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Seneca Army Depot Activity
Romulus, New York

USACE - New York District
US Army, Engineering & Support Center
Huntsville, AL

Final Work Plan for the PFAS Expanded Site Investigation, SEAD 25 and SEAD 26, Seneca Army Depot Activity

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LIST OF ACRONYMS

ACRONYM	DEFINITION	ACRONYM	DEFINITION
AFFF	Aqueous Film Forming Foams	ORP	Oxidation-Reduction Potential
APP	Accident Prevention Plan	Parsons	Parsons Government Services, Inc.
ASTM	American Society for Testing and Materials	PFAS	Poly- and perfluoroalkyl substances
BRAC	Base Realignment and Closure	PFOA	Perfluorooctanoic acid
BTEX	benzene, toluene, ethylbenzene, and xylene	PFOS	Perfluorooctane sulfonic acid
cm/sec	centimeters per second	PID	Planned Industrial Development/Warehousing Area
COC	Contaminants of Concern	PM	Project Manager
cPAH	carcinogenic polycyclic aromatic hydrocarbons	PPE	Personal Protective Equipment
DO	Dissolved Oxygen	QA	Quality Assurance
DoD	Department of Defense	QC	Quality Control
DQO	Data Quality Objective	RA	Remedial Action
EDD	Electronic Data Deliverable	RI	Remedial Investigation
ELAP	Environmental Laboratory Accreditation Program	ROD	Record of Decision
EPA	Environmental Protection Agency	SCIDA	Seneca County Industrial Development Agency
ESI	Expanded Site Inspection	SEDA	Seneca Army Depot Activity
ft	Feet	SI	Site Investigation
FS	Feasibility Study	SOPs	Standard Operating Procedures
HDPE	high-density polyethylene	SSHP	Site Safety and Health Plan
LRA	Local Redevelopment Authority	SW	Surface Water
LTM	Long term monitoring	UFP-QAPP	Uniform Federal Policy – Quality Assurance Project Plan
MW	Monitoring Well	U.S.	United States
MS	Matrix Spike	USACE	United States Army Corps of Engineers
MSD	Matrix Spike Duplicate	USCS	Unified Soil Classification System
NTU	Nephelometric Turbidity Unit	VOC	Volatile Organic Compound
NYSDEC	New York State Department of Environmental Conservation		

PFAS Expanded Site Investigation Work Plan

Chapter 1 Objectives

This work plan serves as a supplement to the UFP-QAPP and UFP-QAPP Addendum (Parsons 2017a, 2018a) and presents details of the Expanded Site Investigation (ESI) for poly- and perfluoroalkyl substances (PFAS) compounds at two sites within the Seneca Army Depot Activity (**Figure 1**). The two sites include: Fire Training and Demonstration Pad (SEAD 25) and Fire Training Pit and Area (SEAD 26) and were previously targeted during a 2017 Site Investigation as locations where Aqueous Film Forming Foams (AFFF) (e.g., firefighting foams) were potentially used (**Figure 1**).

PFAS, including primary constituents Perfluorooctanoic Acid (PFOA) and Perfluorooctane sulfonic acid (PFOS), are emerging contaminants and are the frequent focus of new investigations. The chemical structures of PFAS make them resistant to breakdown in the environment. Due to their persistence, bioaccumulation potential, and toxicity, PFAS have the potential to impact human health and the environment.

Although there is no evidence that AFFF was used, or stored, at Seneca Army Depot, the presence of PFAS compounds in groundwater was confirmed at two sites, SEAD 25 and SEAD 26, where firefighting training activities were formerly conducted (Parsons, 2018). Based on the detection of PFOS and PFOA at concentrations above the Environmental Protection Agency (EPA) health advisory level of 70 parts per trillion (nanograms per liter [ng/L]) of PFOS and PFOA combined, the New York State Department of Environmental Conservation (NYSDEC) requested that the Army further investigate the nature and extent of impacts in the SEAD 25 and SEAD 26 areas (NYSDEC, 2017).

The objectives of the ESI are to further characterize and document the source(s) and fate and transport of PFAS in groundwater and surface water at the SEAD 25 and SEAD 26 sites as initially delineated in the 2017 PFAS Site Inspection (SI) (Parsons, 2018). The ESI falls between the SI and Remedial Investigation (RI) in the regulatory pathway and will further characterize the potential sources, groundwater direction, and pathways for contaminant spread near the suspected source areas. Potential receptors within a one-mile radius will be identified and the local water sources will be documented to determine if any potable wells may be impacted or if a public water system is in use.

Due to concerns of cross contamination, the Army will take precautions to conduct the sampling in a manner that will reduce the possibility of contamination from outside sources. The field activities and methods herein were appropriately modified to prevent cross-contamination and to avoid the introduction of external contaminant sources. **Appendix A** includes a summary of prohibited and acceptable items for PFAS sampling and PFAS standard operating procedures (SOPs). **Appendix B** includes a summary of the hydrogeology of SEAD 25 and SEAD 26 from the RI (Parsons, 1998). **Appendices C** and **D** contain NYSDEC and Department of Defense (DoD) PFAS Guidance.

Chapter 2 Site History

2.0 SEDA HISTORY

Seneca Army Depot Activity (SEDA), a 10,587-acre former military facility located in Seneca County near Romulus, New York, is located between Seneca Lake and Cayuga Lake, and is bordered by New York State Highway 96 to the east, New York State Highway 96A to the west, and sparsely populated farmland to the north and south (**Figure 1**). The facility was wholly owned by the United States Government and was operated by the Department of the Army between 1941 and 2000 with the primary mission to receive, store, maintain, and supply military items. In 1995, SEDA was designated for closure under the DoD's Base Realignment and Closure (BRAC) process. To address employment and economic impacts associated with the SEDA's closure, the Seneca County Board of Supervisors established the Seneca Army Depot Local Redevelopment Authority (LRA) in October 1995. The primary responsibility assigned to the LRA was to prepare a plan for redevelopment of the SEDA property. Following a comprehensive planning process, a Reuse Plan and Implementation Strategy for Seneca Army Depot was completed and adopted by the LRA on October 8, 1996. The Seneca County Board of Supervisors subsequently approved this Reuse Plan on October 22, 1996. In 2005, after it had acquired portions of the former Depot from the Army, the Seneca County Industrial Development Agency (SCIDA) changed the planned use of land in many portions of the Depot. Both SEAD 25 and SEAD 26 are located within an area designated as a Planned Industrial Development/Warehousing Area (PID). A site plan showing SEAD 25 and SEAD 26 for PFAS groundwater sampling is included as **Figure 1**.

2.1 SEAD 25

SEAD 25 (Fire Training and Demonstration Pad) is located in the east-central portion of SEDA (**Figure 1**). The site is bounded to the east by Administration Avenue, beyond which is undeveloped land covered by deciduous trees; to the south by Ordnance Drive beyond which is an open grassy field and a stand of conifer trees; to the west by a drainage ditch running from the northeast to the southwest with grassland, brush and conifers between the site and the ditch; and, to the north by grassland and a former baseball field. SEAD-25 was in use from the late 1960s to the late 1980s. The former pad was used for fire control training. During the 1980s, the pad was used twice for fire-fighting demonstrations, including one demonstration in 1982 or 1983, and one in 1987. A firehouse was located approximately 2,000 feet northeast of SEAD 25. If PFAS was stored or spilled here this area may be a source of PFAS contamination. The local drainage infrastructure which transports storm water from the area of the firehouse to an open drainage ditch is the most likely overland flow path for local surface water. This drainage system trends northeast-southwest and crosses the northwest corner of SEAD 25. The drainage pathways would likely focus any surface water infiltration within the ditches and would transport any potentially contaminated surface water towards SEAD 25. The former firehouse was not previously investigated.

A RI and Feasibility Study (FS) completed at SEAD 25 determined that the primary contaminants of concern (COCs) were benzene, toluene, ethylbenzene, and xylene (BTEX) in soil and groundwater and chlorinated ethene compounds in groundwater (Parsons ES, 1998). Following the completion of a Record of Decision (ROD) (Parsons, 2004), a Remedial Action (RA) was completed and approximately 1,722 cubic yards of soil were excavated from the pad and swale at SEAD 25 (Parsons, 2006a). Over 10 years of long-term monitoring (LTM) of the groundwater has recorded a decrease of BTEX and chlorinated volatile organic compound (VOC) detections to two source wells (MW25-2 and MW25-3) where the COC concentrations are approximately equal to promulgated groundwater standards (Parsons, 2016). Prior to the PFAS SI, dedicated Teflon tubing was used in the existing SEAD 25 LTM wells. The dedicated tubing was removed and replaced approximately every other year. All dedicated tubing was removed prior to the PFAS SI and Teflon tubing is no longer used in any of the SEAD 25 or SEAD 26 wells during any groundwater monitoring events.

During the 2017 PFAS SI, the groundwater from 12 existing wells was analyzed for PFAS compounds at SEAD 25 (Parsons 2018). Twelve of 14 PFAS compounds were detected at SEAD 25. PFOS and PFOA were detected in all 12 wells sampled at SEAD 25. The combined concentrations of PFOS and PFOA exceeded the EPA health advisory level in all 12 wells. The maximum detection of PFOS was 8,300 ng/L in well MW25-8. The maximum detection of PFOA was 89,000 J ng/L in well MW25-2 (Note: Based on LTM results, MW25-2 is considered the main source well for BTEX and chlorinated VOCs at SEAD 25).

2.2 SEAD 26

SEAD 26 (Fire Training Pit and Area), located in the southeastern portion of SEDA, was used for firefighting training during which various flammable materials were floated on water, ignited, and extinguished (**Figure 1**). Prior to 1977, the fire training area may have also been used for firefighting demonstrations. In accordance with the Parsons (2004) ROD and the Final Remedial Design Work Plan and Design Report (Parsons ES, 1998), a RA was completed at SEAD 26 in 2005. During this effort, five distinct areas were excavated to a depth of one-foot bgs and approximately 828 cubic yards of soil impacted with carcinogenic polycyclic aromatic hydrocarbons (cPAHs) was removed. Prior to the RA, groundwater at SEAD-26 was found to be impacted by low-levels of VOCs above the NYSDEC Class GA standards (Parsons ES, 1998); however, the contaminants that exceeded the NYSDEC GA standards in the groundwater were no longer found in the soil. As such, no treatment of the groundwater was proposed for the RA. Subsequent to the RA, three rounds of semi-annual LTM were conducted at SEAD-26. No COCs were detected in any of the sampling rounds therefore, with concurrence from NYSDEC and EPA, LTM at this site was concluded in February 2007 (Parsons, 2007a).

During the 2017 PFAS SI, the groundwater from eight temporary one-inch wells was analyzed for PFAS compounds at SEAD 26 (Parsons, 2018). Nine of 14 PFAS compounds were detected at SEAD 26. PFOS and PFOA were detected in all eight wells sampled at SEAD 26. Combined PFOS/PFOA concentrations exceeded the EPA health advisory level in four wells (TMW-26-2, -3, -6 and -7) with a maximum concentration of 580 ng/L in well TMW-26-3. Well locations TMW-26-3, -6, and -7 are located directly downgradient of the main former fire training area at SEAD 26. Similar to SEAD 25, the PFOA concentrations were higher than the PFOS concentrations with the exception of the concentrations at TMW-26-1.

2.3 GEOLOGY AND HYDROGEOLOGY

The site is underlain by a broad north-to-south trending series of rock terraces covered by a mantle of glacial till. As part of the Appalachian Plateau, the region is underlain by a tectonically undisturbed sequence of Paleozoic rocks consisting of shale, sandstone, conglomerate, limestone and dolostone. At the Ash Landfill site, these rocks (the Ludlowville Formation) are characterized by gray, calcareous shale and mudstone and thin limestone with numerous zones of abundant invertebrate fossils. Locally, the shale is soft, gray, and fissile. The shale, which has a thin weathered zone at the top, is overlain by 2 to 3 feet of Pleistocene-age till deposits. The till matrix varies locally, but generally consists of unsorted silt, clay, sand, and gravel (Brett et al., 1995).

The stratigraphy at SEAD-25 consists of 1 to 2 feet of crushed shale fill at the ground surface, 2.5 to 10 feet of till, both of which lie above Devonian shale (i.e., bedrock) encountered at depths of 3.5 to 12.2 feet; the upper 0.4 to 2.4 feet of the shale is weathered. Geologic cross-sections from the RI indicate that the fire training pad at SEAD-25 occurs on a local natural high in the shale topography (Parsons, 1998).

The depth to groundwater at SEAD-25 varies seasonally, but generally occurs at depths of between 2 to 6 feet below ground surface. Hydraulic conductivities were found to range from 1.0 x 10^{-5} cm/sec to 3.4 x10^{-3} cm/sec with an average of 6.1 x 10^{-4} cm/sec in the shallow portion of the groundwater. The radial groundwater flow that has developed below the former pad at SEAD 25 is believed to be a local phenomenon that is present because of the influence from the bedrock topographic mound below the pad. Groundwater maps developed during the RI indicate that the water table flattens north of the pad with a rise in the water table. It was concluded that the gradient in this region would continue to flatten as the water table rises throughout the late winter and spring. In the spring, when the water table is at its highest, the expected continued flattening of the water table would strengthen the regional westerly flow direction (outside the local area of SEAD 25) and thus reduce the influence from the locally developed radial flow. Vertical connection tests performed on six well pairs indicate that the till/weathered shale aquifer shows very small displacement, such that it was hard to measure; however, the degree to which the upper and lower aquifer are connected is unknown at this time (Parsons, 1998).

At SEAD-26, the Fire Training Pit and surrounding areas are comprised mostly of fill that varies in thickness from 6 feet to 14 feet. The fill is mainly construction debris. Below the fill is glacial till ranging in thickness between 1.3 feet and 2.5 feet. Devonian shale, with a weathered zone ranging in thickness between at 1.7 feet and 6.0 feet, underlies the till at depths between 6.0 feet and 18.0 feet bgs (Parsons, 1998).

At SEAD-26, during the RI, the depth to groundwater varied from between 5 feet in the spring to 16 feet in the winter season. The approximate water depth in April 2017 was between 8 feet and 10 feet bgs (Parsons, 2018). Hydraulic conductivities were found to range from 1.5 x 10^{-3} cm/sec to 3.9 x10^{-3} cm/sec with an average of 2.5 x 10^{-3} cm/sec. The higher conductivity at SEAD 26 versus SEAD 25 is attributed to the presence of the fill beneath the site. The groundwater flow at SEAD 26 is to the west (Parsons, 1998).

Chapter 3 Description of Work

The key elements of the PFAS ESI approach are as follows:

- **Well Installation.** New 2-inch monitoring wells will be installed using hollow stem auger techniques. All wells will be permanent constructed with stick-up surface completions. Wells will be developed prior to sampling.
- **Sampling.** Sampling of all wells will be conducted using a peristaltic pump with new clean high-density polyethylene (HDPE) tubing. Low flow sampling techniques, modified to avoid PFAS cross-contamination, will be used to collect groundwater samples. Surface water samples will be collected from the drainage ditch at SEAD 25. All materials related to PFAS sampling, including sample bottles, will be free of Teflon.
- **Field Sampling PFAS specific Procedures and Decontamination.** To avoid PFAS contamination, sources of contamination in the field and lab environments shall be identified and avoided.
- **Analytical.** The samples will be analyzed by modified EPA Method 537 by Test America Sacramento. A full list of the analytes are included in the Uniform Federal Policy - Quality Assurance Project Plan (UFP QAPP).
- **QAPP.** Worksheets for the QAPP were prepared, as necessary, to document the sampling approach and analytical methods for PFAS.

Specific details regarding implementation of the key points listed above and a summary of the guidance for sampling PFAS from NYSDEC and U.S. Army Corp of Engineers (USACE) are provided in the work plan and referenced documents. Additional details for implementation of the groundwater investigation activities are provided in the appendices to this document:

- Appendix A – PFAS Field Procedures & Standard Operating Procedures (SOPs)
- Appendix B – SEAD 25/26 Hydrogeology Summary
- Appendix C – NYSDEC PFC Groundwater Samples from Monitoring Wells Sample Protocol Revision 1.1
- Appendix D – USACE / DoD PFAS Guidance

3.0 MONITORING WELL INSTALLATION AND SAMPLING AND FIELD PROCEDURES

3.0.1 DRILL METHODS

Hollow stem auger drilling will be used to collect shallow and deeper overburden soils and create the boreholes for permanent monitoring well installation. This drilling method typically allows for the advancement of borings through most soil types including denser soils (e.g., glacial till), and when coupled with split spoon sampling conducted in accordance with American Society for Testing and Materials (ASTM) Method D1586, can provide geotechnical information. When used, the following procedures will be followed by field personnel:

- Soil samples will be collected continuously from the ground surface to the bottom of the borings using 2-inch diameter split-barrel samplers in accordance with ASTM Method D1586.
- Soil samples retrieved from the borehole will be described for: 1) percent recovery; 2) soil type; 3) color; 4) moisture content; 5) density; 6) texture; 7) grain size and shape; 8) consistency; 9) evidence of staining or other chemically-related impacts; and 10) any other relevant observations. Soils will be described in accordance with the Unified Soil Classification System (USCS) [ASTM Method D2487]. This descriptive information will be recorded on a soil boring log form. An example of the typical soil boring log form is provided in the UFP-QAPP Addendum.
- Soil samples will not be submitted for laboratory analysis.
- Soils extracted during the advancement of the hollow stem auger borings will be used to backfill the boring, provided that the boring is not to be used for installation of permanent monitoring well. However, soils that exhibit "gross" contamination, as evidenced by waste materials, staining or free-phase product, or any visual, olfactory, or high PID readings, will be managed in a manner that is acceptable for disposal and in accordance with regulatory requirements. In this event, a cement/bentonite grout will be used to backfill the boring if the borehole is not being used for installation of a permanent monitoring well. The grout will be tremied through the auger string as the auger string is removed.
- Borings will be advanced to refusal or top of competent bedrock. The Army (USACE-Huntsville and USACE-New York), EPA and NYSDEC will be notified if a boring exceeds 15ft bgs.
- Drilling equipment will be decontaminated between each boring in accordance with methods specified in **Section 3.0.7**.

- A daily equipment blank sample will be collected from the decontaminated drilling equipment. PFAS-free water provided by the lab will be used to rinse the equipment for sample collection.
- Decontamination will be handled in accordance with **Section 3.0.7.**

3.0.2 PERMANENT OVERBURDEN MONITORING WELL INSTALLATION AND CONSTRUCTION

Monitoring well borings will be advanced using the hollow stem auger drilling method, as described in the previous section. During boring advancement, soil samples will be collected at continuous 2-foot intervals using 2-inch diameter split barrel samplers in accordance with ASTM Method D1586.

Permanent monitoring wells will be installed per Part 360 requirements as detailed below. Deviations from Part 360 requirements will be discussed with NYSDEC prior to installation.

Monitoring wells will be constructed with 2-inch ID, threaded, flush-joint, PVC casings and 0.010-inch slotted well screens. The well screen, plug, and riser should be certified clean from the manufacturer. If they are not, they will be cleaned using a high-pressure steam cleaner. Joints and end caps will be threaded or force fitted. No Teflon tape, solvents, or glues will be used to connect well sections.

In general, well screens will be 5 or 10-feet long, unless greater lengths are required to meet project objectives.

The annulus around the screens will be backfilled with clean silica sand. The filter pack will be tremied in and will be installed in increments as the augers are withdrawn to enable monitoring of progress and to prevent bridging. If bridging occurs, the bridge will be broken before proceeding with installation. The filter pack should extend a minimum of 6 inches below the bottom of the screen and 3 feet or 20% above the top of the screen, whichever is greater. If vertical space allows, a finer grained “choke” sand (100% passing a No. 30 sieve and less than 2% passing the No. 200 sieve) will be installed between the sand pack and the bentonite seal described below.

A bentonite chip or pellet seal with a minimum thickness of 2 feet will be placed above the filter pack. The seal will be manually hydrated using potable water. The remainder of the annular space will be filled with cement-bentonite grout to ground surface using a tremie pipe. The grout will be allowed to set before wells are developed.

Well heads will be completed above grade. The well heads will extend approximately 3-foot above grade and will be fitted with a protective casing with a lockable lid. An approximate 2-foot diameter concrete well pad will be installed around the protective casing. The well pad will be sloped away from the protective casing to shed surface water away from the well head. The well identification will be clearly visible on the inside and outside of the lid of the protective casing. A drain hole will be installed at the base of the protective casing and vent hole will also be located at the top of the protective casing. The annulus of the protective casing will be filled with gravel and a locking well cap installed at the top of the protective casing.

The top of the well casing and ground surface will be marked and surveyed to 0.01 feet, and the elevation will be determined relative to a fixed benchmark or datum. The measuring point on all wells will be on the innermost PVC casing.

Soil cuttings generated during the advancement of the monitoring well borings will remain onsite and used as backfill around the monitoring wells.

A Well Completion Log will be completed for each well installed. An example of the Well Completion Log is provided in the QAPP Addendum.

3.0.3 MONITORING WELL DEVELOPMENT

After installation, monitoring wells will be developed to remove the fine material which may have settled within the filter pack and monitoring wells and to improve/restore the hydraulic communication with the surrounding formation. Traditional best practice techniques and procedures shall be subject to modification to prevent the introduction of non-site-derived PFAS contaminants into target samples as discussed in **Appendices A, C** and **D.**

Monitoring well development will be performed or overseen by a field geologist.

- Development will be performed by surging and purging the well, as appropriate, using either a bailer or pump. Groundwater parameters will be recorded before, during, and after well development. Parameters will include turbidity, pH, temperature, and specific conductance.
- Water levels will be measured in each well to the nearest 0.01 feet prior to development.
- Monitoring wells will be developed until the water discharge from the well is 10 nephelometric turbidity unit (NTU) or less, or three consecutive turbidity readings are within 10% and the other field parameters (temperature, pH, and conductivity) have stabilized (pH ±0.2 units, temperature ± 1° Centigrade, and conductivity 10%). If field parameters have not stabilized after five borehole volumes of water have been removed, the Field Geologist will contact the Site Manager to determine further action. If the well goes dry during development, it will be allowed to recharge to 80% of initial water level and pumped or bailed again. The well will be considered developed after pumping the well dry three times.
  - Wells that run dry or have extremely slow recharge will be brought to the attention of the Army (USACE-Huntsville and USACE-New York).
- Well development information will be recorded on a Well Development Log. An example of the Well Development Log is provided in the UFP QAPP Addendum.
- Ideally, dedicated and/or disposable equipment will be used for well development. However, if non-dedicated well development equipment is used, it will be decontaminated after use in accordance with **Section 3.0.7**.
- Development water will be discharged to the ground surface unless contaminants are known to be present at unacceptable concentrations, in which case alternate disposal methods will be utilized. Well development water should be directed away from surface water bodies and allowed to infiltrate back into the ground unless other techniques are stipulated on a site-specific basis.
- Following development, the monitoring wells will be allowed to equilibrate for a minimum of 48 hours prior to groundwater sampling.

3.0.4 MONITORING WELL ABANDONMENT

There may be occasions when monitoring wells will require abandonment. For incomplete monitoring wells, the approach will be to pull the PVC well materials from the borehole and backfill the remaining open portion of the borehole with cement/bentonite grout to approximately 0.5 feet below the ground surface. The ground surface will be restored to a similar condition as the surrounding grade (*i.e.,* topsoil, asphalt, etc.). For permanent overburden monitoring wells, depending on the site-specific subsurface geologic conditions and nature of contamination, the abandonment approach will be in accordance with NYSDEC Policy CP-43 – Groundwater Monitoring Well Decommissioning Policy. Details regarding the well abandonment will be documented on the Well Decommissioning Record provided in the UFP- QAPP Addendum.

3.0.5 LOW FLOW GROUNDWATER SAMPLING

Groundwater samples will be collected using low-flow purging and sampling. Traditional best practice techniques and procedures shall be subject to modification to prevent the introduction of non-site-derived PFAS contaminants as discussed in **Appendix A, C** and **D**.

3.0.5.1 Equipment and Supplies

- Well gauging and sampling logs (no weatherproof field books permitted);
- Project plans;
- Personal protective equipment (PPE) in accordance with the Accident Prevention Plan-Site Safety and Health Plan (APP-SSHP) and free of PFAS products (see **Appendix A**);
- PFAS free water level probe (see **Appendix A** for list of PFAS free equipment);
- Temperature, conductivity, and pH meter;
- Turbidity meter;
- Graduated 5-gallon buckets;

- Flow-through cell;
- Battery;
- Decontamination supplies;
- PFAS free peristaltic pump capable of achieving flow rates of 0.5 liters per minute or less (see **Appendix A** for list of PFAS free equipment);
- HDPE plastic tubing (appropriately sized for the chosen peristaltic or submersible pump);
- HDPE plastic sheeting;
- Clear tape, duct tape;
- Coolers and ice;
- Laboratory sample bottles; and
- Shipping labels.

3.0.5.2 Purging

Equipment will be decontaminated prior to use at each location.

Prior to sampling, the static water level will be measured to the nearest 0.01 foot from the surveyed well elevation mark on the top of the PVC casing with a decontaminated water interface probe. The measurement will be recorded on the field sheets.

Prior to commencing sampling activities and daily thereafter, the groundwater quality monitoring probes/meters including pH, conductivity, oxidation reduction potential (ORP), dissolved oxygen, and turbidity will be calibrated in accordance with the manufacturer's instructions. Calibration results will be recorded in the field log notebook.

The intake of the peristaltic pump will be positioned in the center of the screened interval and the upper end of the tubing will be connected to the flow through cell. The extraction flow rate shall not exceed 0.5 liters/min (500 ml/min). Due to the tight till formation, an initial flow rate between 100 and 200 ml/min will be used. The drawdown will be monitored using a water level probe and the flow rate will be reduced if the drawdown exceeds 0.3 feet. Efforts should be made to minimize the generation of air bubbles in the sample tubing by either increasing the flow rate as appropriate or restricting the flow by clamping the tubing

During purging, pH, specific conductivity, temperature, ORP, dissolved oxygen, and turbidity will be monitored and recorded at time intervals sufficient to evacuate the volume of the flow-through cell. This information along with water level readings to monitor drawdown will be recorded on the Low Flow Groundwater Sampling Log. An example of the Low Flow Groundwater Sampling Log is provided in the UFP-QAPP Addendum.

Well sampling will commence after equilibration of water quality parameters. The equilibration guidelines are as follows:

- Temperature ± 1°C of measurement
- pH ± 0.2 pH units
- Specific conductance ± 3% of measurement
- ORP ± 20 mV
- Dissolved Oxygen (DO) ± 10% of measurement
- Turbidity ± 10% for values greater than 5 NTU; if three turbidity values are less than 5 NTU, consider the values as stabilized

If the water level will not stabilize even at lower flow rates, then the well will not be able to be sampled using the low flow method. In this situation, the well will be pumped to dryness and the water will be allowed to recover prior to collection of the sample. The Army (USACE-Huntsville and USACE-New York) will be notified if the well runs dry or has extremely slow recharge.

3.0.5.3 Sampling

Prior to filling the sample bottles, the temperature, pH, dissolved oxygen, conductivity, and ORP will be measured within a flow-through cell. Turbidity will be measured with a hand-held turbidity meter. All measurements will be recorded on the Low Flow Groundwater Sampling Log (see UFP-QAPP Addendum). The turbidity reading should be less than 50 NTUs before sample collection. If turbidity levels remain high, consult the project manager to discuss further purging of the well prior to sample collection.

Prior to collecting the sample, the flow-through cell will be disconnected from the tubing.

Laboratory provided sample containers, appropriate to meet USEPA requirements for each analysis, will be used. Groundwater will be allowed to flow from the tubing into the sample container carefully to limit aeration of the sample. If preservative is present in a container, the container will not be overfilled.

Keep sample bottles cool and with their caps on until they are ready to receive samples. Sample bottles for PFAS samples should be kept separate from other sample bottles. The type of analysis for which a sample is collected determines the type of container, preservative, holding time, and filtering requirement as specified in the UFP-QAPP.

Record the appearance of the groundwater on the Standard Groundwater Sampling Log (**see UFP-QAPP Addendum**).

A PFAS field blank should be collected daily during sampling activities. The PFAS field blank is a PFAS sample bottle pre-filled at the laboratory and sent with the sample bottles. Open the PFAS field blank bottle provided by the analytical laboratory and place adjacent to the sample collection area. Gloves should be changed prior to handling the PFAS field blank bottle.

Prior to sampling, the field team will change their gloves. Groundwater will be transferred directly to the container and the sample container will be closed. After sampling is complete, the date and time will be recorded and the sample labels will be inspected to make sure the samples are properly identified. The sample containers will be labeled, placed in a laboratory-supplied cooler (keeping PFAS sample bottles separate from any other sample bottles), with protective packaging (*i.e.,* bubble wrap) and packed on ice (to maintain a temperature of 4°C). Do not use ice packs.

Samples from each site (SEAD 25, SEAD 26, Former Fire House) will be packed in separate coolers with associated site-specific QC blanks.

A PFAS equipment blank should be collected daily from each groundwater sample set-up. The equipment blank is collected by pouring or pumping PFAS free deionized water, provided by the analytical laboratory, through sample apparatuses and collecting in appropriate sample bottles. Gloves should be changed prior to collecting the equipment blank sample.

A temperature blank in the appropriate sample bottle (i.e., no Teflon lined caps for PFAS temperature blank bottles) should accompany each cooler.

A trip blank in the appropriate sample bottle (i.e., no Teflon lined caps for PFAS temperature blank bottles) should accompany each cooler.

The cooler will be shipped overnight or delivered to the laboratory for analysis.

Samples for laboratory analysis will be submitted to an approved DoD Environmental Laboratory Accreditation Program (ELAP) and New York State certified laboratory. Analyses will be conducted using EPA methodologies as specified in the UFP-QAPP. Samples will be managed in accordance with the UFP-QAPP. COC procedures will be followed as outlined in the UFP-QAPP.

3.0.6 SURFACE WATER SAMPLING

PFAS compounds are highly soluble in water and as a result are easily transported in surface water. To assess if PFAS are present in the surface water at SEAD 25, the open drainage ditch will be sampled upstream of SEAD 25 and downstream (**Figure 2**). The techniques and procedures presented in **Appendix A, C** and **D** will be used to prevent the introduction of non-site-derived PFAS contaminants.

3.0.6.1 Equipment and Supplies

- Sampling logs (no weatherproof field books permitted);
- Project plans;
- PPE in accordance with the APP-SSHP and free of PFAS products (see **Appendix A**);
- Temperature, conductivity, and pH meter;
- Turbidity meter;
- Flow-through cell;
- Battery;
- Decontamination supplies;
- PFAS free peristaltic pump capable of achieving flow rates of 0.5 liters per minute or less (see **Appendix A** for list of PFAS free equipment);
- Silicon and HDPE plastic tubing (appropriately sized for the chosen peristaltic or submersible pump);
- Coolers and ice;
- Laboratory sample bottles; and
- Shipping labels.

3.0.6.2 Preparation for Surface Water Sampling

The following steps shall be completed when preparing for collection of surface water samples:

1. The Sampling Team Leader shall review the applicable section(s) of the work plan/QAPP to confirm the sample location, quantities, required sample containers, and other relevant information.
2. If needed, the Sampling Team Leader shall determine the optimal type of sampling equipment required to collect the sample (e.g., stainless-steel dipper, pond sampler).
3. The Sampling Team will navigate to the sample location, make initial observations, and complete the required documentation.
4. The Sampling Team shall review **Appendix A**, SOP #2 PFAS Specific Guidelines and document any deviations from the SOP and their solutions.
5. The Sampling Team shall don clean, powderfree nitrile gloves before each sampling event.
6. The Sampling Team shall assemble the necessary sampling equipment and supplies, sample containers, decontamination materials, etc. in the sampling area. If on-site decontamination is required, arrange the necessary supplies in a nearby but separate location, away from the sample location. All equipment utilized shall be decontaminated prior to use.
7. The Sampling Team shall calibrate required equipment and document the calibration on an equipment calibration form.

3.0.6.3 Collection of Surface Water Samples

Following the preparatory actions above, the Sampling Team shall complete the following steps to collect surface water samples:

1. With minimal surface disturbance, submerge the appropriate sample collection container. The mouth of the container will be facing upstream (if applicable).
    a. The sample location in the water column should consider the potential stratification of PFAS in solution and their tendency to accumulate at the air/water interface. If possible, the transfer container will be lowered sufficiently below the water surface but above the bottom sediments.
    b. Transfer containers, such as beakers or dippers, which may be attached to extension rods, should be used if sample containers have preservatives. Sampling by direct sample container immersion is not recommended when preservatives are used.
2. The sampler, if wading, will remain downstream of the sample collection point. *Downstream samples will be collected prior to upstream samples.*

3. Care will be taken not to disturb bottom sediments. Allow the device to fill slowly and continuously. If disturbed, wait until the sediment settles.
4. Fill sample containers directly from the sampling device.
5. When sample containers are filled, secure the caps tightly on the containers and place on ice as soon as possible (if required by sample preservation method).
6. Once sample has been collected, if a sufficient amount of water is available, submerge a water quality meter in the sample location and record the water parameters including temperature, pH, conductivity, ORP, DO, and turbidity.
7. Perform post-sampling activities.

3.0.6.4 Post Sampling Activities for Surface Water Sampling

The following steps shall be completed once surface water sample collection is complete:

1. The Sampling Team Leader or designee shall label each sample container with the Sample ID, date, time, analysis, and other information required on the sample label.
2. The Sampling Team Leader or designee will confirm the required samples were collected, including necessary QC samples as specified in the approved work plan/QAPP.
3. The Sampling Team will decontaminate reusable sampling equipment as described in Section 3.0.7.

The Sampling Team Leader or designee shall complete the CoC and other required documentation and prepare the sample for shipment.

3.0.7 DECONTAMINATION OF SAMPLING EQUIPMENT

3.0.7.1 Equipment Decontamination

The following procedures will be used to decontaminate equipment used during the field activities.

- Drilling equipment including the drilling rig; augers; bits; rods; tools; split-spoon samplers; and tremie pipes will be cleaned with a high-pressure, steam-cleaning unit before beginning work, following the completion of borings, wells, and prior to exiting the site.
- Tools, drill rods, and augers will be placed on polyethylene plastic sheets following pressure washing. Direct contact with the ground will be avoided.
- Augers, rods, and tools will be decontaminated between each drilling location per the above procedures.
- The back of the drill rig and all tools, augers, and rods will be decontaminated at the completion of the work and prior to leaving the site.

3.0.7.2 Sampling Equipment Decontamination

3.0.7.2.1 Equipment and Supplies

- Potable water;
- PFAS-free, phosphate-free detergent (see **Appendix A**);
- Distilled water;
- HDPE sheeting;
- Plastic buckets and brushes; and
- PPE in accordance with the APP-SSHP.

3.0.7.2.2 Decontamination Procedures

- Prior to sampling, non-dedicated sampling equipment (e.g., bailers, bowls, spoons, certified PFAS-free interface probes, etc.) will be washed with potable water and a PFAS/phosphate-free detergent (see **Appendix A**).

Decontaminated items will not be wrapped in aluminum foil. Decontamination may take place at the sampling location as long as all liquids are contained in pails, buckets, etc. Traditional best practice techniques and procedures shall be subject to modification to prevent the introduction of non-site-derived PFAS contaminants into target samples. **Appendix A** includes a summary of prohibited and acceptable PFAS items. A PFAS sampling checklist is included as **Appendix A** and should be filled out daily by field personnel.

- The sampling equipment will then be rinsed with potable water followed by a distilled water rinse.
- Between rinses, equipment will be placed on HDPE sheets, if necessary. At no time, will washed equipment be placed directly on the ground.
- Equipment will be wrapped in HDPE foil for storage or transportation from the designated decontamination area to the sampling location.

3.1 SAMPLING STRATEGY

The purpose of this ESI is to further characterize and document the source(s) and fate and transport of PFAS in groundwater. To achieve this objective, monitoring wells will be placed in locations which will further define the plume geometry and/or help define source areas and or fate and transport of contamination.

Monitoring well locations will be installed as described above using a hollow stem auger drilling method to achieve ESI objectives. This investigation will be completed using a dynamic sampling approach where-in primary monitoring well locations established through analysis of existing datasets will be installed and sampled first. Samples collected from the primary monitoring well locations will be submitted to an off-site laboratory for rapid turn analysis (e.g., 7-10 days). When the rapid-turn data is returned from the laboratory it will immediately be combined with existing groundwater datasets and analyzed / interpreted and new monitoring well locations will be designated (secondary or contingency locations). During the sampling effort, Parsons proposes frequent teleconferences with the Army (USACE-Huntsville and USACE-New York), EPA and NYSDEC to present data and streamline the regulatory review approach. These frequent discussions will allow the regulatory agencies to be involved in the decision-making process, address any concerns early in the project, and ensure that the agencies are on-board throughout the process. This continuous approval mechanism will improve potential for a streamlined lower cost ESI and reduce comments on the ESI letter report. Additionally, as part of the ESI report, a well survey of drinking water wells within one mile of the Depot boundary will be conducted to determine potential groundwater receptors.

3.1.1 MONITORING WELL LOCATIONS

3.1.1.1 SEAD 25

PFAS concentrations detected at all 12 of the 12 wells sampled during the SI at SEAD 25 exceeded the EPA action level; based on these findings, additional wells are needed to further define the lateral extent of the plume. Based on results from 10 years of long-term monitoring at this site, the local groundwater flow is radial, approximately centered on well MW25-2. Because of this, six primary wells will be installed in accessible locations surrounding the former SEAD 25 pad to further define the lateral extent of the PFAS plume and help evaluate potential source areas (**Figure 2**).

Based on client knowledge, the source of the PFAS may be associated with a firehouse (Building 103) located northeast of SEAD 25. The local drainage infrastructure which transports storm water from the area of the firehouse to an open drainage ditch was determined to be the most likely overland flow path for local surface water. This drainage system trends northeast-southwest and crosses the northwest corner of SEAD 25. The drainage pathways would likely focus any surface water infiltration within the ditches and would transport any potentially contaminated surface water towards SEAD 25. To further investigate the possibility that the firehouse is the source of the PFAS contamination, one primary well will be installed adjacent to and downgradient of the firehouse (**Figure 2**). Two primary wells will be installed further downgradient of the firehouse and in close proximity to the storm sewer (e.g., locations where COCs may have entered the system, storm grates).

Based on the results of the samples from the primary wells (**Figure 2**), an additional five secondary wells are proposed as optional step-out wells, if needed, to further define the source(s) and fate and transport of the PFAS contamination in groundwater. Results from the primary wells will be provided to the Army (USACE-Huntsville and USACE-New York), EPA and NYSDEC to determine if secondary wells will be needed and to facilitate discussion of appropriate locations.

3.1.1.2 SEAD 26

PFAS concentrations detected in 4 of 8 wells sampled at SEAD 26 during the SI exceeded the EPA action level. The wells with PFAS concentrations above the PFAS action level are localized in the central part of SEAD 26 near the former burning pit. One primary well will be installed east (upgradient) of the former burn pit to define the upgradient limit of any potential contamination (**Figure 3**). Two additional primary wells will be installed to the north and south of the former burn pit to characterize the lateral extent of impacts (establish plume width). Three primary wells will be installed west (downgradient) of SEAD 26 in line with the plume core and east and west of the plume core. These wells will help to define the toe of the plume.

In the event that the primary wells do not meet the ESI objectives of determining the source(s) and fate and transport of PFAS, six optional secondary wells are proposed. It is anticipated that these optional wells could be needed at locations further upgradient (1 optional well), further cross-gradient (2 optional wells) and further downgradient (3 optional wells). Results from the primary wells will be provided to the Army (USACE-Huntsville and USACE-New York), EPA and NYSDEC to determine if secondary wells will be needed and to facilitate discussion of appropriate locations.

