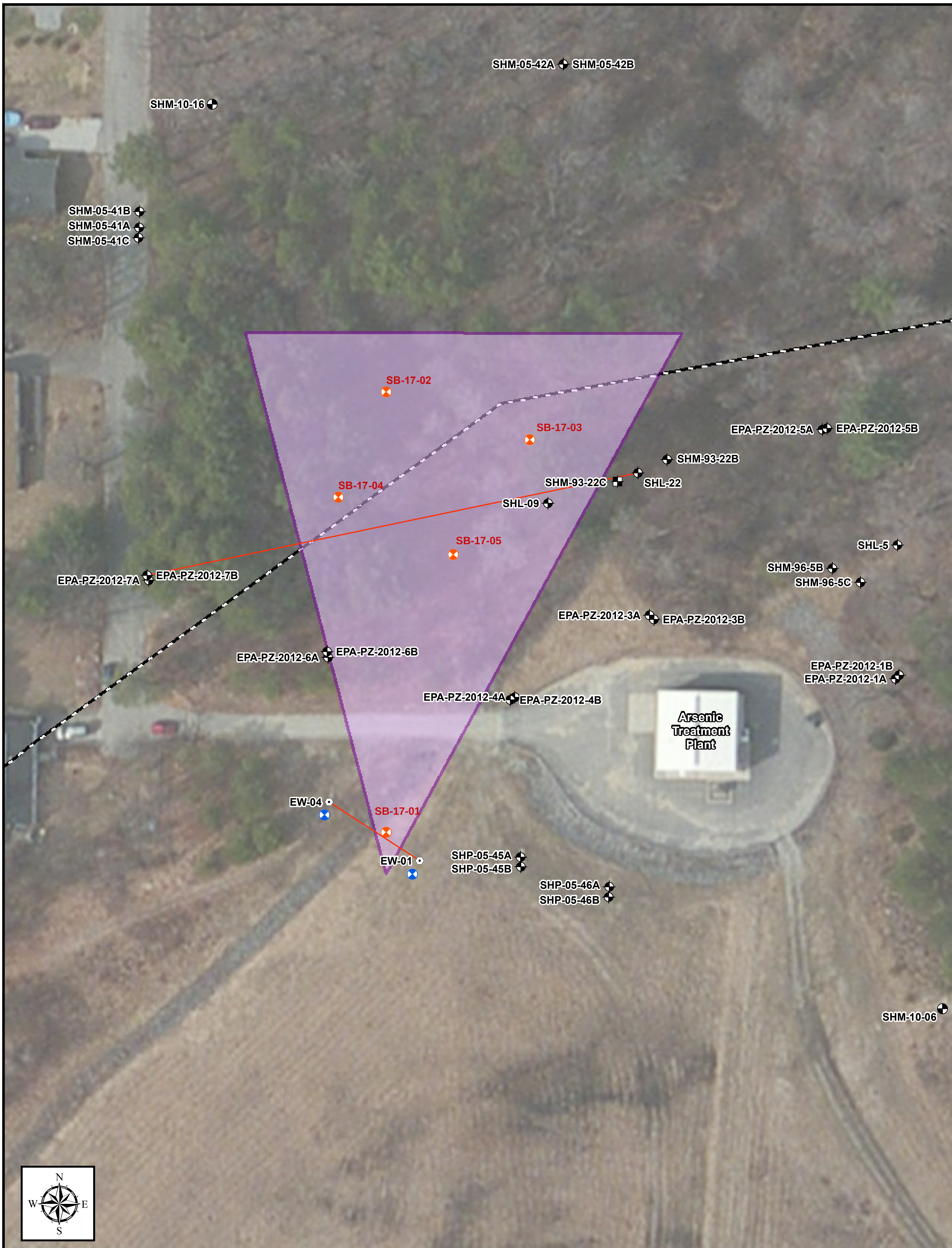
0 200 400 Feet	Date: 06/09/2017	Figure 2	KGS

File: SIWP2017_SHL_DrillingLoc.mxd



Legend

- New Boring Location
- Overburden Monitoring Well/Piezometer
- Groundwater Profiling Location/Monitoring Well
- Bedrock Monitoring Well
- Extraction Well
- New Piezometer Location
- Transect Lines
- Supplemental Capture Zone Investigation Area
- Former Fort Devens Boundary

References: Sovereign/HGL LTMMP 2015

Aerial Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 3
Shepley's Hill Landfil Drilling Locations near Extraction Wells

2017 Supplemental Investigations Work Plan
Shepley's Hill Landfill

Former Fort Devens Army Installation and Sudbury Annex
Devens, Massachusetts

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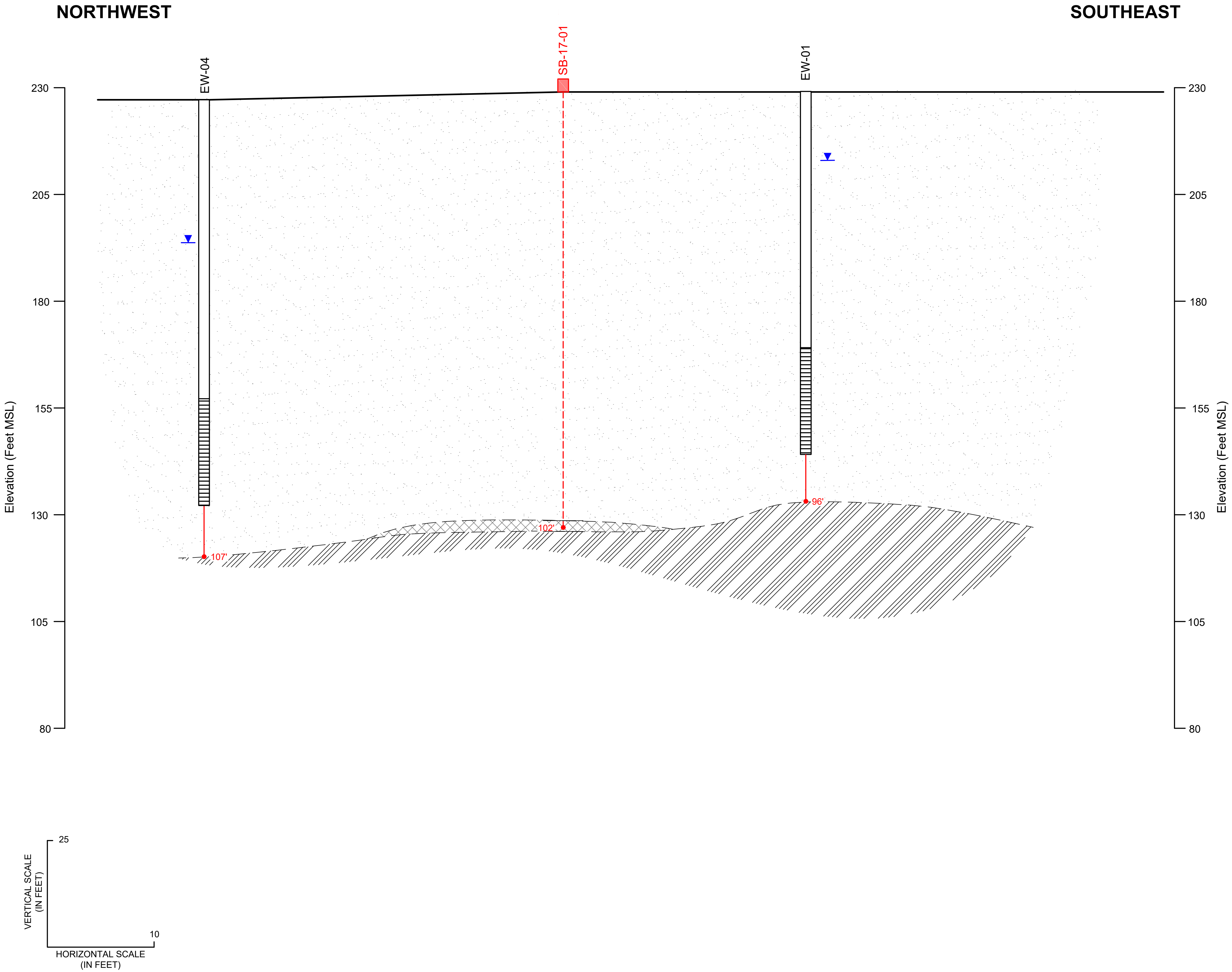
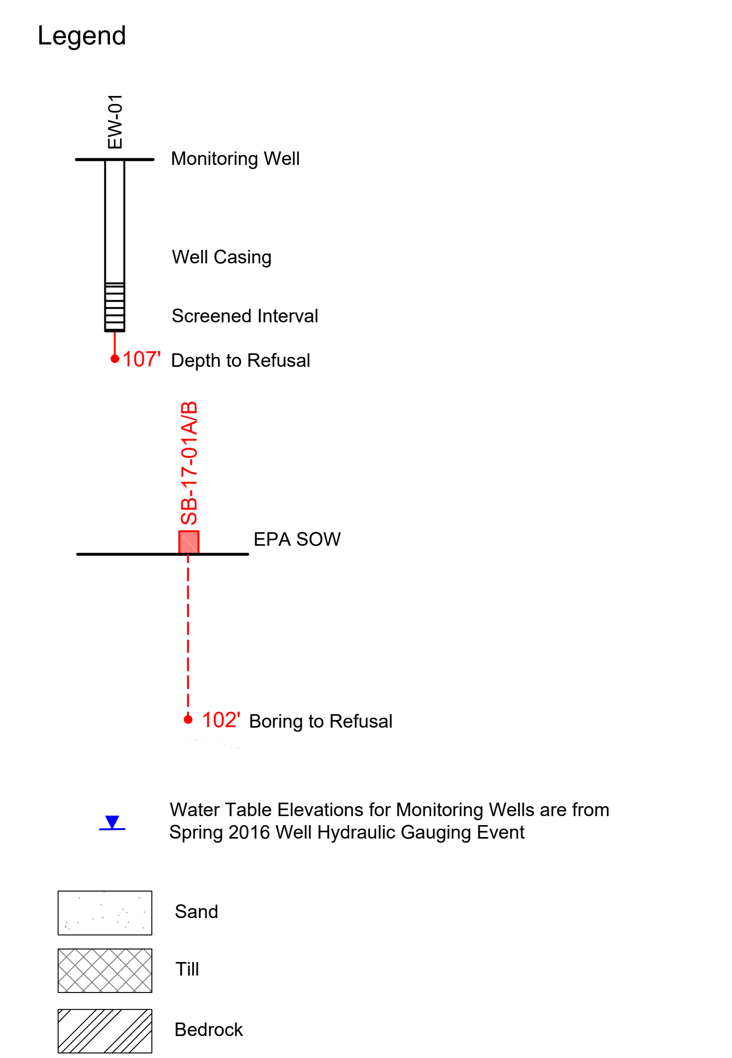
Scale	Date:	Figure
0 25 50 Feet	06/09/2017	3