Table 1 – Groundwater Sample Matrix

	LOCATION ID(1)	SAMPLE ID(2)	MATRIX	TYPE	ANALYTE / ANALYTICAL GROUP	COMMENTS
SEAD 25 Sample Locations and Nomenclature						
Primary	MW25-20	25ESI20001	GW	SA	PFAS	SEAD 25 Perimeter Well
	MW25-21	25ESI20002	GW	SA	PFAS	SEAD 25 Perimeter Well
	MW25-22	25ESI20003	GW	SA	PFAS	SEAD 25 Perimeter Well
	MW25-23	25ESI20004	GW	SA	PFAS	SEAD 25 Perimeter Well
	MW25-24	25ESI20005	GW	SA	PFAS	SEAD 25 Perimeter Well
	MW25-25	25ESI20006	GW	SA	PFAS	SEAD 25 Perimeter Well
	MWFH-01	25ESI20007	GW	SA	PFAS	Fire House Well
	MWFH-02	25ESI20008	GW	SA	PFAS	Fire House Well
	MWFH-03	25ESI20009	GW	SA	PFAS	Fire House Well
	TBD	25ESI20010	GW	DU	PFAS	Duplicate
SEAD 26 Sample Locations and Nomenclature						
Primary	MW26-12	26ESI20001	GW	SA	PFAS	Upgradient
	MW26-13	26ESI20002	GW	SA	PFAS	Side-Gradient
	MW26-14	26ESI20003	GW	SA	PFAS	Side-Gradient
	MW26-15	26ESI20004	GW	SA	PFAS	Down-Gradient
	MW26-16	26ESI20005	GW	SA	PFAS	Down-Gradient
	MW26-17	26ESI20006	GW	SA	PFAS	Down-Gradient
	TBD	26ESI20007	GW	DU	PFAS	Duplicate
QA/QC Samples						
QA/QC	TBD	25ESI00001 / 26ESI00001	Aqueous	EB	PFAS	1 per day of drilling / 1 per day of GW sampling, per site
	TBD	25ESI01000 / 26ESI01000	Aqueous	FB	PFAS	1 per day of GW sampling, per site

Table 1 – Groundwater Sample Matrix

LOCATION ID(1)	SAMPLE ID(2)	MATRIX	TYPE	ANALYTE / ANALYTICAL GROUP	COMMENTS
TBD	25ESI00100 / 26ESI00100	Aqueous	TB	PFAS	1 per site specific cooler

Key: TBD = To be determined; GW = Groundwater; SA = Sample; DU = Duplicate; MS/MSD = Matrix Spike / Duplicate; EB = Equipment Blank; FB = Field Blank; TB = Trip Blank

(1) MS/MSD and field duplicates will be collected from both SEAD 25/Fire House and SEAD 26 at a rate of 1:20 and 1:10, respectively. The locations of the MS/MSD and field duplicate will be determined in the field based on site conditions. One of the existing sample IDs in the table above will be appended with MS and MSD (e.g., 25ESI20001MS and 25ESI20001MSD). Each set of MS/MSD samples will have a low and moderate spike. The field duplicate will be collected at the same locations as the MS/MSD. Field duplicate sample ID will be one larger than the last ID shown in the table (e.g., 25ESI20010).

(2) One equipment (rinse) blank will be collected per day of drilling and per day of groundwater sampling. Each day the equipment (rinse) blank ID will increase by one. The equipment blank ID will start with those collected during drilling.

(3) One field blank will be collected per day of groundwater sampling. Each day the field blank ID will increase by one.

(4) One trip blank will be included per cooler of samples shipped. Each trip blank will increase by one.

(5) Secondary well IDs will start one larger increment than the highest primary well ID (e.g., MW25-26 or MWFH-04).

(6) New locations will be drilled so no screen depth is known at this time.

3.1.2 SURFACE WATER SAMPLING

Two surface water samples will be collected from the open drainage ditch at SEAD 25. One sample will be collected upstream of SEAD 25 to determine if upgradient sources are contributing PFAS to the surface water and one sample will be collected downstream of SEAD 25 to assess if PFAS impacted surface water is present at the site.

Table 2 Surface Water Sample Matrix

SAMPLE ID (1, 2)	MATRIX	TYPE	ANALYTE / ANALYTICAL GROUP	COMMENTS
25ESI30001	SW	SA	PFAS	Upstream
25ESI30002	SW	SA	PFAS	Downstream
25ESI30003	SW	DU	PFAS	Duplicate
QA/QC Samples				
25ESI0000X	Aqueous	EB	PFAS	1 per day of SW sampling, per site
25ESI0100X	Aqueous	FB	PFAS	1 per day of SW sampling, per site
25ESI0010X	Aqueous	TB	PFAS	1 per site specific cooler

Key: SW = Surface Water; SA = Sample; DU = Duplicate; MS/MSD = Matrix Spike / Duplicate; EB = Equipment Blank; FB = Field Blank; TB = Trip Blank

(1) MS/MSD and field duplicates will be collected from SEAD 25 at a rate of 1:20 and 1:10, respectively. The locations of the MS/MSD and field duplicate will be determined in the field based on site conditions. One of the existing sample IDs in the table above will be appended with MS and MSD (e.g., 25ESI30001MS and 25ESI30001MSD). Each set of MS/MSD samples will have a low and moderate spike. The field duplicate will be collected at the same locations as the MS/MSD. Field duplicate sample ID will be one larger than the last ID shown in the table (e.g., 25ESI30003).

(2) One equipment (rinse) blank will be collected per day sampling, if a sample collection vessel is used. Each day the equipment (rinse) blank ID will increase by one. The equipment blank ID will be coordinated to be separate from the groundwater sampling IDs (i.e., the X replaced with the appropriate number).

(3) One field blank will be collected per day of surface water sampling. The blank ID will be coordinated to be separate from the groundwater sampling IDs (i.e., the X replaced with the appropriate number).

(4) One trip blank will be included per cooler of samples shipped. Each trip blank will increase by one.

3.1.3 DATA QUALITY OBJECTIVES

Addendum 1 to the Final UFP-QAPP was updated for this groundwater investigation to ensure environmental data collected are scientifically sound, of known and documented quality, and suitable for their intended purposes. This UFP-QAPP includes monitoring methods, analytical services, data management and validation procedures, and field and laboratory SOPs.

Project-specific data quality objectives (DQOs) were developed based on the Conceptual Site Model and these are described on **Worksheet #11** of the UFP QAPP Addendum. These DQOs include a design for obtaining data to support the design for sampling emerging contaminants related to AFFF. The design for obtaining data described in the last column of the DQO tables on **Worksheet #11** summarizes the technical approach. The project approach is described in detail on **Worksheet #17** and specific analyzes are noted on **Worksheet #18**.

3.1.4 SCHEDULE

Table 2 summarizes the proposed schedule for the completion of key project activities. Note that each work activity is connected to the next activity, and this schedule is subject to change if any delays are encountered.

Table 3 – Proposed Schedule for the PFAS ESI

ACTIVITIES	EXPECTED START DATE	TIMELINE
Field Work 1	May 2019	Approximately 4 weeks to install, develop and sample primary wells
Receipt of the Laboratory Data	June 2019	10-15 days after sampling completed
Conference call with Army, EPA, NYSDEC	June 2019	Discuss results and secondary well locations, if needed
Field Work 2	July 2019	Remobilize to install and sample secondary wells, if needed
Receipt of the Laboratory Data	August 2019	30 days after demoblization
Prepare and Submit Draft ESI Report	November 2019	60 days after receipt of the laboratory data
Prepare and Submit Draft Final ESI Report	January 2020	30 days after receipt of review comments
Prepare and Submit Final ESI Report	March 2020	30 days after receipt of Regulatory review comments

Chapter 4 Reporting

The results of the investigation field activities will be documented in an Expanded Site Investigation Report/Technical Memorandum including:

- Summary of completed field activities;
- Survey of drinking water wells within one mile of the Depot boundary;
- Summary of data, including presentation on tables and figures;
- An Electronic Data Deliverable (EDD) in NYSDEC format will be provided to the NYSDEC Project Manager (PM);
- Evaluation of contamination and recommendations for future actions.

The analytical data shall be validated in accordance with EPA guidance. Sample results will be compared against EPA Health Advisory Limit for combined PFOA/PFOS of 70 ng/L. Detections in primary wells above this limit will be discussed with the Army (USACE-Huntsville and USACE-New York), EPA and NYSDEC to determine if additional wells are installed or if further action is required at these sites.

References

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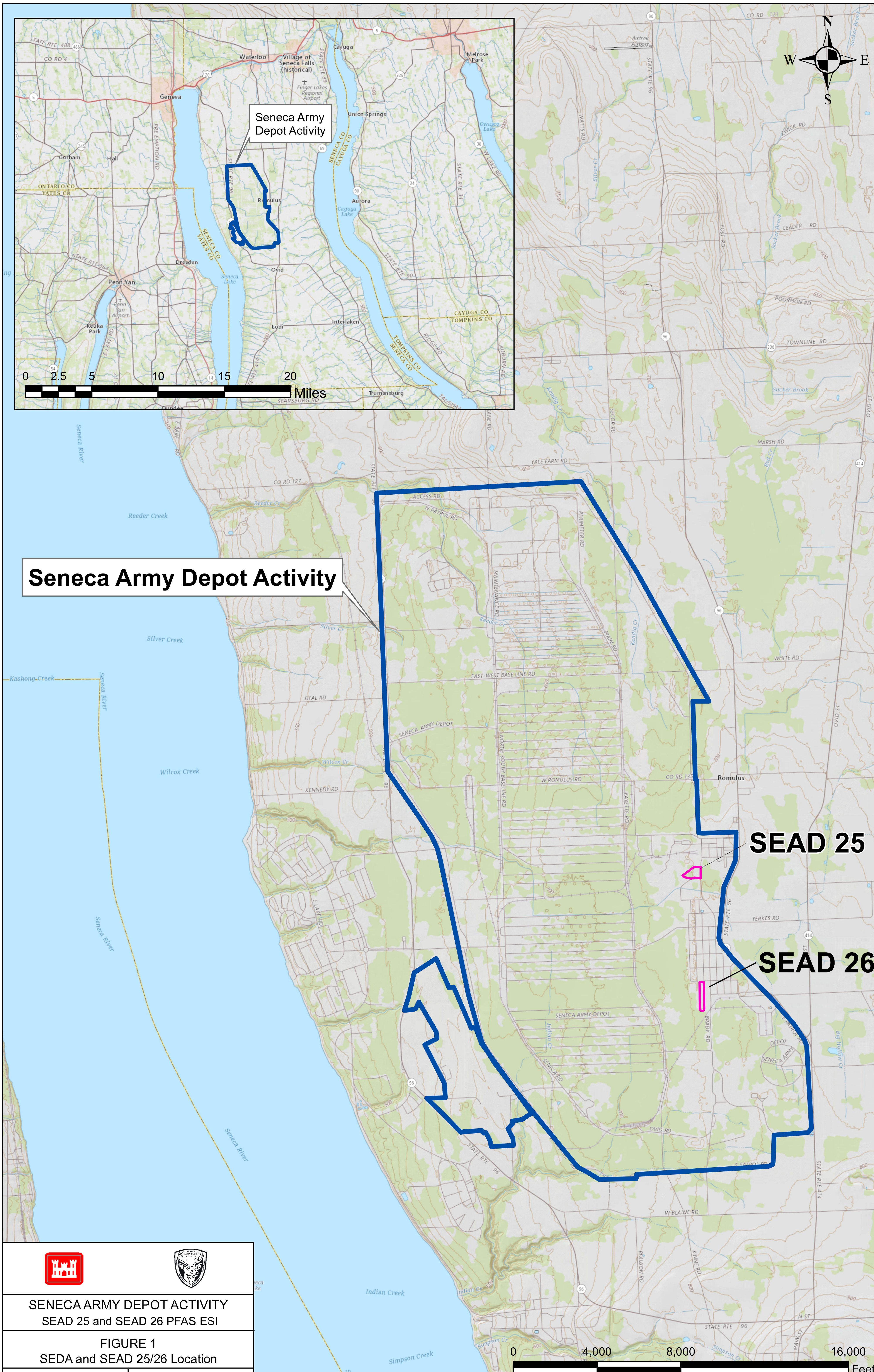
LIST OF FIGURES

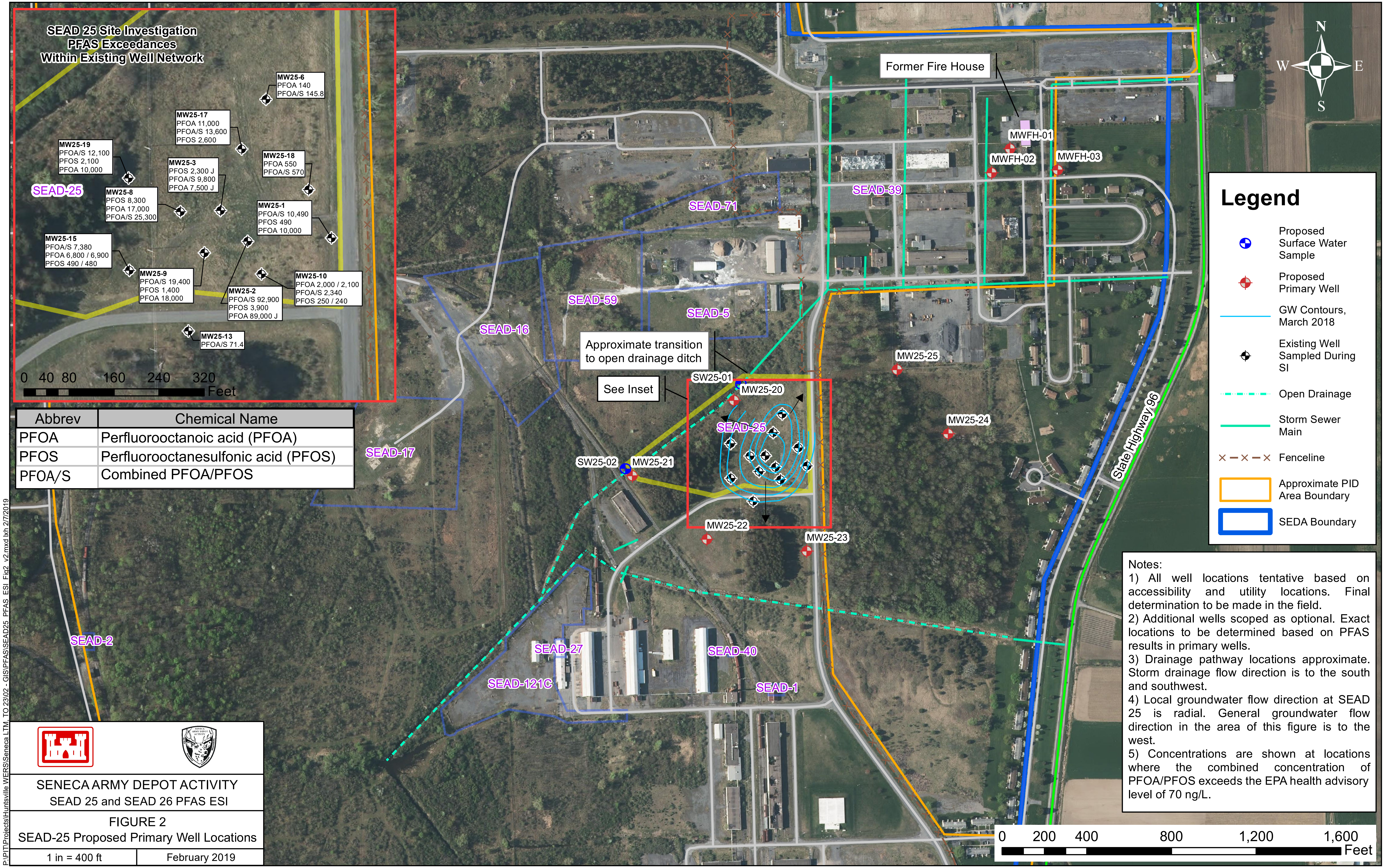


SENECA ARMY DEPOT ACTIVITY
SEAD 25 and SEAD 26 PFAS ESI

FIGURE 1
SEDA and SEAD 25/26 Location

1 in = 4,000 ft	August 2018

Path: P:\PIT\Projects\Huntsville WERS\Seneca LTM, TO 23\02 - GIS\PFAS\SEAD25_26_Site_Location.mxd



Abbrev	Chemical Name
PFOA	Perfluorooctanoic acid (PFOA)
PFOS	Perfluorooctanesulfonic acid (PFOS)
PFOA/S	Combined PFOA/PFOS

Notes:

1) All well locations tentative based on accessibility and utility locations. Final determination to be made in the field.
2) Additional wells scoped as optional. Exact locations to be determined based on PFAS results in primary wells.
3) Drainage pathway locations approximate. Storm drainage flow direction is to the south and southwest.
4) Local groundwater flow direction at SEAD 25 is radial. General groundwater flow direction in the area of this figure is to the west.
5) Concentrations are shown at locations where the combined concentration of PFOA/PFOS exceeds the EPA health advisory level of 70 ng/L.

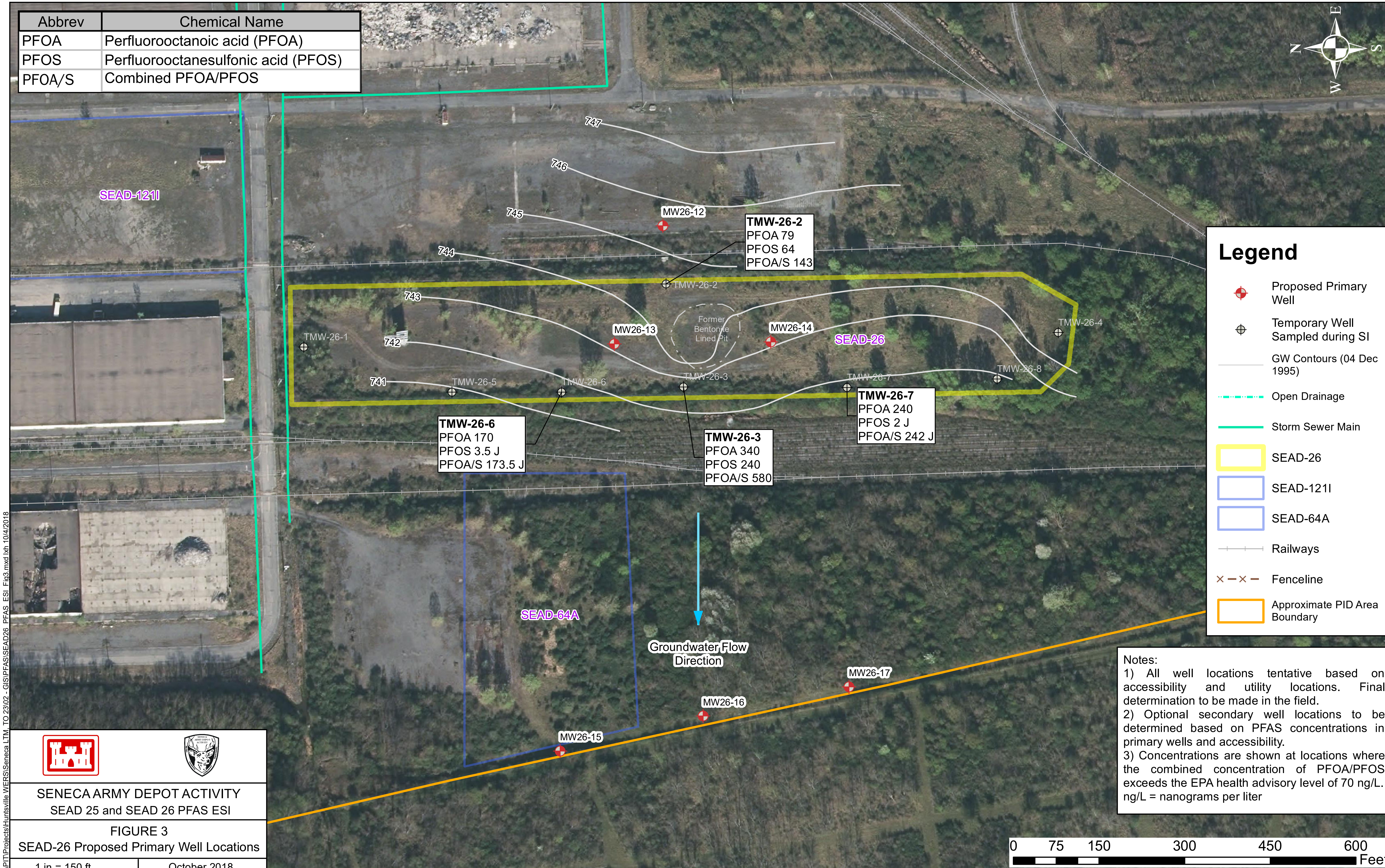
SENECA ARMY DEPOT ACTIVITY

SEAD 25 and SEAD 26 PFAS ESI

FIGURE 2

SEAD-25 Proposed Primary Well Locations

1 in = 400 ft	February 2019



P:\PIT\Projects\Huntsville WERS\Seneca LTM_TO 23102 - GIS\PFAS\SEAD26_PFAS_ESI_Fig3.mxd lxh 10/4/2018

LIST OF APPENDICES

Appendix A

PFAS Field Procedures & Standard Operating Procedures (SOPs)

Site Name: ______________________________ Task: ______________________________

Weather (temp/precip): ______________________ Date: ______________________________

Field Clothing and PPE:

☐ Powder-Free Nitrile Gloves ONLY

☐ No clothing or boots containing Gore-Tex™

☐ No clothing or boots treated with water-resistant spray

☐ Safety boots made from polyurethane and PVC or leather boots covered with overboots

☐ No materials containing Tyvek®

☐ Field crew has not used fabric softener on clothing

☐ Field crew has not used cosmetics, moisturizers, hand cream, or other related products this morning

☐ Field crew has not applied unauthorized sunscreen or insect repellant

☐ Samplers don fresh nitrile gloves for each sample collected

Field Equipment:

☐ No Teflon® or LDPE containing materials other than QED brand LDPE

☐ All sample materials made from stainless steel, HDPE, acetate, silicon, or polypropylene or QED brand LDPE

☐ No waterproof field books, waterproof paper or waterproof bottle labels, waterproof markers/Sharpies®

☐ No plastic clipboards, binders, or spiral hard cover notebooks

☐ No Post-It Notes®

☐ No aluminum foil

☐ Coolers filled with regular ice only; no chemical (blue) ice packs in possession

Sample Containers:

☐ Containers for PFAS Shipped in separate cooler

☐ Sample containers made of HDPE or polypropylene

☐ Caps are unlined and made of HDPE or polypropylene

Wet Weather (as applicable):

☐ Wet weather gear made of polyurethane and PVC only

Equipment Decontamination:

☐ "PFAS-free" water on-site for decontamination of sample equipment; no other water sources to be used

☐ Alconox® or 7th Generation Free & Clear Dish Soap to be used as decontamination cleaning agents

Food Considerations:

☐ No food or drink on-site with exception of bottled water and/or hydration drinks (*i.e.*, Gatorade® and Powerade®) that is available for consumption only in the staging area

Vehicle Considerations:

☐ Avoid utilizing areas inside vehicle as sample staging areas

If any applicable boxes cannot be checked, the field team leader shall describe the deviations on the back and work with field personnel to address issues prior to commencement work. See additional information on the back of this form.

Sampling Equipment and Supply Summary (include brand names and serial numbers where available)

Decontamination Fluid Source(s): ______________________________

Soap and other fluids used: ______________________________

Gloves: ______________________________ : Misc: ______________________________

Sampling Equipment: ______________________________

Field Team Names: ______________________________

Field Team Leader Signature: ______________________________

LIST OF FIELD STANDARD OPERATING PROCEDURES (SOPS)

SOP #1 – SITE RECONNAISSANCE, PREPARATION, AND RESTORATION PROCEDURES

1.1 SITE ACCESS

Parsons will obtain any required security badges for Parsons and subcontractor personnel working on this project, as well as any vehicle passes that are required. In addition, Parsons will also provide SEDA with a minimum of one week notice prior to requiring access to any secure sites. However, there may be instances where one-week notice is not feasible given project-specific requirements; these will be addressed on a case-by-case basis and as much notice as possible will be provided to SEDA.

1.2 UTILITY LOCATION

Areas designated for intrusive activities will be assessed for the presence of underground utilities. In addition, Dig Safely New York will be contacted at least 48 hours prior to intrusive activities to obtain a routine ticket for utility location. Dig Safely New York ticket requests will be made by calling 811 (if inside New York) or 800-962-7962 if outside of New York or by placing a request online at http://www.digsafelynewyork.com using i-Notice. Based on the type of investigation, additional methods to identify utilities may be used including geophysical survey, hand probes, and line tracing.

1.3 ESTABLISHMENT OF DECONTAMINATION AREA

A centralized decontamination area will be established in an area designated by SEDA for drilling rigs and equipment if necessary. The decontamination area will be large enough to allow storage of cleaned equipment and materials prior to use, and to stage drums of decontamination waste, if generated. The decontamination area will be lined with heavy-gauge plastic sheeting and designed with a collection system to capture decontamination waters and steam condensate. Solid wastes will be accumulated in United States (U.S) Department of Transportation (DOT) approved 55-gallon drums and subsequently transported to a waste storage area designated by SEDA. Smaller decontamination areas for portable equipment will be provided, as necessary. These locations will include basins, tubs, or buckets to capture decontamination fluids.

1.4 SITE RESTORATION

Each work site or sampling location will be restored to its original condition whenever possible. Efforts will be made to minimize impacts to work sites and sampling locations, particularly those in or near sensitive environments such as wetlands. Following the completion of work at a site; drums, trash, and other waste generated from the work process will be removed. Decontamination and/or purge water and soil cuttings will be transported to designated locations. Site restoration will also consist of repair of tire ruts and installation of topsoil and an appropriate seed mix when necessary.

SOP #2 – PFAS SPECIFIC GUIDELINES

2.1 INFORMATION AND SPECIAL PRECAUTIONS SPECIFIC TO PER/POLY FLUORINATED ALKYL SUBSTANCES (PFAS)

2.2.1 Prohibited and Acceptable Items

Required laboratory detection limits for the analysis of PFAS are extremely low and the use of PFAS in everyday products is widespread leading to many sources of potential trace contamination. Field personnel are expected to avoid the use of all products treated with PFAS while on site. Additional information regarding sampling PFAS is included in Appendix C.

A summary of prohibited and acceptable items for sampling PFAS is provided in **Appendix A, Table 1**. General precautions to follow and products to avoid while on-site include the following. Note that this is not an exhaustive list.

Food Related

- Paper food packaging is often treated with PFAS to resist wetting. As such, personnel should avoid paper bags, paper food packaging, paper wrapping (e.g. sandwich wrap), paper beverage cups, as well as other coated papers.
- Aluminum foil should not be used on site.
- Food that has been fried in a frying pan due to the potential for contamination from Teflon-coated cooking surfaces.
- Coated textiles of any type should be used on site.
- Snacks and meals should not be eaten in the field vehicle or in the work area. Field personnel should step-away from the work area by a minimum of 10 meters (downwind whenever possible) when taking breaks for food and beverages.

Field Gear/Clothing

- Water resistant, water proof, or stain treated clothing such as Gore-Tex should not be worn by field personnel. Clothing worn during field sampling should be made of natural fiber such as cotton or wool.
- Clothing made of synthetic fibers. Clothing worn during field sampling should be made of natural fiber such as cotton or wool.
- Field clothing should ideally be old and well laundered.
- Field clothing should be washed using a minimal use of unscented detergent and no fabric softener or other additives. Once clean the clothing should be washed again in water only before drying. No fabric conditioner or dryer sheets should be used while drying.
- Rite in the Rain field notebooks/paper and similar products are not to be used. Field records should be recorded on loose uncoated paper.

- Field notes, records, and sample labels should be made in pencil or using Rite in the Rain pens (confirmed to be PFAS-free from the manufacturer). Ballpoint pens and markers are not to be used for notes. Sample labels may also be pre-printed by the laboratory; if pencil is used to write on the sample labels, those bottles will be double bagged using Zip-Lock® brand bags.
- Clipboards should be made of Masonite or aluminum. Plastic clipboards, binders, and spiral bound notebooks are not acceptable.
- Safety toe boots made from synthetic fibers and treated for water resistance are acceptable for use in order to maintain personnel protection. However, all contact with the boots is to be made at least 10 meters away from the work area. New gloves are to be donned prior to making contact with the boots and are to be disposed immediately afterwards. Boots containing Gore-Tex and/or Tyvek are not to be used on site.
- Disposable nitrile gloves must be worn at all times. A new set of gloves will be donned prior to conducting any of the following activities at each sample location:
  - Equipment decontamination,
  - Contact with bottleware and/or PFAS free water containers,
  - Insertion of anything into the well (e.g. samplers, tubing, etc…),
  - Insertion of silicone tubing into peristaltic pump,
  - Completion of well purge, prior to sample collection,
  - Collection/handling of QC/QA samples,
  - Following handling any non-dedicated field equipment, contact with non-decontaminated surfaces, and
  - When deemed necessary by field personnel.
- Vehicle seating is often treated with stain resistant products. Therefore, direct contact with vehicle seats should be avoided by covering each seat with a well laundered cotton sheet for the duration of the sampling event.
- Samples should be kept on ice using only regular water ice double-bagged in Zip-Lock® brand bags. No chemical ice packs (blue ice) are allowed.

Personal Hygiene

- On the day of sampling, field personnel should not use shampoo, conditioner, body gel, cosmetics, or cosmetic/hand/body creams as part of their personal hygiene routine. The use of bar soap is acceptable; however, bar soaps containing additional moisturizers should be avoided.
- It is recommended that field personnel shower the night before the sampling event and rinse with water only the morning of the sampling event.

- Cosmetics, moisturizers, sunscreens, insect repellant, and dental floss, except for those in **Table 1**, shall not be used on or off site throughout the duration of the field sampling program.
- For restroom breaks, field personnel shall move at least 10 meters from the work area before removing gloves and overalls. Personnel should wash their hands as normal allowing for extra time for rinsing after soap use. It is preferred to dry hands after washing using a hand dryer rather than paper products whenever possible.

Site Visitors

- All visitors to the site are to be asked to remain a minimum distance of at least 10 meters from all sampling areas.

Rain Events

- The use of waterproof rain gear is not permitted while sampling. Therefore, field sampling will not take place in the presence of persistent rainfall. Field gear shall be removed from the sampling area during rainfall and can be returned after the rain subsides.
- The use of a waterproof gazebo tent is acceptable for use to provide shelter from the rain if the schedule does not allow for work to stop during rain. The gazebo should be erected directly overtop of the sampling area taking precautions that water running off of the gazebo does not enter into work areas. Since a waterproof gazebo represents a potential for PFAS cross-contamination precautions should be taken when using them. Gloves should be donned whenever contact with the gazebo is made and the gloves should be disposed of immediately following contact.

Table 1: Summary of Prohibited and Acceptable Items for Sampling of PFAS

PROHIBITED ITEMS	ACCEPTABLE ITEMS
Field Equipment	
Teflon® containing materials	High-density polyethylene (HDPE) materials
Low density polyethylene (LDPE)	Acetate liners
Aluminum foil	Silicon tubing
Waterproof field books	Loose paper (non-waterproof)
Plastic clipboards, binders, or spiral hard cover notebooks	Aluminum field clipboards or with Masonite
Ball point pens	Rite in the Rain pens®
Post-It Notes	
Re-usable Chemical (blue) ice packs	Regular ice in polyethylene bags (double bagged)
Field Clothing and Personal Protective Equipment (PPE)	
New cotton clothing or synthetic water resistant, waterproof, or stain-treated clothing, clothing containing Gore-Tex™	Well-laundered clothing, defined as clothing that has been washed 6 or more times after purchase, made of natural fibers (preferable cotton)
Clothing laundered using fabric softener	No fabric softener
Boots containing Gore-Tex™ Tyvek®	Boots made with polyurethane and polyvinyl chloride (PVC) Cotton Clothing
No cosmetics, moisturizers, hand cream, or other related products as part of personal cleaning/showering routine on the morning of sampling	Sunscreens - Alba Organics Natural Sunscreen, Yes to Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my face, Baby sunscreens that are "free" or "natural" Insect Repellents - Jason Natural Quit Bugging Me, Repel
	Lemon Eucalyptus Insect repellant, Herbal Armor, California
Sample Containers and tubing	
LDPE or glass containers and lined lids	HDPE
Teflon®-lined caps	Unlined polypropylene caps
Rain Events	
Waterproof or resistant rain gear	Gazebo tent that is only touched or moved prior to and following sampling activities
Equipment Decontamination	
Decon 90	Alconox®, Liquinox® and/or 7th Generation Free & Clear Dish Soap
Water from an on-site well Potable water from municipal drinking water supply	PFAS-free deionized water
Food Considerations	
All food and drink, with exceptions noted on the right	Bottled water and hydration drinks (i.e. Gatorade® and Powerade®) to be brought and consumed only in the staging area

2.2.2 Equipment Cleaning Procedure

Field equipment that is utilized at each sample location will require cleaning between uses. Upon donning a new pair of nitrile gloves, equipment will be:

- Rinse with a Alconox® (or similar) cleaning solution;
- Rinse with laboratory-provided, "PFAS-free" water; (Grade 3 distilled, Millipore deionized); and,
- Rinse with laboratory-provided, "PFAS-free" water.

All rinsate should be collected in a sealed pail for disposal.

For groundwater sampling, the flow-through cell and any non-dedicated equipment (i.e. interface probe) that comes into contact with well water should be decontaminated between uses.

Field equipment used at locations that are suspected of containing AFFF (i.e. those that foam during shaking) will be cleaned as per above in triplicate.

Appendix B

SEAD 25/26 Hydrogeology Summary

(provided on the electronic (CD)

version of this report)

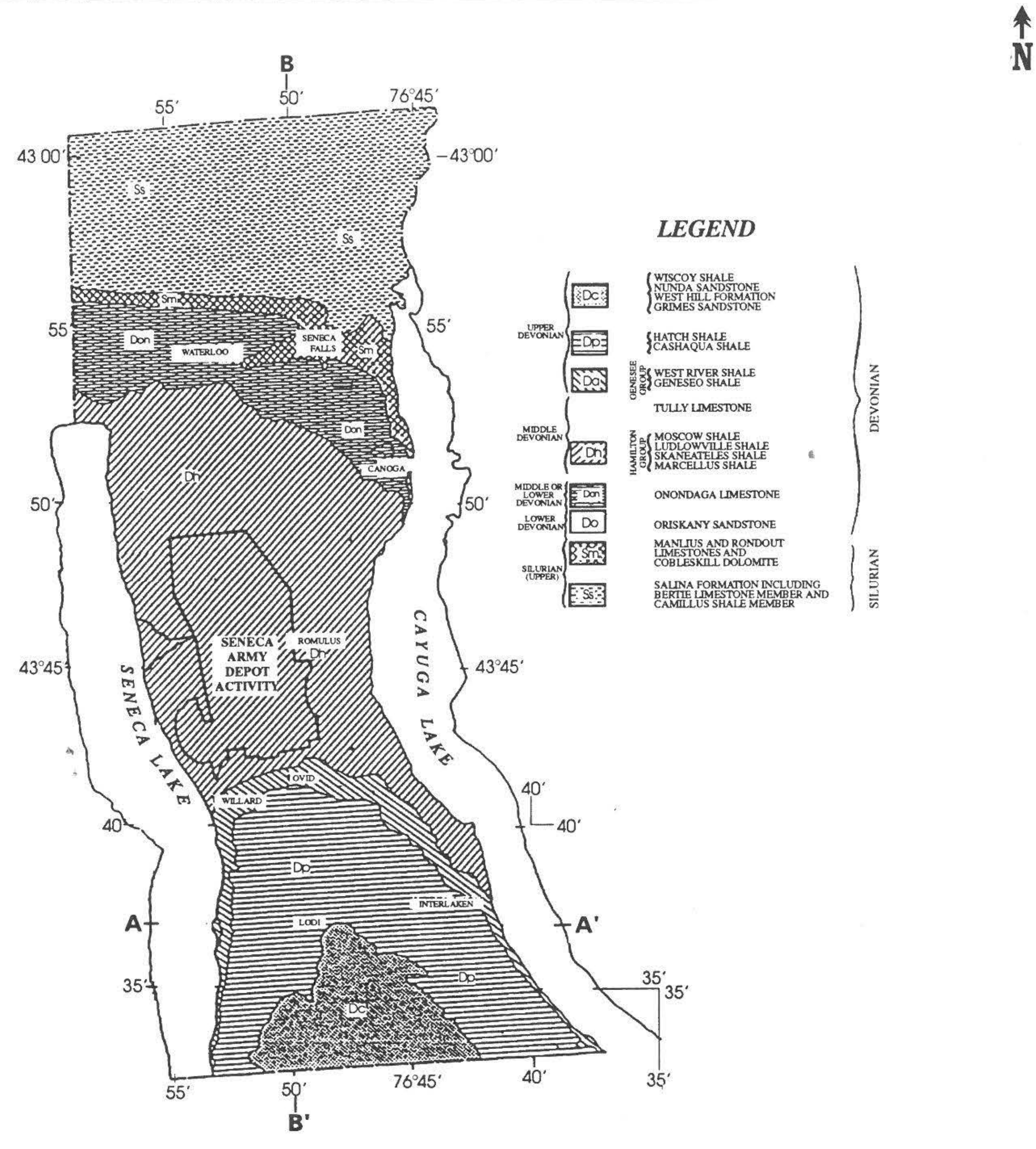
also reported for surface soils samples collected from around the pit. A sediment sample collected from within the pit also had elevated TPH concentrations. Groundwater sampling indicated that selected metals were present at elevated concentrations, although the results may have been skewed by high sample turbidities. A detailed discussion of the analytical results from this ESI is discussed more fully in Section 4.0. Ultimately, the ESI report was successful in confirming that there had been a release of semivolatile organic compounds primarily to the surface soils at SEAD-26.

1.5 BACKGROUND INFORMATION

1.5.1 Regional Geologic Setting

The Finger Lakes uplands area is underlain by a broad north-to-south trending series of rock terraces mantled by glacial till. As part of the Appalachian Plateau, the region is underlain by a technically undisturbed sequence of Paleozoic rocks consisting of shales, sandstones, conglomerates, limestones and dolostones. Figure 1-5 shows the regional geology of Seneca County. In the vicinity of SEDA, Devonian age (385 million years bp) rocks of the Hamilton group are monoclinally folded and dip gently to the south (Figure 1-6). No evidence of faulting or folding is present. The Hamilton Group is a sequence of limestones, calcareous shales, siltstones, and sandstones. These rocks were deposited in a shallow inland sea at the north end of the Appalachian Basin (Gray, 1991). Terrigenous sediments from topographic highs associated with the Acadian landmass of Western New England, eastern New York and Pennsylvania were transported to the west across a marine shelf (Gray, 1991). These sediments were deposited in a northeast-southwest trending trough whose central axis was near what is now the Finger Lakes (Gray, 1991).