File: SIWP2017_SHL_DrillingLoc_EW.mxd

Figure 4
Proposed Boring Locations
Cross Section EW-04 to EW-01





2017 Supplemental Investigations Work Plan
Shepley's Hill Landfill

Former Fort Devens Army Installation and Sudbury Annex
Devens, Massachusetts

KOMAN Government Solutions, LLC
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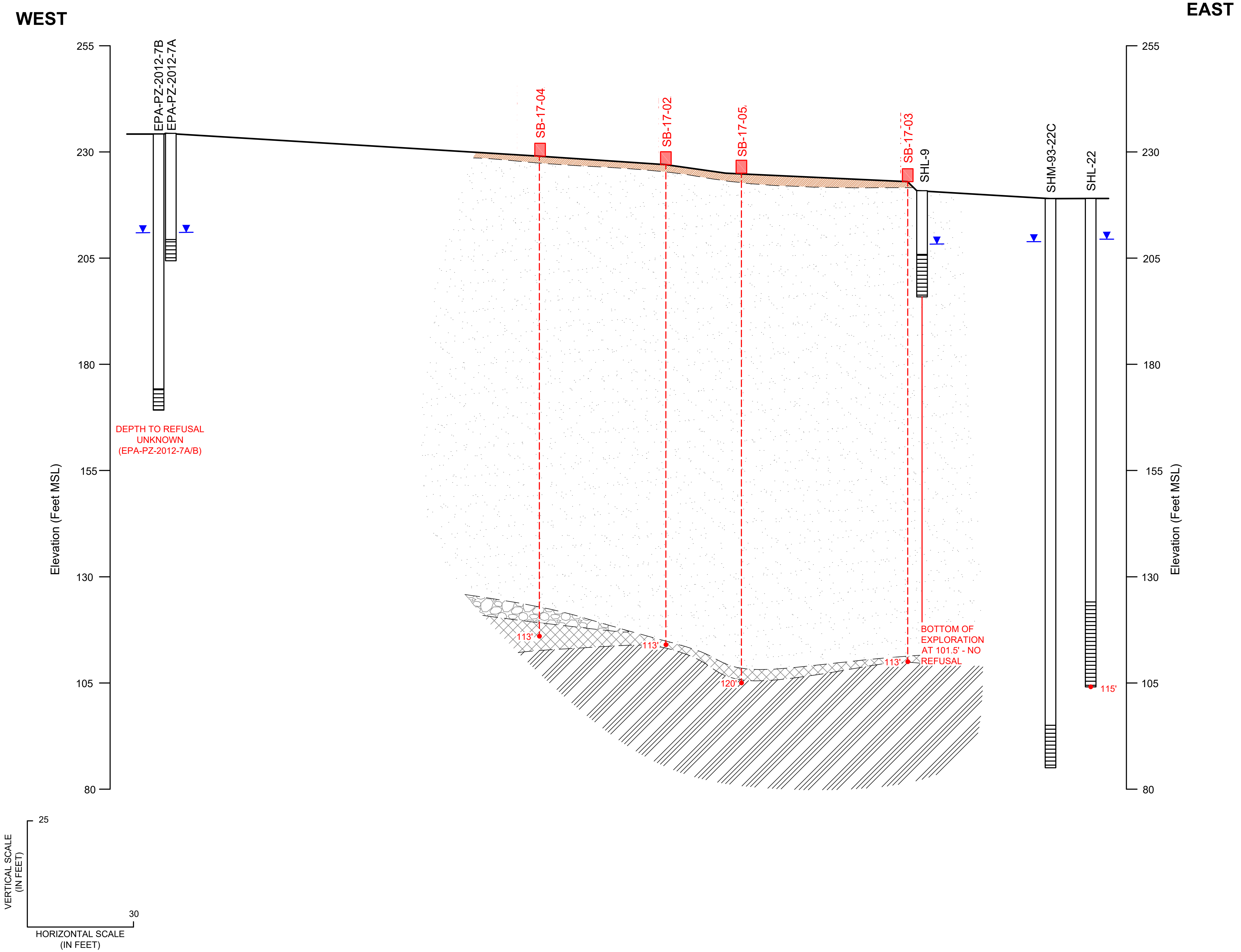
0 0 0
FEET

Date:
06/09/2017

Figure
4

Figure 5
Proposed Boring Locations Cross Section EPA-PZ-2012-7A to SHL-22



Legend

- Monitoring Well (SHL-9)
- Well Casing
- Screened Interval
- 115' Depth to Refusal
- EPA SOW (SB-17-03A/B)
- 113' Boring to Refusal
- Water Table Elevations for Monitoring Wells are from Spring 2016 Well Hydraulic Gauging Event
- Topsoil
- Till
- Sand
- Weathered Bedrock
- Gravel
- Bedrock

2017 Supplemental Investigations Work Plan
Shepley's Hill Landfill

Former Fort Devens Army Installation and Sudbury Annex
Devens, Massachusetts

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0 0 0 FEET	Date: 06/09/2017	Figure 5

Legend

	New Piezometer Location
	New Boring Location
	Overburden Monitoring Well/Piezometer
	Groundwater Profiling Location/Monitoring Well
	Bedrock Monitoring Well
	Extraction Well
	Transet Line
	Former Fort Devens Boundary

References: Sovereign/HGL LTMMP 2015

Aerial Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 6
Shepley's Hill Landfill Upgradient Drilling Locations

2017 Supplemental Investigations Work Plan
Shepley's Hill Landfill

Former Fort Devens Army Installation and Sudbury Annex
Devens, Massachusetts

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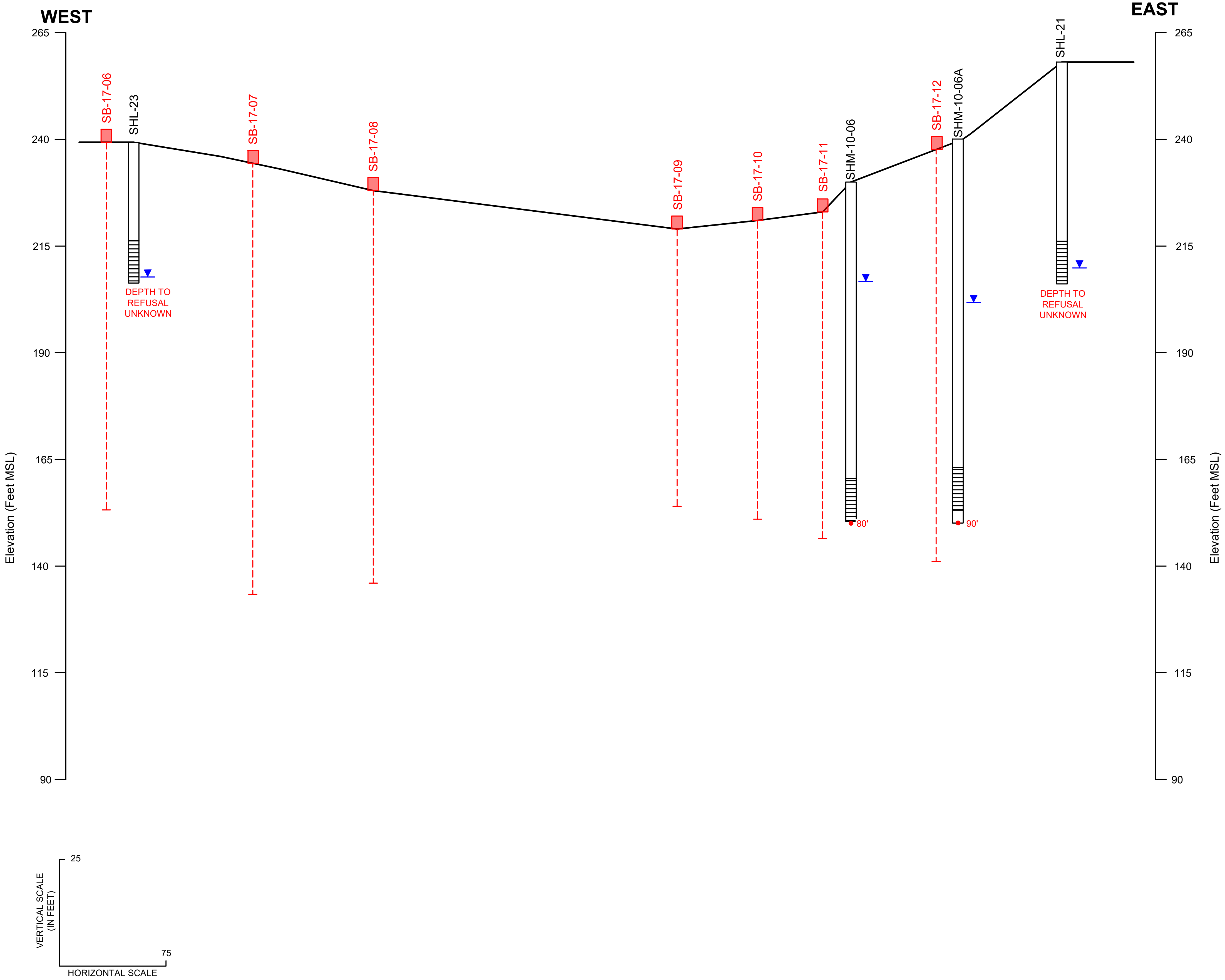
0 40 80
Feet

Date: 07/28/2017

Figure 6

File: SIWP2017_SHL_DrillingLoc_UG.mxd

Figure 7
Proposed Boring Locations
Cross Section SHL-23 to SHL-21



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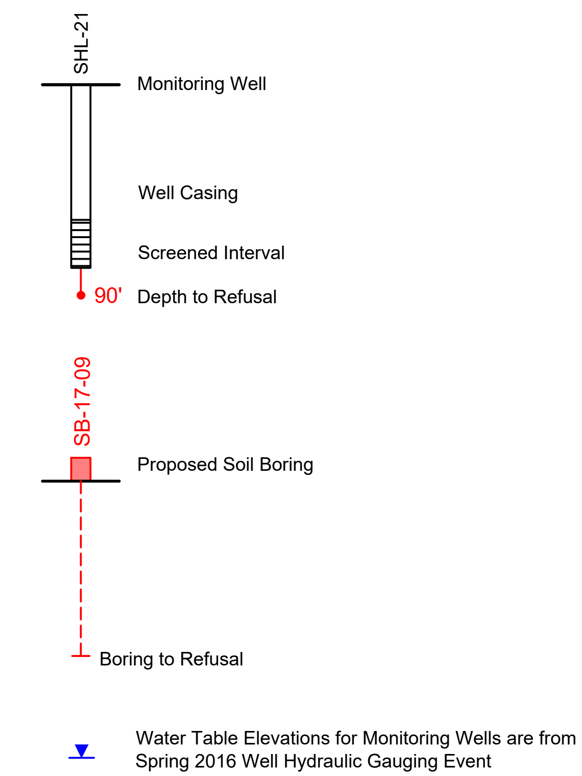

2017 Supplemental Investigations Work Plan
Shepley's Hill Landfill

Former Fort Devens Army Installation and Sudbury Annex
Devens, Massachusetts

KOMAN Government Solutions, LLC
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0 0 0
FEET

Date:
07/28/2017

Figure
7

File: X:\HS_Environmental\FortDevens_Mass\Drawings\SIWP2017_NIA_SL_XSections.dwg

Legend

- New Boring Location
- Overburden Monitoring Well/Piezometer
- Groundwater Profiling Location/Monitoring Well
- Transect Line
- Former Fort Devens Boundary

References: Sovereign/HGL LTMMP 2015

Aerial Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 8
Shepley's Hill Landfill Downgradient/Sculley Road Drilling Locations

2017 Supplemental Investigations Work Plan
Shepley's Hill Landfill

Former Fort Devens Army Installation and Sudbury Annex
Devens, Massachusetts

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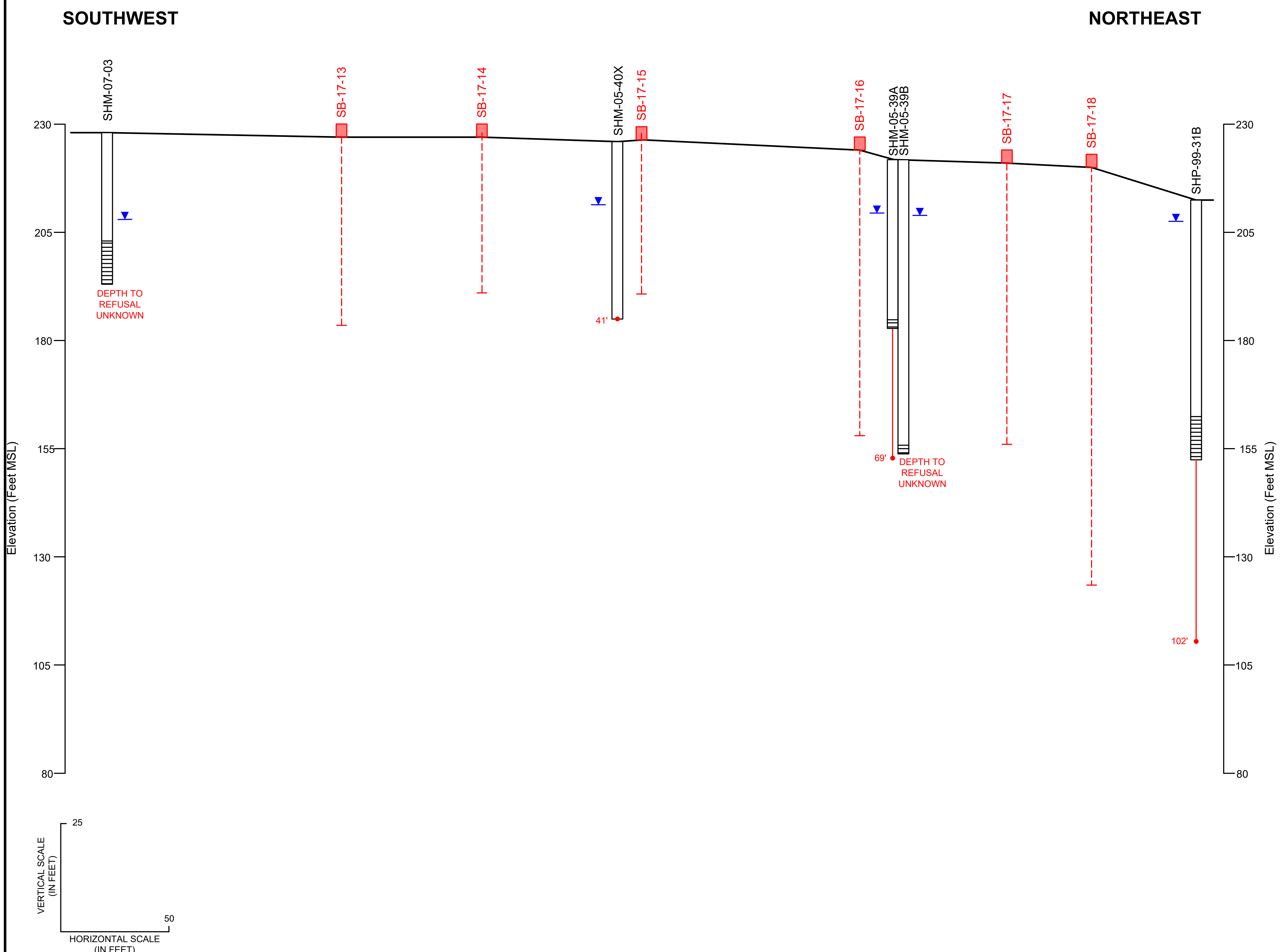
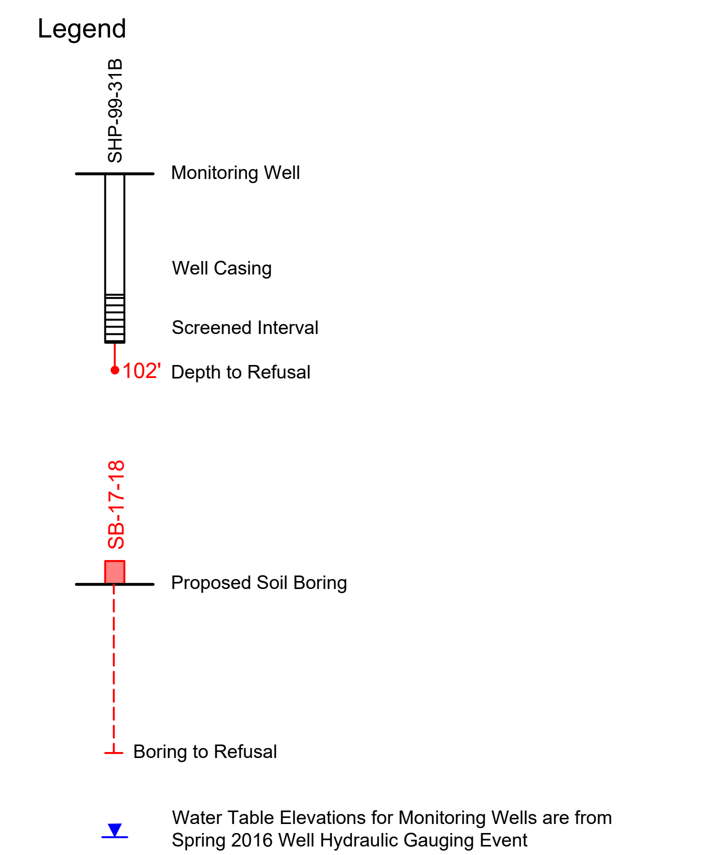
0 30 60 Feet	Date: 06/08/2017	Figure 8	KGS

File: SIWP2017_SHL_DrillingLoc_DG.mxd

Figure 9
Proposed Boring Locations Cross Section SHM-07-03 to SHP-99-31B





2017 Supplemental Investigations Work Plan
Shepley's Hill Landfill

Former Fort Devens Army Installation and Sudbury Annex
Devens, Massachusetts

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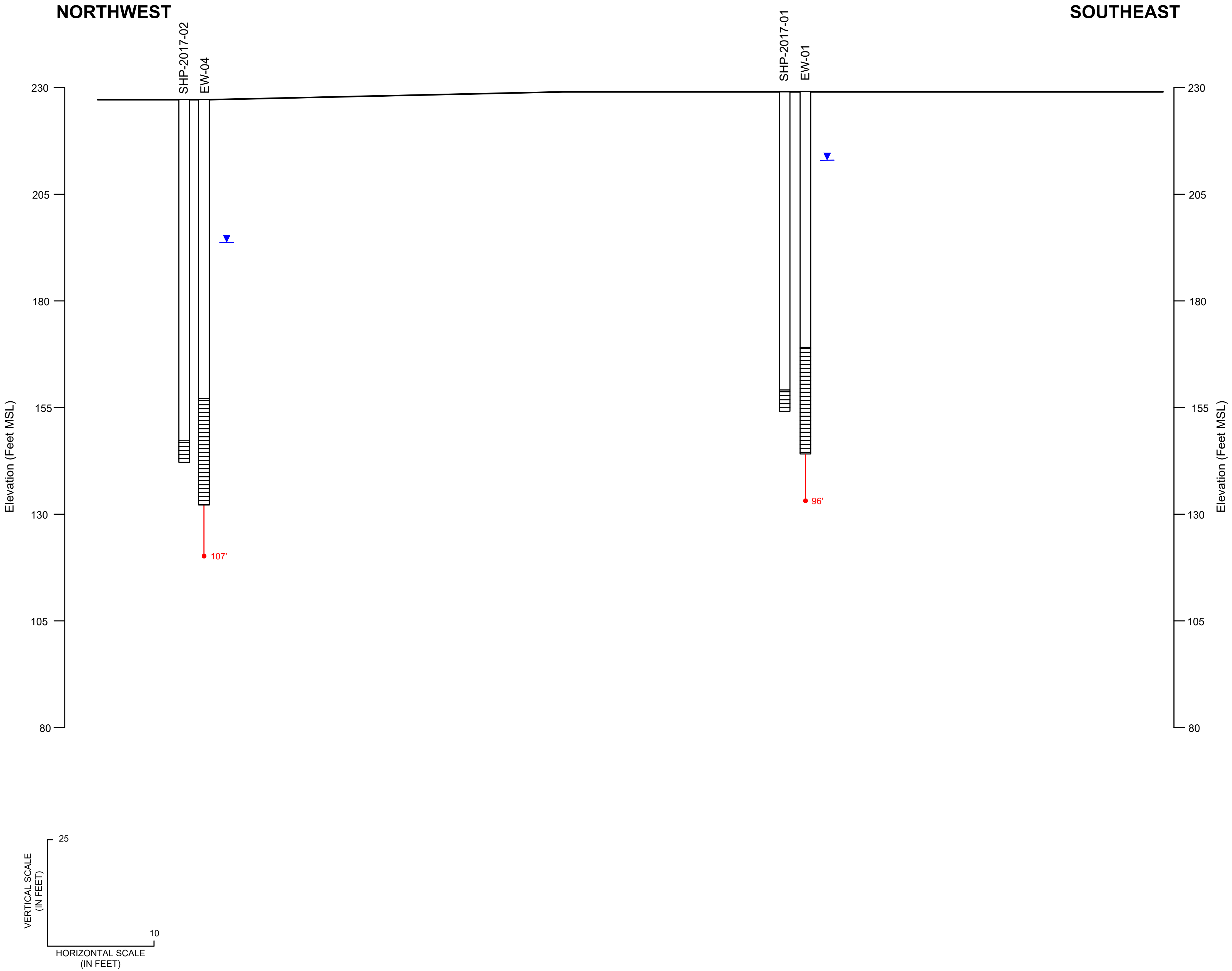
0 0 0 FEET	Date: 06/08/2017	Figure 9	KGS