The Hamilton Group, 600 to 1500 feet thick, is divided into four formations. They are, from oldest to youngest, the Marcellus, Skaneateles, Ludlowville, and Moscow formations. The western portion of SEDA is generally located in the Ludlowville Formation while the eastern portion is located in the younger Moscow Formation. The Ludlowville and Moscow formations are characterized by gray, calcareous shales and mudstones and thin limestones with numerous zones of abundant invertebrate fossils that form geographically widespread encrinites, coral-rich layers, and complex shell beds. The Ludlowville Formation is known to contain brachiopods, bivalves, trilobites, corals and bryozoans (Gray, 1991). In contrast, the lower two formations (Skaneateles



SOURCE:MODIFIED FROM-THE GROUND WATER RESOURCES OF SENECA COUNTY, NEW YORK: MOZOLA, A.J., BULLETIN GW-26, ALBANY, NY, 1951

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CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY
RI/FS
SEAD-25 and SEAD-26

DEPT.	DWG NO.
ENVIRONMENTAL ENGINEERING	728059-02003

FIGURE 1-5

GEOLOGIC MAP OF SENECA COUNTY

SCALE	DATE
1" = 5 MILES	MARCH 1996

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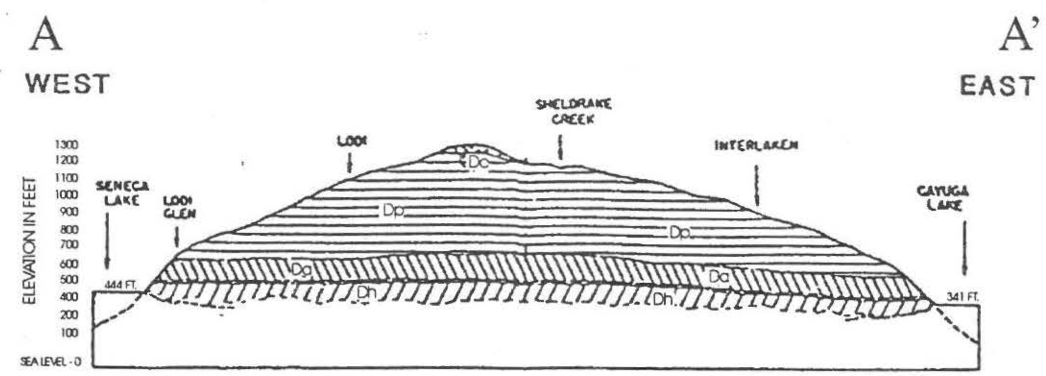
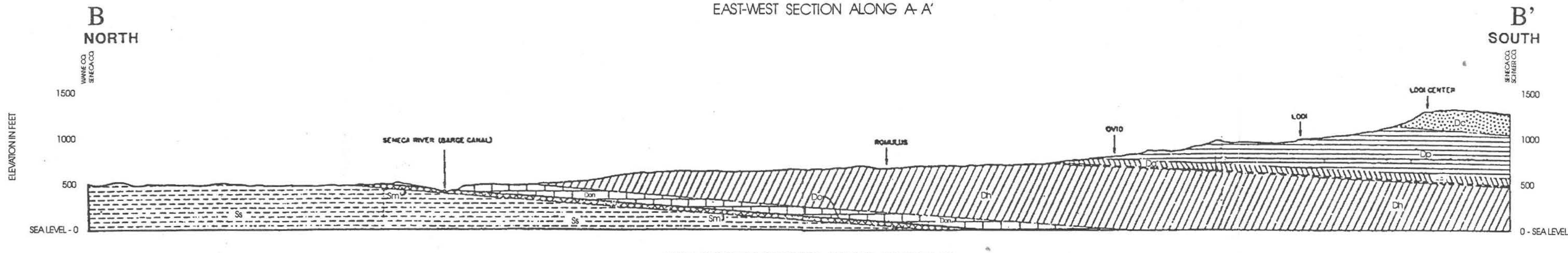
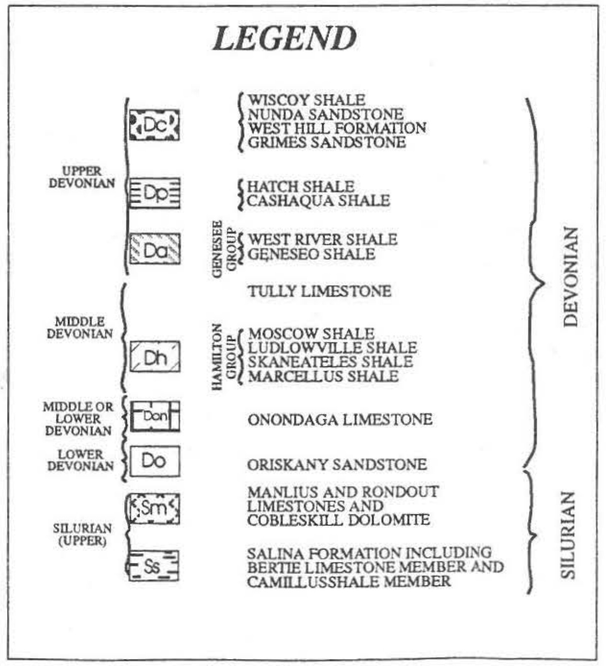


EAST-WEST SECTION ALONG A- A'



NORTH-SOUTH SECTION ALONG 76°50' (B-B')



HORIZONTAL SCALE

1 0 1 2 3 MILES

SOURCE:MODIFIED FROM-THE GROUND WATER RESOURCES OF SENECA COUNTY, NEW YORK: MOZOLA, A.J., BULLETIN GW-26, ALBANY, NY, 1951

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FIGURE 1-6

REGIONAL GEOLOGIC CROSS SECTIONS

SCALE VARIABLE

DATE MARCH 1996

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and Marcellus) consist largely of black and dark gray sparsely fossiliferous shales (Brett et al., 1991). Figure 1-7 displays the stratigraphic section of Paleozoic rocks of Central New York.

The physiography of Seneca County is shown on Figure 1-8. The majority of the area between Seneca and Cayuga Lakes is characterized by a till plain, which encompasses the entire SEDA facility. The Appalachian Plateau encroaches on the southern portion of this area. To the north of SEDA, the till plain gives way to glacial lake sediments in and near the towns of Waterloo and Seneca Falls. Farther north still is an area of drumlin and drumlinoid hills, which is flanked on the east by the marsh areas of the Montezuma National Wildlife Refuge and on the west by outwash plains and gravel hills (Figure 1-8).

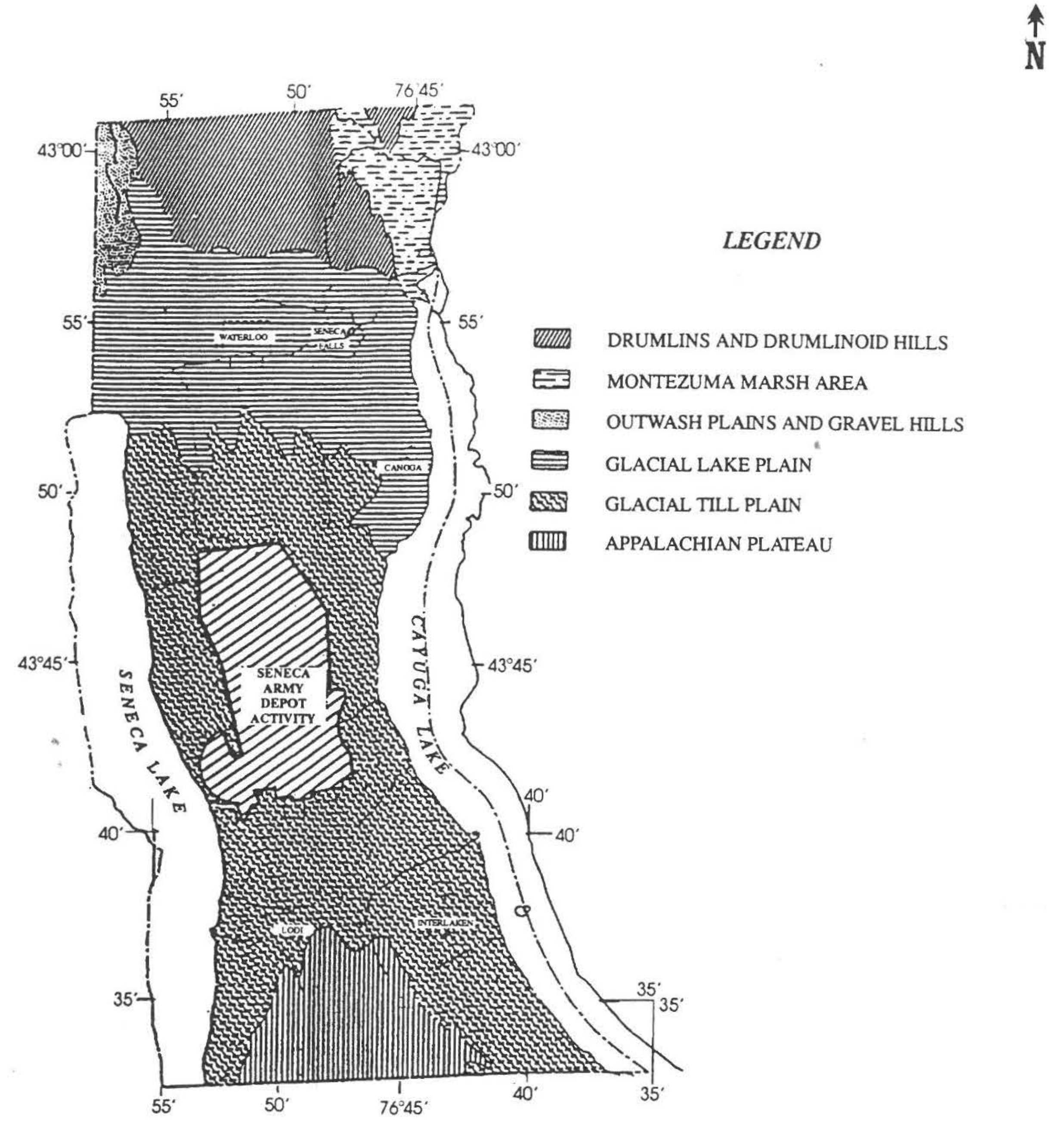
Regional background elemental concentrations for soils from the Finger Lakes region of New York State are not available. However, background elemental concentrations for soils from the eastern United States, and in particular New York State, are available in the literature. Table 1-1 presents data for soils in the eastern United States from a United States Geological Survey (USGS) professional paper (Shacklette and Boerngen, 1984) and data for the New York State soils from a New York State Department of Environmental Conservation (NYSDEC) report by McGovern (undated).

According to the General Soils Map, Seneca County, New York (Hutton, 1972), the soils in the vicinity of SEDA are from the Darien-Anglo association, which is characterized by deep and moderately deep, somewhat poorly-drained soils that have a silty clay loam and clay loam subsoil (Figure 1-9).

1.5.2 Geology at SEDA

Subsurface investigations conducted at 27 separate sites at SEDA have provided important information that was used to develop more detailed descriptions of the till and shale at SEDA that are not discernible at a regional scale. Generally, the geology at SEDA is characterized by a thin mantle of till overlying gray Devonian shale, with a thin weathered shale zone at the contact between these two units. This stratigraphy is consistent over the entire SEDA facility.

The predominant surficial geologic unit present at the site is dense till. The till is distributed across the entire Depot and generally ranges in thickness from 3 feet to approximately 15 feet, although it is generally between 6 and 10 feet thick; at a few locations the thickness of the till is greater than



SOURCE: MODIFIED FROM-THE GROUND WATER RESOURCES OF SENECA COUNTY, NEW YORK: MOZOLA, A.J., BULLETIN GW-26, ALBANY, NY, 1951

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FIGURE 1-8

PHYSIOGRAPHIC MAP OF SENECA COUNTY

SCALE	DATE
1" = 5 MILES	MARCH 1996

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MESOZOIC	Lower Cretaceous	**MESOZOIC INTRUSIVES** Kimberlite and alnoite dikes and diatremes.
PALEOZOIC	Upper Devonian	**CONNEAUT GROUP** 600-1000 ft. (180-300 m.) Germania Formation—shale, sandstone; Whitesville Formation—shale, sandstone; Hinsdale Sandstone; Wellsville Formation—shale, sandstone; Cuba Sandstone.
		CANADAWAY GROUP 800-1200 ft. (240-370 m.) Machias Formation—shale, siltstone; Rushford Sandstone; Caneadea, Canisteo, and Hume Shales; Canaseraga Sandstone; South Wales and Dunkirk Shales; In Pennsylvania: Towanda Formation—shale, sandstone.
		JAVA GROUP 300-700 ft. (90-210 m.) Wiscoy Formation—sandstone, shale; Hanover and Pipe Creek Shales.
		WEST FALLS GROUP 1100-1600 ft. (340-490 m.) Nunda Formation—sandstone, shale. West Hill and Gardeau Formations—shale, siltstone; Roricks Glen Shale; upper Beers Hill Shale; Grimes Siltstone. lower Beers Hill Shale; Dunn Hill, Millport, and Moreland Shales. Nunda Formation—sandstone, shale; West Hill Formation—shale, siltstone; Corning Shale. "New Milford" Formation—sandstone, shale. Gardeau Formation—shale, siltstone; Roricks Glen Shale. Slide Mountain Formation—sandstone, shale, conglomerate. Beers Hill Shale; Grimes Siltstone; Dunn Hill, Millport, and Moreland Shales
		SONYEA GROUP 200-1000 ft. (60-300 m.) In west: Cashaqua and Middlesex Shales. In east: Rye Point Shale; Rock Stream ("Enfield") Siltstone; Pulteney, Sawmill Creek, Johns Creek, and Montour Shales.
		GENESEE GROUP AND TULLY LIMESTONE 200-1000 ft. (60-300 m.) West River Shale; Genundewa Limestone; Penn Yan and Geneseo Shales; all except Geneseo replaced eastwardly by Ithaca Formation—shale, siltstone and Sherburne Siltstone. Oneonta Formation—shale, sandstone. Unadilla Formation—shale, siltstone.
	Middle Devonian	Tully Limestone.
		HAMILTON GROUP 600-1500 ft. (180-460 m.) Moscow Formation—In west: Windom and Kashong Shales, Menteth Limestone Members; In east: Cooperstown Shale Member, Portland Point Limestone Member. Ludlowville Formation—In west: Deep Run Shale, Tichenor Limestone, Wanakah and Ledyard Shale Members, Centerfield Limestone Member. In east: King Ferry Shale and other members, Stone Mill Sandstone Member. Skaneateles Formation—In west: Levanna Shale and Stafford Limestone Members; In east: Butternut, Pompey, and Delphi Station Shale Members, Mottville Sandstone Member. Marcellus Formation—In west: Oakta Creek Shale Member; In east: Cardiff and Chittenango Shale Members, Cherry Valley Limestone and Union Springs Shale Members. Panther Mountain Formation—shale, siltstone, sandstone.
		ONONDAGA LIMESTONE AND ORISKANY SANDSTONE 75-150 ft. (23-45 m.) Onondaga Limestone—Seneca, Morehouse (cherty) and Nedrow Limestone Members, Edgecliff cherty
	Lower Devonian	Limestone Member, local bioherms. Oriskany Sandstone.
		HELDERBERG GROUP 0-200 ft. (0-60 m.) Coeymans and Manlius Limestones; Rondout Dolostone.
	Upper Silurian	**AKRON DOLOSTONE, COBLESKILL LIMESTONE, AND SALINA GROUP** 700-1000 ft. (210-300 m.) Akron Dolostone; Bertie Formation—dolostone, shale. Camillus and Syracuse Formations—shale, dolostone, gypsum, salt. Cobleskill Limestone; Bertie and Camillus Formations—dolostone, shale. Syracuse Formation—dolostone, shale, gypsum, salt. Vernon Formation—shale, dolostone.
		LOCKPORT GROUP 80-175 ft. (25-55 m.) Oak Orchard and Penfield Dolostones, both replaced eastwardly by Sconondoa Formation—limestone, dolostone.
	Lower Silurian	**CLINTON GROUP** 150-325 ft. (40-100 m.) Decew Dolostone; Rochester Shale. Irondequoit Limestone; Williamson Shale; Wolcott Furnace Hematite; Wolcott Limestone; Sodus Shale; Bear Creek Shale; Wallington Limestone; Furnaceville Hematite; Maplewood Shale; Kodak Sandstone. Herkimer Sandstone; Kirkland Hematite; Willowvale Shale; Westmoreland Hematite; Sauquoit Formation—sandstone, shale; Oneida Conglomerate.
		MEDINA GROUP AND QUEENSTON FORMATION 0-900 ft. (0-270 m.) Medina Group: Grimsby Formation—sandstone, shale. Queenston Formation—shale, siltstone. Undifferentiated Medina Group and Queenston Formation.
	Upper Ordovician	**LORRAINE GROUP** 700-900 ft. (210-270 m.) Oswego Sandstone. Pulaski and Whetstone Gulf Formations—siltstone, shale.
	Middle Ordovician	**TRENTON GROUP** 100-300 ft. (30-90 m.) Utica Shale

Hamilton group

Moscow shale	140±	Lower two-thirds of section is a fossiliferous, soft gray calcareous shale; upper third highly friable but less calcareous and fossiliferous. Staining by iron oxide very common. Concretions present in greater abundance in lower beds, but irregular calcareous masses occur throughout section. Joints parallel, tightly sealed, trending N.65°E. and N.25°-30°W.
Ludlowville shale	140±	Lower beds are thinly laminated, light-colored, fossiliferous, shaly passage beds; overlain by hard calcareous black shales 13 to 30 centimeters thick and rich in corals and brachiopods; hard layers responsible for falls and cascades. Middle beds are less fossiliferous, soft gray arenaceous shales, rich in concretions, calcareous lenses, and occasional thin sandstone layers. Upper beds (Tichenor limestone member) are thin, irregularly bedded gray shales becoming light blue gray upon exposure, calcareous, coarsely textured, and fossiliferous. Joints parallel 5 to 50 centimeters apart, well developed but tight.
Skaneateles shale	185±	Basal beds composed of dark fissile shale. Upper shale more calcareous, grayish to bluish impure limestone layers. Joint pattern N.75°E. and N.30°W.; diagonal joints N.50°E. Joints sealed, parallel and spaced 15 centimeters to 1.2 meters apart.
Marcellus shale	50	Black, slatelike, bituminous shale with occasional limestone layers in sequence, and containing zones rich in iron sulfides or calcareous concretions, often with septarian structures; very fissile. Iron-stained and gray when weathered. Joint pattern N.25°W., N.65°E., 2.5 centimeters to 1.2 meters apart.

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DEPT. ENVIRONMENTAL ENGINEERING | DWG NO. 728059-02003

FIGURE 1-7
BEDROCK STRATIGRAPHIC COLUMN

SCALE | DATE MARCH 1996

SOURCE: MODIFIED FROM THE GROUND WATER RESOURCES OF SENECA COUNTY, NEW YORK: MOZOLA, A.J., BULLETIN GW-26, ALBANY, NY, 1951

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SCALE IN MILES
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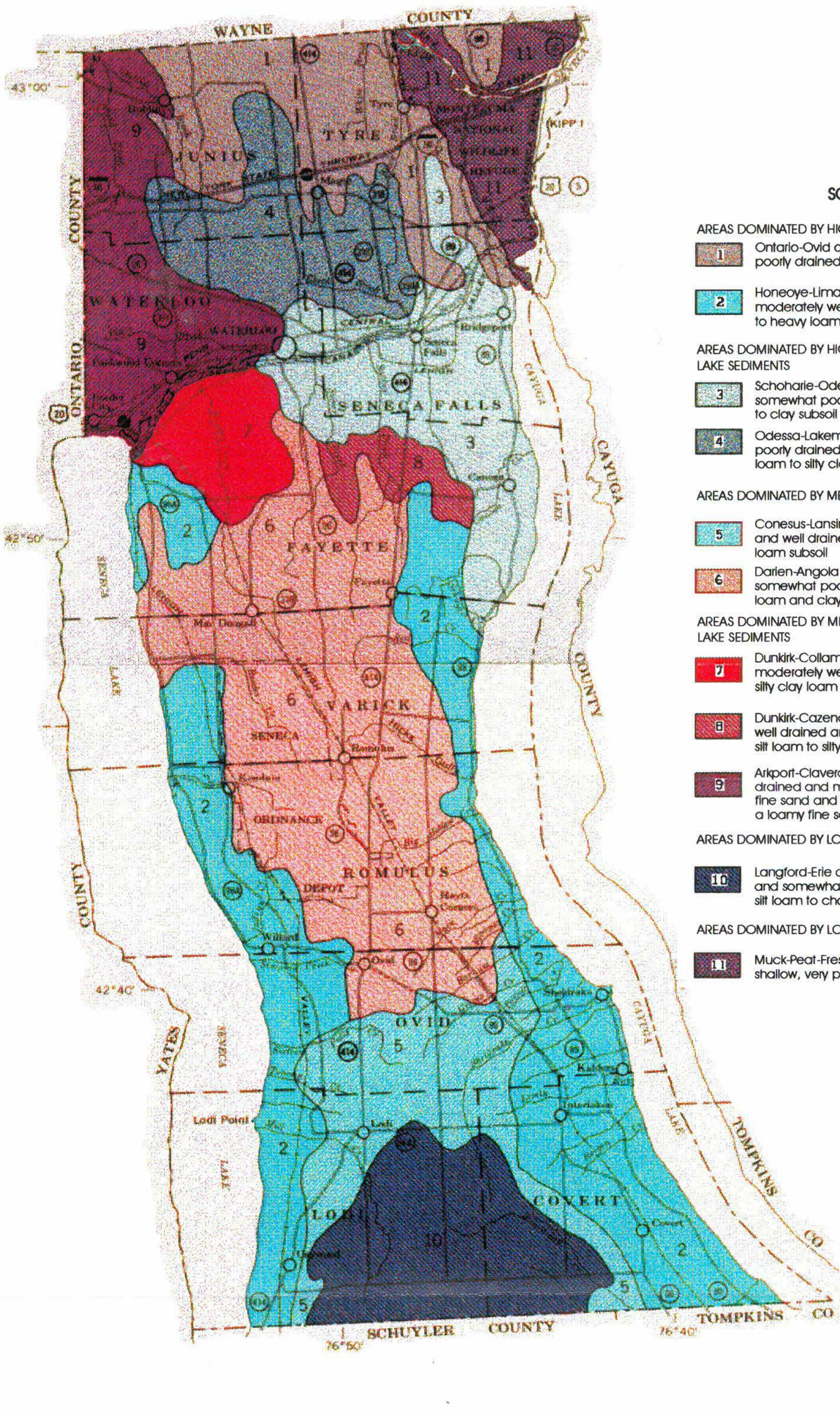

SOIL ASSOCIATIONS

AREAS DOMINATED BY HIGH-LIME SOILS DEVELOPED IN GLACIAL TILL

1 Ontario-Ovid association: Deep, well-drained to somewhat poorly drained soils that have a loam to silty clay loam subsoil

2 Honeoye-Lima association: Deep, well-drained and moderately well drained soils that have a heavy silt loam to heavy loam subsoil

AREAS DOMINATED BY HIGH-LIME SOILS DEVELOPED IN GLACIAL LAKE SEDIMENTS

3 Schoharie-Odessa association: Deep, well-drained to somewhat poorly drained soils that have a silty clay loam to clay subsoil

4 Odessa-Lakemont association: Deep, dominantly somewhat poorly drained and poorly drained soils that have a silty clay loam to silty clay subsoil

AREAS DOMINATED BY MEDIUM-LIME SOILS DEVELOPED IN GLACIAL TILL

5 Conesus-Lansing association: Deep, moderately well drained and well drained soils that have a heavy silt loam to heavy loam subsoil

6 Darien-Angola association: Deep and moderately deep, somewhat poorly drained soils that have a silty clay loam and clay loam subsoil

AREAS DOMINATED BY MEDIUM-LIME SOILS DEVELOPED IN GLACIAL LAKE SEDIMENTS

7 Dunkirk-Collamer association: Deep well drained and moderately well drained soils that have a silt loam to silty clay loam subsoil

8 Dunkirk-Cazenovia association: Moderately deep and deep, well drained and moderately well drained soils that have a silt loam to silty clay loam subsoil that overlies limestone

9 Arkport-Claverack association: Deep, dominantly well drained and moderately well drained soils that are loamy fine sand and fine sandy loam throughout or that have a loamy fine sand subsoil over silty clay or clay

AREAS DOMINATED BY LOW-LIME SOILS DEVELOPED IN GLACIAL TILL

10 Langford-Erie association: Deep, moderately well drained and somewhat poorly drained soils that have a channery silt loam to channery loam fragipan

AREAS DOMINATED BY LOW-LIME SOILS DEVELOPED IN ORGANIC MATERIAL

11 Muck-Peat-Fresh Water Marsh association: Deep to shallow, very poorly drained organic soils

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DEPT. ENVIRONMENTAL ENGINEERING	DWG NO. 728059-02003

FIGURE 1-9
GENERAL SOIL MAP
SENECA COUNTY, NEW YORK

SCALE 1" = 2000'	DATE MARCH 1996

SOURCE: U.S. DEPARTMENT OF ARGRICULTURE
SOIL CONSERVATION SERVICE
CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION

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30 feet. The till is generally characterized as brown to olive-gray silt and clay, with little fine sand and variable amounts of fine to coarse gravel-sized inclusions of dark gray shale. Larger diameter clasts of shale (as large as 6 inches in diameter) are sometimes present in the basal portion of the till and are probably rip-up clasts removed from the weathered shale zone and incorporated into the till by the once-active glacier. Grain size analyses of the till show a wide distribution of particle sizes within the till (Metcalf & Eddy, 1989), however, there is a high percentage of silt and clay with the balance comprised of coarser particles. The porosities of 5 gray-brown silt clay (i.e., till) samples ranged from 34.0 percent to 44.2 percent with an average of 37.3 percent (USAEHA, 1985).

Darien silt-loam soils, 0 to 18 inches thick, have developed over the Wisconsin age till at both SEAD-25 and SEAD-26 (Figures 1-10 and 1-11). Figure 1-12 provides a legend for both maps. These soils are poorly drained and have a silt clay loam and a clay subsoil. In general, the topographic relief associated with these soils is 3 to 8 percent.

As part of the CERCLA investigations being conducted at SEDA, a total of 57 soil samples have been collected from 16 glacial till locations to provide a background data set for inorganic constituents in SEDA soils. The 57 samples were collected from 14 separate sites and are presented in Table 1-2.

The minimum, maximum, average, standard deviation and the 95th upper confidence level (UCL) of the mean for background concentrations of inorganic constituents in the soil at SEDA are also shown in Table 1-2. In addition to the statistical summary information, the actual data from the individual sample points are also presented. For the statistical calculations, non-detect values have been adjusted to one-half the detection limit.

The Moscow shale (a member of the Hamilton group) is soft, gray, and fissile. This shale is extensively jointed and weathered at the contact with the overlying till. Joint spacings are from 1 inch to 4 feet based upon surface exposures. Three prominent joint directions are evident in the shale (N 60° E, N 30° W, and N 20° E) with the joint dips being primarily vertical (Mozola, 1951). Merrin (1992) also cites three prominent vertical joint directions of northeast, north-northwest, and east-northeast in outcrops of the Genesse Formation 15 miles southeast of SEDA near Ithaca, New York. Cores performed in the upper 5 to 8 feet of the bedrock revealed low Rock Quality Designations (RQDs), i.e., less than 5 percent with almost 100 percent recovery suggesting a high degree of weathering in this upper zone (Parsons ES, 1995a; Metcalf & Eddy, 1989). Below this depth the shale is significantly less fractured.

1.5.3 Regional Hydrogeologic Setting

Regionally, four distinct hydrologic units have been identified within Seneca County (Mozola, 1951). These include two distinct shale formations, a series of limestone units, and unconsolidated beds of Pleistocene glacial drift. Overall, the groundwater in the county is very hard, and therefore, the quality is minimally acceptable for use as potable water. Approximately 95 percent of the wells in the county are used for domestic or farm supply and the average daily withdrawal is approximately 500 gallons, or 0.35 gallons per minute (gpm). About five percent of the wells in the county are used for commercial, industrial, or municipal purposes. Seneca Falls and Waterloo, the two largest communities in the county, are in the hydrogeologic region which is most favorable for the development of a groundwater supply. However, because the hardness of the groundwater is objectionable to the industrial and commercial establishments operating within the villages, both villages utilize surface water (Cayuga Lake and Seneca River, respectively) as their municipal supplies. The villages of Ovid and Interlaken, both of which are without substantial industrial establishments, utilize groundwater as their public water supplies. Ovid obtains its supply from two shallow gravel-packed wells, and Interlaken is served by a developed seepage-spring area.

Regionally, the water table aquifer of the unconsolidated surficial glacial deposits of the region would be expected to flow in a direction consistent with the dropping ground surface elevations. Geologic cross-sections from Seneca Lake and Cayuga Lake have been constructed by the State of New York, (Mozola, 1951). This cross-section information, along with groundwater flow directions established at numerous sites on SEDA and stream drainage patterns in the area, suggests that a groundwater divide exists approximately half way between the two finger lakes; the divide is believed to run approximately parallel to Route 96 near the eastern boundary of SEDA. Further evidence for the divide is provided in Parsons ES (1995a). SEDA is located on the western slope of this divide and, therefore, regional groundwater flow on the depot is expected to be west toward Seneca Lake.

A substantial amount of information concerning the hydrogeology in the area has been compiled in a report by Mozola (1951). This report has been reviewed in order to better understand the hydrogeology of the area surrounding SEDA. The report indicates that within a four (4) mile radius of SEDA there are a number of wells from which geologic and hydrogeologic information is available. This information includes: 1) the depth; 2) the yield; and 3) the geological strata through which the wells were drilled. Although the information was compiled in the 1950s, these data are useful in providing an understanding and characterization of the aquifers present within the area surrounding SEDA.

A review of this information suggests that three geologic units have been used to produce water for both domestic and agricultural purposes. These units include: 1) a bedrock aquifer, which in this area is predominantly shale; 2) an overburden aquifer, which includes Pleistocene deposits (glacial till); and 3) a deep aquifer present within beds of limestone the underlying shale. The occurrence of water derived from limestone is considered to be unusual for this area and is more commonplace to the north of this area. The limestone aquifer in this area is between 100 and 700 feet deep. As of 1957, twenty-five wells utilized water from the shale aquifer, six wells tapped the overburden aquifer, and one used the deep limestone as a source of water. For the six wells that utilized groundwater extracted from the overburden, the average yield was approximately 7.5 gpm. The average depth of these wells was thirty-six feet. The geologic material which comprises this aquifer is generally Pleistocene till, with the exception of one well located northeast of the site. This well penetrates an outwash sand and gravel deposit. The yields from the five overburden wells ranged from 4 to 15 gpm. The well located in the outwash sand and gravel deposit, drilled to 60 feet, yielded only 5 gpm. A 20-foot hand dug well, located to the southeast of the outwash well, yielded 10 gpm.

The geologic information reviewed indicates that the upper portions of the shale formation would be expected to yield small, yet adequate, supplies of water for domestic use. For mid-Devonian shales such as those of the Hamilton group, the average yields, (which are less than 15 gpm), are consistent with what would be expected for shales (LaSala, 1968). The deeper portions of the bedrock, (i.e., at depths greater than 235 feet) have provided yields up to 150 gpm. At these depths the high well yields may be attributed to the effect of solutioning on the Onondaga limestone, which is at the base of the Hamilton Group. Based on well yield data, the degree of solutioning is affected by the type and thickness of overlying material (Mozola, 1951). Solution effects on limestones (and on shales which contain gypsum) in the Erie-Niagara have been reported by LaSala (1968). This source of water is considered to comprise a separate source of groundwater for the area. Very few wells in the region adjacent to SEDA utilize the limestone as a source of water, which may be due to the drilling depths required to intercept this water.

The geologic study of the area by Mozola (1951) determined three reasons for the lack of hydrologic interconnection between the groundwater near the surface and the deeper aquifers. First, the shales in this region are relatively impermeable, i.e., absorbing, transmitting, and yielding water very slowly. Joints and other openings in the shales are generally very narrow or are filled with fine silt and clay. This impermeability tends to inhibit downward seepage of water from the surficial deposits. Second, the slope of the bedrock and the land surfaces toward the Finger Lakes favors rapid drainage of surface water. Third, the overlying glacial drift (i.e., till) is considered too thin to hold large quantities of water for gradual recharge of the bedrock.

1.5.4 Hydrogeology at SEDA

Physical characterization studies at 27 sites at SEDA provide some important information on the behavior of the till/weathered shale and competent shale aquifers. The areas addressed below include groundwater flow directions, hydraulic conductivity results, groundwater velocities, and a general conceptual model for groundwater flow at SEDA.

Groundwater flow directions at SEDA are generally to the west based on water table maps prepared for 27 sites on the Depot. However, there are occasions where local topography and/or water bodies cause groundwater to flow in an eastward direction. Water table maps from several of these 27 sites provide additional evidence for a groundwater divide near Route 96 on the eastern flank of SEDA (Parsons ES, 1995a). East of the divide groundwater flows into Cayuga Lake and west of the divide it flows into Seneca Lake.

Hydraulic conductivity data are available from two sites at SEDA, the Ash Landfill and the Open Burning Grounds. The average hydraulic conductivity determined for 10 till/weathered shale monitoring wells at the Ash Landfill was determined to be 4.6×10^{-4} cm/sec (Parsons ES, 1995). At the Open Burning Grounds, the average hydraulic conductivity of wells screened in the till and weathered shale was determined to be 8.7×10^{-4} cm/sec. The typical range for tills described by Freeze and Cherry (1979) is between 1×10^{-4} cm/sec and 1×10^{-10} cm/sec. Hydraulic conductivity's tend to decrease with depth in the competent shale based on data obtained from the Ash Landfill. The average hydraulic conductivity's for approximately 0 to 20 foot and 20 to 40 foot zones in the competent shale were determined to be 7.1×10^{-5} cm/sec and 1.4×10^{-5} cm/sec, respectively based on a total of 10 wells (Parsons ES, 1995).

The average linear velocity of groundwater flow in the till/weathered shale was calculated to be between 27 ft/yr and 36 ft/yr at the Ash Landfill and 32 ft/year at the Open Burning Grounds (Parsons ES, 1995a and 1994). The average linear velocity in the competent shale was determined to be approximately 7 ft/year at the Ash Landfill.

Three years of historical water table data collected at the Ash Landfill site provide information for a conceptual model of the overall behavior of the till/weathered shale aquifer at SEDA (Parsons ES, 1995a). For the relatively thin till/weathered shale aquifer, historical data sampled as part of the Ash Landfill RI indicates fluctuations in the water table of as great as 8.7 feet occur in the monitoring wells. It is noteworthy that at certain times of the year, the saturated interval becomes quite thin (approximately 1 to 3 feet thick) and even dries up in some locations. Based on these historical data, these wells exhibit rhythmic, seasonal water table and saturated thickness fluctuations (Parsons ES, 1995a). The saturated interval is at its thinnest (generally between 1 and 3 feet thick) in the month of September and its thickest (generally between 6 and 8.5 feet thick) between the months of December and March.

Mozola (1951) states that groundwater in Seneca County is derived almost entirely from precipitation within the County. To investigate historical precipitation events and the likely relationship between fluctuations in the water table and these precipitation events, monthly precipitation data for the years 1990 through most of 1993 were obtained from the Aurora Research Farm located approximately 10 miles east of the site. Although no definitive trend is depicted by the data, they generally show higher amounts of precipitation in the spring (March and April) and fall (September) and relatively lower amounts in the summer (with the exception of the month of July 1992) and winter (January and February). These data alone do not explain the observed water table fluctuations.

The rhythmic behavior of the aquifer is not solely controlled by precipitation events, rather it is more likely affected by a combination of precipitation amounts and evapotranspiration rates. This later phenomenon is affected by temperature, exposure to the intensity of the sun, velocity of the wind, and the amount of vegetation. Horizontal flow is not believed to play a major role in discharging water from the till/weathered shale unit, which has a relatively low hydraulic conductivity. While vertical connection tests indicate that low degrees of downward movement are possible from the till/weathered shale aquifer to the competent shale aquifer, no strong downward vertical gradients are believed to occur on-site and, therefore, downward flow is also believed to be minimal compared to evaporative losses.

Therefore, based on the hydrographs for the wells at the Ash Landfill, a conceptual model for the till/weathered shale flow system is that the high water table in the late fall and winter is sustained through the spring by generally high precipitation amounts, snow melting events (predominantly in March and April) and low evapotranspiration rates. An increase in evapotranspiration (due to an increase in temperature and more vegetation uptake) in the summer results in little recharge to the aquifer and thus a fall in the water table. In the summer, evapotranspiration at the surface causes water to move up from the water table to the surface by capillary action, a phenomenon noted by deMarsily (1986). In the late summer and fall (August and September) there is generally an increase in precipitation and a decrease in evapotranspiration, which accounts for the increasing water table elevations that are sustained through the winter months and into the spring. Supporting evidence for the concept of evapotranspiration losses from groundwater and water table fluctuations is provided in Parsons ES (1995a and 1996).

The nature of fractures observed in the competent shale at the Ash Landfill suggests that groundwater flow in the shale aquifer may approach equivalent porous media (EPM) flow conditions (Parsons ES, 1995c). Additionally, Merrin (1992) suggests that groundwater flow through fractured siltstones approximately 15 miles south of SEDA near Ithaca, NY might approximate EPM conditions.

1.5.5 Regional Topography

SEDA lies on the western side of a series of north to south trending rock terraces that separate Cayuga Lake on the east and Seneca Lake on the west. The rock terraces range in elevation from 490 feet above MSL in northern Seneca County to as much as 1,600 feet above MSL at the southern end of the lakes. Elevations on SEDA range from 450 feet above MSL on the western boundary to 760 feet above MSL in the southeast corner. The Depot's land surface generally slopes downward to the west and upwards to the south.

1.5.6 Regional Climate

Table 1-3 summarizes climatological data for the SEDA area. The nearest source of climatological data is the Aurora Research Farm in Aurora, New York which is approximately ten miles east of SEDA on the east side of Cayuga Lake. This research Farm is administered by the Northeast Regional Climate Center located at Cornell University in Ithaca, New York. Only precipitation and temperature measurements are available from this location. The other data reported in Table 1-3 were taken either from isopleth drawings from a climatic atlas, or from data collected at Syracuse, New York, which is 40 miles northeast of SEDA. Meteorological data collected from 1965 to 1974 at Hancock International Airport in Syracuse, New York, were used to prepare the wind rose presented in Figure 1-13.

locations for five of the soil borings are as follows. Soil boring SB25-7 was drilled at a background location north of the pad near the ballfield. This soil boring was subsequently completed as overburden monitoring well MW25-6. The three soil borings, SB25-8, SB25-9, and SB25-10, were drilled at locations west, southwest and south of the pad; respectively. They were completed as overburden monitoring wells, MW25-8, MW25-9, and MW25-10, respectively. One soil boring SB25-11 was drilled on the southwest corner of the pad. This boring was not completed as a monitoring well.

The remaining soil borings were located in areas that were chosen based on the results of the soil gas survey. Soil boring SB25-12 was located north of the pad and was completed as overburden monitoring well MW25-17. Soil boring SB25-13 was located west of the pad and competed as overburden monitoring well MW25-19. Soil boring SB25-14 was located southwest of the pad and west of the crushed shale access road and was completed as overburden monitoring well MW25-15. Soil borings SB25-15 and SB25-16 were located south and southeast of the pad, respectively, along Ordnance Drive.

Each soil boring was continuously sampled to the top of the water table. A total of three samples from each boring were collected for chemical analysis. At each location, one surface soil sample was collected from 0 to 2 inches below the organic matter. Two additional subsurface soil samples were collected from the borings according to the procedures outlined in Section 2.2.5.1. In total, 31 soil samples were collected for chemical analysis as shown in Table 2-3.

In addition, six subsurface soil samples were collected from three of the soil borings and submitted for analysis of TOC and grain size distribution. The samples obtained below the water table were analyzed to characterize the soil in the aquifer. At soil boring SB25-7, a near surface soil sample was collected; at soil boring SB25-9, two subsurface samples (one immediately below the water table, and one intermediate sample) were collected. At monitoring well, MW25-18, three subsurface soil samples were collected.

2.3.7 Groundwater Investigation

2.3.7.1 Introduction

The purpose of the groundwater monitoring program at SEAD-25 was to define the horizontal and vertical extent of impacted groundwater, determine the directions of groundwater flow on the site, determine the hydrogeologic properties of the aquifer to assess contaminant migration and potential remedial actions, and determine the background groundwater quality.

During the ESI, three monitoring wells were installed and the direction of groundwater flow was determined to be to the southwest. During the RI, a total of 16 monitoring wells were installed with ten monitoring wells screened in the till/weathered shale aquifer and six screened in the competent shale aquifer. In addition, physical characteristics of the till/weathered shale and competent shale aquifers and their general groundwater flow conditions were investigated through measurements of depth to water, slug tests, and vertical connection tests. The locations of all monitoring wells are shown in Figure 2-5. Monitoring well construction details for all wells at SEAD-25 are presented in Table 2-4, and monitoring well completion diagrams are included in Appendix D.

2.3.7.2 Monitoring Well Installation

ESI Program

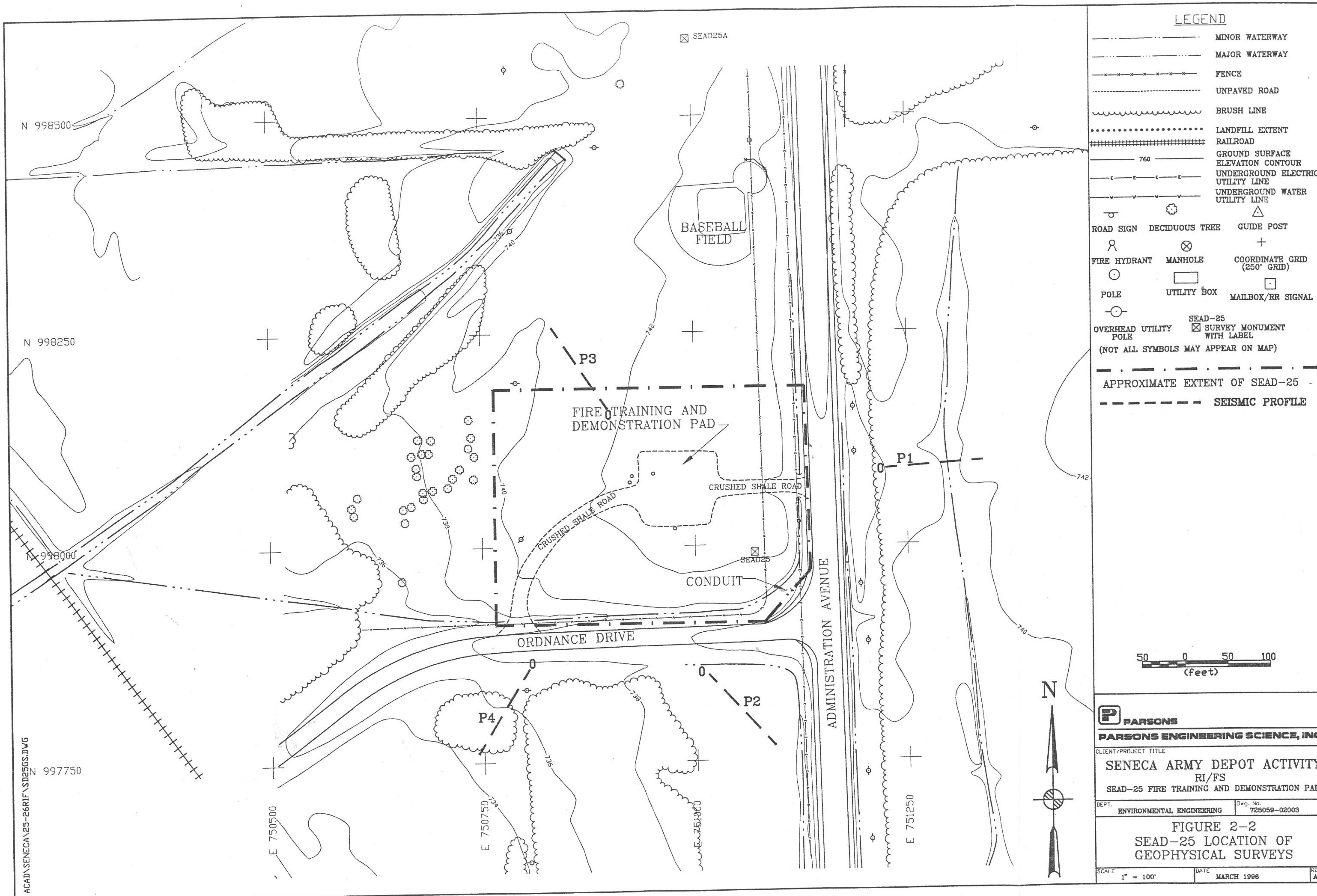
During the ESI, a total of three monitoring wells were installed at this site. One monitoring well, MW25-1, was installed upgradient and east of the pad to obtain background water quality data. The remaining two wells, MW25-2 and MW25-3, were installed adjacent to and downgradient of the pad to determine if hazardous constituents have migrated from the site and to determine the direction of groundwater flow. The presumed direction of groundwater flow at this site was to the southwest which the geophysical survey confirmed. Monitoring well, MW25-3, was moved slightly to the north of the proposed workplan location. One monitoring well was constructed at each designated location and was screened over the entire thickness of the aquifer above the competent bedrock.

RI Program

During the RI, a total of 16 monitoring wells were installed at SEAD-25. Ten of the wells were installed in the overburden and six were installed in the shallow competent bedrock. The final locations of these wells depended on the results of the soil gas survey. The wells were placed in and around the detected VOC plume in the groundwater.

While drilling the boreholes in which the ten overburden wells were installed, split spoon samples of the soil were collected continuously to competent rock. A monitoring well was then installed in the boring and screened over the entire depth of the overburden aquifer.

Double-cased bedrock wells were installed adjacent to six of the overburden well locations in order to determine the groundwater quality within the competent bedrock. During the well



PARSONS

PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY

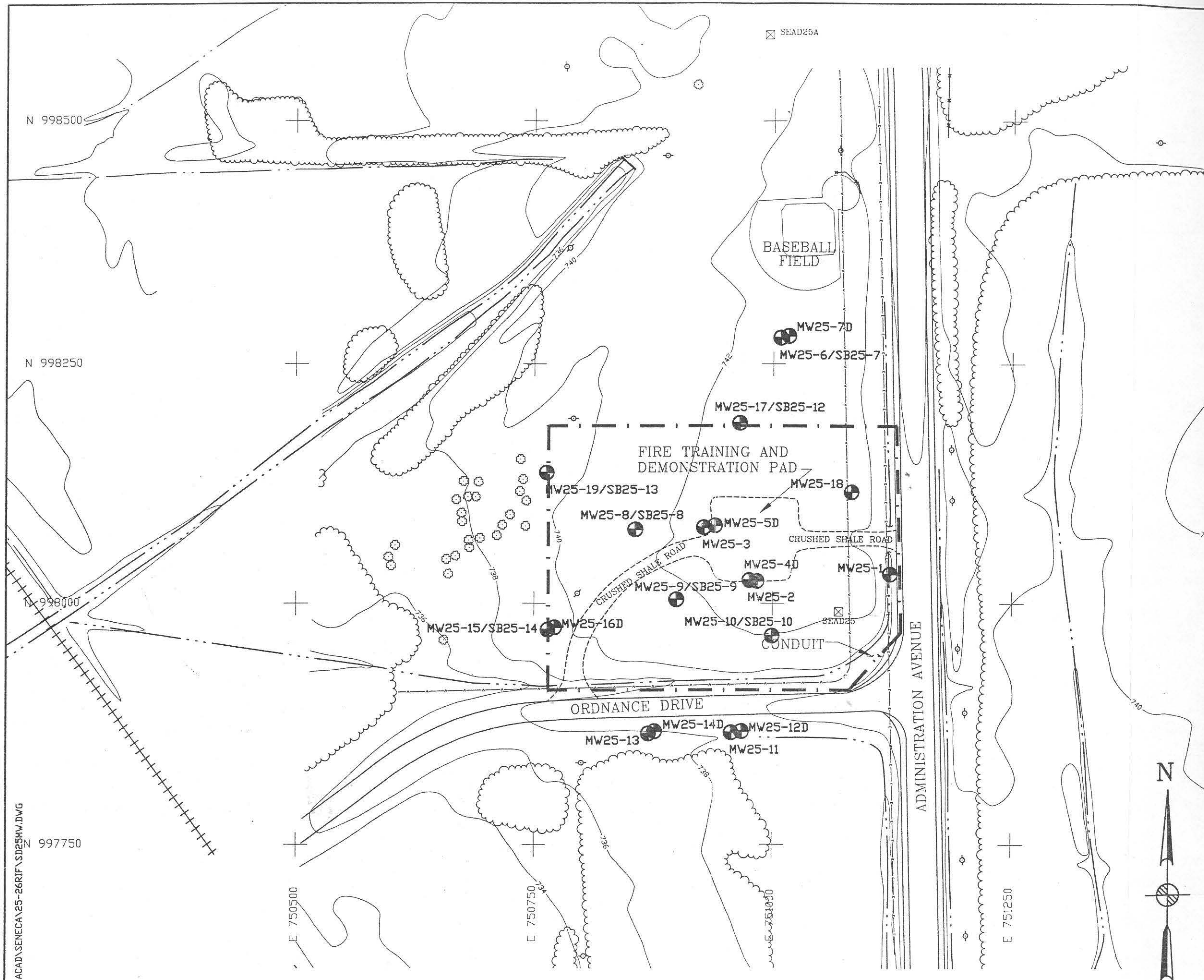
RI/FS

SEAD-25 FIRE TRAINING AND DEMONSTRATION PAD

DEPT.	Dwg. No.
ENVIRONMENTAL ENGINEERING	728059-02003

FIGURE 2-2
SEAD-25 LOCATION OF GEOPHYSICAL SURVEYS

SCALE	DATE	REV
1" = 100'	MARCH 1996	A



LEGEND

- MINOR WATERWAY
- MAJOR WATERWAY
- FENCE
- UNPAVED ROAD
- BRUSH LINE
- LANDFILL EXTENT
- RAILROAD
- GROUND SURFACE ELEVATION CONTOUR (760)
- UNDERGROUND ELECTRIC UTILITY LINE
- UNDERGROUND WATER UTILITY LINE
- ROAD SIGN
- DECIDUOUS TREE
- GUIDE POST
- FIRE HYDRANT
- MANHOLE
- COORDINATE GRID (250' GRID)
- POLE
- UTILITY BOX
- MAILBOX/RR SIGNAL
- OVERHEAD UTILITY POLE
- SEAD-25 SURVEY MONUMENT WITH LABEL

(NOT ALL SYMBOLS MAY APPEAR ON MAP)

APPROXIMATE EXTENT OF SEAD-25

MONITORING WELL LOCATION

50 0 50 100 (feet)

PARSONS

PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE: SENECA ARMY DEPOT ACTIVITY RI/FS SEAD-25 FIRE TRAINING AND DEMONSTRATION PAD

DEPT. ENVIRONMENTAL ENGINEERING | Dwg. No. 728059-02003

FIGURE 2-5 SEAD-25 LOCATION OF MONITORING WELLS

SCALE 1" = 100' | DATE MARCH 1996 | REV A

Table 2-4

SEAD-25 - Monitoring Well Construction Details

SEAD-25 Remedial Investigation
Seneca Army Depot Activity

Well ID	Well Type (1)	Depth of Well Relative to Ground Surface (ft)	Depth of Well Relative to Top of PVC (ft)	Diameter of Boring/Core (in)	Diameter of Well (in)	Well Screen Length (ft)	Screened Interval Relative to Ground Surface (ft)		
MW25-1	T/WS	5.00	7.66	8.00	2.00	1.00	3.10	to	4.10
MW25-2	T/WS	8.50	11.13	8.00	2.00	4.00	3.40	to	7.40
MW25-3	T/WS	6.50	9.02	8.00	2.00	2.00	4.00	to	6.00
MW25-4D	CS	23.80	25.41	3.79	1.88	9.00	13.70	to	22.70
MW25-5D	CS	21.70	23.32	3.79	1.88	9.00	11.60	to	20.60
MW25-6	T/WS	12.20	14.36	8.00	2.00	6.80	4.30	to	11.10
MW25-7D	CS	30.20	31.98	3.79	1.88	9.00	20.10	to	29.10
MW25-8	T/WS	4.50	5.64	8.00	2.00	0.80	3.20	to	4.00
MW25-9	T/WS	4.50	5.57	8.00	2.00	0.80	3.20	to	4.00
MW25-10	T/WS	5.60	6.81	8.00	2.00	2.00	3.20	to	5.20
MW25-11	T/WS	5.70	7.25	8.00	2.00	1.50	3.80	to	5.30
MW25-12D	CS	24.20	25.38	3.79	1.88	9.50	13.90	to	23.40
MW25-13	T/WS	4.00	5.68	8.00	2.00	0.80	2.70	to	3.50
MW25-14D	CS	23.20	24.79	3.79	1.88	9.00	13.10	to	22.10
MW25-15	T/WS	5.80	7.19	8.00	2.00	1.50	3.90	to	5.40
MW25-16D	CS	25.00	26.35	3.79	1.88	9.00	14.90	to	23.90
MW25-17	T/WS	9.90	11.58	8.00	2.00	4.50	4.60	to	9.10
MW25-18	T/WS	9.70	11.04	8.00	2.00	4.50	4.40	to	8.90
MW25-19	T/WS	10.20	12.10	8.00	2.00	4.50	5.25	to	9.75

Notes:
(1) T/WS = Till and Weathered Shale Aqufier
CS = Competent Shale Aquifer

Table 2-4

SEAD-25 - Monitoring Well Construction Details

SEAD-25 Remedial Investigation
Seneca Army Depot Activity

Well ID	Well Screen Slot Size (in)	Thickness of Bentonite Seal (ft)	Height of PVC Well Stickup (ft)	Elevation of Top of PVC Well (MSL)	Well Casing Material	Well Screen Material
MW25-1	0.01	0.70	2.66	737.64	PVC	PVC
MW25-2	0.01	0.80	2.63	741.13	PVC	PVC
MW25-3	0.01	1.00	2.52	740.74	PVC	PVC
MW25-4D	0.01	2.00	1.61	742.20	PVC	PVC
MW25-5D	0.01	1.90	1.62	741.79	PVC	PVC
MW25-6	0.01	1.30	2.16	740.08	PVC	PVC
MW25-7D	0.01	2.10	1.78	740.47	PVC	PVC
MW25-8	0.01	1.00	1.14	740.22	PVC	PVC
MW25-9	0.01	1.00	1.07	740.19	PVC	PVC
MW25-10	0.01	1.10	1.21	740.60	PVC	PVC
MW25-11	0.01	1.30	1.55	737.20	PVC	PVC
MW25-12D	0.01	2.00	1.18	737.71	PVC	PVC
MW25-13	0.01	1.10	1.68	736.26	PVC	PVC
MW25-14D	0.01	2.00	1.59	736.64	PVC	PVC
MW25-15	0.01	1.30	1.39	738.21	PVC	PVC
MW25-16D	0.01	1.90	1.35	738.40	PVC	PVC
MW25-17	0.01	1.60	1.68	740.56	PVC	PVC
MW25-18	0.01	1.50	1.34	741.72	PVC	PVC
MW25-19	0.01	2.00	1.90	738.15	PVC	PVC

Table 2-6

SEAD-25 - Monitoring Well Field Sampling Information

SEAD-25 Remedial Investigation
Seneca Army Depot Activity

Well ID	Sample ID	Date Sampled	Field-Measured Parameters						Gallons of Purge Water Removed	Standing Water Volume (gal)	Well Volumes Removed
			Temperature (°C)	Specific Conductivity (umhos)	pH	Eh (millivolts)	Dissolved Oxygen (mg/L)	Turbidity (NTU)			
MW25-1 (3)	MW25-1	02/06/94	4.00	600	7.00	NA	NA	56.40	1.36	0.34	4.00
MW25-1	MW25-1	11/22/95	8.57	891	7.01	316	3.41	0.64	4.00	0.43	9.30
MW25-2 (3)	MW25-2	02/06/94	3.00	600	7.10	NA	NA	3.55	1.97	0.91	2.16
MW25-2	MW25-2	11/29/95	8.86	973	6.96	62	0.14	1.90	2.50	1.10	2.27
MW25-3 (3)	MW25-3	11/15/93	11.00	510	7.50	NA	NA	2.20	2.40	0.80	3.00
MW25-3	MW25-3	11/19/95	8.26	712	6.81	143	0.54	4.22	1.90	1.10	1.73
MW25-4D	MW25-4D	11/15/95	15.06	720	7.10	1.64	0.22	5.56	5.50	3.10	1.77
MW25-5D	MW25-5D	11/19/95	15.87	813	6.82	174	0.12	3.97	9.00	3.12	2.88
MW25-5D	MW25-50 (1)	11/19/95	15.87	813	6.82	174	0.12	3.97	9.00	3.12	2.88
MW25-6	MW25-6	11/21/95	12.29	927	5.34	326	3.51	4.19	18.00	1.85	9.73
MW25-7D	MW25-7D	11/22/95	15.74	920	7.19	158	1.6	6.06	6.00	4.80	1.25
MW25-8	MW25-8	11/28/95	11.27	430	7.32	206	0.5	30.60	4.00	0.69	5.80
MW25-9	MW25-9	11/19/95	6.91	675	6.99	174	0.68	0.87	2.00	0.70	2.86
MW25-10	MW25-10	11/21/95	8.36	529	6.91	343	3.42	5.58	2.50	0.83	3.01
MW25-11	MW25-11	11/17/95	9.57	1067	7.02	310	2.58	1.81	3.10	0.74	4.19
MW25-12D	MW25-12D	11/18/95	13.84	543	7.26	89	0.08	7.88	15.00	3.70	4.05
MW25-13	MW25-13	11/17/95	6.37	1840	7.06	323	1.55	1.28	1.50	0.57	2.63
MW25-14D	MW25-14D	11/18/95	11.17	495	7.36	124	0.34	2.42	8.50	3.60	2.36
MW25-15	MW25-15	11/20/95	8.01	537	6.78	301	2.99	14.50	1.00	0.83	1.20
MW25-16D	MW25-16D	11/20/95	14.61	641	7.04	106	0.17	9.00	21.50	3.63	5.92
MW25-17	MW25-17	11/20/95	15.04	589	6.87	290	4.13	3.07	2.50	1.50	1.67
MW25-18	MW25-18	11/28/95	3.45	1157	7.38	300	2.63	3.73	2.00	1.27	1.57
MW25-19	MW25-19	11/21/95	14.53	590	5.90	265	1.19	3.48	2.25	1.50	1.50

Notes:

(1) MW25-50 was taken as a field duplicate of MW25-5D.

(2) measurements taken after well development completed.

(3) Well was installed and sampled during the ESI, and was also sampled during the RI.

do. eH. nitrate 15 hr

installation, the boring was drilled to auger refusal. Then the hole was advanced using coring or air hammer methods until 2 to 3 feet of competent shale had been penetrated. An appropriate length of six-inch casing was installed 2 to 3 feet into the competent shale and grouted in place. The grout was allowed to set up for a minimum of 48 hours. Then a 15-foot long section of competent bedrock was cored, logged and archived. A bedrock well with a maximum screen length of 9.5 feet was then installed in the boring.

The bedrock well MW25-4D was paired with MW25-2 which was installed during the ESI field program on the southern edge of the pad. Monitoring well MW25-5D was paired with MW25-3 which was installed during the ESI program on the western edge of the pad. Since volatile organic compounds were detected in these two overburden wells during the ESI at concentrations exceeding the NYSDEC Class GA groundwater standards, bedrock wells were installed at these locations.

The well pair MW25-6/MW5-7D was located north of the pad and upgradient of SEAD-25 in order to obtain background groundwater samples.

Well pairs MW25-11/MW25-12D and MW25-13/MW25-14D were located south of the site and just south of Ordnance Drive to monitor the downgradient extent of the plume. Well pair MW25-15/MW25-16D was located southwest of the pad. This well pair was installed to monitor the downgradient and lateral extent of the plume.

Two wells were located southwest and south of the pad where concentrations of VOCs had been detected during the soil gas survey. Monitoring well MW25-9 was located approximately 40 feet southwest of the pad and monitoring well MW25-10 was located approximately 50 feet south of the pad.

The remaining monitoring wells were located to obtain geographic coverage of the site. MW25-8 was located approximately 80 feet west of the pad. MW25-17 was located approximately 80 feet north of the pad. MW25-17 was located approximately 80 feet north of the pad and MW25-19 was located to the northwest of the pad.

2.3.7.3 Monitoring Well Development

Subsequent to the monitoring well installation, each monitoring well was developed to insure that a proper hydraulic connection existed between the borehole and the surrounding aquifer. The well development details for the ESI and the RI are summarized in Table 2-5 and the details of the procedure are presented in Section 2.2.6.2.

2.3.7.4 Groundwater Sampling

During the ESI, one groundwater sample was collected from each of the three monitoring wells, MW25-1, MW25-2, and MW25-3, following installation and development. The samples were analyzed for the parameters listed in Section 2.2.5.2. The monitoring wells were sampled using the procedure described in Section 2.2.5.2.

During the RI, groundwater from all 19 monitoring wells at SEAD-25 were sampled twice and analyzed for the parameters listed in Section 2.2.5.2. The first round of sampling was completed in November 1995. The second round of groundwater sampling were conducted in March 1996. The second set of samples were analyzed using the same methods as the first round with the one exception. Groundwater from monitoring wells in which no volatile organic compounds were detected in the first round was analyzed using EPA Method 524.2 in the second round. The monitoring wells were sampled using the latest version of the EPA groundwater sampling procedure as described in Section 2.2.5.2 The field sampling data are presented in Table 2-6.

2.3.8 Aquifer Testing

Duing the ESI, groundwater levels were measured at the three monitoring wells MW25-1, MW25-2, and MW25-3, on April 4, 1994.

During the RI, three rounds of water level measurements were performed at all 19 monitoring wells. One round of measurements was taken before well development with this measurement used only for well development calculations. The second round of water levels was performed before the first round of groundwater sampling in November 1995. The final round of measurements were performed before the second round of groundwater sampling in March 1996.

2.3.8.1 Rising Head Slug Tests

Slug tests were performed during the RI field program at the 19 monitoring wells on site to determine hydraulic conductivities. The slug test parameters and related information are shown in Table 2-7. The procedures for slug testing are provided in Section 2.2.7.

Table 2-5

SEAD-25 - Monitoring Well Development Information

SEAD-25 Remedial Investigation
Seneca Army Depot Activity

Well ID	Installation Date	Development Method	Field-Measured Parameters (1)				Gallons of Purge Water Removed	Well Volumes Removed
			Temperature (°C)	Specific Conductivity (umhos)	pH	Turbidity (NTU)		
MW25-1	12/03/93	Teflon Bailer & Pump	4.0	600	7.00	4.4	21.70	10.96
MW25-2	11/07/93	Teflon Bailer & Pump	12.0	700	7.19	1.2	17.20	17.37
MW25-3	11/07/93	Teflon Bailer & Pump	12.2	500	7.42	1.7	14.30	17.88
MW25-4D	10/31/95	Surge Block & Pump	13.8	600	7.16	12.1	52.00	17.33
MW25-5D	10/30/95	Surge Block & Pump	14.8	700	6.96	11.0	24.20	8.64
MW25-6	09/25/95	Surge Block & Pump	15.0	790	7.18	2.9	36.80	28.09
MW25-7D	10/24/95	Surge Block & Pump	10.0	700	7.32	10.6	22.60	5.31
MW25-8	09/26/95	Surge Block & Pump	14.5	350	7.35	7.3	14.70	21.62
MW25-9	09/26/95	Surge Block & Pump	14.0	490	7.18	4.4	15.30	22.50
MW25-10	09/27/95	Surge Block & Pump	14.9	425	7.30	5.5	22.80	6.79
MW25-11	10/11/95	Surge Block & Pump	14.0	920	7.11	25.1	14.60	27.04
MW25-12D	11/01/95	Surge Block & Pump	11.0	400	7.58	13.3	79.60	22.74
MW25-13	10/11/95	Surge Block & Pump	14.0	1000	7.10	9.7	6.70	33.50
MW25-14D	10/31/95	Surge Block & Pump	11.0	390	7.66	16.9	44.00	12.94
MW25-15	10/10/95	Surge Block & Pump	15.0	450	6.93	8.4	8.15	18.95
MW25-16D	10/25/95	Surge Block & Pump	11.9	480	6.98	4.6	49.00	14.85
MW25-17	10/16/95	Surge Block & Pump	13.0	550	7.12	4.2	20.60	22.89
MW25-18	10/16/95	Surge Block & Pump	14.5	1480	7.00	8.6	30.45	42.29
MW25-19	10/07/95	Surge Block & Pump	16.0	550	6.96	5.9	32.50	21.96

1) Measurements taken after well development completed.

Table 2-7

SEAD-25 - Data for Slug Test Hydraulic Conductivity Determinations

SEAD-25 Remedial Investigation
Seneca Army Depot Activity

Well I.D.	Well Type (1)	Depth to Bottom of Aquifer Relative to Top of PVC (2) (ft)	Well Point Relative to Top of PVC (ft) (3)	Screened Interval Relative to Top of PVC (ft)	Screen Length - saturated (ft) (2)	Static Water Level Relative to Top of PVC (ft)	Saturated Thickness of Aqufer Static (ft) (2)	Height of Water Column - Static (ft) (2)	Initial Drawdown Relative to static (ft) (2)	Initial Drawdown Relative to Top of PVC (ft)	Internal Radius of Well Casing (ft) (2)	Effective Radius of Well Boring (ft) (2)	Comments
MW25-1	T/WS	7.78	7.78	5.88-6.88	1.34	5.54	2.24	2.24	0.96	6.50	0.086	0.33	slug test performed-by hand
MW25-2	T/WS	11.20	11.20	6.10-10.10	4.00	3.92	7.28	7.28	1.34	5.26	0.086	0.33	slug test performed-data logger
MW25-3	T/WS	9.80	9.80	7.30-9.30	2.00	3.84	5.96	5.96	2.81	6.65	0.086	0.33	slug test performed-data logger
MW25-4D	CS	422.00	25.40	15.3-24.3	9.00	4.09	419.51	21.31	2.42	6.51	0.086	0.16	slug test performed-data logger
MW25-5D	CS	422.00	23.35	13.25-22.25	9.00	4.78	418.87	18.57	3.60	8.38	0.086	0.16	slug test performed-data logger
MW25-6	T/WS	14.24	14.24	6.14-13.14	7.00	3.95	10.29	10.29	1.24	10.36	0.086	0.33	slug test performed-data logger
MW25-7D	CS	422.00	31.96	21.86-30.86	9.00	3.03	420.73	28.93	4.42	7.45	0.086	0.16	slug test performed-data logger
MW25-8	T/WS	5.46	5.46	4.16-4.96	0.80	1.89	3.57	3.57	1.61	3.50	0.086	0.33	slug test performed-by hand
MW25-9	T/WS	5.45	5.45	4.15-4.95	0.80	1.44	4.01	4.01	1.95	3.39	0.086	0.33	slug test performed-data logger
MW25-10	T/WS	6.44	6.44	4.04-6.04	2.00	3.60	2.84	2.84	1.58	5.18	0.086	0.33	slug test performed-by hand
MW25-11	T/WS	7.22	7.22	5.32-6.82	1.50	2.83	4.39	4.39	1.83	4.66	0.086	0.33	slug test performed-data logger
MW25-12D	CS	422.00	25.25	14.95-24.45	9.50	2.40	420.65	22.85	3.72	6.12	0.086	0.16	slug test performed-data logger
MW25-13	T/WS	5.50	5.50	4.20-5.00	0.80	2.88	2.62	2.62	1.95	4.80	0.086	0.33	slug test performed-by hand
MW25-14D	CS	422.00	24.92	14.82-23.82	9.00	2.39	421.33	22.53	3.83	6.22	0.086	0.16	slug test performed-data logger
MW25-15	T/WS	7.24	7.24	5.34-6.84	1.50	2.60	4.64	4.64	1.80	4.40	0.086	0.33	slug test performed-data logger
MW25-16D	CS	422.00	26.18	16.08-25.08	9.00	4.31	418.87	21.87	3.59	7.90	0.086	0.16	slug test performed-data logger
MW25-17	T/WS	11.32	11.32	6.02-10.52	4.50	3.21	8.11	8.11	1.66	4.87	0.086	0.33	slug test performed-data logger
MW25-18	T/WS	11.30	11.30	6.00-10.50	4.50	5.20	6.10	6.10	2.26	7.55	0.086	0.33	slug test performed-by hand
MW25-19	T/WS	12.04	12.04	7.09-11.59	4.50	3.70	8.34	8.34	1.71	5.41	0.086	0.33	slug test performed-data logger

Notes:
(1) T/WS = Till Weathered Shale Aqufier
CS Competent Shale Aquifer
(2) Input data to determine hydraulic conductivity with the AQTESOLV program.
(3) Well point depths may vary from those measured during well construction because sediments in the bottom of the well are removed during well development

2.3.8.2 Vertical Connection Tests

To assess the vertical connection between the shallow till/weathered shale aquifer and the deep competent shale aquifer, vertical connection tests were performed at the six well pairs. The procedure for the vertical connection test is described in Section 2.2.7.3.

2.3.9 Surface Water and Sediment Investigation

The objectives of the surface water and sediment investigation at SEAD-25 were to determine the nature and extent of contamination in the drainage ditches in the immediate vicinity of the site, to establish the potential for impacts to off-site surface water and sediment, and to obtain a background surface water and sediment sample to allow comparison to SEAD-25 data. The results from the surface water and sediment sampling program were also used to determine the potential exposure levels for the risk assessment. The sample program for surface water and sediment is summarized in Tables 2-8 and 2-9, respectively. Sample locations are shown in Figure 2-6. The sampling procedures are described in Section 2.2.8.

During the RI, ten surface water and sediment samples were collected in the drainage ditches on the east, south, and west sides of the site. The sampling was completed during November 1995.

Two surface water/sediment samples, SW/SD25-1 and SW/SD25-2, were collected in the drainage ditch east of the site and adjacent to Administration Avenue. Two samples, SW/SD25-3 and SW/SD25-4, were collected in the drainage ditch south of the site and adjacent to Ordnance Drive. Two samples, SW/SD25-5 and SW/SD25-10 were collected at downstream locations in the same drainage ditch. Four samples, SW/SD25-6, SW/SD25-7, SW/SD25-8, and SW/SD25-9, were collected in the western drainage ditch. This ditch comprises the upper reaches of Kendaia Creek.

These locations were chosen to determine the surface water and sediment quality at background locations and at locations adjacent to and downstream of the site. Surface water and sediment sampling occurred during or immediately after a rainstorm when there was water in the drainage channels and streams. This information was used to delineate the extent of contamination on site and identify areas where contaminants have migrated off-site.

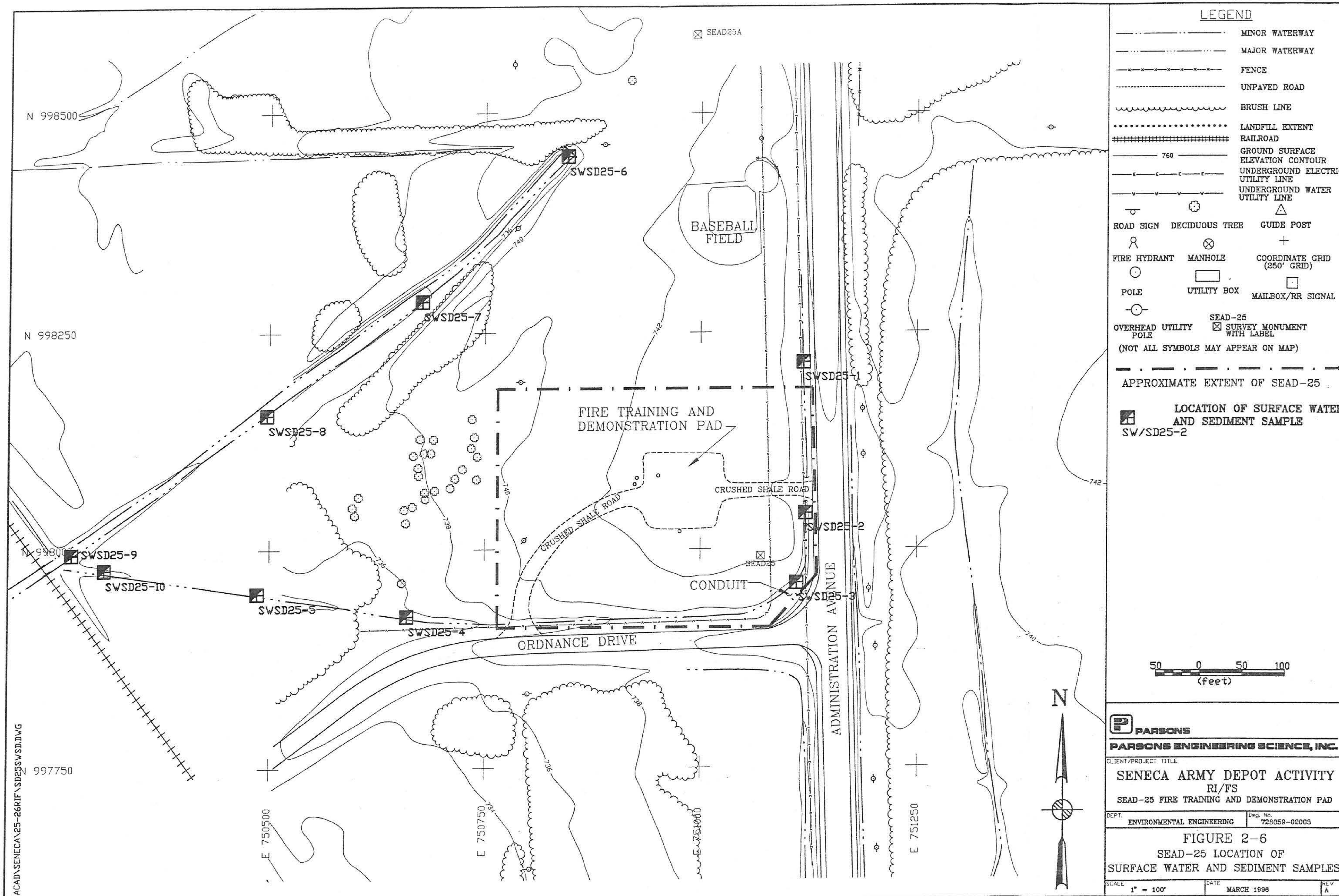


FIGURE 2-6
SEAD-25 LOCATION OF SURFACE WATER AND SEDIMENT SAMPLES

Table 2-8

SEAD-25 - Surface Water Sampling Summary

SEAD-25 Remedial Investigation
Seneca Army Depot Activity

Surface Water Sampling Location	Surface Water Sample ID	Date Sampled	Sample Depth (in)	Field-Measured Parameters				Field Comments
				Temperature (°C)	pH	Specific Conductivity (umhos)	Dissolved Oxygen (mg/L)	
SW25-1	SW25-1	10/06/95	0 to 2	23.0	8.05	650	5.4	Clear standing water.
SW25-2	SW25-2	10/06/95	0 to 2	19.5	7.52	450	5.5	Clear standing water.
SW25-3	SW25-3	10/22/95	0 to 2	6.0	7.51	280	10.8	Clear water.
SW25-4	SW25-4	10/06/95	0 to 2	18.0	7.33	550	8.1	Clear standing water.
SW25-5	SW25-5	10/06/95	0 to 2	16.5	7.22	525	7.8	Clear, slowly flowing water.
SW25-6	SW25-6	10/09/95	0 to 2	17.0	6.97	1380	7.2	Clear water.
SW25-6	SW25-15 (1)	10/09/95	0 to 2	17.0	6.97	1380	7.2	Clear water.
SW25-7	SW25-7	10/08/95	0 to 2	16.0	7.51	1300	7.0	Clear water flowing in a grassy wetland.
SW25-8	SW25-8	10/08/95	0 to 2	17.0	7.34	1225	7.0	Clear water flowing in a cattail wetland.
SW25-9	SW25-9	10/08/95	0 to 2	15.5	7.26	1220	8.9	Clear water.
SW25-10	SW25-10	10/06/95	0 to 2	16.5	6.95	525	8.5	Clear, slowly flowing water in a ditch.

Notes
(1) SW25-15 was taken as a field duplicate of SW25-6.

Table 2-9

SEAD-25 - Sediment Sampling Summary

SEAD-25 Remedial Investigation
Seneca Army Depot Activity

Sediment Sampling Location	Sediment Sample ID	Date Sampled	Sample Depth (in)	Field Description
SD25-1	SD25-1	10/06/95	0 to 3	Brown SILT, some Clay and fine angular Shale fragments.
SD25-2	SD25-2	10/06/95	0 to 2	Lt. brn. CLAY, SILT and SAND, v.f. to f. angular shale fragments.
SD25-3	SD25-3	10/22/95	0 to 2	Brn. SILT, some + f. Sand, little m. angular Shale fragments, tr. Clay.
SD25-3	SD25-30 (1)	10/22/95	0 to 2	Brn. SILT, some + f. Sand, little m. angular Shale fragments, tr. Clay.
SD25-4	SD25-4	10/06/95	0 to 3	Lt. brown CLAY, some + Silt and Roots, trace f.to c. Shale fragments.
SD25-5	SD25-5	10/06/95	0 to 3	Lt. brn. CLAY, some Silt and Roots, tr. v.f. angular Shale fragments.
SD25-6	SD25-6	10/09/95	0 to 2	Dark brown to black m.to c. SAND, little + dk. brown Silt, slight odor.
SD25-6	SD25-15 (2)	10/09/95	0 to 2	Dark brn. to blk. m.to c. SAND, little + dk.brn. Silt, slight odor.
SD25-7	SD25-7	10/08/95	0 to 3	Brn. to blk. ORG. MATTER and SILT, some Roots, little - Clay, odor.
SD25-8	SD25-8	10/08/95	0 to 3	Dk. brn. ORG. MATTER and SILT, some + Roots, little - Clay, odor.
SD25-9	SD25-9	10/08/95	0 to 3	Dk. brown ORG. MATTER, some + Roots, little - Clay, slight odor.
SD25-10	SD25-10	10/06/95	0 to 2	Lt. yellow-orange CLAY and f. to c. angular SHALE, some Silt.

Notes:
(1) SD25-30 was taken as a field duplicate of SD25-3.
(2) SD25-15 was taken as a field duplicate of SD25-6.

Using the method, a rectangular area encompassing the site was established and a random point within this area was located using equations that are based on the size of the area to be sampled and random numbers. The random numbers in this instance, were generated on a hand calculator. This location was the random starting point for the grid.

Using the equations specified in the method, a distance of 103 feet between sampling points was determined and 30 was the specified number of sampling points for the grid. The distance between grid lines was determined to be 89 feet. After laying out the individual sampling points in the area to be sampled, the resulting grid contained 39 points. The location of the sampling points is shown in Figure 2-11.

Surface soil samples (0 to 2 inches below the organic matter) were collected at all 39 sample locations (SS26-9 to SS26-47) as presented in Table 2-11. Procedures for the collection of surface soil samples are provided in Section 2.2.5.3.

2.4.6 Groundwater Investigation

2.4.6.1 Introduction

The purpose of the groundwater monitoring program at SEAD-26 was to define the horizontal and vertical extent of impacted groundwater, determine the directions of groundwater flow at the site, determine the hydrogeologic properties of the aquifer to assess contaminant migration and potential remedial actions, and determine the background groundwater quality.

During the ESI, four monitoring wells were installed and the direction of groundwater flow was assumed to be to the west.

The results of the ESI groundwater investigation indicated that the groundwater has not been significantly impacted by the site; however, the array of wells installed during the ESI did not provide for complete coverage of the areas of concern at the site. Additional monitoring wells were needed around the fire training pit and the drum and tank storage area to ensure that groundwater has not been impacted by contaminants that may have migrated from these areas. As a result, a total of seven new monitoring wells were installed for the RI. All seven of these monitoring wells were screened in the till/weathered shale aquifer. In addition, physical characteristics of the till/weathered shale aquifer and the general groundwater flow conditions were investigated through measurements of depth to water and slug tests. The location of all monitoring wells is shown in Figure 2-10. Monitoring well construction details for all wells at SEAD-26 are presented in

Table 2-12 and monitoring well completion diagrams are included in Appendix D.

2.4.6.2 Monitoring Well Installation

During the ESI, four monitoring wells were installed at SEAD-26, one upgradient (MW26-1) for background water quality data and three downgradient of the site to determine the groundwater flow direction and determine if hazardous constituents have migrated from the site. The presumed direction of groundwater flow at this site was to the southwest. The geophysical survey indicated that the direction was more to the west. Adjustments to the location of monitoring wells were based upon the seismic survey to assure wells were placed in upgradient and downgradient locations.

Monitoring well MW26-2 was located on the north end of the site downgradient of the fire training building. Monitoring well MW26-3 was located downgradient of the pit while monitoring well MW26-4 was located at the south end of the site downgradient of the drum storage area.

One monitoring well was constructed at each location and was screened over the entire thickness of the aquifer above competent bedrock.

During the RI, a total of seven overburden monitoring wells were installed. The wells were located in the three areas of interest, i.e., Fire Training Pit, the drum storage area, and the area near the training tower and storage trailer. At the Fire Training Pit, three wells were installed; one each on the northwestern (MW26-5), eastern (MW26-6), and southeastern (MW26-7) sides of the pit. At the drum and tank storage area, three monitoring wells were installed; one each on the northern (MW26-8), eastern (MW26-9) and southern (MW26-10) portions of the area. One well, MW26-11, was installed near the training tower and storage trailer. Each well was screened over the entire depth of the overburden aquifer with a maximum screen length of 9 feet.

2.4.6.3 Monitoring Well Development

Subsequent to well installation, each monitoring well was developed to insure that a proper hydraulic connection existed between the borehole and the surrounding aquifer. The well development details for the ESI and the RI are summarized in Table 2-13 and the details of the procedure are presented in Section 2.2.6.2.