Figure 10
Proposed Piezometer Locations
Cross Section EW-04 to EW-01



Legend

EW-01 Monitoring Well

Well Casing

Screened Interval

107' Depth to Refusal

Water Table Elevations for Monitoring Wells are from Spring 2016 Well Hydraulic Gauging Event

2017 Supplemental Investigations Work Plan
Shepley's Hill Landfill

Former Fort Devens Army Installation and Sudbury Annex
Devens, Massachusetts

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0 0 0 FEET	Date: 06/08/2017	Figure 10	KGS

APPENDIX A

Examples of Field Forms

KGS

Date: __________________

Groundwater Water Level Measurement Sheet

Project/Site Name: _____________ Water Level Meter: _______________

Field Team Member: _____________ Weather: _______________

Well ID	Time	Depth to Water (ft-bgs)	Depth of Well (ft-bgs)	Well Inspection Notes
	-			

Signature: ____________________________ Date: ________________________________

Field Instrument Calibration Log

Date: ______________________________ **Weather:** ______________________________

Project/Site Name: ______________________________ **Instrument:** ______________________________

Calibrated By: ______________________________ **Serial Number:** ______________________________

Parameters	**Solution Expiration Date**	**Morning Calibration Time ________**		**Cal. Temperature °C**	**Afternoon Calibration Time ________**		**Cal. Temperature °C**
Specific Conductivity (1.413 µS/cm^{c})							
pH (7)							
pH (4)							
pH (10)							
ORP (240 mv)							
Dissolved Oxygen (%)							
Dissolved Oxygen (mg/L)							
Barometric Pressure (mmHg)							

Notes:

Signature: ______________________________ **Date:** ______________________________

KOMAN GOVERNMENT SOLUTIONS LLC

Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: ____________________

Project: ____________________ Date: ____________

Location: Fort Devens Massachusetts Sampler: ____________

Well Integrity	Yes	No	N/A
Casing Secure			
Concrete Pad intact			
PVC casing intact			
Well gripper present			
Bolts present			
Locked (stickup wells)			

Well Information	
Diameter	
Material	
Depth to water (ft-bgs)	
Depth to bottom (ft bgs)	
Screen Interval (ft-bgs)	
Total volume purged (gal)	

Sampling Type

Purging Method ________ Tubing type ________ Dedicated pump (Y/N) ________

Purge start/stop time ________ Tubing diameter ________ Air source ________

Field Instrument (Model/S/N) ________

Stabilization Parameters

Time (hhmm)	**Flow Rate (ml/min)**	**Depth to Water (ft)**	**Temp (ºC)**	**pH (STD)**	**SPC (µS/cm^c)**	**DO (mg/L)**	**ORP (mv)**	**Turbidity (NTU)**	**Color/Clarity**
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	

2" Screen Volume = 0.163 gal/ft or 616 ml per foot   Per EPA Region 1 Low Flow SOP V3, 1/19/10

Sampling Details

Field Filtered (Y/N): ________ Duplicate (Y/N): ________ MS/MSD (Y/N): ________

Filter Size: ________ Dup ID/Time: ________

Sample Collection Time: ________

Comments: ____________________

____

Signature Date

KGS

MONITORING WELL DEVELOPMENT RECORD

SITE:		WELL IDENTIFICATION NO.		SCREEN LENGTH (FT):	
SITE ADDRESS:		DATE INSTALLED:		CASING ID (IN):	
PROJECT NAME:		DATE DEVELOPED:		DEPTH TO BOTTOM (FT):	
PROJECT NUMBER:		DEVELOPMENT METHOD:		STATIC WATER LEVEL BEFORE (FT).	
PERSONNEL:		PUMP TYPE:		STATIC WATER LEVEL AFTER (FT).	
COMPANY:					

TIME	ESTIMATED SEDIMENT THICKNESS (IN.) Measured from TOC before/during/after	CUMULATIVE WATER VOLUME (GALS).	WATER LEVEL READINGS (FT. BELOW TOC)	TURBIDITY (NTU)	TEMP (C°)	SP. COND. (UNITS___ _)	DO (mg/L)	pH	ORP (mV)	REMARKS (odor, color, clarity, particulate matter)
	Before During After									

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Fort Devens	Boring No.:
Project No.:	Drilling Co.:
Address:	Driller:
Logger:	Drilling Method:
Dates:	Drilling Equip:
Total Boring Depth:	Static Water:

Core Section	Recovery (ft)	Interval (ft)	PID (ppm)	Soil Profile	GEOLOGIC LOG

Notes:

Soil Characterization

Top soil	Primarily Clay	Gravel
Primarily Sand	Till	Heterogeneous Mixture
Primarily Silt	Shale	Bedrock

KOMAN Government Solutions, LLC
293 Boston Post Road
Marlborough, MA 01752

Turbidity Instrument Calibration Log

Project/Site Name: ______________________________ **Instrument:** ______________________________

Calibrated By: ______________________________ **Serial Number:** ______________________________

Date	Pre-Cal 0 NTU AM	Pre-Cal 0 NTU AM	Post-Cal 10 NTU AM	Post-Cal 10 NTU AM	Pre-Cal 0 NTU PM	Pre-Cal 0 NTU PM	Post-Cal 10 NTU PM	Post-Cal 10 NTU PM

Signature: ______________________________ **Date:** ______________________________

SOIL BORING / MONITORING WELL FIELD LOG

MW / SB No.:	Drilling Location:	Project/Client:	Project No:
		Site Contact:	
Contractor:		Site Location:	PID Backgr.(ppm):
Crew:	Date:		PID Lamp (eV):
	Time Start:	Weather:	Surface Elevation (ft above ref. point):
Drill Method:	Time End:	Logged By:	TOC Elevation (ft above ref. point):
Sample Method:		Notes (Surface Condition, Soil Sample Numbers, Soil Drums, etc) :	
Sample Submission:			

Drive / Recovery % ft. in.	Sample No. / Depth	Blow Counts	PID/FID (ppm)	Depth (feet)	Soil Details	Well Details	Well Location: Longitude:	Latitude:
				0			**Geological Information:**	
				2				
				4				
				6				
				8				
				10				
				12				
				14				
				16				
				18				
				20				
				22				
				24				
				26				
				28				
				30				
				32				
				34				
				36				
				38				

Monitoring Well Construction

- Asphalt
- Well Casing
- Screen (slotted)
- Sand Pack (quartz)
- Bentonite
- Grout
- Sump
- Depth to Groundwater

Soil Characterization

- Transitional Material
- Primarily Sand
- Primarily Silt
- Primarily Clay
- Shale
- Heterogeneous Mixture
- Fill Material

Well Construction Information Screened Interval (ft bgs):

Well Depth:	Well Dia. (ID/OD):	Stickup Height
Screen length:	Casing length:	Riser length:
Screen size:	Casing Type:	Sand pack Type:
Sump length:	Auger Dia. (ID/OD):	Locked:
Sand Pack:	Bentonite:	Grout:
Comments:		

KGS
293 Boston Post Road
Marlborough, MA 01752

APPENDIX B

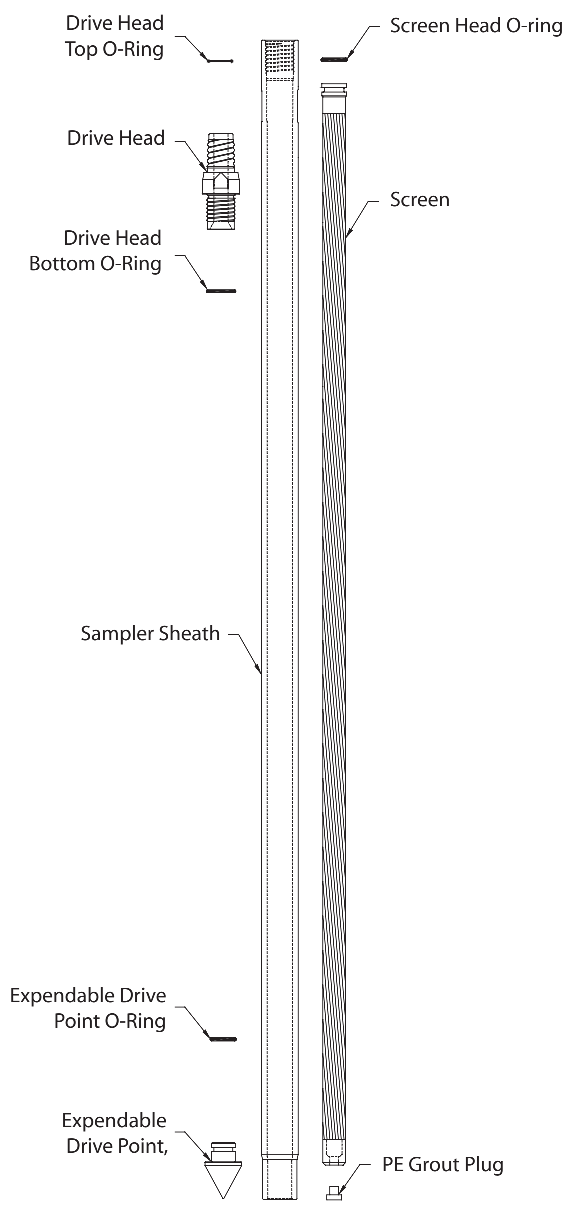
Geoprobe® Screen Point 16 Groundwater Sampler

GEOPROBE® SCREEN POINT 16 GROUNDWATER SAMPLER

STANDARD OPERATING PROCEDURE

Technical Bulletin No. MK3142

PREPARED: November, 2006



GEOPROBE® SCREEN POINT 16 GROUNDWATER SAMPLER PARTS

Geoprobe® and Geoprobe Systems®, Macro-Core® and Direct Image® are Registered Trademarks of Kejr, Inc., Salina, Kansas

Screen Point 16 Groundwater Sampler is manufactured under U.S. Patent 5,612,498

1.0 OBJECTIVE

The objective of this procedure is to drive a sealed stainless steel or PVC screen to depth, deploy the screen, obtain a representative water sample from the screen interval, and grout the probe hole during abandonment. The Screen Point 16 Groundwater Sampler enables the operator to conduct abandonment grouting that meets American Society for Testing and Materials (ASTM) Method D 5299 requirements for decommissioning wells and borings for environmental activities (ASTM 1993).