Table 2-12

SEAD-26 - Monitoring Well Construction Details

SEAD-26 Remedial Investigation
Seneca Army Depot Activity

Well ID	Well Type (1)	Depth of Well Relative to Ground Surface (ft)	Depth of Well Relative to Top of PVC (ft)	Diameter of Boring (in)	Diameter of Well (in)	Well Screen Length (ft)	Screened Interval Relative to Ground Surface (ft)		
MW26-1	T/WS	6.00	8.56	8	2	2	3.30	to	5.30
MW26-2	T/WS	14.00	16.80	8	2	9	3.90	to	12.90
MW26-3	T/WS	14.00	16.58	8	2	9	4.30	to	13.30
MW26-4	T/WS	11.50	14.03	8	2	4	6.40	to	10.40
MW26-5	T/WS	15.00	17.06	8	2	8.95	4.90	to	13.85
MW26-6	T/WS	15.00	17.00	8	2	9	4.90	to	13.90
MW26-7	T/WS	18.00	20.31	8	2	8.95	7.90	to	16.85
MW26-8	T/WS	11.50	13.37	8	2	4	6.30	to	10.30
MW26-9	T/WS	12.20	14.27	8	2	4	7.05	to	11.05
MW26-10	T/WS	12.00	13.80	8	2	6.9	4.30	to	11.20
MW26-11	T/WS	15.00	16.38	8	2	9.5	4.70	to	14.20

Notes:
(1) T/WS = Till Weathered Shale Aqufier

Table 2-12

SEAD-26 - Monitoring Well Construction Details

SEAD-26 Remedial Investigation
Seneca Army Depot Activity

Well ID	Well Screen Slot Size (in)	Thickness of Bentonite Seal (ft)	Height of PVC Well Stickup (ft)	Elevation of Top of PVC Well (MSL)	Well Casing Material	Well Screen Material
MW26-1	0.01	0.80	2.56	748.65	PVC	PVC
MW26-2	0.01	1.00	2.80	751.01	PVC	PVC
MW26-3	0.01	1.00	2.58	748.94	PVC	PVC
MW26-4	0.01	1.50	2.53	747.58	PVC	PVC
MW26-5	0.01	1.30	2.06	752.56	PVC	PVC
MW26-6	0.01	1.30	2.00	752.67	PVC	PVC
MW26-7	0.01	1.80	2.31	752.06	PVC	PVC
MW26-8	0.01	1.70	1.87	748.66	PVC	PVC
MW26-9	0.01	2.00	2.07	748.81	PVC	PVC
MW26-10	0.01	1.20	1.80	749.66	PVC	PVC
MW26-11	0.01	1.80	1.38	753.56	PVC	PVC

2.4.6.4 Groundwater Sampling

During the ESI, one groundwater sample was collected from each of the four monitoring wells following installation and development and analyzed for the parameters listed in Section 2.2.5.2. The monitoring wells were sampled using the procedure described in Section 2.2.5.2.

During the RI, groundwater samples from all 11 monitoring wells on site will be sampled twice and analyzed for the parameters listed in Section 2.2.5.2. The first round of groundwater sampling was completed in November 1995. The second round of sampling will be conducted in the spring 1996. The wells will be sampled using the latest version of the EPA groundwater sampling procedure, which is described in Section 2.2.5.2, and analyzed for the parameters listed in Section 2.2.5.2. The field sampling data are presented in Table 2-14.

2.4.7 Aquifer Testing

Slug tests were performed during the RI at the 11 monitoring wells to determine hydraulic conductivities. Of the 11 wells, eight had sufficient amounts of water to perform a slug test.

During the ESI, groundwater levels were measured at the four monitoring wells.

During the RI, three rounds of water level measurements will be performed at all 11 monitoring wells. One round of measurements was conducted before well development with this measurement used only for well development calculations. The second round of water level measurements was performed before the first round of grondwater sampling in November 1995. The final round of measurements will be performed before the second round of groundwater sampling which is scheduled for late March to early April of 1996.

2.4.7.1 Rising Head Slug Tests

Slug tests were performed during the RI at 8 of the 11 monitoring wells to determine hydraulic conductivities. Three monitoring wells had insufficient amounts of water to perform the test. The slug test parameters and related information are shown in Table 2-15. The procedures for slug testing are provided in Section 2.2.7.

2.4.8 Surface Water and Sediment Investigation

Table 2-13

SEAD-26 - Monitoring Well Development Information

SEAD-26 Remedial Investigation
Seneca Army Depot Activity

Well ID	Installation Date	Development Method	Field-Measured Parameters (2)				Gallons of Purge Water Removed	Well Volumes Removed
			Temperature (°C)	Specific Conductivity (umhos)	pH	Turbidity (NTU)		
MW26-1	11/17/93	Teflon Bailer & Pump	10.5	550	7.62	5.2	6.55	10.92
MW26-2	11/18/93	Teflon Bailer & Pump	NA (1)	NA (1)	NA (1)	NA (1)	0.20	1.35
MW26-3	11/18/93	Teflon Bailer & Pump	11.0	700	6.64	5.3	15.00	18.29
MW26-4	11/19/93	Teflon Bailer & Pump	12.0	850	7.07	6.1	14.00	25.00
MW26-5	09/24/95	Surge Block & Pump	15.5	925	6.55	8.5	16.45	22.53
MW26-6	09/23/95	Surge Block & Pump	16.5	490	6.55	3.4	14.90	21.26
MW26-7	09/23/95	Surge Block & Pump	15.0	750	6.60	13.3	32.90	23.50
MW26-8	09/21/95	Surge Block & Pump	15.0	700	6.71	17.1	11.30	23.54
MW26-9	09/25/95	Surge Block & Pump	13.8	625	6.90	8.4	11.00	18.64
MW26-10	09/20/95	Surge Block & Pump	15.6	1250	7.25	3.4	33.60	36.13
MW26-11	10/19/95	Surge Block & Pump	16.1	780	7.20	8.3	17.60	26.27

Notes:
1) Not Available. There was an insufficient amount of standing water to develop the well.
2) Measurements taken after well development completed.

Table 2-14

SEAD-26 - Monitoring Well Field Sampling Information

SEAD-26 Remedial Investigation
Seneca Army Depot Activity

Well ID	Sample ID	Date Sampled	Field-Measured Parameters						Gallons of Purge Water Removed	Standing Water Volume (gal)	Well Volumes Removed
			Temperature (°C)	Specific Conductivity (umhos)	pH	Eh (millivolts)	Dissolved Oxygen (mg/L)	Turbidity (NTU)			
MW26-1	MW26-1	01/21/94	1	400	7.6	NA	NA	4.76	0.24	0.16	1.5
MW26-1	MW26-1	11/13 to11/15/95	14.52	789	7.15	372	4.87	5.51	1.00	0.33	3.03
MW26-2	MW26-2	dry									
MW26-2	NA (1)	NA (1)	NA (1)	NA (1)	NA (1)	NA (1)	NA (1)	NA (1)	0.00	0.026	0.00
MW26-3	MW26-3	01/22/94	8.25	650	6.80	NA	NA	325.00	1.60	0.550	2.91
MW26-3	MW26-3	11/16 to11/17/95	14.55	1142	6.49	363	0.19	14.10	12.50	0.68	18.38
MW26-4	MW26-4	01/22/94	7.5	775	7.00	NA	NA	5000.00	0.78	0.26	3.00
MW26-4	MW26-4	11/08/95	12.68	1218	6.74	367	0.84	0.27	3.00	0.42	7.14
MW26-5	MW26-5	11/05/95	14.2	1345	6.63	364	0.25	1.39	2.20	0.67	3.28
MW26-6	MW26-6	11/05/95	14.18	692	6.66	323	0.13	0.37	3.20	0.36	8.89
MW26-7	MW26-7	11/14/95	17.94	759	6.50	57	0.11	14.20	6.00	1.00	6.00
MW26-7	MW26-70 (2)	11/14/95	17.94	759	6.50	57	0.11	14.20	6.00	1.00	6.00
MW26-8	MW26-8	11/06/95	13.49	976	6.87	337	1.08	1.54	1.00	0.50	2.00
MW26-9	MW26-9	11/13/95	13.15	798	6.77	291	1.72	138.00	3.10	0.64	4.84
MW26-10	MW26-10	11/16/95	11.07	1600	6.54	322	1.23	7.65	3.50	0.82	4.27
MW26-11	MW26-11	11/16/95	9.31	952	6.57	210	0.66	3.95	2.75	0.32	8.59

Notes:
(1) Not Availible. There was an insufficient amount of standing water to sample.
(2) MW26-70 was taken as a field duplicate of MW26-7.
(3)Measurements taken after well development completed.

Table 2-15

SEAD-26 - Data for Slug Test Hydraulic Conductivity Determinations

SEAD-26 Remedial Investigation
Seneca Army Depot Activity

Well I.D.	Well Type (1)	Dept to Bottom of Aquifer Relative to Top of PVC (2) (ft)	Well Point Relative to Top of PVC (ft) (3)	Screened Interval Relative to Top of PVC (ft)	Screen Length - saturated (ft) (2)	Static Water Level Relative to Top of PVC (ft)	Saturated Thickness of Aqufer Static (ft) (2)	Height of Water Column - Static (ft) (2)	Initial Drawdown Relative to Static (ft) (2)	Initial Drawdown Relative to Top of PVC (ft)	Internal Radius of Well Casing (ft) (2)	Effective Radius of Well Boring (ft) (2)	Comments
MW26-1	T/WS	8.24	8.24	5.54-7.54	1.59	5.95	2.29	2.29	NA	NA	0.086	0.33	insuficient water for test
MW26-2	T/WS	16.60	16.60	6.50-15.50	0.00	15.66	0.94	0.94	NA	NA	0.086	0.33	insuficient water for test
MW26-3	T/WS	16.34	16.34	6.64-15.64	3.79	11.85	4.49	4.49	1.77	13.62	0.086	0.33	slug test performed-data logger
MW26-4	T/WS	13.80	13.80	8.70-12.70	1.84	10.86	2.94	2.94	1.14	12.00	0.086	0.33	slug test performed-by hand
MW26-5	T/WS	17.14	17.14	7.04-16.04	4.03	12.01	5.13	5.13	1.74	13.75	0.086	0.33	slug test performed-data logger
MW26-6	T/WS	17.00	17.00	6.90-15.90	3.39	12.51	4.49	4.49	2.20	14.71	0.086	0.33	slug test performed-data logger
MW26-7	T/WS	20.04	20.04	9.97-18.82	5.47	13.35	6.69	6.69	3.37	16.72	0.086	0.33	slug test performed-data logger
MW26-8	T/WS	13.40	13.40	8.20-12.20	2.37	9.83	3.57	3.57	1.31	11.14	0.086	0.33	slug test performed-by hand
MW26-9	T/WS	14.24	14.24	9.09-13.09	3.14	9.95	4.29	4.29	1.76	11.71	0.086	0.33	slug test performed-data logger
MW26-10	T/WS	13.88	13.88	6.08-13.08	4.45	8.63	5.25	5.25	1.95	10.58	0.086	0.33	slug test performed-data logger
MW26-11	T/WS	16.45	16.45	6.15-15.65	1.97	13.68	2.77	2.77	NA	NA	0.086	0.33	insuficient water for test

Notes:
1) T/WS = Till Weathered Shale Aquifer
2) Data used in hydraulic conductivity calculation using AQTESOLV
(3) Well point depths may vary from those measureed during well construction because sediments in the bottom of the well are removed during well development.

2.4.8.1 Introduction

The objectives of the surface water and sediment sampling program at SEAD-26 were to determine the nature and extent of impacts to on-site and off-site surface water and sediment, to sample surface water and sediment from the swale areas that surround the elevated Fire Training Pit and from within the Fire Training Pit, and to determine the background surface water and sediment quality. The results from the surface water and sediment sampling program will also be used to determine potential exposure levels for the risk assessment. The sampling program for surface water and sediment is summarized in Tables 2-16 and 2-17, respectively. Sample locations are shown in Figure 2-12. Sampling procedures are described in Section 2.2.8.

2.4.8.2 Chemical Sampling of Surface Water and Sediment

During the ESI, two samples were obtained from the fire training pit. One sample of the stagnant water (SW26-1), and one of the sediment at the bottom of the pit (SD26-1) were collected. These samples were analyzed for the parameters listed in Section 2.2.8. No oil sample was obtained as outlined in the workplan because no oil was present on the water in the pit at the time of sampling.

During the RI, a total of ten surface water and sediment samples were collected on or near the site. Surface water and sediment samples were collected from the same locations. Eight samples (SW/SD26-2 to SW/SD26-9) were collected from drainage ditches around the base of the site. One sample (SW/SD26-10) was collected from the center of the Fire Training Pit. One background sample (SW/SD26-11) was obtained from a drainage channel located 300 ft. east of SEAD-26. This background location was selected because it was near the site, but not affected by it. The drainage channels that surround the site originate at the base of the slope and therefore, there is no section of the drainage channel that is upstream of SEAD-26. Surface water and sediment samples SW/SD26-100 were duplicate samples of SW/SD26-10, respectively.

Surface water and sediment sampling occurred during or immediately after a rainstorm when there was water in the drainage channels. This information was used to delineate the extent of contamination on-site and identify whether contaminants have migrated off-site.

2.4.9 <u>Ecological Investigation</u>

The overall objectives of the ecological investigation were to characterize the existing aquatic and terrestrial biotic environment on and near SEAD-26, to delineate any wetlands in and around

3.0 DETAILED SITE DESCRIPTION

3.1 SEAD-25

3.1.1 Site Features

The Fire Training and Demonstration Pad is located in the east-central portion of SEDA. It encompasses approximately 6-acres and is composed mostly of undeveloped land with a centrally located crushed shale pad. The site is bounded on the north by a grassy field that is part of a former baseball field, on the east by Administration Drive beyond which is a large stand of deciduous trees, on the south by Ordnance Drive beyond which is a stand of coniferous trees, and on the west by tall grass and low brush. These features are presented in Figure 1-3. Administration Drive is a heavily traveled road at SEDA because it provides access to many areas in the southern portion of SEDA, and it is also the main thoroughfare for shipping and receiving. The areas surrounding the site are mostly developed. The administration buildings and maintenance areas for SEDA are located approximately 1,000 feet north and northeast of the site. An elongated stretch of utility and storage buildings are located approximately 1,200 feet south-southwest of the site.

Utilities on the site include a buried water main, a buried electrical line and overhead utilities for phone and electricity. A 6-inch diameter underground water main is located approximately 50 feet west of Administration Avenue. This water line bends west at the intersection with Ordnance Drive where it parallels the drive until it exits the western portion of the site. An underground electric line is located approximately 10 feet west of Administration Avenue. This line parallels Administration Avenue and continues south through the intersection with Ordnance Drive. Along the western edge of the site a series of utility poles carry electric and phone lines south across Ordnance Drive where they become underground lines. Overhead utility lines also exist on the east side of Administration Avenue.

Vehicle access to the Fire Training and Demonstration Pad is provided via a crushed shale road that intersects both Administration Avenue and Ordnance Drive. The crushed shale road is the only vehicle access to the site. On a larger scale, access to SEDA is controlled by fencing and security patrols around the entire depot.

3.1.2 Topography

The Fire Training and Demonstration Pad is located on a relatively flat part of the facility in the eastern portion of SEDA. The slightly elevated pad on the site, which is roughly defined by a portion of the 742 foot contour, is superimposed on a generally west-southwest-sloping regional land surface west of Administration Drive. However, east of Administration Drive the land surface slopes gently to the east to a small north-south trending intermittent drainage area, which is beneath a canopy of deciduous trees. Elevations on the site range from greater than 742 feet above mean sea level (msl) on the pad to 734 feet above msl beyond the stand of coniferous trees south and southwest of the site.

3.1.3 Surface Water

In the immediate vicinity of the pad, surface water runoff via overland flow is primarily collected in drainage ditches along Administration Avenue and Ordnance Drive, both of which eventually drain west. The presumed directions of surface water runoff at the site are shown in Figure 3-1. Most of the overland flow in the areas northwest of the pad is collected in a well-defined drainage ditch that drains to the southwest into what eventually becomes Kendaia Creek. South of the site, surface water is collected in roadside drainage ditches that parallel Ordnance Drive and Administration Avenue. East of Administration Avenue surface water collects in a well-defined, north-south-trending drainage ditch that discharges to the south. No wetland areas were identified on the site. The drainage ditches on and in the vicinity of the site are several of the many drainage ditches that comprise the upper drainage area of Kendaia Creek.

Precipitation data from the Aurora Research Farm monitoring station, were reviewed to gain a perspective on the seasonal variations in precipitation that would directly impact surface water flow. These data indicate that, historically, June has the greatest amount of precipitation at 3.7 inches, and the winter months of January and February generally have had the least amount of precipitation. These data are summarized in Table 1-3.

3.1.4 Site Geology

3.1.4.1 Introduction

The site geology is characterized by gray Devonian shale with a thin weathered zone where it contacts the overlying mantle of Pleistocene till. This stratigraphy is consistent over the entire site.

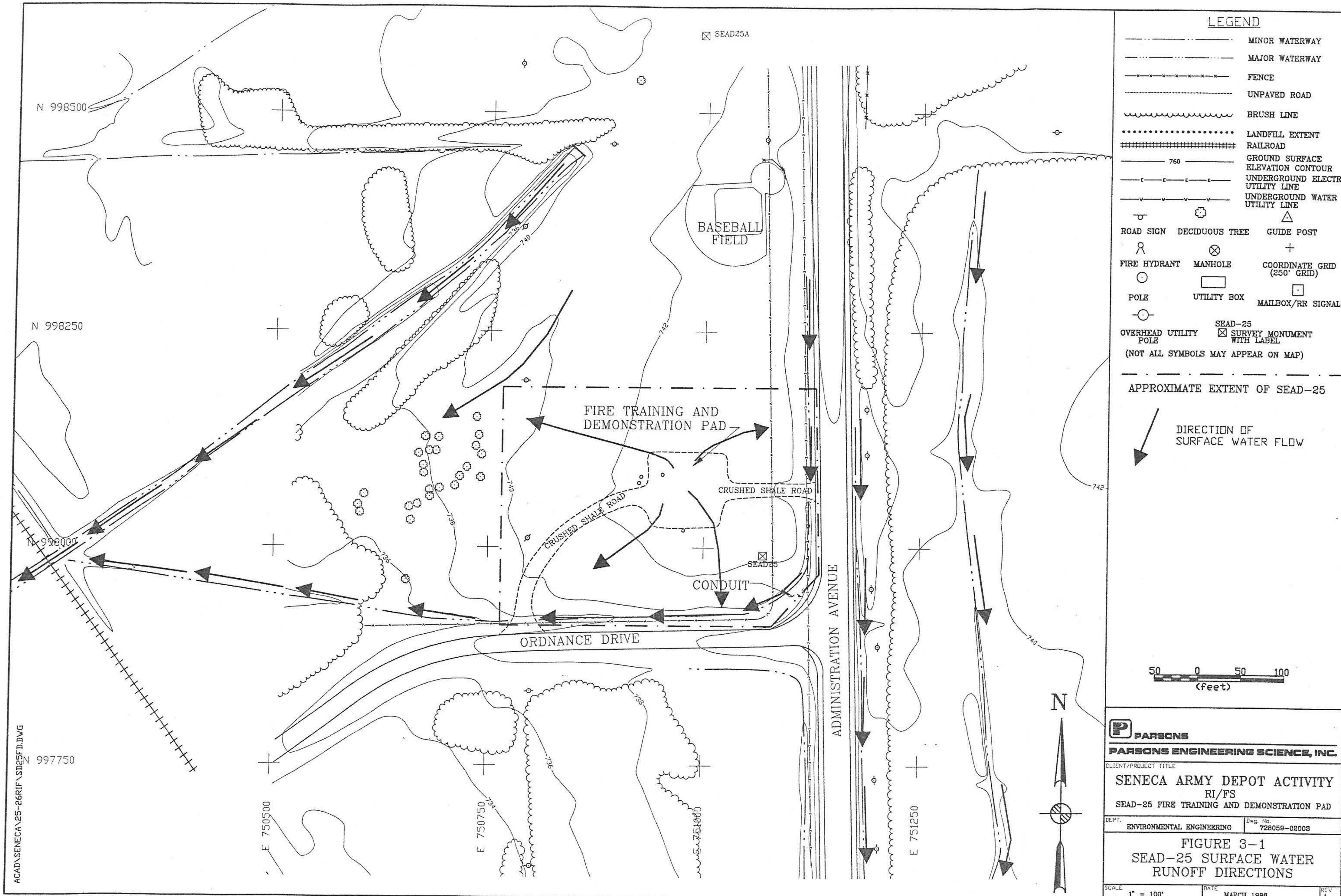


FIGURE 3-1
SEAD-25 SURFACE WATER RUNOFF DIRECTIONS

Artificial fill consisting of crushed shale occurs above the till at the location of the Fire Training and Demonstration Pad.

3.1.4.2 Till

The predominant surficial geologic unit present at the site is dense till. The till is distributed across the entire site and ranges in thickness from 2.5 feet to as much as 10 feet, although the average thickness of the till on-site, based upon refusal data collected during the ESI and RI, is 4.7 feet. The thickest section of glacial till was encountered at monitoring well MW25-6, which is approximately 170 feet north of the pad, while the thinnest section of till was found at SB25-15, which is 100 feet southwest of the pad. The till is generally characterized by brown to olive gray silt and clay, trace of fine sand with few fine to coarse gravel-sized inclusions of weathered shale. Generally, larger diameter weathered shale clasts are more prevalent in basal portions of the till and are probably ripped-up clasts removed by the once-active glacier. The general Unified Soil Classification System description of the till on-site is as follows: Clay-silt, brown to olive gray, slightly plastic, small percentage of fine to medium sand, small percentage of fine to coarse gravel-sized gray shale clasts, dense and mostly dry in place, till, (ML).

Darian silt-loam soils, 0 to 18 inches thick, are developed in till derived mainly from local alkaline and calcareous, dark-gray and black silty shale and a small quantity of limestone (Hutton, 1972). These surficial soils are somewhat poorly drained and have a silt clay loam and clay subsoil. These are nearly level to gently sloping soils on uplands in the central part of Seneca County. In general, 0-3 percent slopes are associated with these soils (Hutton, 1972).

Grain size analyses were performed on six till samples collected from varying depths at SEAD-25 (Appendix). For the three samples collected from the 0-2 foot depth, which are representative of the Darian soil loam that has developed in the upper portion of the till, from 69 to 79 percent of the samples contained silt-and clay-sized particles. Two samples from 2 to 4 feet contain 47 and 49 percent silt and clay, and these samples are likely to represent the till that has been relatively unaffected by soil development processes, which is known to extend down to approximately 18 inches at SEDA (Hutton, 1972). The deepest sample collected at the site was from 6-8 feet and it contained only 28 percent silt and clay. However, this sample is believed to represent the basal portion of the till that contains a larger percentage of shale rip-up clasts than upper portions of the till. This sample was collected from immediately above the contact with the weathered shale. Thus, grain size results from varying depths in the till at SEAD-25 indicate that the till generally becomes coarser with depth. This phenomenon is likely the result of soil development processes near the ground surface, which tend to physically and chemically break down the parent soil material (i.e., till), and the incorporation of relatively large shale clasts into basal portions of the till by the once-active glacier.

Grain size analysis curves for till samples collected during the installation of monitoring wells on another portion of SEDA show a wide distribution of sediment sizes (Metcalf & Eddy, 1989). Based on all of the available grain size analyses at SEDA, the till generally has a high percentage of silt and clay with lesser amounts of sand and fine gravel-sized particles. The porosities of five gray-brown silty clay (i.e., till) samples ranged from 34.0 percent to 44.2 percent with an average of 37.3 percent (USAEHA, 1985).

The minimum, maximum and average background concentrations of selected inorganic constituents in the till located on SEDA have been extensively characterized. These data are discussed in Section 1 and presented in Table 1-2.

3.1.4.3 Weathered Shale

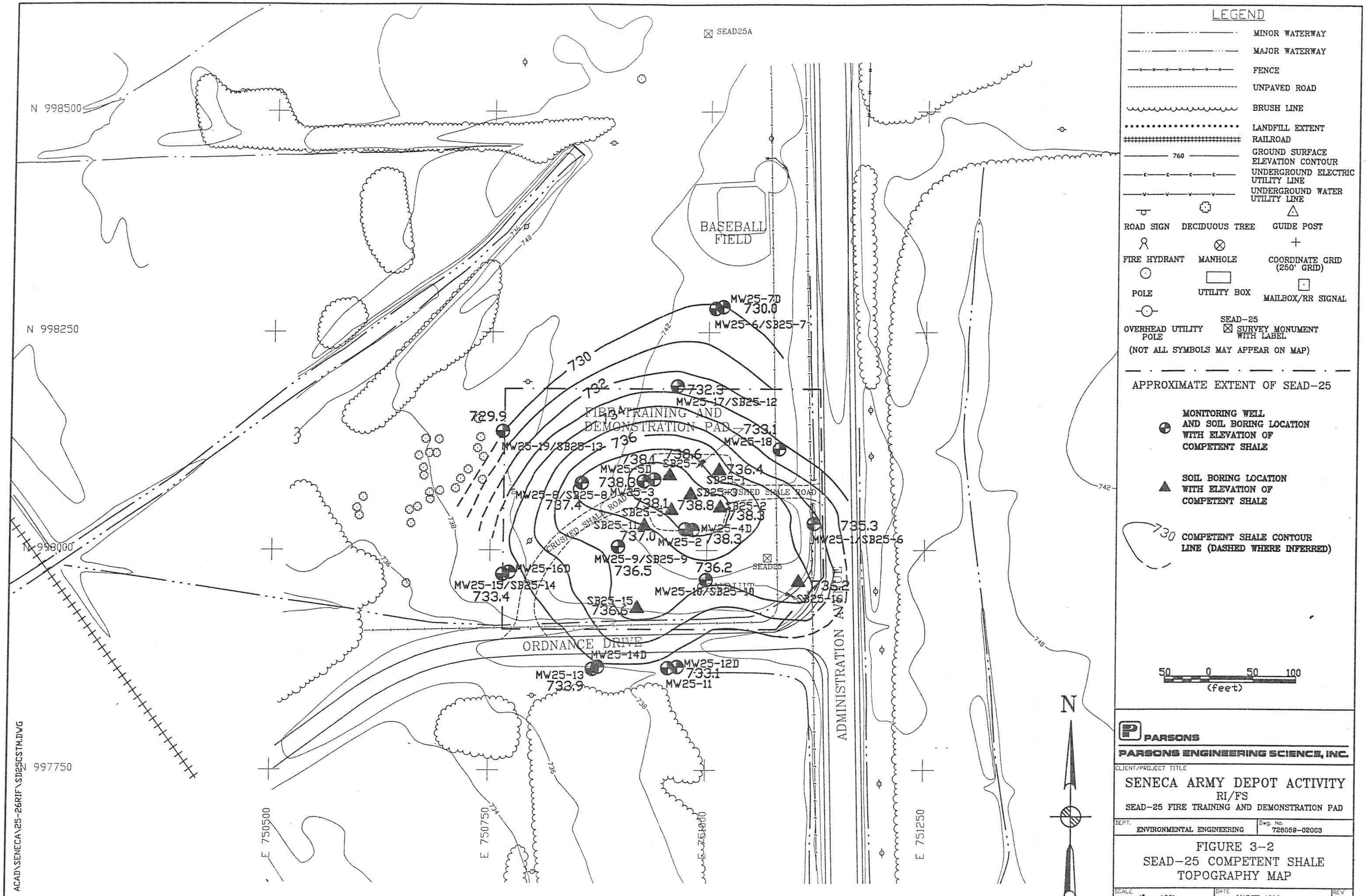
A zone of gray weathered shale of variable thickness was encountered below the till at all of the locations drilled on-site. This zone is characterized by fissile shale with a large amount of brown interstitial silt and clay. The upper boundary of the weathered shale was recorded in split spoon samples and the base of the weathered shale was, for the purposes of this investigation, defined as the depth of refusal with the hollow stem augers or where augering became abruptly difficult and slow. The thickness of the weathered shale ranges between 0.4 feet to 2.4 feet on the site. The average thickness on the site is 1.2 feet. Differential weathering through geologic time is likely responsible for the variable thickness. No outcrops of weathered or competent shale are exposed at SEAD-25.

3.1.4.4 Competent Shale

The bedrock underlying the site is composed of the Moscow Formation of the Devonian age Hamilton Group; specifically, the site lies in the lower one-quarter of the Moscow Formation. The lower two thirds of the Moscow shale is a soft gray calcareous shale containing an abundance of fossils (Mozola, 1951). The upper or younger part of the Moscow shale is dark, highly friable, and less calcareous than the lower two-thirds. Weathered surfaces are generally medium to light gray and may be stained with iron oxide. Many of the joint openings in the shale strike in two predominant joint directions, N 65^{o} E and N 25-30^{o} W (Mozola, 195). These joints are primarily vertical. Merrin (1992) cites three prominent vertical joint directions of northeast, north-northwest, and east-northeast in outcrops of the Genesse Formation 15 miles southeast of SEAD-25 near Ithaca, New York. The Hamilton Group is a gray-black, calcareous shale that is fissile and exhibits parting (or separation) along bedding planes.

Gray competent shale was encountered between 3.5 feet and 12.2 feet below the land surface in the borings performed on the site. A bedrock topographic map was developed based upon hollow stem auger refusal depths from these soil borings and upon visual observations made by the drilling supervisors. In all instances, auger refusal was considered to be the top of the competent shale. The bedrock topographic map is presented in Figure 3-2. These data show that the surface of the shale is mounded below the pad. The bedrock topography is at a maximum elevation (over 738 feet) below the central and southwestern portions of the pad and it slopes down radially away from the pad. Bedrock topographic gradients are steepest on the northern side of the pad, but the data indicate that the surface of the competent shale flattens out and the gradient is less steep further away from the pad. South of the pad the gradient is generally less steep than on the northern side. Figure 3-2 indicates that there are two small plateaus defined by the 736 foot contour. The regional slope of the surface of the competent shale based on data from other sites at SEDA and on a general knowledge of the site stratigraphy is believed to be to the west-southwest, mimicking the land surface topography. However, the available site data does not extend significantly beyond the local topographic high below the pad to show this.

The characteristics of the competent shale were observed in a total of 89.5 feet of core collected during the installation of the bedrock monitoring wells where approximately 15 feet of core was collected from 6 separate locations (MW25-4D, MW-25-5D, MW25-7D, MW25-12D, MW25-14D, and MW25-16D). Major characteristics of the competent shale bedrock cores include bedding plane fractures, joints, limestone layers, fossil beds, and minor mineralization along fractures. Bedding plane fractures were present throughout the competent shale although they were more well developed and more closely spaced near the top of the competent shale. Bedding plane fractures also tended to be filled with silt and clay near the top of the shale. Well defined bedding plane fractures were also noted by Merrin (1992) in cores from well cemented, gray, thin-bedded siltstones of the Genessee Formation near Ithaca, New York. Generally, the fracture frequency decreased with depth as evidenced by the coincidental increase in RQDs. RQDs are the total length of recovered core sections over 4" in length expressed as a percentage of the interval cored. RQDs for the first five feet of competent shale ranged between 0 % and 88 % with an average of only 33%. RQDs for the second five feet of competent shale ranged between 10 % and 80 % and the average was 46 %. For the third five foot interval of competent shale the RQDs were significantly higher



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RI/FS
SEAD-25 FIRE TRAINING AND DEMONSTRATION PAD

DEPT. ENVIRONMENTAL ENGINEERING | Dwg. No. 728059-02003

FIGURE 3-2
SEAD-25 COMPETENT SHALE TOPOGRAPHY MAP

SCALE 1" = 100' | DATE MARCH 1996 | REV A

(between 52 % and 92 %) and the average for this interval was 72 %. The RQD data are shown on the coring logs contained in Appendix A. Merrin (1992) also noted that bedding plane fracture frequency decreased with depth in Devonian siltstones near Ithaca, New York.

Joints were very common in the competent shale. They were observed in most cores at a variety of angles (between 0^o and 90^o) although most tended to be between 30^o and 60^o. Below the top of the competent shale the fractures were less than a millimeter thick. They were generally free of silt or clay except in the upper few feet of the shale where they were filled with silt and clay. In some instances, the fractures were filled with a secondary calcium carbonate mineral. The spacing between the joints was usually 4-5 inches. The orientation of the joints in space could not be determined because the drilling program did not require the collection of oriented cores.

Fossil beds were present at many locations in the shale. The beds ranged in thickness from 5 to 15 feet. Occasionally only a single fossil was seen in the shale and not associated with an accumulation bed. The fossil beds provide planes of weakness in the shale and were almost always associated with bedding plane fractures. They tended to be composed of the fossil types described in Section 2.0.

3.1.4.5 Filled Areas

The Fire Training and Demonstration Pad was the only filled area identified on the site. Based on data from the boring logs, the pad was composed of approximately 1.0 to 2.0 feet of crushed shale, which forms a low mound on the site.

3.1.4.6 Site Stratigraphy

Two geologic cross-sections were constructed for the site. The locations of these sections are shown in Figure 3-3. Cross-sections A-A' and B-B' show the consistent till, weathered shale, competent shale stratigraphy beneath the site based on data from borings and monitoring wells. The geologic cross sections are shown in Figures 3-4 and 3-5. North-South cross-section A-A' shows the characteristic mounding of the competent shale beneath the pad, where the till is between 3 and 5 feet thick with a general thickening of the till north of the pad. South of the pad the till is approximately 5 feet thick. East-west cross-section B-B' shows similar features mentioned above in section A-A'. The fill material associated with the Fire Training and Demonstration Pad is only 1 to 2 feet thick and is also shown on sections A-A' and B-B'. The sections were drawn to provide a somewhat detailed view of the subsurface stratigraphy by intersecting as many data points (i.e., soil borings or monitoring wells) as possible while maintaining a uniform direction for the cross-section.

3.1.5 Geophysics

3.1.5.1 Seismic Refraction Survey

A seismic refraction survey was performed along 4 profiles at SEAD-25. The results of the seismic refraction survey performed at SEAD-25 are listed in Table 3-1 while the locations of the individual seismic transects are shown in Figure 2-2. The seismic survey detected 4 to 8 feet of till, which is characterized by a 1,100 to 1,350 ft/sec travel time, that was overlying bedrock, which was characterized by a 12,600 to 14,400 ft/sec travel time. Saturated till was not detected at the time of the survey. Possible explanations as to why the water table was not detected are that the water table was within the bedrock, or the thickness of saturated till was small (less than 3 feet) and was not detectable by the seismic survey.

The seismic survey indicates that the bedrock surface slopes to the southwest, generally following the slope of the regional ground surface. Based on this information, groundwater is expected to flow to the southwest. The survey was effective in determining the depth to bedrock at these 4 locations and helped determine the regional slope of the bedrock surface and thus infer the direction of groundwater flow.

3.1.6 Hydrogeology

3.1.6.1 Introduction

The hydrogeologic properties of the site were characterized in accordance with the investigation programs described in Section 2.0. This section presents the results of the investigation of the till/weathered shale and competent shale aquifers. It addresses topics such as groundwater flow directions, hydraulic conductivities, velocity of groundwater, vertical gradients, and vertical connection tests between the shallow and deep aquifers.

Table 3-1

SEAD-25 - Results of Seismic Refraction Survey

SEAD-25 Remedial Investigation
Seneca Army Depot Activity

Profile Number	Distance on Profile (feet)	Ground Elevation (feet)	Bedrock	
			Depth (feet)	Elevation (feet)
P1	0	100.0	4.9	95.1
	57.5	97.0	5.9	91.1
	115	97.3	4.0	93.3
P2	0	95.8	6.6	89.2
	57.5	96.3	5.9	90.4
	115	96.5	6.8	89.7
P3	0	98.8	7.6	91.2
	57.5	98.1	7.1	91.0
	115	97.4	7.2	90.2
P4	0	94.0	4.1	89.9
	57.5	92.9	4.6	88.3
	115	93.6	3.9	89.7

Notes:

1) All elevations are relative to a temporary benchmark.

2) Bedrock elevations are for the competent shale formation.

3.1.6.2 Groundwater Flow Directions

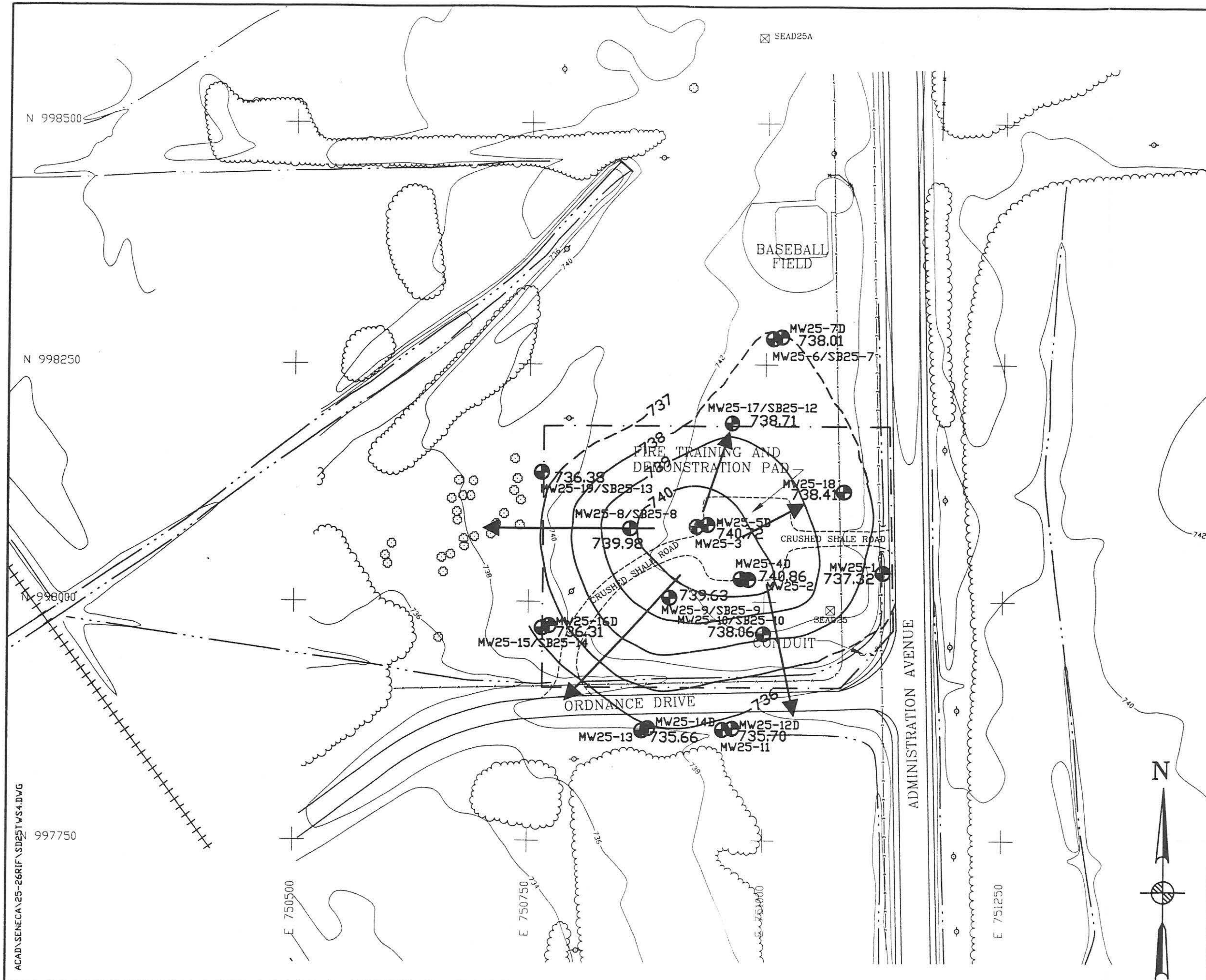
3.1.6.2.1 Till/Weathered Shale Aquifer

Three groundwater contour maps with one-foot contour intervals were constructed using depth to water table measurements in the till/weathered shale aquifer. The depth to water measurements for four separate events (April 4, 1994, November 4, 1995, December 6, 1995 and March 25, 1996) are shown in Table 3-2. The April 4 data set was not contoured because it contains only three data points.

The groundwater contour map for the November 4, 1995 data set, which is presented in Figure 3-6, clearly indicates that groundwater flow is radial below the pad. Groundwater elevations range from a high of 740 feet below the southwestern portion of the pad to a low of 735 feet away from the pad. The groundwater gradient is steeper to the south and west of the pad than it is on the north and east. The horizontal groundwater gradient was calculated to be 0.02 ft/ft between two sets of wells south and west of the pad (MW25-3 to MW25-13; and MW25-3 to MW25-15). North and east of the pad the horizontal groundwater gradient was calculated to be 0.01ft/ft. The transects north and east of the pad were MW25-3 to MW25-6 and MW25-3 to MW25-18, respectively. Thus, while radial flow at SEAD-25 is indicated by the data, there is a stronger horizontal gradient to the south and west.

For comparison purposes, second and third groundwater contour maps were constructed based on depth to water measurements made on December 6, 1995 and March 25, 1996. These data are shown in Figures 3-7 and Figure 3-8. In general, the groundwater table elevations were 1 to 2 feet higher in the set of measurements from December 1995 than in the November 1995 measurements. The groundwater table elevations were up to 1.2 feet higher in the March 1996 measurements than in the December 1995 measurements. Although the water table had risen at the time of the December and March measurements, the radial flow configuration of the water table was still present. The most significant difference between the three maps was that the water table gradient was less steep and the radial flow was less well defined north of the pad on the December map.

The radial groundwater flow that has developed below the pad at SEAD-25 is believed to be a local phenomenon that is present because of the influence from the bedrock topographic mound below the pad. Because the groundwater topographic maps show that the water table flattens north of the pad with a rise in the water table, it is likely that the gradient in this region will continue to flatten as the



LEGEND

- MINOR WATERWAY
- MAJOR WATERWAY
- FENCE
- UNPAVED ROAD
- BRUSH LINE
- LANDFILL EXTENT
- RAILROAD
- GROUND SURFACE ELEVATION CONTOUR (760)
- UNDERGROUND ELECTRIC UTILITY LINE
- UNDERGROUND WATER UTILITY LINE
- ROAD SIGN
- DECIDUOUS TREE
- GUIDE POST
- FIRE HYDRANT
- MANHOLE
- COORDINATE GRID (250' GRID)
- POLE
- UTILITY BOX
- MAILBOX/RR SIGNAL
- OVERHEAD UTILITY POLE
- SEAD-25 SURVEY MONUMENT WITH LABEL

(NOT ALL SYMBOLS MAY APPEAR ON MAP)

APPROXIMATE EXTENT OF SEAD-25

738.01 MONITORING WELL LOCATION AND ELEVATION OF WATER TABLE

730 GROUNDWATER CONTOUR LINE (DASHED WHERE INFERRED)

ARROW INDICATES PREDOMINANT GROUNDWATER FLOW DIRECTION

50 0 50 100 (feet)

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ENVIRONMENTAL ENGINEERING	728059-02003

FIGURE 3-6
SEAD-25 GROUNDWATER TOPOGRAPHY FOR THE TILL/WEATHERED SHALE AQUIFER-NOVEMBER 4, 1995

SCALE	DATE	REV
1" = 100'	APRIL 1998	A

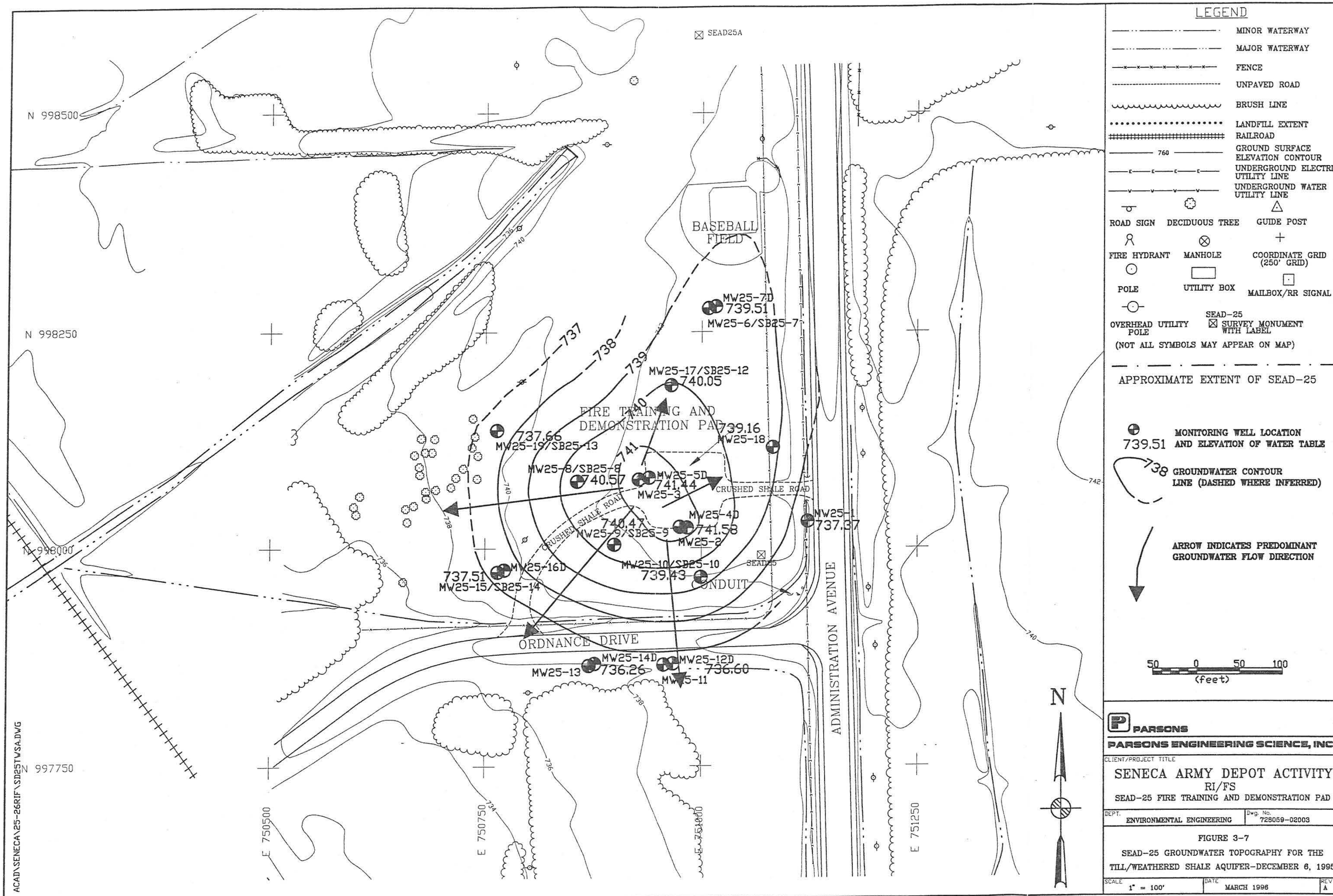

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FIGURE 3-7
SEAD-25 GROUNDWATER TOPOGRAPHY FOR THE TILL/WEATHERED SHALE AQUIFER-DECEMBER 6, 1995

SCALE	DATE	REV
1" = 100'	MARCH 1996	A

Table 3-2

SEAD-25 - Water Table Elevations in Monitoring Wells

SEAD-25 Remedial Investigation
Seneca Army Depot Activity

Monitoring Well	Top of PVC Elevation (1) (feet)	April 4, 1994		November 4, 1995		December 6, 1995		March 25, 1996	
		Depth to Water (feet)	Water Table Elevation (2) (feet)	Depth to Water (feet)	Water Table Elevation (feet)	Depth to Water (feet)	Water Table Elevation (feet)	Depth to Water (feet)	Water Table Elevation (feet)
MW25-1	742.98	5.45	737.53	5.66	737.32	5.61	737.37	5.44	737.54
MW25-2	746.40	4.35	742.05	5.54	740.86	4.82	741.58	4.45	741.95
MW25-3	745.82	3.15	742.67	5.10	740.72	4.38	741.44	3.7	742.12
MW25-4D	745.42	NA	NA	7.09	738.33	6.54	738.88	5.98	739.44
MW25-5D	745.02	NA	NA	6.50	738.52	5.39	739.63	4.45	740.57
MW25-6	744.39	NA	NA	6.38	738.01	4.88	739.51	3.69	740.70
MW25-7D	744.03	NA	NA	5.80	738.23	4.50	739.53	3.29	740.74
MW25-8	742.49	NA	NA	2.51	739.98	1.92	740.57	1.56	740.93
MW25-9	742.33	NA	NA	2.70	739.63	1.86	740.47	1.38	740.95
MW25-10	743.03	NA	NA	4.97	738.06	3.60	739.43	2.45	740.58
MW25-11	740.30	NA	NA	4.60	735.70	3.70	736.60	2.62	737.68
MW25-12D	740.06	NA	NA	3.40	736.66	2.73	737.33	2.64	737.42
MW25-13	739.61	NA	NA	3.95	735.66	3.35	736.26	2.46	737.15
MW25-14D	739.82	NA	NA	5.43	734.39	2.76	737.06	2.55	737.27
MW25-15	740.99	NA	NA	4.68	736.31	3.48	737.51	2.7	738.29
MW25-16D	741.10	NA	NA	5.35	735.75	4.75	736.35	4.54	736.56
MW25-17	743.93	NA	NA	5.22	738.71	3.88	740.05	2.73	741.20
MW25-18	744.39	NA	NA	5.98	738.41	5.23	739.16	4.41	739.98
MW25-19	742.00	NA	NA	5.62	736.38	4.34	737.66	3.59	738.41

Notes:

1) Elevations are relative to the North American Vertical Datum (NAVD) 1988.
2) These data were collected as part of the ESI.

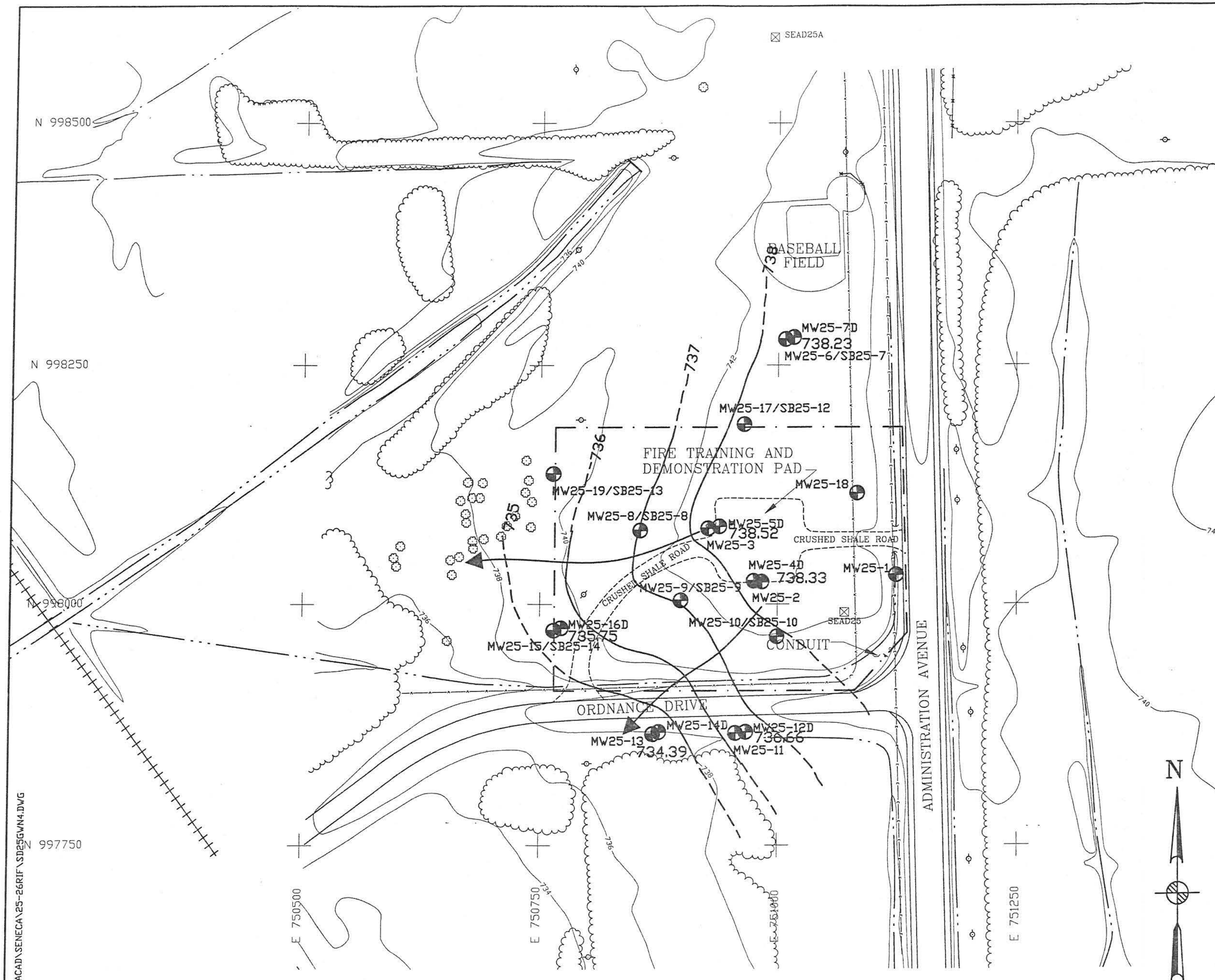
water table rises throughout the late winter and spring. In the spring when the water table is at it highest, the expected continued flattening of the water table would strengthen the regional westerly flow direction (which is believed to exist outside the immediate area of the pad) and thus reduce the influence from the locally developed radial flow.

3.1.6.2.2 Competent Shale Aquifer

Groundwater contour maps were constructed using depth to water table measurements in the competent shale aquifer on November 4, 1995 and December 6, 1995 as shown in Figures 3-9 and 3-10, respectively. The depth to water measurements are presented in Table 3-2. These maps show that the groundwater flow direction on the site is to the west and southwest, which is consistent with the expected direction of regional groundwater flow. The piezometric surface, and thus the flow direction, of the competent shale aquifer is not significantly affected by the local topographic high on the site. In the northern portion of the site the flow is to the west, but it shifts slightly to the southwest in the southern portion of the site. It is clear from the data that there is no significant radial flow in the competent shale, although the slight shift of the water table is likely due to the influence of the bedrock mound beneath the pad. The horizontal groundwater gradients range from 0.01 ft/ft to 0.02 ft/ft for well sets to the west an southwest (MW25-5D to MW25-16D; and MW25-4D to MW25-14D, respectively).

The physical characteristics of the competent shale aquifer that affect the flow of groundwater were investigated by reviewing a report prepared by Mozola (1951) and reviewing the core data collected at each of the bedrock monitoring wells. Mozola (1951) described two distinct sets of joints in the area. The main set, termed dip joints, appear to be in the form of two conjugate shear planes that intersect to form acute angles ranging from 10^{o} to 30^{o}. The mean direction of the dip joints ranges from North 15^{o} to 30^{o} East to North 30^{o} to 45^{o} West. Strike joints at right angles to the dip joints trend from North 50^{o} East to North 70^{o} East and are spaced from 1 inch to 4 feet apart. The dip of the joint planes ranges from 46^{o} to nearly vertical. In addition, Mozola (1951) found that most of the joints in the beds of the shale are filled with clay or fine silt which may inhibit groundwater flow.

The flow of groundwater in the competent shale is believed to be influenced primarily by the joints and bedding plane fractures that were observed in the cores. No other flow pathways were observed



LEGEND

- MINOR WATERWAY
- MAJOR WATERWAY
- FENCE
- UNPAVED ROAD
- BRUSH LINE
- LANDFILL EXTENT
- RAILROAD
- 760 GROUND SURFACE ELEVATION CONTOUR
- UNDERGROUND ELECTRIC UTILITY LINE
- UNDERGROUND WATER UTILITY LINE
- ROAD SIGN
- DECIDUOUS TREE
- GUIDE POST
- FIRE HYDRANT
- MANHOLE
- COORDINATE GRID (250' GRID)
- POLE
- UTILITY BOX
- MAILBOX/RR SIGNAL
- OVERHEAD UTILITY POLE
- SEAD-25 SURVEY MONUMENT WITH LABEL

(NOT ALL SYMBOLS MAY APPEAR ON MAP)

APPROXIMATE EXTENT OF SEAD-25

738.23 MONITORING WELL LOCATION AND ELEVATION OF WATER TABLE

736 GROUNDWATER CONTOUR LINE (DASHED WHERE INFERRED)

ARROW INDICATES PREDOMINANT GROUNDWATER FLOW DIRECTION

50 0 50 100 (feet)

PARSONS

PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY

RI/FS

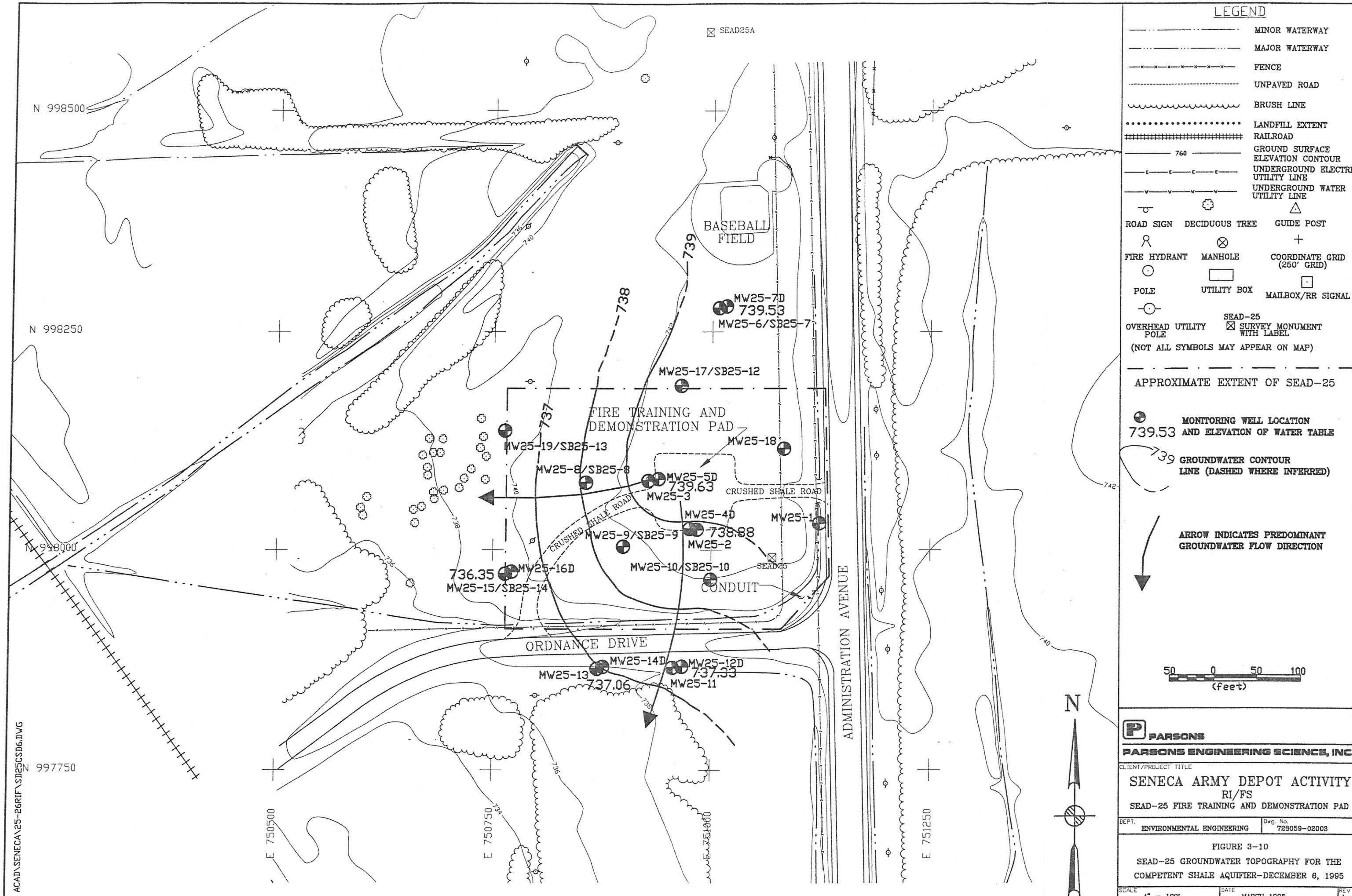
SEAD-25 FIRE TRAINING AND DEMONSTRATION PAD

DEPT. ENVIRONMENTAL ENGINEERING	Dwg. No. 728059-02003

FIGURE 3-9

SEAD-25 GROUNDWATER TOPOGRAPHY FOR THE COMPETENT SHALE AQUIFER-NOVEMBER 4, 1995

SCALE	DATE	REV
1" = 100'	MARCH 1996	A



PARSONS

PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY

RI/FS

SEAD-25 FIRE TRAINING AND DEMONSTRATION PAD

DEPT.	Dwg. No.
ENVIRONMENTAL ENGINEERING	729059-02003

FIGURE 3-10

SEAD-25 GROUNDWATER TOPOGRAPHY FOR THE COMPETENT SHALE AQUIFER-DECEMBER 6, 1995

SCALE	DATE	REV
1" = 100'	MARCH 1996	A

in the core samples. This view was put forth by Mozola (1951) for rocks of the Hamilton Group and more recently by Merrin (1992) for Devonian siltstones near Ithaca, New York. In Merirn's (1992) conceptual model of groundwater flow, a network of horizontal and vertical bedding plane fractures and joints exists in the subsurface. Groundwater moves through vertical and horizontal planes of porosity (i.e., fractures) each of which is a fraction of a millimeter thick and extends several inches to tens of feet in length. Based on the physical characteristics of the competent shale observed in this investigation, this model is believed to apply to the competent shale at SEAD-25.

3.1.6.3 Hydraulic Conductivities

3.1.6.3.1 Introduction

Horizontal hydraulic conductivities were determined for 19 wells at SEAD-25, 13 of which were till/weathered shale wells and 6 of which were competent shale wells. The hydraulic conductivity data are presented Appendix E. Hydraulic conductivities for all 19 wells were calculated using the method described by Bouwer and Rice (1976) as described in Section 2.0. Hydraulic conductivities on the site range from 1.0×10^{-5} cm/sec to 3.4×10^{-3} cm/sec as shown in Table 3-3. In most instances the conductivity values for the till/weathered shale aquifer are greater than for the competent shale aquifer, however, some of the lowest conductivities were measured in the till/weathered shale aquifer.

3.1.6.3.2 Till/Weathered Shale Aquifer

Hydraulic conductivity values for the shallow till/weathered shale aquifer range from 1.0×10^{-5} cm/sec to 3.4×10^{-3} cm/sec and averaged 6.1×10^{-4} cm/sec. Published hydraulic conductivity values for till or representative materials are: 1) 0.49 m/day (5.67×10^{-4} cm/sec) for a repacked predominantly sandy till (Todd 1980), and 2) from 10^{-2} to 10^{-3} m/day (10^{-5} to 10^{-6} cm/sec) for representative materials of silt, sand, and mixtures of sand, silt, and clay (Todd 1980). No published hydraulic conductivity values for weathered shale were identified.

3.1.6.3.3 Competent Shale Aquifer

Hydraulic conductivity values for the competent shale aquifer (Moscow Formation), as determined by slug testing, ranged from 1.8×10^{-5} cm/sec to 7.2×10^{-4} cm/sec and averaged 3.3×10^{-4} cm/sec. These values are higher than those measured in the Ludlowville Formation at the Ash Landfill where the average value was approximately 10^{-6} cm/sec (Parsons ES, 1995a).

3.1.6.4 Velocity of Groundwater

3.1.6.4.1 Introduction

Using Darcy's Law, the average linear velocity of groundwater in both the shallow till/weathered shale and deep competent shale aquifers was calculated. The velocity estimates were calculated using average site hydraulic conductivities, effective porosity estimates, and on-site groundwater gradients. A porosity estimate for weathered fissile shale with large amounts of silt in the interstices could not be located in the literature. Therefore, effective porosities for the till of 15 percent to 20 percent were used in the calculations. According to Todd (1980), competent shale is reported to have an effective porosity of 6.75 percent.

3.1.6.4.2 Till/Weathered Shale Aquifer

The average linear velocity of groundwater in the till/weathered shale aquifer was calculated using the method described by Darcy's Law. The Darcy equation for the average linear velocity (*V*) of groundwater flow (Freeze and Cherry 1979) is:

$$V = \frac{K \frac{dh}{dl}}{n}$$

where:

K is the horizontal hydraulic conductivity (cm/sec);
n is the estimated effective porosity (percent); and
dh/dl is the hydraulic gradient (ft/ft).

Because two different groundwater gradients were identified within the radial groundwater flow configuration at the site, two horizontal flow velocities were calculated.

Table 3-3

SEAD-25 - Hydraulic Conductivity Values for Rising Head Slug Tests

SEAD-25 Remedial Investigation
Seneca Army Depot Activity

Well ID	Well Type (1)	Hydraulic Conductivity, K (cm/sec)
MW25-1	T/WS	3.4E-03
MW25-2	T/WS	1.0E-05
MW25-3	T/WS	7.6E-05
MW25-4D	CS	3.4E-04
MW25-5D	CS	1.8E-04
MW25-6	T/WS	4.1E-04
MW25-7D	CS	1.8E-05
MW25-8	T/WS	1.2E-03
MW25-9	T/WS	3.7E-04
MW25-10	T/WS	1.2E-04
MW25-11	T/WS	6.3E-04
MW25-12D	CS	7.2E-04
MW25-13	T/WS	8.2E-04
MW25-14D	CS	4.3E-04
MW25-15	T/WS	2.7E-05
MW25-16D	CS	2.9E-04
MW25-17	T/WS	2.3E-04
MW25-18	T/WS	2.4E-05
MW25-19	T/WS	5.4E-04

Average K* for the 13 Till/Weathered Shale Wells:	2.2E-04
Average K* for the 6 Competent Shale Wells:	2.1E-04

Note:

1) T/WS = Till Weathered Shale Aqufier
2) CS = Competent Shale Aquifer
3) K = hydraulic conductivity (horizontal)
* The average K values shown are geometric means

For the calculation of the groundwater flow velocity south and west of the pad the input values used in the equation were: 1) an average hydraulic conductivity of 2.2 x 10^{-4} cm/sec (0.62 ft/day), 2) an estimated effective porosity of 15 percent (0.15) to 20 percent (0.20), and 3) a groundwater gradient of 0.02 ft/ft. Total porosities for till samples from another location at SEDA ranged from 34.0 percent to 44.2 percent with an average of 37.3 percent. Therefore, an effective porosity of 15 percent to 20 percent was determined to be reasonable. Substituting the above-referenced values into the Darcy equation yields an average linear velocity of 0.06 feet/day (or 22.6 feet/year) at 20 percent effective porosity, and 0.083 feet/day (or 30 feet/year) at 15 percent effective porosity.

To calculate the groundwater flow velocity north and east of the pad the same input parameter values were used as noted above, with the exception that the groundwater gradient value of 0.01 ft/ft was used instead of 0.02 ft/ft. Again, substituting the above-referenced values into the Darcy equation yields an average linear velocity of 0.031 feet/day (or 11.3 feet/year) at 20 percent effective porosity and 0.041 feet/day (or 15 feet/year) at 15 percent effective porosity.

Therefore, the average linear velocity south and west of the pad at SEAD-25 ranges from 22.6 ft/yr to 30 ft/yr. North and east of the pad where the gradient is less it ranges from 11.3 ft/yr to 15 ft/yr. It is important to note that during certain times of the year, portions of the till weathered shale aquifer may be completely dry. For example, during the installation of the till/weathered shale wells at SEAD-25 in late September 1995 (a month known for historically low water table conditions at SEDA), no groundwater was encountered in the till/weathered shale wells to the south and west of the pad. No groundwater flow occurs in the dry regions of the till/weathered shale aquifer at these times of the year and as a result, the calculated groundwater velocities are not likely to be sustained throughout the year. Consequently, the actual annual distance of groundwater flow is likely to be significantly lower than the calculated velocities.

3.1.6.4.3 Competent Shale Aquifer

The average linear velocity of groundwater in the competent shale was calculated using the method described by Darcy's Law and the equation presented in Section 3.1.6.4.2. The input parameter values used were: 1) an average hydraulic conductivity of 2.1 x 10^{-4} cm/sec (0.56 ft/day), 2) an estimated effective porosity of 6.75 percent (0.0675), and 3) groundwater gradients of 0.01 ft/ft and 0.02 ft/ft (to evaluate two possible velocity scenarios). The effective porosity for the shale was derived from a total porosity value cited by deMarsily (1986); deMarsily cites a total porosity for shale of up to 7.5 percent. A plot of total and effective porosity for various materials shows that the effective porosity is approximately 90 percent of the total porosity for materials with a blocky nature (i.e., fractured shale). Using this visual relationship between total and effective porosities depicted by deMarsily, 90 percent of the total porosity (7.5 percent) is 6.75 percent.

Substituting the above-referenced input parameter values, including a gradient of 0.01 ft/ft, into the Darcy equation yields an average linear velocity of 0.08 ft/day (or 30 ft/year) for the competent shale. Using a gradient of 0.02 ft/ft and these same input parameter values an average linear velocity of 0.106 ft/day (60 ft/year) was calculated.

3.1.6.5 Vertical Hydraulic Heads and Gradients

Vertical gradients were calculated at the 6 pairs of till/weathered shale and competent shale wells at SEAD-25. These data are presented in Table 3-4. The vertical gradient (G_{vert}) for each well pair was calculated using the following equation:

$$G_{vert} = \frac{dh}{dl}$$

where:

dh is the difference in hydraulic head between the shallow and deep wells (ft); and
dl is the distance between the midpoints of the two wells screens (ft).

Both downward and upward vertical gradients were calculated for SEAD-25. The magnitude of the downward gradients (indicating the potential for downward movement of groundwater) ranged from -0.04 ft/ft to -0.21 ft/ft. The magnitude of the upward gradients (indicating a potential for upward movement of groundwater) were significantly lower and ranged from 0.01 ft/ft to 0.07 ft/ft. The direction and magnitude of the vertical gradients were generally consistent for the November 4, 1995 and the December 6, 1995 measurement events.

Strong downward gradients (between -0.17 ft/ft and -0.21 ft/ft) were calculated only for well pairs MW25-2/MW25-4D and MW25-3/MW25-5D, which are located in the immediate vicinity of the crushed shale pad. One explanation for the strong downward gradient in this area is that the crushed shale pad acts as an area of increased infiltration for precipitation; according to Mozola (1951), precipitation is the sole source of water for the overburden aquifer in Seneca County. Thus,

Table 3-4

SEAD-25 - Vertical Gradients in Paired Monitoring Wells

SEAD-25 Remedial Investigation
Seneca Army Depot Activity

Monitoring Well	Top of PVC Elevation (feet)	Screened Invterval		Mid-Point of Screen (TOC)	Elevation of Mid-Point of Screen (feet)	November 4, 1995			December 6, 1995		
		Top of Screen (TOC)	Bottom of Screen (TOC)			Depth to Water (feet)	Water Table Elevation (feet)	Vertical Gradient	Depth to Water (feet)	Water Table Elevation (feet)	Vertical Gradient
MW25-2	746.40	6.04	10.04	8.04	738.36	5.54	740.86	-0.20	4.82	741.58	-0.21
MW25-4D	745.42	15.31	24.31	19.81	725.61	7.09	738.33		6.54	738.88	
MW25-3	745.82	6.55	8.55	7.55	738.27	5.10	740.72	-0.20	4.38	741.44	-0.17
MW25-5D	745.02	13.21	22.21	17.71	727.31	6.50	738.52		5.39	739.63	
MW25-6	744.39	6.45	13.25	9.85	734.54	6.38	738.01	0.01	4.88	739.51	0.00
MW25-7D	744.03	21.88	30.88	26.38	717.65	5.80	738.23		4.50	739.53	
MW25-11	740.30	5.35	6.85	6.10	734.20	4.60	735.70	0.07	3.70	736.60	0.05
MW25-12D	740.06	15.07	24.57	19.82	720.24	3.40	736.66		2.73	737.33	
MW25-13	739.61	4.37	5.17	4.77	734.84	3.95	735.66	-0.09	3.35	736.26	0.06
MW25-14D	739.82	14.69	23.69	19.19	720.63	5.43	734.39		2.76	737.06	
MW25-15	740.99	5.29	6.79	6.04	734.95	4.68	736.31	-0.04	3.48	737.51	-0.08
MW25-16D	741.10	16.25	25.25	20.75	720.35	5.35	735.75		4.75	736.35	

Notes:

1) Elevations are relative to the North American Vertical Datum (NAVD) 1988.
2) Potential upward movement of groundwater is indicated by a positive vertical gradient. Potential downward movement of groundwater is indcated by a negative gradient..

H:\ENG\SENECA\S2526RI\TABLES\VGPMW25.WK4 precipitation that falls onto the crushed shale pad can infiltrate easier than in the surrounding areas occupied by only dense till. The increased infiltration would tend to cause the groundwater to mound up beneath the pad, creating the potential for a strong downward gradient. Also, this may explain the presence of water in the overburden wells in the immediate vicinity of the pad in September 1995, whereas there was no groundwater encountered in the overburden aquifer south and west of the pad at this time.

3.1.6.6 Vertical Connection Between Till/Weathered Shale and Competent Shale Aquifers

Vertical connection tests were performed at six paired wells (MW25-2 and MW-25-4D; MW25-3 and MW25-5D; MW25-6 and MW25-7D; MW25-11 and MW25-12D; MW25-13 and MW-25-14D; MW25-15 and MW25-16D) to determine the degree of connection between the till/weathered shale and competent shale aquifers. Specifically, these qualitative tests were performed to determine whether the contact between the till/weathered shale and competent shale could be considered a lower impermeable boundary for the shallow groundwater flow system at SEAD-25. Such an impermeable boundary would prove to be an important influence on the possible spread of contaminants.

The water table displacements for each of the vertical connection tests are presented in tabular form in Appendix F. The vertical connection tests indicate that there is little to no measurable drawdown in the shallow wells screened in the till/weathered shale when groundwater is purged from their respective paired deep wells screened in competent shale. In nearly all of the vertical connection tests at the well pairs, the degree of displacement in the till/weathered shale wells was negligible. The largest drawdown (0.16 feet) was measured in well MW25-6 after 100 minutes of purging groundwater from MW25-7D, its bedrock well pair. Overall, the results indicate that the till/weathered shale aquifer is not significantly connected to the competent shale aquifer below it. This could be due to refilling of bedding plane fractures and joints by silt and clay in the upper portions of the shale aquifer.

It is noteworthy that during the vertical connection test artificial gradients are created between separate aquifers and only the interconnection between the screened intervals in the wells was evaluated. The tests do not necessarily imply the direction of groundwater movement that would exist under static conditions.

released for plant absorption. Soil exposure pathways are potentially important for terrestrial plants and wildlife within the subject area.

The impacts to surface soils at the site are from SVOCs, predominantly PAHs. Impacts from metals pesticides and PCBs, and herbicides were less significant that impacts from SVOCs. A detailed discussion of impacts to the soil and the relation of detected levels of constituents to applicable criteria are presented in Section 4.

3.2 SEAD-26

3.2.1 Site Features

The Fire Training Pit (SEAD-26) is located in the southeastern portion of SEDA. It is characterized by an elevated, 1,400-foot long, rectangular, grass-covered pad that contains a fire training tower, a storage trailer, a circular burning pit, and a former drum storage area as shown in Figure 1-4. The fire training tower, storage trailer, and several burned automobiles are located in the north and north-central portion of the site. The centrally-located circular burning pit has a diameter of approximately 75 feet and is surrounded by an approximately 2-3-foot-high soil berm. The bermed perimeter of the pond is characterized by blackened soil and is void of vegetation. Approximately 50 feet south of the pond are two large, empty cylindrical steel tanks. Farther south is the burned out fuselage of a helicopter. A former drum storage area is located in the central portion of the far southern end of the site. Additionally, concrete rubble and other debris are located in the southern portion of the site. An oval unpaved road parallels the fenced boundaries of SEAD-26.

The site is bounded on the west by numerous sets of SEDA railroad tracks beyond which is open grassland, on the south by grassland and low brush, on the north by 7th Street beyond which are numerous warehouse buildings, and on the east by paved and unpaved storage areas. Vehicular access is provided to the site via a locking gate on 7th Street; access is also available via a small crushed shale road (with a locking gate) that originates at a paved storage area immediately east of the site. On a larger scale, access to SEDA is controlled by fencing and security patrols around the entire depot.

The only utility on the site is a fire hydrant which is fed by a buried water line. The water line enters the northeastern portion of the site from 7th Street and connects to a fire hydrant that is located approximately 75 feet beyond the fenced SEAD-26 boundary. Overhead utility poles carry electric and phone lines past the northern side of the site along 7th Street. Several overhead utility lines are also present in the unpaved storage area immediately east of the site.

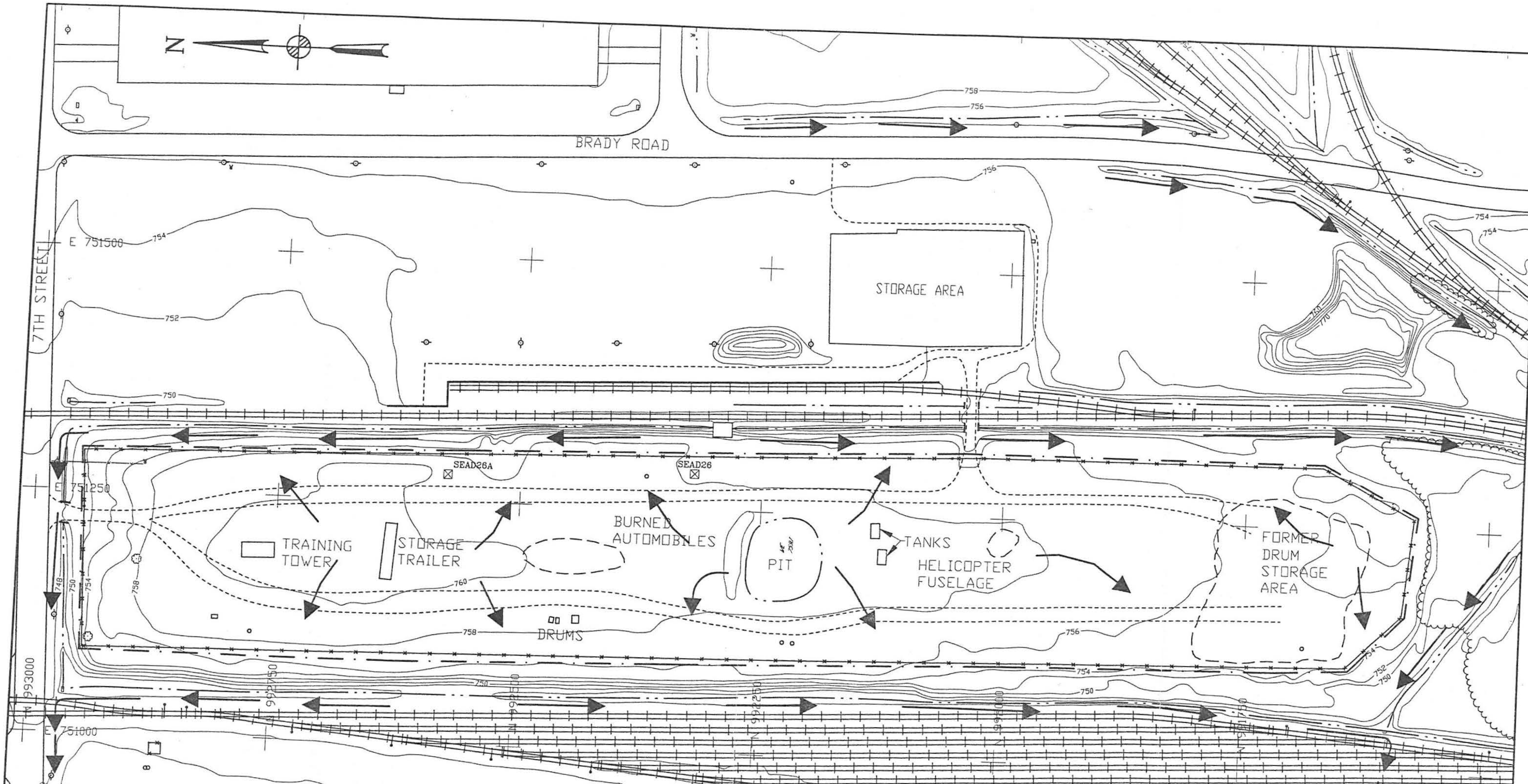
3.2.2 Topography

The fire pit (i.e., the pond) is located on elevated terrain which is rectangular in shape and with steep sides on the east, south and west; the northern side is less steep and provides a adequate grade for the unpaved access road. On the site, the pit is defined by a 2 to 3 foot high circular soil berm. Elevations on the flat pad range from 756 feet to 760 feet while the elevation of the land surface immediately off of the elevated pad is approximately 750 feet. Based on the topography surrounding the elevated site, the regional land surface slopes to the west.

3.2.3 Surface Water

Surface water flow directions are controlled predominantly by the changes in relief on the surface of the elevated rectangular pad that comprises SEAD-26. The small circular pond located in the center of the site contains surface water that is collected only from the areas immediately inside the soil berm that encompasses it. Although the pond is very shallow (1 -1.5 feet deep), it is believed to be sustained for much of the year by precipitation events and because of a bentonite liner that forms its base.