2.0 BACKGROUND

2.1 Definitions

Geoprobe®: A brand name of high quality, hydraulically powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling and monitoring, soil conductivity and contaminant logging, grouting, and materials injection.

Screen Point 16 (SP16) Groundwater Sampler: A direct push device consisting of a PVC or stainless steel screen that is driven to depth within a sealed, steel sheath and then deployed for the collection of representative groundwater samples. The assembled SP16 Sampler is approximately 51.5 inches (1308 mm) long with an OD of 1.625 inches (41 mm). Upon deployment, up to 41 inches (1041 mm) of screen can be exposed to the formation. The Screen Point 16 Groundwater Sampler is designed for use with 1.5-inch probe rods and machines equipped with the more powerful GH60 Hydraulic Hammer. Operators with GH40 Series hammers may chose to use this sampler in soils where driving is difficult.

Rod Grip Pull System: An attachment mounted on the hydraulic hammer of a direct push machine which makes it possible to retract the tool string with extension rods or flexible tubing protruding from the top of the probe rods. The Rod Grip Pull System includes a pull block with rod grip jaws that are bolted directly to the machine. A removable handle assembly straddles the tool string while hooking onto the pull block to effectively grip the probe rods as the hammer is raised. A separate handle assembly is required for each probe rod diameter.

2.2 Discussion

In this procedure, the assembled Screen Point 16 Groundwater Sampler (Fig. 2.1A) is threaded onto the leading end of a Geoprobe® probe rod and advanced into the subsurface with a Geoprobe® direct push machine. Additional probe rods are added incrementally and advanced until the desired sampling interval is reached. While the sampler is advanced to depth, O-ring seals at each rod joint, the drive head, and the expendable drive point provide a watertight system. This system eliminates the threat of formation fluids entering the screen before deployment and assures sample integrity.

Once at the desired sampling interval, extension rods are sent downhole until the leading rod contacts the bottom of the sampler screen. The tool string is then retracted approximately 44 inches (1118 mm) while the screen is held in place with the extension rods (Fig. 2.1B). As the tool string is retracted, the expendable point is released from the sampler sheath. The tool string and sheath may be retracted the full length of the screen or as little as a few inches if a small sampling interval is desired.

There are three types of screens that can be used in the Screen Point 16 Groundwater Sampler. Two of the these, a stainless steel screen with a standard slot size of 0.004 inches (0.10 mm) and a PVC screen with a standard slot size of 0.010 inches (0.25 mm), are recovered with the tool string after sampling. The third screen is also manufactured from PVC with a standard slot size of 0.010 inches (0.25 mm), but is designed to be left downhole when sampling is complete. This disposable screen has an exposed screen length of approximately 43 inches (1092 mm). The two screens that are recovered with the sampler both have an exposed screen length of approximately 41 inches (1041 mm).

(continued on following page)

An O-ring on the head of the stainless steel screens maintains a seal at the top of the screen. As a result, any liquid entering the sampler during screen deployment must first pass through the screen. PVC screens do not require an O-ring because the tolerance between the screen head and sampler sheath is near that of the screen slot size.

The screens are constructed such that flexible tubing, a mini-bailer, or a small-diameter bladder pump can be inserted into the screen cavity. This makes direct sampling possible from anywhere within the saturated zone. A removable plug in the lower end of the screens allows the user to grout as the sampler is extracted for further use.

Groundwater samples can be obtained in a number of ways. A common method utilizes polyethylene (TB25L) or Teflon® (TB25T) tubing and a Check Valve Assembly (GW4210). The check valve (with check ball) is attached to one end of the tubing and inserted down the casing until it is immersed in groundwater. Water is pumped through the tubing and to the ground surface by oscillating the tubing up and down.

An alternative means of collecting groundwater samples is to attach a peristaltic or vacuum pump to the tubing. This method is limited in that water can be pumped to the surface from a maximum depth of approximately 26 feet (8 m). Another technique for groundwater sampling is to use a stainless steel Mini-Bailer Assembly (GW41). The mini-bailer is lowered down the inside of the casing below the water level where it fills with water and is then retrieved from the casing.

The latest option for collecting groundwater from the SP16 sampler is to utilize a Geoprobe® MB470 Series Mechanical Bladder Pump (MBP)*. The MBP may be used to meet requirements of the low-flow sampling protocol (Puls and Barcelona 1996, ASTM 2003). Through participation in a U.S. EPA Environmental Technology Verification study, it was confirmed that the MB470 can provide representative samples (EPA 2003).

**The Mechanical Bladder Pump is manufactured under U.S. Patent No. 6,877,965 issued April 12, 2005.*

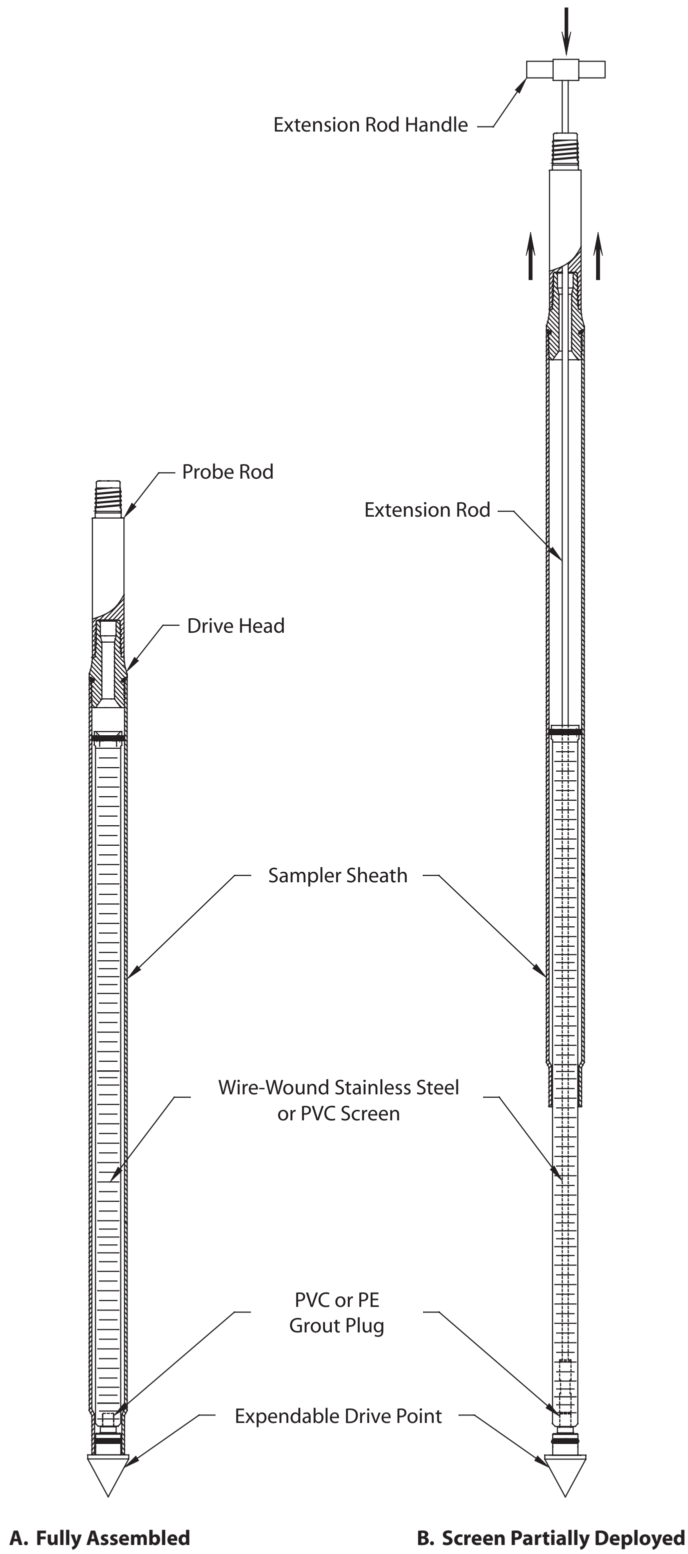


FIGURE 2.1
Screen Point 16 Groundwater Sampler

3.0 TOOLS AND EQUIPMENT

The following tools and equipment can be used to successfully recover representative groundwater samples with the Geoprobe® Screen Point 16 Groundwater Sampler. Refer to Figures 3.1 and 3.2 for identification of the specified parts. Tools are listed below for the most common SP16 / 1.5-inch probe rod configurations. Additional parts for optional rod sizes and accessories are listed in Appendix A.

SP16 Sampler Parts	**Part Number**
SP16 Sampler Sheath	15187
SP16 Drive Head, 0.5-inch bore, 1.5-inch rods*	18307
SP16 O-ring Service Kit, 1.5-inch rods *(includes 4 each of the O-ring packets below)*	15844
O-rings for Top of SP16 Drive Head, 1.5-inch rods only (Pkt. of 25)	*15389*
O-rings for Bottom of SP16 Drive Head (Pkt. of 25)	*13196*
O-rings for GW1520 Screen Head (Pkt. of 25)	*GW1520R*
O-rings for SP16 Expendable Drive Point (Pkt. of 25)	*GW1555R*
Screen, Wire-Wound Stainless Steel, 4-Slot*	GW1520
Grout Plugs, PE (Pkg. of 25)	GW1552K
Expendable Drive Points, steel, 1.625-inch OD (Pkg. of 25)*	GW1555K
Screen Point 16 Groundwater Sampler Kit, 1.5-inch Probe Rods *(includes 1 each of: 15187, 18307, 15844, GW1520, GW1535, GW1540, GW1555K, and GW1552K)*	15770

Probe Rods and Probe Rod Accessories	**Part Number**
Drive Cap, 1.5-inch probe rods, threadless, (for GH60 Hammer)	12787
Pull Cap, 1.5-inch probe rods	15090
Probe Rod, 1.5-inch x 60-inch*	11121

Extension Rods and Extension Rod Accessories	**Part Number**
Screen Push Adapter	GW1535
Grout Plug Push Adapter	GW1540
Extension Rod, 60-inch*	10073
Extension Rod Coupler	AT68
Extension Rod Handle	AT69
Extension Rod Jig	AT690
Extension Rod Quick Link Coupler, pin	AT695
Extension Rod Quick Link Coupler, box	AT696

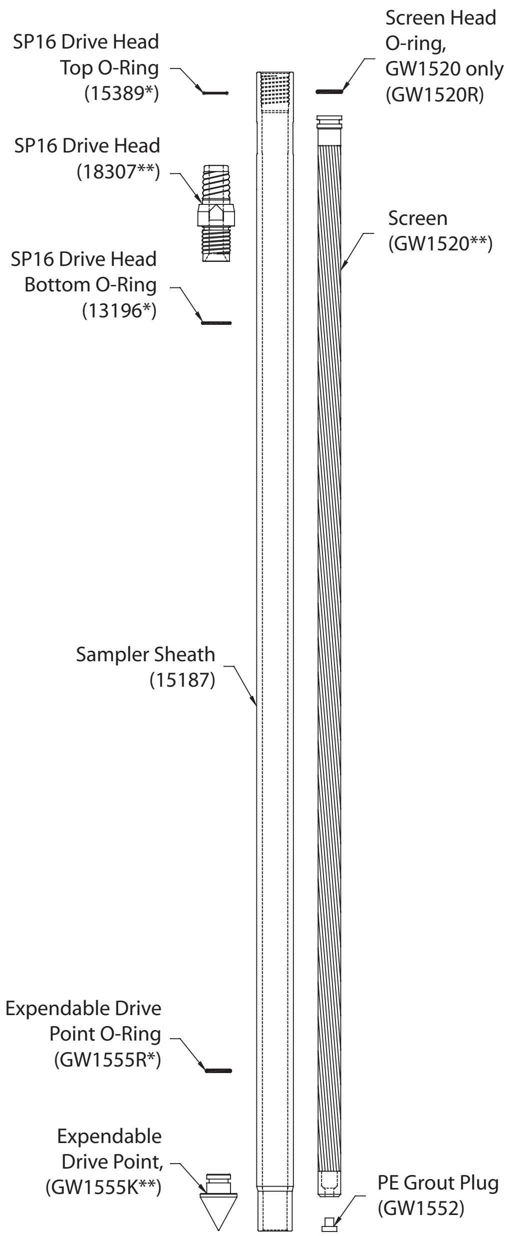
Grout Accessories	**Part Number**
Grout Nozzle, for 0.375-inch OD tubing	GW1545
High-Pressure Nylon Tubing, 0.375-inch OD / 0.25-inch ID, 100-ft. (30 m)	11633
Grout Machine, self-contained*	GS1000
Grout System Accessories Package, 1.5-inch rods	GS1015

Groundwater Purging and Sampling Accessories	**Part Number**
Polyethylene Tubing, 0.375-inch OD, 500 ft.*	TB25L
Check Valve Assembly, 0.375-inch OD Tubing*	GW4210
Water Level Meter, 0.438-inch OD Probe, 100 ft. cable*	GW2000
Mechanical Bladder Pump**	MB470
Mini Bailer Assembly, stainless steel	GW41

Additional Tools	**Part Number**
Adjustable Wrench, 6.0-inch	FA200
Adjustable Wrench, 10.0-inch	FA201
Pipe Wrenches	NA

* See Appendix A for additional tooling options.

** Refer to the Standard Operating Procedure (SOP) for the Mechanical Bladder Pump (Technical Bulletin No. MK3013) for additional tooling needs.



* Included in the SP16 O-ring Service Kit (15844)
** Part numbers show most common tool configuration. See Appendix A for alternative parts.

FIGURE 3.1
SP16 Sampler Parts

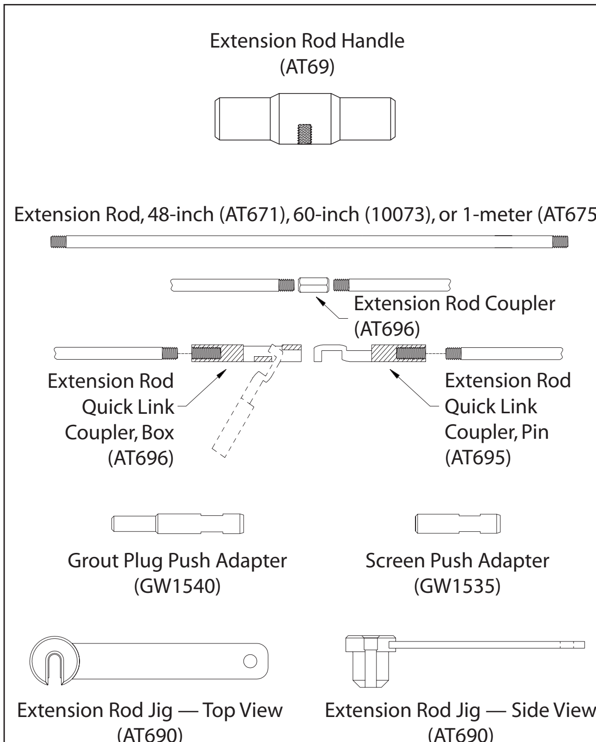


FIGURE 3.2
Geoprobe® Extension Rods and Accessories

4.0 OPERATION

4.1 Basic Operation

The SP16 sampler utilize a stainless steel or PVC screen which is encased in an alloy steel sampler sheath. An expendable drive point is placed in the lower end of the sheath while a drive head is attached to the top. O-rings on the drive head and expendable point provide a watertight sheath which keeps contaminants out of the system as the sampler is driven to depth.

Once the sampling interval is reached, extension rods equipped with a screen push adapter are inserted down the ID of the probe rods. The tool string is then retracted up to 44 inches (1118 mm) while the screen is held in place with the extension rods. The system is now ready for groundwater sampling. When sampling is complete, a removable plug in the bottom of the screen allows for grouting below the sampler as the tool string is retrieved.

4.2 Sampler Options

The Screen Point 15 and Screen Point 16 Groundwater Samplers are nearly identical. Subtle differences in the design of the SP16 sampler make it more durable than the earlier SP15 system. Operators of GH60-equipped machines should always utilize SP16 tooling. Operators of machines equipped with GH40 Series hammers may also choose SP16 tooling when sampling in difficult probing conditions.

A 1.75-inch OD Expendable Drive Point (17066K) and Disposable PVC Screen (16089) provide two useful options for the SP16 sampler. The 1.75-inch drive point may be used when soil conditions make it difficult to remove the sampler after driving to depth. The disposable PVC screen may be left downhole after sampling (when regulations permit) to eliminate the time required for screen decontamination.

4.3 Decontamination

In order to collect representative groundwater samples, all sampler parts must be thoroughly cleaned before and after each use. Scrub all metal parts using a stiff brush and a nonphosphate soap solution. Steam cleaning may be substituted for hand-washing if available. Rinse with distilled water and allow to air-dry before assembly.

4.4 SP16 Sampler Assembly (Figure 4.1)

Part numbers are listed for a standard SP16 sampler using 1.5-inch probe rods. Refer to Page 6 for screen and drive head alternatives.

1. Place an O-ring on a steel expendable drive point (GW1555K). Firmly seat the expendable point in the necked end of a sampler sheath (15187).

2. Install a PE Grout Plug (GW1552) in the bottom end of a Wire-wound Stainless Steel Screen (GW1520). Place a GW1520R O-ring in the groove on the top end of the screen.

3. Slide the screen inside of the sampler sheath with the grout plug toward the bottom of the sampler. Ensure that the expendable point was not displaced by the screen.

4. Install a bottom O-ring (13196) on a Drive Head (18307 or 15188). Thread the drive head into the sampler sheath using an adjustable wrench if necessary to ensure complete engagement of the threads. Attach a Drive Cap (12787 or 15590) to the top of the drive head.

   NOTE: The 18307 drive head should be used whenever possible as the smaller 0.5-inch ID provides a greater material cross-section for increased durability.

Sampler assembly is complete.

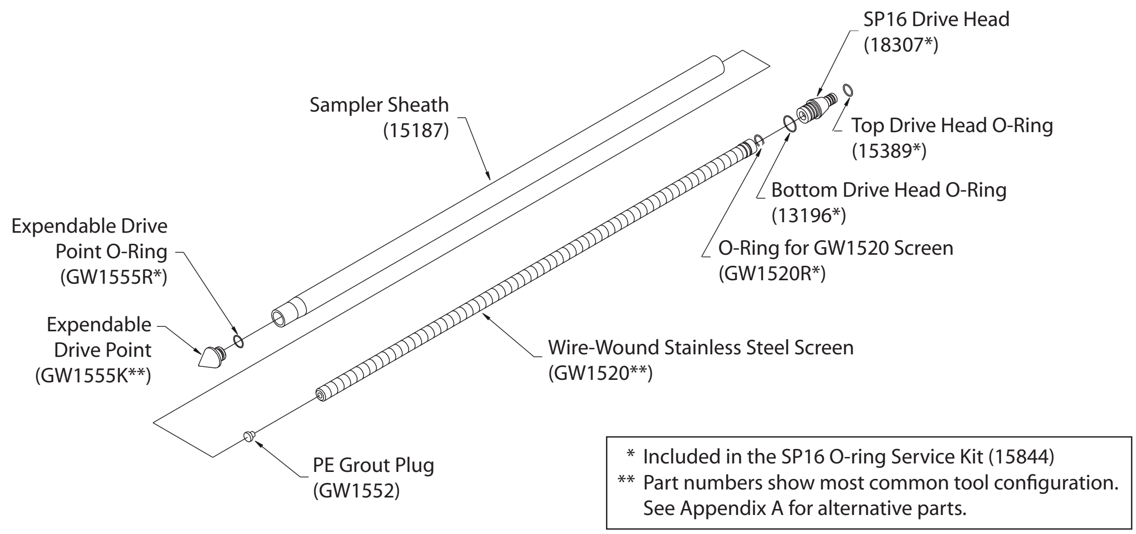


FIGURE 4.1
Screen Point 16 Groundwater Sampler Assembly

4.5 Advancing the SP16 Sampler

To provide adequate room for screen deployment with the Rod Grip Pull System, the probe derrick should be extended a little over halfway out of the carrier vehicle when positioning for operation.