Beyond the area of the bermed pond, overland surface water flow is irregular but ultimately all discharges into the ditches surrounding the site as shown in Figure 3-14. The drainaged ditches that are present at the base of the elevated pad collect surface water that drains from the pad. Along the northern flanks of the site, the drainage ditches drain north until they intersect the swale along 7th Street, which directs surface water west beneath a culvert. Along the southern flanks of the site, the drainage ditches drain south where they intersect another ditch about 50 feet south of the southern tip of the elevated pad. From this point surface water flows west under numerous SEDA railroad tracks. Surface water flow in the drainage ditches is seasonally intermittent and controlled by precipitation events.



LEGEND

MINOR WATERWAY	SEAD-26 SURVEY MONUMENT WITH LABEL
MAJOR WATERWAY	ROAD SIGN
FENCE	DECIDUOUS TREE
UNPAVED ROAD	FIRE HYDRANT
BRUSH LINE	MANHOLE
LANDFILL EXTENT	GUIDE POST
RAILROAD	POLE
760 GROUND SURFACE ELEVATION CONTOUR	UTILITY BOX
UNDERGROUND ELECTRIC UTILITY LINE	COORDINATE GRID (250' GRID)
UNDERGROUND WATER UTILITY LINE	OVERHEAD UTILITY POLE
	MAILBOX/RR SIGNAL

(NOT ALL SYMBOLS MAY APPEAR ON MAP)

APPROXIMATE EXTENT OF SEAD-26

DIRECTION OF SURFACE WATER FLOW

50 0 50 100 (feet)

ACAD\SENECA\25-26RIF\SD26SWF.DWG

PARSONS

PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE
SENECA ARMY DEPOT ACTIVITY
RI/FS
SEAD-26 FIRE TRAINING PIT AND AREA

DEPT. ENVIRONMENTAL ENGINEERING | Dwg. No. 728059-02003

FIGURE 3-14
SEAD-26 SURFACE WATER RUNOFF DIRECTIONS

SCALE 1" = 100' | DATE MARCH 1996 | REV A

3.2.4 Site Geology

3.2.4.1 Introduction

The entire elevated rectangular pad that constitutes SEAD-26 is composed of artificial fill material. The bedrock is composed of gray Devonian Shale with a thin weathered zone where it contacts the overlying glacial till. The fill is the most common unit on the site.

3.2.4.2 Glacial Till

Glacial till is present below the fill at SEAD-26. The till is distributed across the entire site and surrounding area and ranges in thickness from 1.3 feet to 2.5 feet, with an average thickness of 2.0 feet based upon drilling results. The thickest section of glacial till was encountered at monitoring well MW26-1, which is located approximately 250 feet east of the site, while the thinnest section of till was found at MW26-11 , which is located in the northern portion of the site. However, the contact of the fill and till was not distinct at most drilling locations because the fill had a similar composition to the till. Therefore, the fill/till contact is the least certain of the contacts identified at the site. The till is generally characterized by brown to olive gray silt and clay, trace of fine sand with few fine to coarse gravel-sized inclusions of weathered shale. Generally, larger diameter weathered shale clasts are more prevalent in the basal portions of the till and are probably ripped-up clasts removed by the once-active glacier. The general Unified Soil Classification System description of the till on-site is as follows: Clay-silt, brown to olive gray, slightly plastic, small percentage of fine to medium sand, small percentage of fine to coarse gravel-sized gray shale clasts, dense and mostly dry in place, till, (ML).

Darian silt-loam soils surrounding the site, 0 to 18 inches thick, are developed in till derived mainly from local alkaline and calcareous, dark-gray and black silty shale and a small quantity of limestone (Hutton, 1972). These surficial soils are somewhat poorly drained and have a silt clay loam and clay subsoil. These are nearly level to gently sloping soils on uplands in the central part of Seneca County. In general, 0-3 percent slopes are associated with these soils (Hutton, 1972). A region of Angola silt loam, 3 to 8 percent slopes, is located immediately west of the site. These soils are also somewhat poorly drained and they develop in upland areas that are generally fairly broad.

A grain size analysis was performed on one till/weathered shale sample collected from a depth of 12 feet to 14 feet at SB26-11. This sample contained 29 percent silt-and clay-sized particles and 71 percent fine to coarse sand-sized particles. The relatively high percentage of coarse particles in this sample is likely due to inclusion of weathered shale. This sample has a comparable composition to samples at other sites (i.e., SEAD-25) collected at or near the till/weathered shale contact. This sample is believed to contain a relatively larger percentage of shale rip-up clasts than would be expected in upper portions of the till.

Grain size analysis curves for till samples collected during the installation of monitoring wells on another portion of SEDA show a wide distribution of particle sizes (Metcalf & Eddy, 1989). Based on all of the available grain size analyses at SEDA, the till generally has a high percentage of silt and clay with fewer amounts of sand- and fine gravel-sized particles.

The porosities of five gray-brown silty clay (i.e., till) samples ranged from 34.0 percent to 44.2 percent with an average of 37.3 percent (USAEHA, 1985).

The minimum, maximum and average background concentrations of selected inorganic constituents in the till located on SEDA have been extensively characterized. These data are discussed in Section 1 and presented in Table 1-2.

3.2.4.3 Weathered Shale

A zone of gray weathered shale of variable thickness was encountered below the till at all of the locations drilled on-site. This zone is characterized by fissile shale with a large amount of brown interstitial silt and clay. The upper boundary of the weathered shale was recorded in split spoon samples and the base of the weathered shale was, for the purposes of this investigation, defined as the depth of refusal with the hollow stem augers or where augering became abruptly difficult and slow. The thickness of the weathered shale ranges from 1.7 feet to 6.0 feet on the site with an average thickness of 3.2 feet. Differential weathering through geologic time is likely responsible for the variable thickness. No outcrops of weathered or competent shale are exposed at SEAD-26.

3.2.4.4 Competent Shale

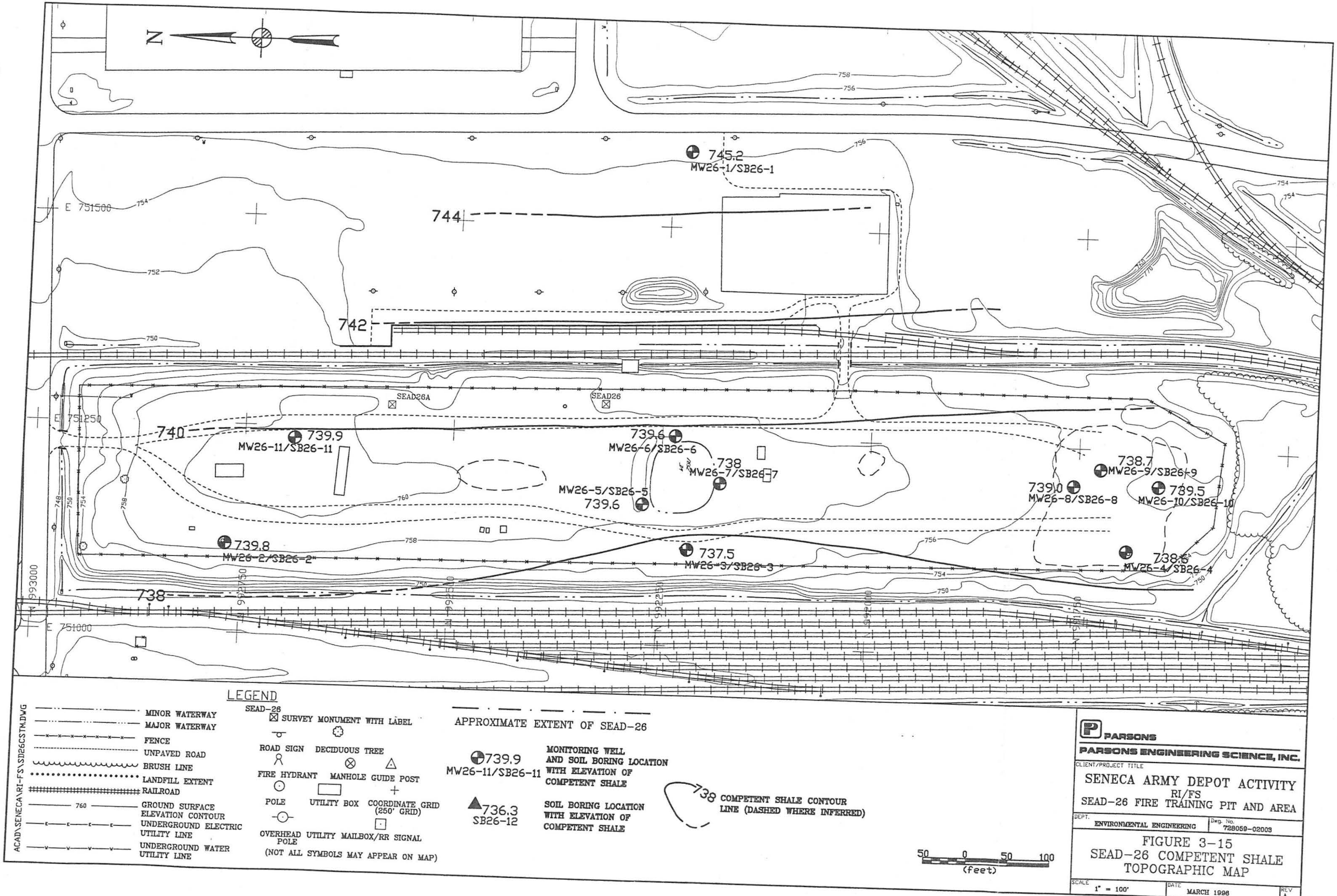
The bedrock underlying the site is composed of the Moscow Formation of the Devonian age Hamilton Group; specifically, the site lies in the lower one-quarter of the Moscow Formation. The lower two thirds of the Moscow shale is a soft gray calcareous shale containing an abundance of fossils (Mozola, 1951). The upper or younger part of the Moscow shale is dark, highly friable, and less calcareous than the lower two-thirds. Weathered surfaces are generally medium to light gray and may be stained with iron oxide. Many of the joint openings in the shale strike in two predominant joint directions, N 65° E and N 25-30° W (Mozola, 1951). These joints are primarily vertical. Merrin (1992) cites three prominent vertical joint directions of northeast, north-northwest, and east-northeast in outcrops of the Genesse Formation 15 miles southeast of the site near Ithaca, New York. The Hamilton Group is a gray-black, calcareous shale that is fissile and exhibits parting (or separation) along bedding planes.

Gray competent shale was encountered between 6.0 feet and 18.0 feet below the ground surface in the borings performed on the site. A bedrock topographic map was developed based upon hollow stem auger refusal depths from these soil borings and upon visual observations made by the drilling supervisors. In all instances, auger refusal was considered to be the top of the competent shale. The bedrock topography slopes to the west as shown in Figure 3-15. The bedrock topography is at a maximum (approximately 745 feet) at the background monitoring well location, MW26-1 which is located on the east side of the site. The minimum bedrock elevation measured on the site was 737 feet at MW26-3, a downgradient well.

The characteristics of the competent shale were not observed at SEAD-26 because no bedrock cores were collected. However, it is likely that the bedrock at SEAD-26 is similar to that described at the SEAD-25, located approximately 1 mile north.

3.2.4.5 Filled Areas

The Fire Training Pit and surrounding area is composed mostly of fill that is from 6.0 to 14.0 feet thick. Grain size analyses of four fill samples collected from various depths (0.5 to 1.2 ft, 0 to 2 ft, and 4 to 6 ft) indicate that it is variable in composition, but contains between 20 and 45 percent silt and clay with the balance being composed of sand- and gravel-sized particles. The complete composition of the fill was not well represented by the split-spoon samples due to, at times, poor recoveries. However, detailed descriptions are provided in the section describing the excavation of the geophysical anomalies below. Generally, these excavation revealed that the fill contained non-metallic construction debris and boulders as well as metallic debris (e.g., pipes, bucket, steel fragments).



744
742
740
738
745.2
MW26-1/SB26-1
739.9
MW26-11/SB26-11
739.6
MW26-6/SB26-6
738
MW26-7/SB26-7
MW26-5/SB26-5
739.6
739.8
MW26-2/SB26-2
737.5
MW26-3/SB26-3
738.7
MW26-9/SB26-9
739.0
MW26-8/SB26-8
739.5
MW26-10/SB26-10
738.6
MW26-4/SB26-4
SEAD26A
SEAD26
E 751500
E 751250
E 751000
LEGEND
MINOR WATERWAY
MAJOR WATERWAY
FENCE
UNPAVED ROAD
BRUSH LINE
LANDFILL EXTENT
RAILROAD
GROUND SURFACE ELEVATION CONTOUR
UNDERGROUND ELECTRIC UTILITY LINE
UNDERGROUND WATER UTILITY LINE
SEAD-26
SURVEY MONUMENT WITH LABEL
ROAD SIGN
DECIDUOUS TREE
FIRE HYDRANT
MANHOLE
GUIDE POST
POLE
UTILITY BOX
COORDINATE GRID (250' GRID)
OVERHEAD UTILITY POLE
MAILBOX/RR SIGNAL
(NOT ALL SYMBOLS MAY APPEAR ON MAP)
APPROXIMATE EXTENT OF SEAD-26
739.9 MW26-11/SB26-11
MONITORING WELL AND SOIL BORING LOCATION WITH ELEVATION OF COMPETENT SHALE
736.3 SB26-12
SOIL BORING LOCATION WITH ELEVATION OF COMPETENT SHALE
738 COMPETENT SHALE CONTOUR LINE (DASHED WHERE INFERRED)
50 0 50 100
(feet)
ACAD\SENECA\RI-FS\SD26CSTM.DWG
PARSONS
PARSONS ENGINEERING SCIENCE, INC.
CLIENT/PROJECT TITLE
SENECA ARMY DEPOT ACTIVITY
RI/FS
SEAD-26 FIRE TRAINING PIT AND AREA
DEPT.
ENVIRONMENTAL ENGINEERING
Dwg. No. 728059-02003
FIGURE 3-15
SEAD-26 COMPETENT SHALE TOPOGRAPHIC MAP
SCALE 1" = 100'
DATE MARCH 1996
REV A

3.2.6 Hydrogeology

3.2.6.1 Introduction

The hydrogeologic properties of the site were characterized in accordance with the investigation programs described in Section 2.0. This section presents the results of the investigation of the till/weathered shale and competent shale aquifers. The following sections present a discussion of groundwater flow directions, hydraulic conductivities, and velocity of groundwater movement at SEAD-26.

3.2.6.2 Groundwater Flow Directions in the Till/Weathered Shale Aquifer

The depth to water measurements for four separate monitoring events (April 4, 1994; November 4, 1995; December 4, 1995, and March 25, 1996) are shown in Table 3-9. Three groundwater elevation contour maps, with one-foot contour intervals, were constructed using depth to water table measurements in the till/weathered shale aquifer. The April 4, 1994 data set, which was collected as part of the ESI, contains only four data points and therefore these data were not contoured.

The groundwater contour map for the November 4, 1995 data set, which is shown in Figure 3-20, clearly indicates that groundwater flow is to the west at SEAD-26. Groundwater elevations above 747 feet are located east of the site and they drop to 742 feet on the western portion of the pad. The only anomalous feature on this map is an area where groundwater contours deflect to the west below the fire training pit. This may be caused by downward leakage of water from the pond created by mounding of the water table in this immediate area. The horizontal groundwater gradient was calculated to be 0.01 ft/ft between monitoring wells MW26-1 and MW26-3.

For comparison purposes, second and third groundwater contour maps were constructed based on depth to water measurements made on December 4, 1995 and March 25, 1996. These data are shown in Figures 3-21 and 3-22. In general, the groundwater table elevations were approximately 0.5 feet higher in the December 1995 measurements than in the November 4, 1995 measurements. The groundwater table elevations were approximately 0.5 feet higher in the March 1996 measurements than during the December 1995 measurements. Although the water table had risen slightly at the time of the December 1995 and March 1996 measurements, the groundwater flow direction and gradients remained generally the same as in November 1995.

Table 3-9

SEAD-26 Water Table Elevations in Monitoring Wells

SEAD-26 Remedial Investigation
Seneca Army Depot Activity

Monitoring Well	Top of PVC Elevation (feet)	April 4, 1994		November 4, 1995		December 4, 1995		March 25, 1996	
		Depth to Water (feet)	Water Table Elevation (feet)	Depth to Water (feet)	Water Table Elevation (feet)	Depth to Water (feet)	Water Table Elevation (feet)	Depth to Water (feet)	Water Table Elevation (feet)
MW26-1	753.75	5.28	748.47	6.30	747.45	5.95	747.80	5.65	748.10
MW26-2	756.61	15.54	741.07	16.43	740.18	15.66	740.95	15.49	741.12
MW26-3	754.10	11.40	742.70	12.13	741.97	11.84	742.26	11.46	742.64
MW26-4	752.66	10.28	742.38	11.23	741.43	10.69	741.97	10.41	742.25
MW26-5	756.68	NA	NA	12.85	743.83	11.98	744.70	11.5	745.18
MW26-6	756.68	NA	NA	12.73	743.95	12.42	744.26	11.97	744.71
MW26-7	756.68	NA	NA	13.71	742.97	13.30	743.38	12.76	743.92
MW26-8	752.40	NA	NA	10.22	742.18	9.73	742.67	9.46	742.94
MW26-9	752.94	NA	NA	10.49	742.45	9.87	743.07	9.52	743.42
MW26-10	753.26	NA	NA	9.26	744.00	8.71	744.55	8.2	745.06
MW26-11	756.33	NA	NA	14.00	742.33	13.68	742.65	13.85	742.48

Notes:

1) Elevations are relative to the North American Vertical Datum (NAVD) 1988.
2) NA = Not Available; monitoring wells not installed.

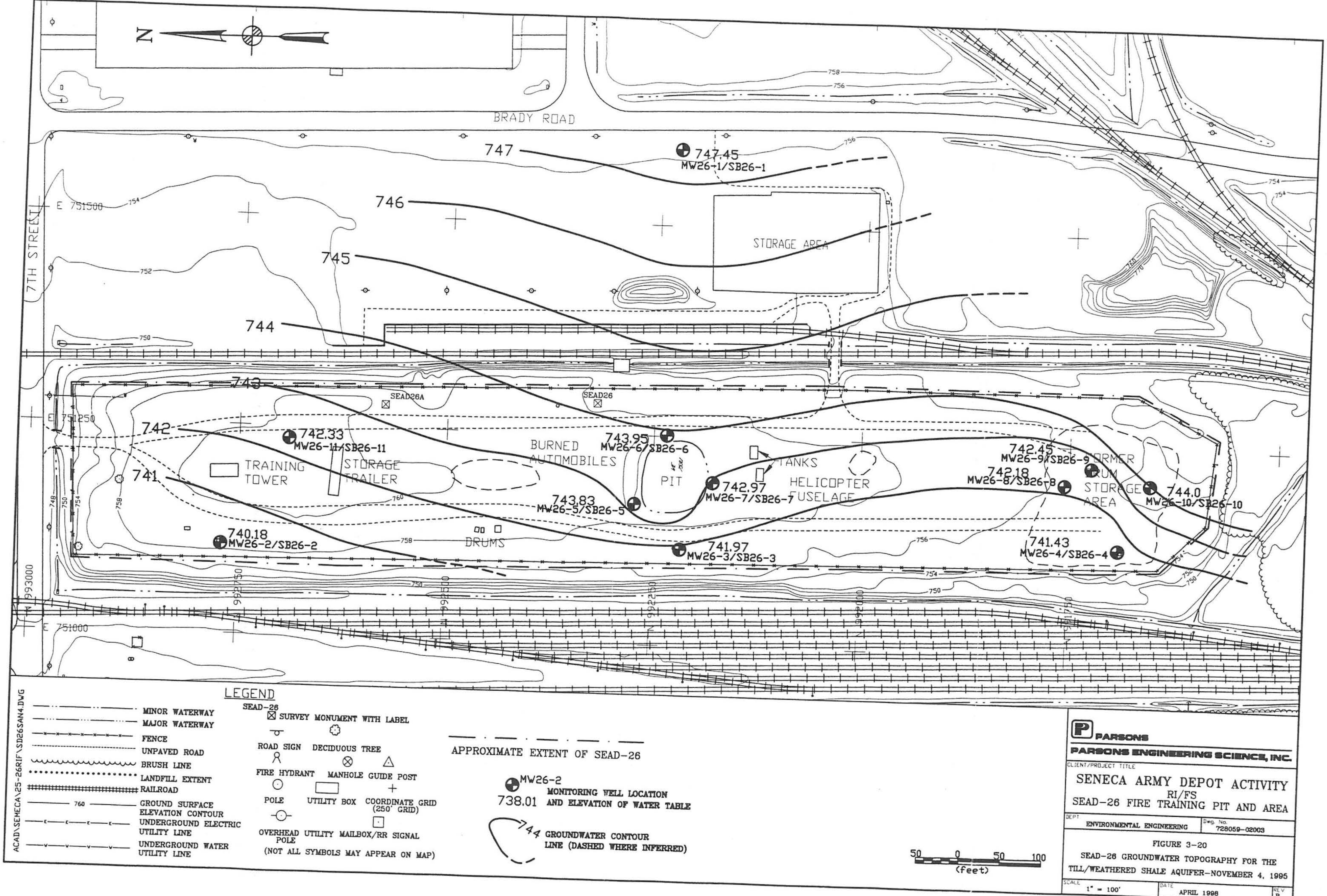
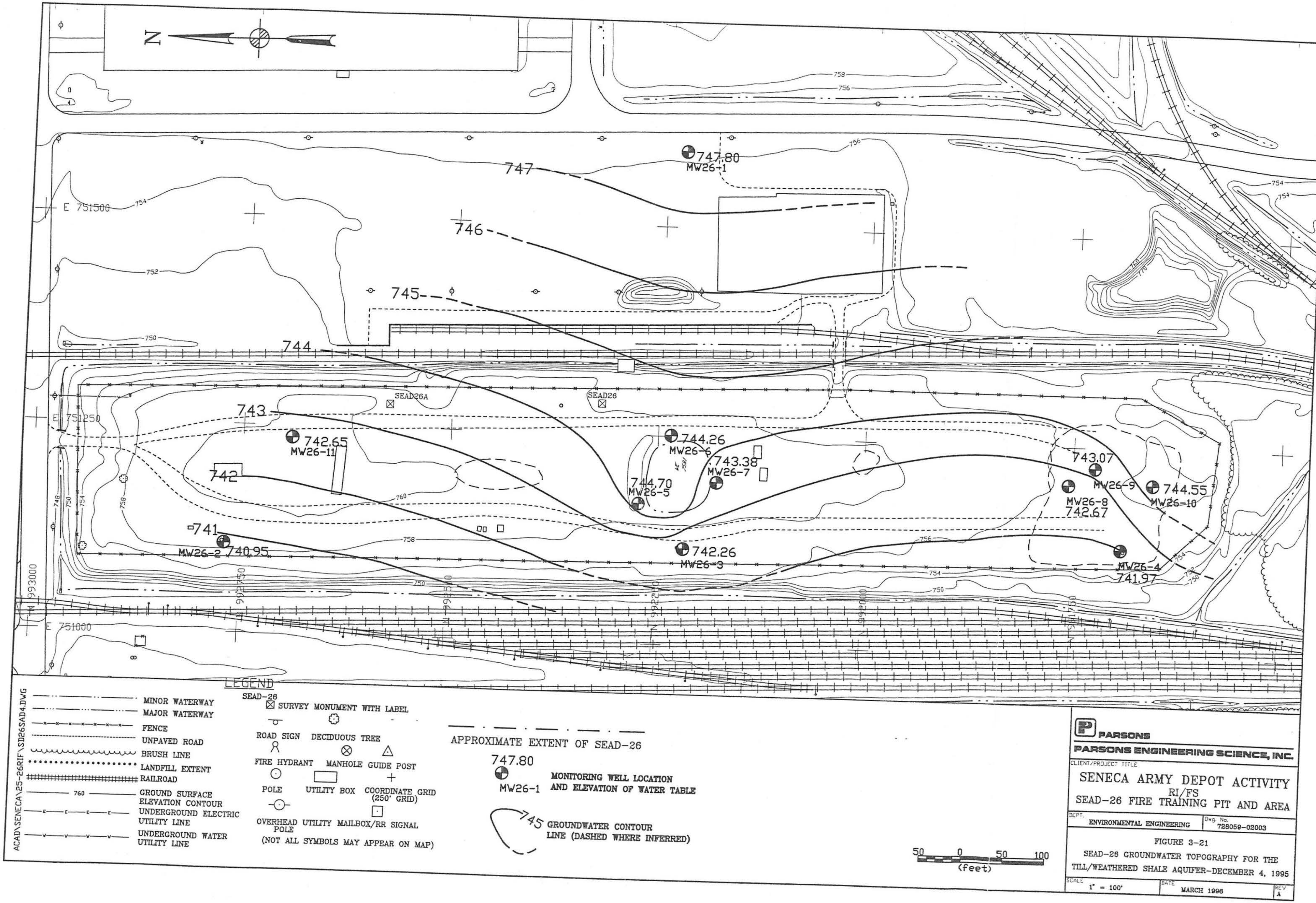


FIGURE 3-20
SEAD-26 GROUNDWATER TOPOGRAPHY FOR THE TILL/WEATHERED SHALE AQUIFER-NOVEMBER 4, 1995



N
747.80
MW26-1
747
746
745
744
743
742
741
742.65
MW26-11
744.26
MW26-6
743.38
MW26-7
744.70
MW26-5
743.07
MW26-9
744.55
MW26-10
MW26-8
742.67
MW26-2 740.95
742.26
MW26-3
MW26-4
741.97
SEAD26A
SEAD26
E 751500
E 751250
E 751000
LEGEND
MINOR WATERWAY
MAJOR WATERWAY
FENCE
UNPAVED ROAD
BRUSH LINE
LANDFILL EXTENT
RAILROAD
GROUND SURFACE ELEVATION CONTOUR
UNDERGROUND ELECTRIC UTILITY LINE
UNDERGROUND WATER UTILITY LINE
SEAD-26
SURVEY MONUMENT WITH LABEL
ROAD SIGN
DECIDUOUS TREE
FIRE HYDRANT
MANHOLE
GUIDE POST
POLE
UTILITY BOX
COORDINATE GRID (250' GRID)
OVERHEAD UTILITY POLE
MAILBOX/RR SIGNAL
(NOT ALL SYMBOLS MAY APPEAR ON MAP)
APPROXIMATE EXTENT OF SEAD-26
MONITORING WELL LOCATION AND ELEVATION OF WATER TABLE
GROUNDWATER CONTOUR LINE (DASHED WHERE INFERRED)
50 0 50 100
(feet)
ACAD\SENECA\25-26RIF\SD26SAD4.DWG
PARSONS
PARSONS ENGINEERING SCIENCE, INC.
CLIENT/PROJECT TITLE
SENECA ARMY DEPOT ACTIVITY
RI/FS
SEAD-26 FIRE TRAINING PIT AND AREA
DEPT.
ENVIRONMENTAL ENGINEERING
Dwg. No.
728059-02003
FIGURE 3-21
SEAD-26 GROUNDWATER TOPOGRAPHY FOR THE TILL/WEATHERED SHALE AQUIFER-DECEMBER 4, 1995
SCALE
1" = 100'
DATE
MARCH 1996
REV
A

3.2.6.3 Hydraulic Conductivities in the Till/Weathered Shale and Fill Aquifer

Hydraulic conductivities were determined at 8 monitoring wells installed in the till/weathered shale and fill at SEAD-26. At three of the SEAD-26 monitoring wells, there was an insufficient amount of water to perform the slug tests. Hydraulic conductivities for all of the wells were calculated using the method described by Bouwer and Rice (1976) as described in Section 2.0. The data is presented in Appendix E. Table 3-10 presents the aquifer hydraulic conductivities for monitoring wells at SEAD-26 that were evaluated using the rising head slug test. Hydraulic conductivities on the site range from 1.5×10^{-3} cm/sec to 3.9×10^{-3} cm/sec with an average of 2.5×10^{-3} cm/sec. These values are approximately one order of magnitude higher than those in the till/weathered shale aquifer at SEAD-25 (and at the Ash Landfill and OB Grounds). It is possible that the fill component of the overburden is contributing to the overall higher conductivity values at SEAD-26. Published hydraulic conductivity values for till or representative materials are: 1) 0.49 m/day (5.67×10^{-4} cm/sec) for a repacked predominantly sandy till (Todd 1980), and 2) from 10^{-2} to 10^{-3} m/day (10^{-5} to 10^{-6} cm/sec) for representative materials of silt, sand, and mixtures of sand, silt, and clay (Todd 1980). No published hydraulic conductivity values for weathered shale were identified.

3.2.6.4 Velocity of Groundwater in the Till/Weathered Shale Aquifer

Using Darcy's Law, the average linear velocity of groundwater in the shallow till/weathered shale aquifer was calculated using average site hydraulic conductivities, effective porosity estimates, and on-site groundwater gradients. A porosity estimate for weathered fissile shale with large amounts of silt in the interstices could not be located in the literature. Therefore, a till effective porosity of 15 percent to 20 percent was used in the calculations, which assumes the till and silty weathered shale porosities are similar.

The average linear velocity of groundwater in the till/weathered shale aquifer was calculated using the method described by Darcy's Law. The Darcy equation for the average linear velocity (V) of groundwater flow (Freeze and Cherry 1979) is:

$$V = \frac{K \frac{dh}{dl}}{n}$$

Table 3-10

SEAD-26 Hydraulic Conductivity Values for Rising Head Slug Tests

SEAD-26 Remedial Investigation
Seneca Army Depot Activity

Well ID	Well Type (1)(2)	Hydraulic Conductivity, K (cm/sec)
MW26-1	T/WS	Not Determined (3)
MW26-2	T/WS & F	Not Determined (3)
MW26-3	T/WS & F	3.9E-03
MW26-4	T/WS & F	3.6E-03
MW26-5	T/WS & F	2.2E-03
MW26-6	T/WS & F	2.1E-03
MW26-7	T/WS & F	1.8E-03
MW26-8	T/WS & F	3.3E-03
MW26-9	T/WS & F	2.9E-03
MW26-10	T/WS & F	1.5E-03
MW26-11	T/WS & F	Not Determined (3)

Average K* for the Till/Weathered Shale & Fill Wells:	2.5E-03

Notes:
(1) T/WS = Till Weathered Shale Aqufier
(2) T/WS & F = Till Weathered Shale and Fill Aquifer.
(3) There was an insufficient amount of water in the well to run a valid slug test (i.e. less than 1 foot).
(4) K = Hydraulic conductivity (horizontal)
* Average K is the geometric mean

where:

K is the horizontal hydraulic conductivity (cm/sec);
n is the estimated effective porosity (percent); and
dh/dl is the hydraulic gradient.

For the calculation of groundwater flow velocity at SEAD-26 the input values used in the equation were: 1) an average hydraulic conductivity of 2.5 x 10^{-3} cm/sec (7.1ft/day), 2) an estimated effective porosity of 15 percent (0.15) to 20 percent (0.20), and 3) a groundwater gradient of 0.01 ft/ft. Total porosities for till samples from another location at SEDA ranged from 34.0 percent to 44.2 percent with an average of 37.3 percent. Therefore, an effective porosity of 15 percent to 20 percent was determined to be reasonable. Substituting the above-referenced values into the Darcy equation yields an average linear velocity of 0.355 feet/day (or 130 feet/year) at 20 percent effective porosity and 0.473 feet/day (or 173 feet/year) at 15 percent effective porosity. The actual velocity on-site may be locally influenced by more permeable zones possibly associated with differences in the porosity of the overburden.

3.2.7 Ecological Investigation

3.2.7.1 Introduction

The purpose of the Phase I ecological assessment is to develop a site description to address existing environmental conditions and to characterize local ecological resources. The ecological assessment section follows the requirements outlined as Step I and Step IIA of the October 1994 NYSDEC Division of Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites (FWIA). A preliminary evaluation of the potential for ecologic impacts is included in the assessment. This preliminary evaluation is based on the observed contaminant levels detected in various media at the site and the incidence of contaminants in habitats available to resident wildlife. References to fish, wildlife and vegetation in this section will be presented by common name only, with a listing of all corresponding scientific genus and species compiled in Tables 3-11 through 3-13. A

The characterization and description of the local wildlife habitat and ecological conditions within the radius of concern is presented in Section 3.2.7.2. Section 3.2.7.3 addresses the value of local habitats to both wildlife and humans. An evaluation of the potential for site attributable contaminants to adversely impact local ecology is presented in the Pathway Analysis, Section 3.2.7. B

Appendix C

NYSDEC PFC Groundwater Samples from Monitoring Wells Sample Protocol Revision 1.1

Collection of Groundwater Samples for Perfluorooctanoic Acid (PFOA) and Perfluorinated Compounds (PFCs) from Monitoring Wells Sample Protocol

Samples collected using this protocol are intended to be analyzed for perfluorooctanoic acid (PFOA) and other perfluorinated compounds by Modified (Low Level) Test Method 537.

The sampling procedure used must be consistent with the NYSDEC March 1991 SAMPLING GUIDELINES AND PROTOCOLS
http://www.dec.ny.gov/regulations/2636.html with the following materials limitations.

At this time acceptable materials for sampling include: stainless steel, high density polyethylene (HDPE) and polypropylene. Additional materials may be acceptable if proven not to contain PFCs. **NOTE: Grunfos pumps and bladder pumps are known to contain PFC materials (e.g. Teflon™ washers for Grunfos pumps and LDPE bladders for bladder pumps).** All sampling equipment components and sample containers should not come in contact with aluminum foil, low density polyethylene (LDPE), glass or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer. Standard two step decontamination using detergent and clean water rinse should be considered for equipment that does come in contact with PFC materials. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFC materials must be avoided. Many food and drink packaging materials and “plumbers thread seal tape” contain PFCs.

All clothing worn by sampling personnel must have been laundered multiple times. The sampler must wear nitrile gloves while filling and sealing the sample bottles.

Pre-cleaned sample bottles with closures, coolers, ice, sample labels and a chain of custody form will be provided by the laboratory.

1. Fill two pre-cleaned 500 mL HDPE or polypropylene bottle with the sample.
2. Cap the bottles with an acceptable cap and liner closure system.
3. Label the sample bottles.
4. Fill out the chain of custody.
5. Place in a cooler maintained at 4 ± 2º Celsius.

Collect one equipment blank for every sample batch, not to exceed 20 samples.

Collect one field duplicate for every sample batch, not to exceed 20 samples.

Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, not to exceed 20 samples.

Request appropriate data deliverable (Category A or B) and an electronic data deliverable.

Appendix D

USACE / DoD PFAS Guidance

(provided on the electronic

(CD) version of this report)

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT CHIEF OF STAFF FOR INSTALLATION MANAGEMENT
600 ARMY PENTAGON
WASHINGTON, DC 20310-0600

DAIM-ISE

SEP 04 2018

MEMORANDUM FOR

COMMANDER, ARMY MATERIEL COMMAND
DIRECTOR, NATIONAL GUARD BUREAU
COMMANDER, INSTALLATION MANAGEMENT COMMAND
CHIEF, U.S. ARMY RESERVE
CHIEF, BASE REALIGNMENT AND CLOSURE DIVISION

SUBJECT: Army Guidance for Addressing Releases of Per- and Polyfluoroalkyl Substances

1. References:

a. Memorandum, ASA(IE&E), 10 Jun 16, subject: Perfluorinated Compound (PFC) Contamination Assessment.
b. Memorandum, DASD(IE&E), 10 Jun 16, subject: Testing DoD Drinking Water for Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA).
c. Memorandum, DAIM-IS, 29 Aug 16, Department of Army Guidance to Address Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) Contamination
d. Department of Defense Instruction 4715.18, Emerging Contaminants, 11 Jun 09.
e. Department of Defense Instruction 4715.07,Defense Environmental Restoration Program (DERP), 21 May 13.
f. Department of Defense Manual 4715.20, Defense Environmental Restoration Program (DERP) Management, 9 Mar 12.
g. Memorandum, ACSIM, 16 Apr 08, subject: Army Environmental Compliance-Related Cleanup Policy Guidance.

2. This guidance applies to Active Army installations, Base Realignment and Closure installations, Army National Guard facilities, and U.S. Army Reserve facilities, and provides a consistent framework for addressing historic releases of perflurooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and any other per- and polyfluoroalkyl substances (PFAS) on Army Installations with Army and DoD approved regulatory standards or advisories applicable to Army facilities. It includes instructions for identifying the Army's inventory of sites where releases of PFAS may have occurred and for prioritizing sites for future investigations and response actions. It also includes guidelines for applying risk-based criteria during the cleanup process and requirements for sampling and analysis.

3. Further, this guidance applies to all Army-owned property. In cases where an environmental regulator, Federal Land Manager, or other stakeholder requests the Army to investigate known or suspected releases of PFAS on transferred property (e.g., BRAC and non-BRAC excess locations), the Army will evaluate the request on a site-specific basis. Such requests shall be sent through the chain of command, with input from the respective Staff Judge Advocate, to the Office of the Assistant Chief of Staff for Installation Management, Installation Services Directorate, Environmental Division (OACSIM Environmental Division) for resolution.

4. Due to the uncertainty in the regulatory and legal environment surrounding PFAS in general this guidance is subject to frequent updates.

5. My point of contact for this action is Mr. Malcolm Garg, (571) 256-9709 or malcolm.j.garg.civ@mail.mil.

COL Mary C. Williams-Lynch

Encl

MARY WILLIAMS-LYNCH
COL, EN
Chief, Army Environmental Programs

CF:
DASA(ESOH) (SAIE-ESOH)
APHC (MCHB-IP-EWS)
HQDA OTJAG (Environmental Law Division)

Army Guidance for Addressing Releases of Per- and Polyfluoroalkyl Substances (PFAS)

September 2018

1. REFERENCES:

a. Memorandum, ASA(IE&E), 10 Jun 16, subject: Perfluorinated Compound (PFC) Contamination Assessment.

b. Memorandum, DASD(IE&E), 10 Jun 16, subject: Testing DoD Drinking Water for Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA).

c. Memorandum, DAIM-IS, 29 Aug 16, Department of Army Guidance to Address Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) Contamination

d. Department of Defense Instruction 4715.07 Defense Environmental Restoration Program (DERP), 21 May 13.

e. Department of Defense Instruction (DoDI) 4715.18, Emerging Contaminants, 11 Jun 09

f. Department of Defense Manual 4715.20 DERP Management, 9 Mar 12.

g. Memorandum, Assistant Chief of Staff for Installation Management, subject: Army Environmental Compliance-related Cleanup (CC) Policy Guidance, 16 Apr 08.

2. PURPOSE AND SCOPE:

This guidance applies to Active Army installations, Base Realignment and Closure installations, Army National Guard facilities, and U.S. Army Reserve (USAR) facilities when planning and implementing environmental response actions to address releases of per- and polyfluoroalkyl substances (PFAS) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. While PFAS is not a CERCLA hazardous substance, it is a pollutant or contaminant, so CERCLA investigations and potential response actions may be required when a PFAS release presents an imminent and substantial threat to human health. PFAS is also not a hazardous substance under the Resource Conservation and Recovery Act (RCRA), so any installations and facilities subject to RCRA corrective action would still conduct any PFAS investigations under the Army's CERCLA authority.