1. Begin by placing the assembled sampler (Fig. 2.1.A) in the driving position beneath the hydraulic hammer of the direct push machine as shown in Figure 4.2.

2. Advance the sampler with the throttle control at slow speed for the first few feet to ensure that the sampler is aligned properly. Switch to fast speed for the remainder of the probe stroke.

3. Completely raise the hammer assembly. Remove the drive cap and place an O-ring in the top groove of the drive head. Distilled water may be used to lubricate the O-ring if needed.

Add a probe rod (length to be determined by operator) and reattach the drive cap to the rod string. Drive the sampler the entire length of the new rod with the throttle control at fast speed.

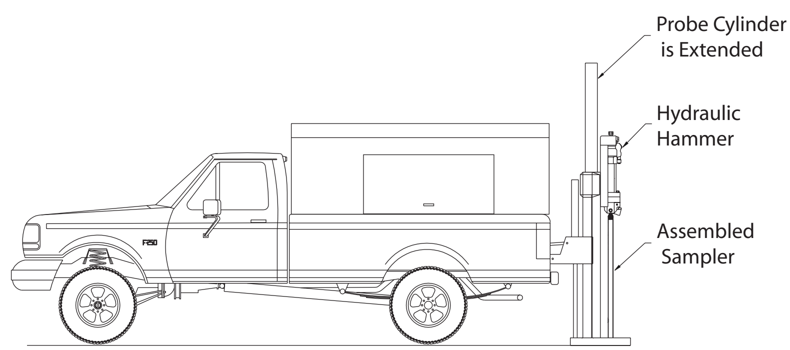


FIGURE 4.2
Screen Point 16 Groundwater Sampler in Driving Position

4. Repeat Step 3 until the desired sampling interval is reached. Approximately 12 inches (305 mm) of the last probe rod must extend above the ground surface to allow attachment of the puller assembly. A 12-inch (305 mm) rod may be added if the tool string is over-driven.

5. Remove the drive cap and retract the probe derrick away from the tool string.

4.6 Screen Deployment

1. Thread a screen push adapter (GW1535) on an extension rod of suitable length (AT671, 10073, or AT675). Attach a threaded coupler (AT68) to the other end of the extension rod. Lower the extension rod inside of the probe rod taking care not to drop it down the tool string. An extension rod jig (AT690) may be used to hold the rods.

2. Add extension rods until the adapter contacts the bottom of the screen. To speed up this step, it is recommended that Extension Rod Quick Links (AT695 and AT696) are used at every other rod joint.

3. Ensure that at least 48 inches (1219 mm) of extension rod protrudes from the probe rod. Thread an extension rod handle (AT69) on the top extension rod.

4. Maneuver the probe assembly into position for pulling.

5. Raise (pull) the tool string while physically holding the screen in place with the extension rods (Fig. 4.3.B). A slight knock with the extension rod string will help to dislodge the expendable point and start the screen moving inside the sheath.

   Raise the hammer and tool string about 44 inches (1118 cm) if using a GW1520 or GW1530 screen. At this point the screen head will contact the necked portion of the sampler sheath (Fig. 4.3.C.) and the extension rods will rise with the probe rods. Use care when deploying a PVC screen so as not to break the screen when it contacts the bottom of the sampler sheath.

   The Disposable Screen (16089) will extend completely out of the sheath if the tool string is raised more than 45 inches (1143 mm). Measure and mark this distance on the top extension rod to avoid losing the screen during deployment.

6. Remove the rod grip handle, lower the hammer assembly, and retract the probe derrick. Remove the top extension rod (with handle) and top probe rod. Finally, extract all extension rods.

7. Groundwater samples can now be collected with a mini-bailer, peristaltic or vacuum pump, tubing bottom check valve assembly, bladder pump, or other acceptable small diameter sampling device.

   When inserting tubing or a bladder pump down the rod string, ensure that it enters the screen interval. The leading end of the tubing or bladder pump will sometimes catch at the screen head giving the illusion that the bottom of the screen has been reached. An up-and-down motion combined with rotation helps move the tubing or bladder pump past the lip and into the screen.

4.7 Abandonment Grouting for GW1520 and GW1530 Screens

The SP16 Sampler can meet ASTM D 5299 requirements for abandoning environmental wells or borings when grouting is conducted properly. A removable grout plug makes it possible to deploy tubing through the bottom of GW1520 and GW1530 screens. A GS500 or GS1000 Grout Machine is then used to pump grout into the open probe hole as the sampler is withdrawn. The following procedure is presented as an example only and should be modified to satisfy local abandonment grouting regulations.

1. Maneuver the probe assembly into position for pulling. Attach the rod grip puller to the top probe rod. Raise the tool string approximately 4 to 6 inches (102 to 152 cm) to allow removal of the grout plug.

2. Thread the Grout Plug Push Adapter (GW1540) onto an extension rod. Insert the adapter and extension rod inside the probe rod string. Add extension rods until the adapter contacts the grout plug at the bottom of the screen. Attach the handle to the top extension rod. When the extension rods are slightly raised and lowered, a relatively soft rebound should be felt as the adapter contacts the grout plug. This is especially true when using a PVC screen.

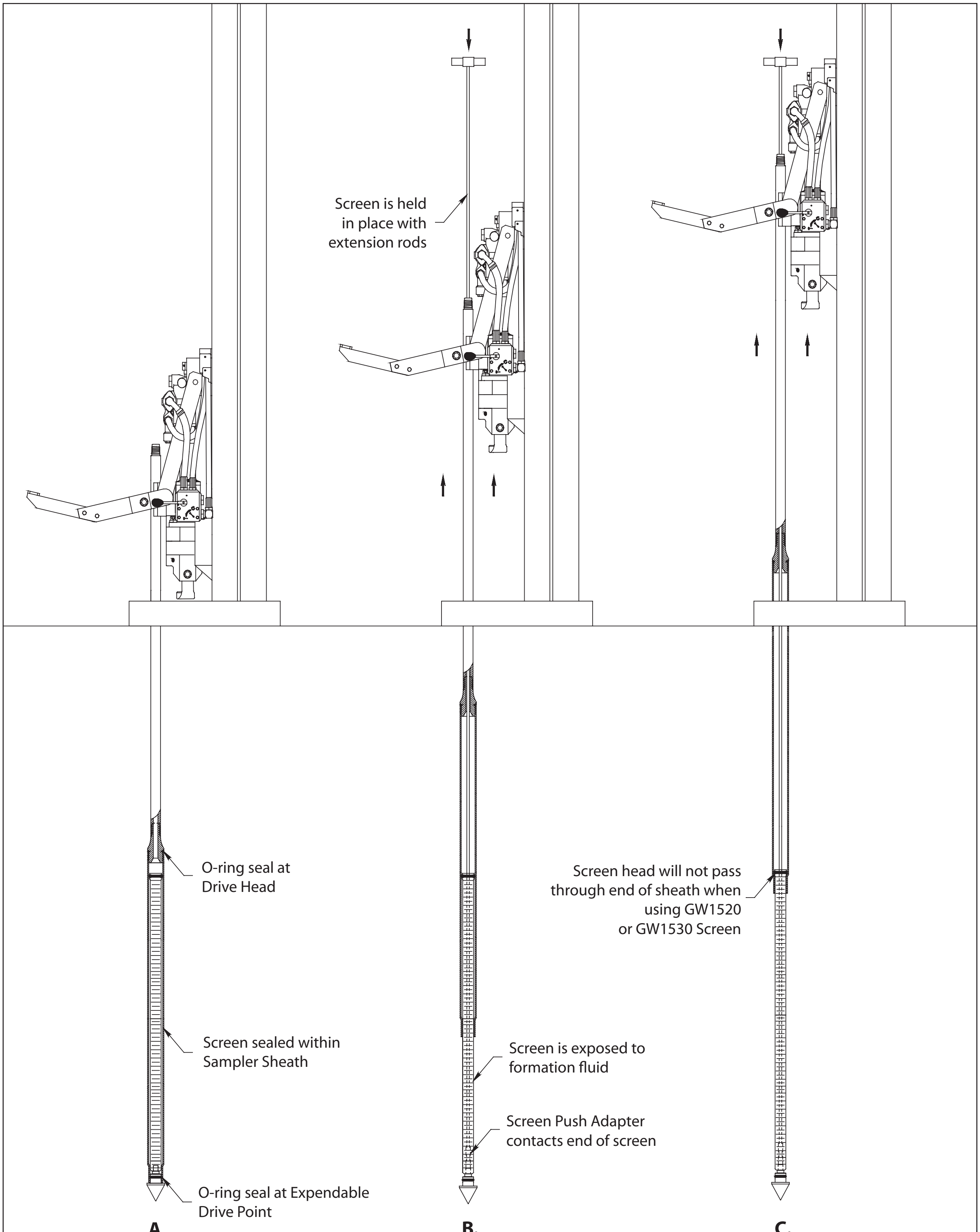


FIGURE 4.3
Screen Deployment for SP16 Sampler

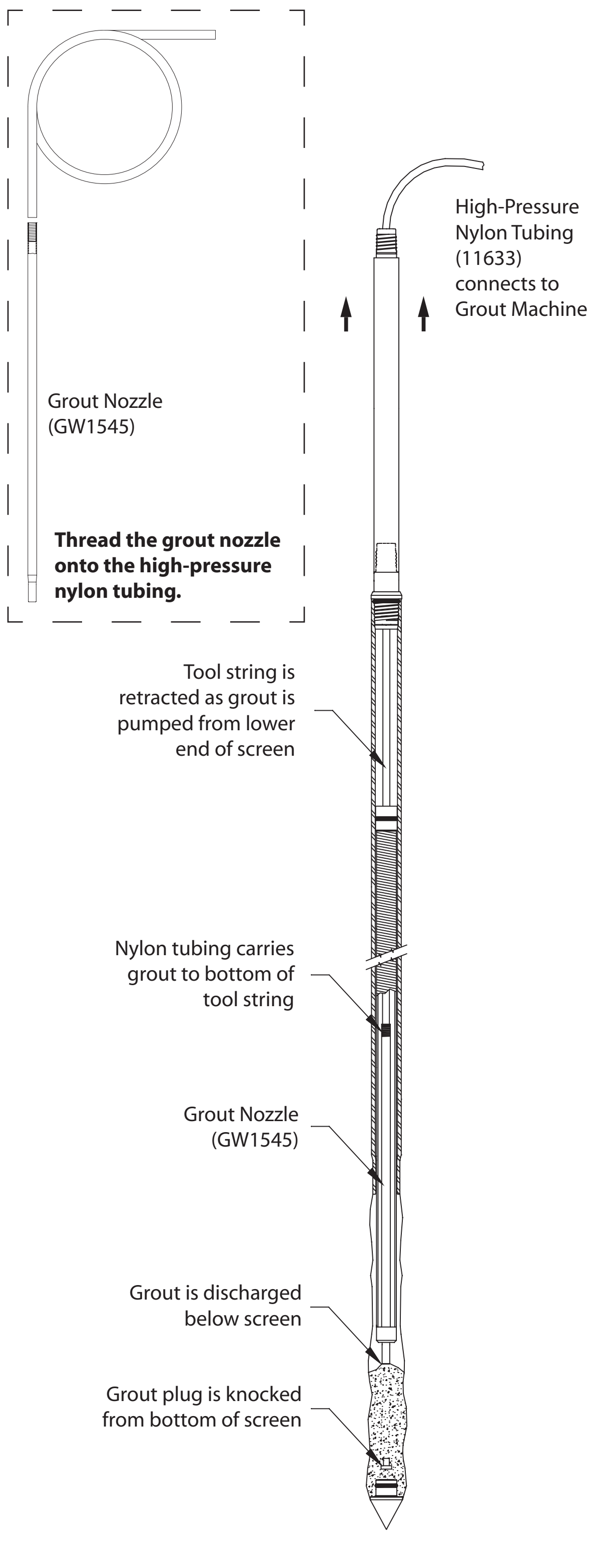


FIGURE 4.4

Grouting the SP16 Sampler With a GW1520 or GW1530 Screen

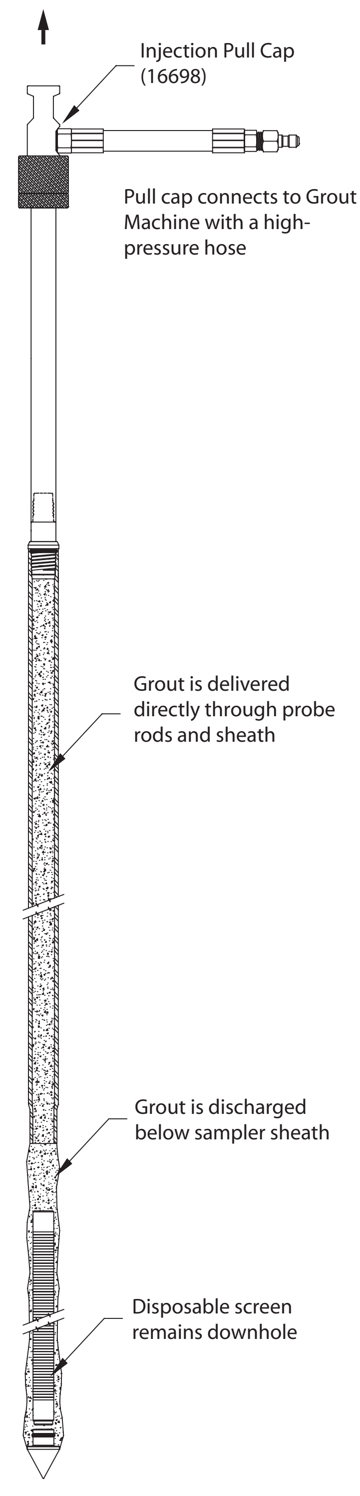


FIGURE 4.5

Grouting the SP16 Sampler With a 16089 Disposable Screen

3. Place a mark on the extension rod even with the top of the probe rod. Apply downward pressure on the extension rods and push the grout plug out of the screen. The mark placed on the extension rod should now be below the top of the probe rod. Remove all extension rods.

   Note: When working with a stainless steel screen, it may be necessary to raise and quickly lower the extension rods to jar the grout plug free. When the plug is successfully removed, a metal-on-metal sensation may be noted as the extension rods are gently "bounced" within the probe rods.

4. A Grout Nozzle (GW1545) is now connected to High-Pressure Nylon Tubing (11633) and inserted down through the probe rods to the bottom of the screen (Fig. 4.4). It may be necessary to pump a small amount of clean water through the tubing during deployment to jet out sediments that settled in the bottom of the screen. Resistance will sometimes be felt as the grout nozzle passes through the drive head. Rotate the tubing while moving it up-and-down to ensure that the nozzle has reached the bottom of the screen and is not hung up on the drive head.

   Note: *All probe rods remain strung on the tubing as the tool string is pulled. Provide extra tubing length to allow sufficient room to lay the rods on the ground as they are removed. An additional 20 feet is generally enough.*

5. Operate the grout pump while pulling the first rod with the rod grip pull system. Coordinate pumping and pulling rates so that grout fills the void left by the sampler. After pulling the first rod, release the rod grip handle, fully lower the hammer, and regrip the tool string. Unthread the top probe and slide it over the tubing placing it on the ground near the end of the tubing.

6. Repeat Step 5 until the sampler is retrieved. Do not bend or kink the tubing when pulling and laying out the probe rods. Sharp bends create weak spots in the tubing which may burst when pumping grout. Remember to operate the grout pump only when pulling the rod string. The probe hole is thus filled with grout from the bottom up as the rods are extracted.

7. Promptly clean all probe rods and sampler parts before the grout sets up and clogs the equipment.

4.8 Abandonment Grouting for the 16089 Disposable Screen

ASTM D 5299 requirements can also be met for the SP16 samplers when using the 16089 disposable screen. Because the screen remains downhole after sampling, the operator may choose either to deliver grout to the bottom of the tool string with nylon tubing or pump grout directly through the probe rods using an Injection Pull Cap (16698). A GS500 or GS1000 Grout Machine is needed to pump grout into the open probe hole as the sampler is withdrawn. The following procedure is presented as an example only and should be modified to satisfy local abandonment grouting regulations.

1. Maneuver the probe assembly into position for pulling with the rod grip puller.

2. Thread the screen push adapter onto an extension rod. Insert the adapter and extension rod inside the probe rod string. Add extension rods until the adapter contacts the bottom of the screen. Attach the handle to the top extension rod.

3. The disposable screen must be extended at least 46 inches (1168 mm) to clear the bottom of the sampler sheath. Considering the length of screen deployed in Section 4.7, determine the remaining distance required to fully extend the screen from the sheath. Mark this distance on the top extension rod.

4. Pull the tool string up to the mark on the top extension rod while holding the disposable screen in place.

   The screen is now fully deployed and the sampler is ready for abandonment grouting. Apply grout to the bottom of the tool string during retrieval using either flexible tubing (as described in Section 4.7) or an injection pull cap (Fig. 4.5). This section continues with a description of grouting with a pull cap.

5. Remove the rod grip handle and maneuver the probe assembly directly over the tool string. Thread an Injection Pull Cap (16698) onto the top probe rod and close the hammer pull latch over the top of the pull cap.

6. Connect the pull cap to a Geoprobe® grout machine using a high-pressure grout hose.

7. Operate the pump to fill the entire tool string with grout. When a sufficient volume has been pumped to fill the tool string, begin pulling the rods and sampler while continuing to operate the grout pump. Considering the known pump volume and sampler cross-section, time tooling withdrawal to slightly "overpump" grout into the subsurface. This will ensure that all voids are filled during sampler retrieval.

   The grouting process can lubricate the probe hole sufficiently to cause the tool string to slide back downhole when disconnected from the pull cap. Prevent this by withdrawing the tool string with the rod grip puller while maintaining a connection to the grout machine with the pull cap.

4.9 Retrieving the Screen Point 16 Sampler

If grouting is not required, the Screen Point 16 Sampler can be retrieved by pulling the probe rods as with most other Geoprobe® applications. The Rod Grip Pull System should be used for this process as it allows the operator to remove rods without completely releasing the tool string. This avoids having the probe rods fall back downhole when released during the pulling procedure. A standard Pull Cap (15164) may still be used if preferred. Refer to the Owner's Manual for your Geoprobe® direct push machine for specific instructions on pulling the tool string.

5.0 REFERENCES

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Appendix A
ALTERNATIVE PARTS

The following parts are available to meet unique soil conditions. See section 3.0 for a complete listing of the common tool configurations for the Geoprobe® Screen Point 16 Groundwater Sampler.

SP16 Sampler Parts and Accessories	Part Number
SP16 Drive Head, 0.625-inch bore, 1.5-inch rods	15188
Expendable Drive Points, aluminum, 1.625-inch OD (Pkg. of 25)	GW1555ALK
Expendable Drive Points, steel, 1.75-inch OD (Pkg. of 25)	17066K
Screen, PVC, 10-Slot	GW1530
Screen, Disposable, PVC, 10-Slot	16089

Groundwater Purging and Sampling Accessories	Part Number
Polyethylene Tubing, 0.25-inch OD, 500 ft.	TB17L
Polyethylene Tubing, 0.5-inch OD, 500 ft.	TB37L
Polyethylene Tubing, 0.625-inch OD, 50 ft.	TB50L
Check Valve Assembly, 0.25-inch OD Tubing	GW4240
Check Valve Assembly, 0.5-inch OD Tubing	GW4220
Check Valve Assembly, 0.625-inch OD Tubing	GW4230
Water Level Meter, 0.375-inch OD Probe, 100-ft. cable	GW2001
Water Level Meter, 0.438-inch OD Probe, 200-ft. cable	GW2002
Water Level Meter, 0.375-inch OD Probe, 200-ft. cable	GW2003
Water Level Meter, 0.438-inch OD Probe, 30-m cable	GW2005
Water Level Meter, 0.438-inch OD Probe, 60-m cable	GW2007
Water Level Meter, 0.375-inch OD Probe, 60-m cable	GE2008

Grouting Accessories	Part Number
Grout Machine, auxiliary-powered	GS500

Probe Rods, Extension Rods, and Accessories	Part Number
Probe Rod, 1.5-inch x 1-meter	17899
Probe Rod, 1.5-inch x 48-inch	13359
Drive Cap, 1.5-inch rods (for GH40 Series Hammer)	15590
Rod Grip Pull Handle, 1.5-inch Probe Rods (for GH40 Series Hammer)	GH1555
Extension Rod, 48-inch	AT671
Extension Rod, 1-meter	AT675

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