3. BACKGROUND:

a. PFAS are a diverse group of compounds resistant to heat, water, and oil. For decades, they have been used in hundreds of industrial applications and consumer products such as carpeting, apparel, upholstery, food paper wrappings, fire-fighting foams, and metal plating. PFAS have been detected both in the environment and in the blood samples of the general U.S. population. These chemicals are persistent, and resist degradation in the environment. They also bioaccumulate, meaning that their concentration increases over time in the blood and organs. At high concentrations, certain PFAS have been linked to adverse health effects in laboratory animals that may reflect associations between exposure to these chemicals to include health problems such as low birth weight, delayed puberty onset, elevated cholesterol levels, and reduced immunologic responses to vaccination. (Reference: https://www.epa.gov/chemical-research/research-and-polyfluoroalkyl-substances-pfas)

b. The suite of chemicals known as PFAS includes, but is not limited to, the following:

(1) perfluorooctanesulfonic acid (PFOS, CASRN 1763-23-1),
(2) perfluorooctanoic acid (PFOA, CASRN 335-67-1),
(3) perfluorobutanesulfonic acid (PFBS, CASRN 375-73-5),
(4) perfluorodecanoic acid (PFDA CASRN 83-89-6),
(5) perfluorododecanoic acid (PFDoA, CASRN 307-55-1),
(6) perfluoroheptanoic acid (PFHpA, CASRN 374-85-9),
(7) perfluorohexanesulfonic acid (PFHxS, CASRN 355-46-4),
(8) perfluorohexanoic acid (PFHxA, CASRN 307-24-4),
(9) perfluorononanoic acid (PFNA, CASRN 375-95-1),
(10) perfluorotetradecanoic acid (PFTA, CASRN 376-06-7),
(11) perfluorotridecanoic acid (PFTrDA, CASRN 72629-94-68),
(12) perfluoround ecanoic acid (PFUnA, CASRN 2058-94-8),
(13) perfluorodecane sulfonate (PFDS, CASRN 335-77-3)
(14) perfluorobutanoic acid (PFBA, CASRN 375-22-4)
(15) perfluorooctane sulfonamide (PFOSA, CASRN 754-91-6)
(16) perfluoropentanoic acid (PFPeA, CASRN 2706-90-3)
(17) n-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA, CASRN 2991-50-6),
(18) n-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA, CASRN 2355-31-9).

c. In May 2016, the U.S. Environmental Protection Agency (EPA) issued a Lifetime Health Advisory (LHA) for PFOS and PFOA, singly or combined, of 0.07 micrograms per liter (µg/L) or 70 nanograms per liter (ng/L) or 70 parts per trillion (ppt) in drinking water. In addition to the USEPA LHA, some states are issuing regulatory standards of their own in multiple media, not just for PFOS and PFOA but other PFAS as well.

d. At Army installations, the primary mechanism for releases of PFAS is through the historic use (post-1972) of Aqueous Film Forming Foam (AFFF), a product applied during firefighting and firefighting-related training. AFFF for firefighting was, and is, generally used in areas where fuel- or petroleum-based fires may have occurred; such as in the vicinity of aviation assets, fuel farms, or aircraft crash sites. The Army's current practice is not to use AFFF for petroleum-based training fires. Other known sources of environmental releases of PFAS include mist suppressants for chrome plating operations and landfills and wastewater treatment plants that have inadvertently accepted PFAS containing materials.

4. STRATEGY:

The Army has begun conducting historical records reviews to identify locations where there is a potential for a release of PFAS. Locations on Army installations with the greatest likelihood of releases of PFAS include fire training areas, AFFF storage locations, aircraft crash sites, fuel farms and sites associated with aviation assets. The Army will assess and investigate potential releases and implement necessary response actions in accordance with CERCLA to ensure that there are no human health-based exposures above the CERCLA risk-based values or the LHA in drinking water. Response actions at sites meeting eligibility requirements per DoD Manual 4715.20 may be implemented using Defense Environmental Restoration Program (DERP) funding; all activities determined to be ineligible for DERP funding will be investigated under the Compliance-related Cleanup (CC) Program.

5. INVENTORY AND PRIORITIZATION:

a. The Army shall review and identify potential sites where PFAS releases may have occurred. Consistent with the DoD's "worst first" approach, potential PFAS release sites will be prioritized and sequenced along with other DERP or CC sites for further action based on risk, with higher risk sites being addressed before lower risk sites, in consideration of other factors. Sites where human exposure to contaminated drinking water exists will be addressed first and as quickly as possible (e.g., treatment at the distribution point, such as well head treatment, or by providing bottled water under a Time-Critical Removal Action) to eliminate the exposure, and will be subsequently prioritized and sequenced to conduct the investigations and response actions necessary to characterize and, if necessary, remediate the source of PFAS contamination.

Potential Army locations where releases of PFAS may have occurred and which merit evaluation include:

- Current or former fire training areas (FTAs) where AFFF is known or suspected to have been applied, including sites at Response Complete (RC) after completion of CERCLA response actions to address contaminants other than PFAS (e.g., petroleum hydrocarbons and semi-volatile organic compounds).
- Current or former AFFF storage locations.
- Aircraft crash sites where AFFF may have been applied for fire control.
- Aviation hangars and other buildings where AFFF is or was used in the fire suppression system and where a release may have occurred.
- Plating facilities that may have used PFAS-containing mist suppressants.

- Landfills where PFAS-containing materials may have been disposed.

- Wastewater treatment plants that may have received wastewater from facilities that used or disposed of PFAS-containing liquid effluents.

b. All installations or facility environmental offices (or equivalent) are required to provide all PFAS drinking water sampling data to Army Public Health Center (APHC) so PFAS results can be entered into the DOEHRS database. Additionally, all installation and facility environmental offices (or equivalent) will maintain an inventory of drinking water wells where PFAS associated with past Army activities was detected. The Army has completed the testing of all Army-owned drinking water systems, to include single wells.

6. INVESTIGATIVE PROCESS:

The Army will conduct historical research of potential PFAS source areas and determine whether there is a CERCLA release requiring a response action. Initially, Preliminary Assessments (PAs) will be conducted at installations where AFFF or other PFAS-containing materials were used or stored as part of operational history based on the prioritization process described in Section 5. Site Inspections (SI) will be conducted at sites where the PA identifies locations where further investigation is warranted to determine whether or not a release has occurred. If the SI indicates a release has occurred, a Remedial Investigation (RI) will be conducted to quantify the nature and extent of contamination; in some cases, an “expanded Site Inspection” may be appropriate and will be a site-specific decision. As noted in Section 5 sites will be prioritized and sequenced for further action along with other sites in the DERP or CC inventory based on risk, with higher risk sites being addressed before lower risk sites after considering potential exposure routes. For example, SIs for sites where no human drinking water exposure is expected may potentially be delayed to allow investigation of sites with the potential for human drinking water exposure. Similarly, RIs will be prioritized to focus on those facilities where the SI indicates human drinking water exposure is confirmed.

The PA shall be conducted on an installation-wide or facility-wide basis. If the site is determined to be DERP eligible, PFAS investigations or response actions may be funded through the Environmental Restoration, Army (ER,A) account. PA funding for DERP eligible sites will be reported as Program Management costs for end of year reporting. Project costs for newly identified sites will be tracked at the site level in Headquarters Army Environmental System (HQAES) once a SI phase or subsequent phase is deemed necessary. In addition to entering the necessary SI data to HQAES, a PA phase shall be added for each site using the start and end dates for the installation-wide PA.

PFAS investigations for sites that are not DERP eligible shall be conducted under the CC program with funding from the Operations and Maintenance, Army (OMA) account, Operations and Maintenance, National Guard (OMNG), or Operations and

Maintenance, Army Reserve (OMAR) account, as appropriate. CC sites requiring a SI will be added to HQAES and where appropriate, identify the need for future phases. If a new site requires CERCLA investigations or response actions beyond the SI phase, a cost-to-complete (CTC) estimate shall be prepared in accordance with the Army's FY17 CTC Guidance.

If additional investigation is required for a site where a response action has already occurred and the site is considered RC, an investigation phase for the site will be reopened, retaining the current site name and number in HQAES. In most cases, the site will be reopened at the SI phase; however, there may be instances in which sufficient data exists to move directly to an RI. The HQAES phase status for any post-investigation phase will be changed to "underway" to reflect the previous work conducted at the site. If PFAS were not considered to be constituents of concern (COCs) previously, but the PA determines that investigations are necessary for sites with ongoing investigations (e.g., SI or RI phases) or sites with ongoing response actions (e.g., RA-C or RA-O phase), the additional work shall be recorded in the current open HQAES phase. If an SI is required for a new site, the new site will be added to HQAES and included in the DERP or CC inventory.

7. EVALUATING HAZARDS AND TAKING ACTION:

a. The EPA established a reference dose (RfD) for both PFOA and PFOS of 0.02 µg/kg/day or 20 ng/kg/day. This equates to a Drinking Water Equivalent Level (DWEL) of 370 ng/L or 370 ppt for both PFOA and PFOS based on a lactating woman drinking water intake per day per body weight of 0.054 L/day/Kg (approximately three liters per day for a 60 kilogram individual). The LHA further assumes that 80% of exposure is derived through exposure via sources other than drinking water (e.g., food and air), leaving 20% allowable for drinking water exposure; therefore, the LHA is established at 70 ng/l or 70 ppt (74 ppt, rounded to 70 ppt). Further, the EPA determined that because the health effects for both PFOS and PFOA are similar the LHA of 70 ppt would combine (sum) both compounds.

b. The CERCLA process uses the RfD to determine non-carcinogenic hazard. In the case of PFOA and PFOS, the RfDs are equivalent. When assessing the hazard not associated with human drinking water exposure, the individual RfDs will be used (equates to 370 ppt in water) and will not be combined. When evaluating hazard against human drinking water exposure, the LHA of 70 ppt will be used and PFOS and PFOA concentrations will be combined. Currently, PFBS is the only other PFAS with a toxicity value meeting the requirements of Ref 1.d for CERCLA risk assessments. - Evaluating risks or hazards for PFAS other than PFOS and PFOA will be conducted in accordance with Ref 1.d.

c. It should be noted that the EPA also established a cancer oral slope factor (OSF) for PFOA, however the non-carcinogenic RfD led to a lower DWEL and therefore the RfD was used as a basis for the LHA. For PFOS, EPA determined that the evidence did not support the development of a cancer OSF.

d. Some states have issued their own standards for individual PFAS chemicals, while others have similar actions underway that are still working through the legislative and/or regulatory process. State promulgated PFAS standards reviewed and approved by DoD will be considered Applicable or Relevant and Appropriate Requirements (ARARs) during the Army's CERCLA investigations and actions; however, many states and/or regulatory bodies have non-promulgated health advisories (HAs) or similar. While the DoD and Army are acting on EPA's LHA of 70 ppt for combined PFOS/PFOA for drinking water and have committed to using the CERCLA process to address any releases, non-promulgated, non-enforceable state standards will not be considered ARARs. Requests for an exception should be submitted through the chain of command, with input from the respective Staff Judge Advocate, to the Office of the Assistant Chief of Staff for Installation Management, Installation Services Directorate, Environmental Division (OACSIM Environmental Division); if the exception is approved, these criteria will be classified as "to be considered" (TBC) values in the ARARs analysis.

e. If an environmental regulator requests PFAS sampling as part of a CERCLA response action at sites where the operational history does not suggest that PFAS-containing materials were used or stored, the issue should be elevated through the chain of command, to OACSIM Environmental Division for resolution.

f. Currently there is no guidance or obligation to assess for ecological risk; however, the human health risk from ingestion of fish, livestock, and plants; as well as water and soil, should be considered in accordance with Ref 1.d.

8. ANALYTICAL METHODS:

Drinking water analysis for PFAS shall only be performed using DoD Environmental Laboratory Accreditation Program (ELAP) accredited laboratories and shall use EPA Method 537, Rev. 1.1. All PFAS analytes that are available through this method should be reported. EPA Method 537, Rev. 1.1 currently includes 14 analytes; in the event that additional analytes are added to EPA Method 537 in the future, the new analytes shall be reported going forward if determined to be constituents of concern on a site-specific basis. Any additional PFAS analyte determined to be a site-specific constituent of concern should also be added to the list of compounds the laboratory is requested to report. All compounds to be reported should be on the laboratory's ELAP scope of accreditation.

Analysis for all other matrices (i.e., groundwater, surface water, soil, and sediment) shall be performed by an ELAP accredited laboratory using a liquid chromatography tandem mass spectrometry (LC/MS/MS) method that is on the laboratory's ELAP scope of accreditation and is compliant with the requirements in the DoD Quality Systems Manual (QSM) for Environmental Laboratories (the QSM version to which the laboratory is currently accredited (e.g., QSM version 5.1.1, Table B-15)). All PFAS analytes that are on the laboratory's ELAP scope of accreditation should be reported and must include at least the analytes listed in EPA 537. Additional analytes that are added to EPA Method 537 in the future shall be reported going forward if determined to be site-specific constituents of concern. Any additional PFAS analyte determined to be a site-specific constituent of concern should also be added to the list of compounds the laboratory is requested to report. All compounds to be reported should be on the laboratory's ELAP scope of accreditation.

It should be noted that PFAS analysis is improving and method revisions, or new methods, are likely to come into existence in the near future. In all cases, the laboratory must be ELAP accredited, have the method and reported analytes on the laboratory's ELAP scope of accreditation, and be in compliance with the version of the DoD QSM to which the laboratory is accredited.

DoD Environmental Laboratory Accreditation Program (ELAP) accredited labs for PFAS (PFC) analysis may be found at:
https://www.denix.osd.mil/edqw/accreditation/accreditedlabs

9. INVESTIGATION-DERIVED WASTE (IDW):

Waste containing PFAS is not classified as a characteristic or listed hazardous waste based solely on the presence of PFAS chemicals; however, given the potential for future liability, it is recommended that project teams design investigations to minimize generation of IDW.

Solid IDW may be disposed as non-hazardous solid waste. Investigators should clearly note the presence of PFAS on waste manifests for full disclosure of contents. For liquid IDW (e.g., purge water), a sample shall be analyzed using EPA Method 537 (Modified) prior to disposal. If the combined concentration of PFOS/PFOA is less than 70 ppt, and assuming that no other contamination is present and no state or local regulation prohibits it, the water may be discharged to the sanitary sewer after disclosing the nature and concentrations of PFAS constituents contained in the liquid IDW to the local wastewater authority and after obtaining a recordable authorization from the authority. Liquid IDW with a combined PFOS/PFOA concentration greater than 70 ppt shall be held pending written authorization by the facility director of the treatment plant that will receive the liquid. If no treatment facility is available then disposing liquid IDW as liquid non-hazardous waste at an EPA approved Subtitle-D Industrial Waste Landfill or equivalent facility capable of processing liquid non-hazardous waste should be considered; written authorization and acceptance of the PFAS containing IDW should be obtained from the landfill. Additionally, treatment of liquid IDW to bring the waste to acceptable disposal levels may be conducted.

APPENDIX A

Frequently Asked Questions (FAQs) for Army Programs

(These FAQs are not intended to be used for public affairs)

General/Definitions

Q1. What are emerging contaminants (ECs)?
A1. There is no single, consensus definition of ECs across agencies; different organizations (e.g., DoD, EPA, state agencies) have differing definitions of ECs, and thus, possibly different chemicals identified as ECs.

DoD defines an EC as: (1) Has a reasonably possible pathway to enter the environment; (2) Presents a potential unacceptable human health or environmental risk; and (3) Does not have regulatory standards based on peer-reviewed science, or the regulatory standards are evolving due to new science, detection capabilities, or pathways. (https://www.denix.osd.mil/cmrmp/ecmr/ecprogrambasics/)

EPA's definition is: "An 'emerging contaminant' is a chemical or material that is characterized by a perceived, potential or real threat to human health or the environment or by a lack of published health standards." (EPA 2014a)

Q2. Is it reasonable to assume that PFAS will be present at my site?
A2. If the conceptual site model (CSM) suggests that AFFF was released into the environment, it is likely that a variety of PFAS will be present at the site. Because PFAS is widely used throughout much of the world, varying levels of PFAS are anticipated. At DoD facilities, one of the primary sources of environmental PFAS will be areas where AFFF was used for activities related to firefighting (e.g., fire training areas, runways, crash sites, hangars, fuel farms, where fires or accidental releases of AFFF occurred, equipment testing and washout areas, oil-water separators or other piping systems where released AFFF may have flowed). Sludge in oil-water separators at hangars and sludge from sewage treatment at Army flight lines could potentially contain PFAS.

AFFF is the name on the Military Specification (MIL-SPEC) for the firefighting foam commonly used for hydrocarbon (e.g., fuel) and electrical fires; however, fluorinated foams by any name should be noted in the investigations and their ingredients identified, if known.

Additionally, PFAS were sometimes included in mist suppressants which may have been used in plating baths for hard chrome plating. Low concentrations of PFAS have also been identified in effluent from wastewater treatment plants and in landfill leachate. The historical research aspect of the installation-wide investigation should identify any source of PFAS.

Q3. What are the similarities and differences between AFFF formulations that I need to know about for my site?

A3. AFFF formulations used at DoD facilities differ in their chemical composition. Each formulation is comprised of various individual PFAS at varying individual concentrations. Formulations used at DoD facilities are listed on the Qualified Products List (QPL). To be listed on the QPL, formulations must meet the requirements of the DoD MIL-SPEC for AFFF. Every formulation listed on the QPL must be compatible with all other formulations that are currently listed on the QPL. This allows for the mixing of different formulations without introducing performance issues. Because of this, vessels such as firefighting vehicles containing a formulation were not typically drained and cleaned prior to introducing a different formulation. In addition, some formulations contained such high concentrations of some PFAS that conventional cleaning protocols would not eliminate them. As a result, the determination of potential for release of a particular PFAS should be partially based on AFFF usage, not usage of a particular AFFF formulation.

Eligibility and Funding

Q4. Are PFAS considered Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) contaminants?
A4. PFAS, including PFOA and PFOS, are not listed as CERCLA hazardous substances and therefore have not historically been included in typical CERCLA/DERP environmental investigations. Though not a CERCLA hazardous substance, PFAS are considered a CERCLA pollutant or contaminant.

PFAS fall within the definition of ECs contained in DoD Instruction 4715.18, and can be included in a DERP investigation if a reasonable basis exists to suspect a release may have occurred.

Q5. Can ER,A or BRAC funding be used to investigate and remediate PFAS?
A5. If the CSM indicates the use or release of AFFF or other industrial activities for which PFAS are associated, then ER,A, BRAC or CC funds can be used to investigate, and if necessary, perform restoration of media impacted by PFAS. However, ER,A or BRAC funds can only be used to address past releases of PFAS; ER,A or BRAC funds cannot be used to investigate/remediate potential ongoing releases at active operations or at non-DERP eligible sites.

As with any EC, it can be challenging to reach concurrence on the potential risk and/or cleanup levels for contaminants with limited toxicity information, such as PFAS (see Risk Assessment section). Therefore, RPMs will coordinate within the environmental chain of command and the appropriate Offices of Counsel before agreeing to cleanup levels to ensure the most current scientific/technical information is being appropriately considered.

Q6. What if the site has achieved Response in Place (RIP), Response Complete (RC) or Site Closure (SC)?
A6. If a site has already been investigated and achieved RIP, RC or SC, then any additional investigation should only be initiated after careful consideration, with

adequate justification, and with concurrence from the respective ER Manager (for ER,A) or Base Environmental Coordinator (for BRAC). Existing sites will be re-opened in lieu of adding a new site (refer to the OSD re-opener policy memorandum, *Revised Site Management*, 22 Aug 2016). Installations will send a Memorandum for Record (MFR) to Headquarters, Department of the Army (HQDA) to notify of re-opened sites. In situations where the Army is not in control of the property (i.e., a transferred property) and is requested to investigate for PFAS the issue will be brought up to HQDA through the chain-of-command and will be resolved on a site specific basis. To consider sampling a site for PFAS, the CSM must be well understood and strongly suggest there is reason to believe these chemicals have impacted environmental media in areas where exposure can occur.

<u>Sampling and Analysis</u>

Q7. Are there special sampling techniques for these chemicals?
A7. Yes, special sampling techniques should be used. PFAS are a class of manufactured compounds that are extensively used in a variety of industrial and commercial products to make items more resistant to stains, grease and water. Some of these products could be present and/or used during a routine sampling event, such as plastic bags and bottles, waterproof clothing, detergents and waterproof pens and paper. The use of any of these products could contaminate the samples during sample collection. This includes what is used to prepare the sampling site, what is used to collect the sample, what is used to clean the sampling equipment, what the sample is collected in and how the sample is shipped.

Several precautions should be taken during sample collection to avoid inadvertent sample contamination:

- Post It Notes® should not be used at any time during sample handling, or mobilization/demobilization.
- Personnel involved with sample collection and handling should avoid wearing new clothing (e.g., at least six washings since purchase; no softening agents used during washing/drying).
- Personnel involved with sample collection and handling should not wear water resistant clothing or shoes/boots immediately prior to or during sample collection.
- Personnel involved with sample collection and handling should not wear Tyvek® suits.
- Personnel involved with sample collection and handling should wear nitrile gloves at all times while collecting and handling samples.
- Many food and snack products are packaged in wrappers treated with PFAS. Therefore, hands will be thoroughly washed after handling fast food, carryout food or snacks.
- Pre-wrapped food or snacks (like candy bars, microwave popcorn, etc.) must not be in the possession of sampling personnel during sampling or handling for shipping.
- Blue Ice® must not be used to cool samples or used in sample coolers.
- Products containing Teflon®-containing materials should be avoided (e.g.,

tubing, bailers, tape and plumbing paste). In cases where Teflon®-containing materials are unavoidable, ensure adequate purging is performed prior to sampling (e.g., in-well pumps) and/or collect rinse blanks prior to sampling.

Sample bottles should be obtained from the laboratory performing the analysis. DoD ELAP-accredited laboratories are required to ensure the sample bottles provided to clients have been verified as clean (meet the acceptance criteria for blanks for analysis). Drinking water samples must be collected in accordance with EPA Method 537. EPA Method 537 requires drinking water samples to be collected in polypropylene bottles with a polypropylene screw cap. All other samples must be collected in a high-density polyethylene (HDPE) container with an unlined plastic screw cap.

More information on sampling can be found in the DoD Environmental Data Quality Workgroup (EDQW) PFAS Sampling-Fact Sheet, Rev. 1.2, November 2016. (http://www.denix.osd.mil/edqw/home/)

Q8. What analytical method should be used for drinking water samples?
A8. Drinking water samples must be analyzed by EPA Method 537, which currently lists 14 perfluoroalkyl acids, including PFOS and PFOA.

Q9. What analytical methods are currently available for other media?
A9. There currently are no published EPA methods for media other than drinking water. DoD ELAP laboratories have modified EPA Method 537 for the other media (i.e., groundwater, surface water, sediment, soil) and expanded the analyte list to include other PFAS. These modified methods are the methods that are currently recommended for all matrices other than drinking water. DoD ELAP requirements for these modified methods can be found in the DoD Quality Systems Manual (QSM), Version 5.1.1, Appendix B, Table B-15. A copy of the DoD QSM, Version 5.1.1 can be found under the heading "What's New" on the EDQW page on the DENIX website: http://www.denix.osd.mi1/edqw/home/.

Total Oxidizable Precursor (TOP) assay: In addition to the compounds being analyzed consideration should be given to polyfluorinated compounds or 'precursor' compounds that can biotransform into end-state perfluoroalkyyl acids (PFAAs) like PFOS and PFOA. Such 'precursor' compounds can often explain a detection of PFOS/PFOA where no source is known. A new method, the TOP assay, can help measure the concentration of difficult to measure PFAS compounds that are not determined by conventional analytical methods. The TOP method is relatively expensive when compared to the current conventional analytical methodology and should be used sparingly during a remedial investigation (RI) stage or, when a detection cannot be adequately explained with a source/pathway.

Particle Induced Gamma Ray Emission (PIGE): PIGE analysis can be useful during the remedial design phase to determine total mass loading for different technologies (e.g., GAC treatment), and is also available for field lab analysis that can be used for delineation purposes similar to FID/PID readings used for high resolution site characterization (HRSC) direct push units.

Q10. Are there any DoD ELAP-accredited laboratories that can perform PFAS analysis?
A10. Yes, there are DoD ELAP-accredited laboratories that can provide EPA Method 537 and modified EPA Method 537. A list of DoD ELAP accredited laboratories can be found on DENIX at: https://www.denix.osd.mil/edqw/accreditation/accreditedlabs. A list of DoD ELAP laboratories that are currently accredited to perform analysis of drinking water samples by EPA Method 537 can be generated by performing a method search for "EPA 537." A list of DoD ELAP laboratories that are currently accredited to perform analysis of other media in accordance with the requirements of DoD QSM Version 5.1.1 can be generated by performing a method search for "PFAS by LCMSMS Compliant with QSM 5.1.1 Table B-15".

The DENIX database should be used as a starting point when selecting a laboratory for a project. It does not provide all information needed (e.g., analyte lists for methods). To ensure the laboratory you select is accredited for your project analytes, the project manager/chemist must review the laboratory's scope of accreditation, which is found on their accreditation body's website.

The DoD ELAP accredited laboratory database can be found by following the link under the heading "Search Accredited Labs" on the EDQW page on the DENIX website: http://www.denix.osd.mil/edqw/home/ or at https://www.denix.osd.mil/edqw/accreditation/accreditedlabs

Q11. Is there a difference between how aqueous samples (not including drinking water samples) are prepared and analyzed when the sample contains a high concentration of PFAS, versus low concentrations of PFAS?
A11. Yes, samples containing a high concentration of PFAS, such as AFFF formulations, must be prepared by serial dilution using an aliquot of the sample received and analyzed by direct injection of the serial dilution. Each sample is required to be prepared and analyzed in this manner in duplicate; therefore, two analytical results are reported for each sample.

Preparation of samples not containing high concentrations of PFAS utilizes the entire sample that was collected in the field. The entire sample is extracted using a solid phase extraction process and an aliquot of the extract is analyzed. No duplicate is performed in laboratory analysis on these samples.

To determine which category a sample falls into, laboratories screen each sample. In order to not affect the final result of low concentration samples, it is recommended that a smaller bottle (e.g., 75-125 mL versus 250 mL) be collected for screening purposes alongside the routine sample volumes in the field. If samples are collected that are known to contain high concentrations of PFAS, this should be clearly noted on the chain of custody (CoC) that is sent with the samples to the laboratory.

Requirements for both processes are included in the DoD QSM, Version 5.1.1, Appendix B, Table B-15.

Q12. Is there a standard target analyte list for PFAS investigations?
A12. For drinking water analysis, yes. Method 537, Rev 1.1 currently includes the following 14 compounds:

- N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
- N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)
- Perfluorobutanesulfonic acid (PFBS)
- Perfluorodecanoic acid (PFDA)
- Perfluorododecanoic acid (PFDoA)
- Perfluoroheptanoic acid (PFHpA)
- Perfluorohexanesulfonic acid (PFHxS)
- Perfluorohexanoic acid (PFHxA)
- Perfluorononanoic acid (PFNA)
- Perfluorooctanesulfonic acid (PFOS)
- Perfluorooctanoic acid (PFOA)
- Perfluorotetradecanoic acid (PFTA)
- Perfluorotridecanoic acid (PFTrDA)
- Perfluoround ecanoic acid (PFUnA)

When drinking water is analyzed, results for these compounds should be reported by the laboratory.

Since currently there is no "standard" laboratory method for matrices other than drinking water, laboratories have made modifications to Method 537, Rev. 1.1 to address other media such as soil, groundwater and sediment. These modifications are not standardized among laboratories and therefore, neither are the lists of analytes that are detected. Currently laboratories using modified Method 537, Rev. 1.1 may analyze for 14 to 30 compounds. The Army is currently collecting 18 PFAS compounds (listed in Section 3b, p.3) for its PA/SI effort.

The Army's direction is to apply the LHA to actual drinking water sampling to identify the need for further evaluation. Other media, such as groundwater and soil, should be addressed on a site-specific basis; however, to avoid delays in receipt of results used to assess current exposure, it is recommended that only those PFAS with EPA derived toxicity values (i.e., currently PFOA, PFOS and PFBS) be requested for expedited turn-around time and expedited data validation. Since the other compounds are not being used to make decisions, receipt of those data do not need to be expedited. ·Data evaluation, validation and site management decisions should be based on the DQOs for the site, which should include only the analytes with toxicity values. All other PFAS analytes should be placed in an appendix of the report.

Investigation

Q13. What should an installation-wide PA/SI include?
A13. An installation-wide PA/SI should identify all areas on the installations where AFFF is or was stored, used, released, disposed, etc. Unfortunately, historical documentation of AFFF use and releases is often incomplete because records were not required; therefore, in addition to document reviews, interviews will be crucial to understanding past practices and identifying the potential for environmental releases. The installation fire department should be contacted to determine if the installation currently or historically used AFFF, and to identify locations where it has been used (e.g., training, crashes, etc.). Coordination with the Water Program Media Managers, Spill Program Managers, and the regional Army On-Scene Coordinators (AOSC) will also provide information on AFFF releases/spills. AFFF that was stored or released at installations may have migrated to the subsurface; therefore, potential PFAS-impacted soil or sediment may be an ongoing source for PFAS impacts to groundwater and/or surface water.

Although AFFF is considered the primary source of PFAS at Army installations, PFAS are also found in a variety of other materials/processes, including chromium plating bath mist suppressant, wastewater treatment plant biosolids/effluent, sludge drying beds and landfill leachate.

Identification of sites will be based on the review of existing information about use and disposal practices at the installation and may include limited field data to determine the nature of any releases and potential threat to receptors. Consideration should be given to: 1) areas where firefighting exercises were conducted; 2) areas where fire suppression infrastructure exists or existed (e.g., fire stations, AFFF equipment storage areas and former pump houses); 3) unplanned release areas such as crash sites, equipment cleaning discharge locations, fire suppression systems located at fuel storage areas, also at installation sites where large fires occurred (e.g., large warehouse fires, etc.); 4) areas where chromium electroplating operations were performed; 5) landfill and waste disposal areas receiving waste streams containing PFAS; 6) areas where waste material and sludge from wastewater treatment plants was disposed

To evaluate the threat to human receptors, the PA/SI should include information on groundwater gradients, topographic maps, locations of drinking water wells and maps illustrating the relative positions of potential sites to drinking water wells.

Q14. What should be expected regarding fate and transport of PFAS?
A14. Current sampling results indicate that the highest groundwater concentrations will likely be found near the source area and diminish with distance. Preliminary research data suggest that individual PFAS may differ in their affinity for each matrix as well as their rates of migration from a source. Although PFAS are very water soluble, some PFAS have been found in soils at FTAs that have been closed for years.

Because of the potential of numerous anthropogenic PFAS background sources it is recommended to have a thorough background sampling regimen to be able to differentiate between background PFAS and PFAS releases emanating from an Army facility.

Polyfluorinated compounds or ‘precursor’ compounds found in AFFF can be biotransformed into end-state perfluoroalkyyl acids (PFAAs) (PFOA in particular) as a result of oxidation. This can result in PFOA/PFOS concentrations in areas not easily described through a source/pathway interaction if ‘precursors’ are not evaluated.

Due to the emerging status and complex chemistries, a clear picture of environmental fate and transport is not available at this time. In an effort to begin answering some of these questions, DoD has funded several Strategic Environmental Research and Development (SERDP) and Environmental Security, Testing, and Certification Program (ESTCP) projects related to this topic.

Q15. What if PFAS may have reached a drinking water source?
A15. If, during an investigation, a potential for drinking water exposure to any on- or off-installation human receptor is identified, the installation should immediately: 1) notify the command chain, up to and including HQDA; 2) gain approval to initiate appropriate notifications; 3) implement drinking water sampling of affected properties and 4) have a drinking water distribution contingency plan in place (i.e., bottled water).

The Army Environmental Command in coordination with Army Public Health Center is the repository for all DA-approved notification/communication resources regarding this issue, to include notification templates and fact sheets developed specifically for potentially affected populations. This office can be reached by calling 210-466-1590 and by email to usarmy.jbsa.aec.mbx@mail.mil.

If PFOA and/or PFOS are confirmed in drinking water above the EPA LHAs, immediate actions must be taken to notify affected individuals and reduce/eliminate the exposure. For immediate response, this typically involves providing alternate (e.g., bottled) water for drinking, cooking and any consumption, until a long-term solution is implemented.

If drinking water wells have been impacted, but do not have levels of PFOA and/or PFOS above the EPA LHA, then a site-specific decision needs to be made regarding continued monitoring until a long-term solution is implemented. Consideration should be given to the Army’s facility monitoring schedule for when the PFOS/PFOA level is detected above the method reporting limit but below the LHA sampling will occur quarterly for one year and once every two years thereafter.

Currently DoD is only addressing PFOS and PFOA. Some states are beginning the process to regulate other PFAS in water (both drinking water and/or groundwater). If PFAS other than PFOS and PFOA are affecting a drinking water purveyor the issue should be elevated through the chain of command to ACSIM-ISE for resolution.

Restoration activities evaluating risks or hazards for PFAS other than PFOS and PFOA will be conducted in accordance with Ref 1.d (4715.18, Emerging Contaminants).

Q16. What if a release is suspected to have migrated offsite?
A17. If the CSM indicates that a historical release may have migrated offsite, then sampling may need to be initiated offsite to identify nature and extent and potential complete exposures. The most significant concern is the potential impact that offsite migration would have on drinking water wells in the vicinity. In this instance, ER Managers (for ER,A) or Base Environmental Coordinator (for BRAC), the installation's chain of command, and HQDA should be notified and sampling should be expedited if potentially complete exposures are expected. Coordination with legal, real estate, and possibly regulators will be needed to gain right of entry access agreements to private properties. The nature and extent of the off-site sampling will be site-specific and will depend on the CSM, sample results, concentration of off-site wells and other site-specific considerations. If drinking water is potentially affected the actions listed in paragraph 1 of A15 should be followed.

Q17. Should a PFAS investigation be carried out at a site where foam was used but there are no records supporting that the foam formulation contained PFAS?
A17. Yes, for the following reasons: 1) Current understanding is that any AFFF formulations on the QPL may include perfluoroalkyl substances like PFOA; 2) AFFF formulations likely also contain polyfluoroalkyl substances, some of which have the potential to degrade into the perfluoroalkyl substances, including PFOA; 3) the polyfluoroalkyl substances may possess toxicity; and 4) the equipment used to deliver AFFF may still contain small amounts of older product from previous refills. Reported uses of "protein foam" were typically "fluoroprotein foam" which contained other fluorinated surfactants, including PFOS. Given the different formulations used, it is recommended that PFAS investigations should also include sites that only report uses of "protein foam" or "fluoroprotein foam".

Q18. How should investigation-derived waste (IDW) at PFAS sites be disposed?
A18. Environmental investigations at potential PFAS sites will generate IDW. Waste containing PFAS is not classified as a characteristic or listed hazardous waste based solely on the presence of PFAS chemicals. However, given the potential future liability, it is recommended that project teams design investigations to minimize IDW generation.

Solid IDW may be disposed as non-hazardous solid waste. Investigators should clearly note the presence of PFAS on waste manifests for full disclosure of contents. For liquid IDW (e.g., purge water), a sample shall be analyzed using EPA Method 537 (Modified) prior to disposal. If the combined concentration of PFOS/PFOA is less than 70 ppt, and assuming no other contamination is present and no state or local regulation prohibits it, the water may be disposed to the sanitary sewer without additional special handling after disclosing the nature and concentrations of PFAS constituents contained in the liquid IDW to the local wastewater authority and after obtaining a recordable authorization from the authority. Liquid IDW with a combined PFOS/PFOA concentration greater than 70 ppt shall be held pending written authorization by the facility director of the treatment plant that will receive the liquid.

If it is expected that the concentrations of PFOA and PFOS will be much higher than 70 ppt (e.g., captured residual from an accidental release in a hangar), special actions may be needed to dispose of the waste-stream. These instances should be brought to the attention of HQDA and the installation's chain of command for coordination with the appropriate program (e.g., compliance). The most current technical considerations, limitations and options will be provided for consideration.

If the PFAS containing IDW cannot be disposed then treatment of the IDW should be considered. Presently there are number of viable treatments; skid mounted GAC units, ion exchange resin treatment, reverse osmosis, Advanced Oxidation Processes, etc. New treatment technologies are being made available. The efficacy of the treatment technology should be considered.

Risk Assessment

Q19. Should PFAS automatically be included in the risk assessment?
A19. PFAS should only be sampled for if the CSM suggests the potential for a historical release of these chemicals. If the CSM supports environmental sampling for PFAS, then these sampling results should be considered to make remedial decisions. For the majority of sites, this will include a quantitative risk assessment; however, it should be noted in the uncertainty section that Tier 2 and/or 3 toxicity values would be used for these ECs.

Q20. What human health risk assessment screening levels are available?
A20. As always, screening levels may be developed through partnering relationships between the RPM and regulatory agencies. Ordinarily, the EPA Regional Screening Level (RSL) tables would be a good place to start; however, the most recent version of the RSL table (June 2017) does not include PFOA and PFOS.

On 15 November 2016, the EPA Office of Water released a memorandum that clarified that the Health Advisories developed in May 2016 were only to be applied to drinking water. The Health Advisories (HAs) are based on toxicity values derived in documents that specifically target exposure via drinking water; not dermal contact or inhalation. EPA also stated that the Health Advisories are not applicable in identifying risk levels for ingestion of food. The EPA memo did not specifically address ingestion of non-food solids such as soil or indicate if this restriction extends to the toxicity values upon which the LHAs are based. It should be noted that while PFOS and PFOA both have HAs, PFBS does not.

Until EPA guidance is provided, cleanup teams should discuss the level of confidence they would assign to screening levels based on the EPA Office of Water's toxicity values. When those RfDs are used with the current (June 2017) RSL calculations and default assumptions, the possible screening levels are provided on the table below. Note that since these toxicity values are not listed in the current (June 2017) RSL table, they are not to be considered vetted Tier 3 toxicity values as described in EPA directive (2003).

Screening Level Scenario	Groundwater (µg/L)			Soil (mg/kg)		
	PFOA[1]	PFOS[1]	PFBS[2]	PFOA[1]	PFOS[1]	PFBS[2]
Residential exposure	0.4	0.4	380	1.3	1.3	1,600
Industrial worker exposure	NA	NA	NA	16	16	23,000

1. Values are calculated for PFOA and PFOS using the EPA's on-line RSL calculator in June 2017 and are based on a target hazard quotient of 1.
2. Values are from the EPA Regional Screening Level table, June 2017.
NA means that currently these values are not applicable.

Q21. What human health toxicity values are available?
A21. Currently there are no toxicity values for any PFAS available from a Tier 1 (i.e., EPA's Integrated Risk Information System (IRIS)) source.

Non-cancer toxicity values are currently available for PFOA and PFOS for the ingestion route of exposure (i.e., RfDs) (references n and o). Note that as of June 2017, EPA has not confirmed that these are Tier 3 values. Although Tier 3 toxicity values are appropriate for use in CERCLA Human Health Risk Assessments (HHRAs) per EPA (EPA 2003), there is always increased uncertainty associated with the use of Tier 3 toxicity values since their level of peer review and acceptance in the scientific community are not as rigorous as for Tier 1 and Tier 2 toxicity values. As such, if CERCLA cleanup levels are being derived, RPMs should discuss this with their respective ER Manager.

The chronic non-cancer RfDs for both PFOA and PFOS is 2 x 10^{-05} mg/kg-day (20 ng/kg-day). For both chemicals, this value is based on developmental effects. The EPA Office of Water also estimated a CSF for oral exposure to PFOA of 0.07 mg/kg-day.

A Tier 2 (i.e., EPA's Provisional Peer-Reviewed Toxicity Value (PPRTV)) oral reference dose is available for PFBS (EPA 2014). The chronic Tier 2 non-cancer RfD for PFBS is 0.02 mg/kg-day. This is based on kidney effects in a subchronic rat study. EPA also established a Tier 2 subchronic RfD of 0.2 mg/kg-day based on kidney effects in a rat study. EPA is currently reevaluatiing PFBS toxicity, as such, any actions related to PFBS should take into account the latest findings.

Q22. What exposure pathways should be included in a human health risk assessment?
A22. For PFOA, PFOS, and PFBS, the only toxicity values available are for ingestion. As such, if the CSM supports it, the ingestion exposure route can be estimated for human health. On 15 November 2016, the EPA Office of Water issued a memorandum that clarified the LHA in drinking water cannot be used to identify risk levels for ingestion of food sources (EPA 2016d). The EPA did not clarify if the toxicity values used to develop the LHA can be applied to incidental ingestion of soil, such as is reflected in the EPA RSL for both residential and industrial contact with soil. However, the toxicity values developed by the EPA Office of Water are included in the online RSL calculator. This inconsistency has not been explained by EPA so an explanation is not available for this document. At this time, there is uncertainty regarding the appropriateness of using those Tier 3 RfDs for incidental ingestion of soil.

Q23. Should we still use the EPA's 2009 Short-term Provisional Health Advisory levels and/or the toxicity values generated in 2009 for PFOA and PFOS?
A23. No. When EPA finalized the health advisory documents for both PFOA and PFOS (references n and o), the EPA considered these values to supersede the previous short-term provisional health advisory levels of 2009. Since the 2016 LHA levels are based in part on developmental effects, EPA considers the LHA levels to also be protective for short-term exposure. If the 2009 values were used previously to establish remedial goals, the goals may need to be reevaluated to ensure overall protection of human health, which is a threshold criteria for evaluating remedial alternatives under the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

Q24. Do PFAS need to be considered in the ecological risk assessment?
A24. Yes, if the CSM includes complete exposure pathways for ecological receptors and there are accepted screening values provided in accordance with the EPA Ecological Risk Assessment Guidance for Superfund (ERAGS). Currently no ecological risk guidance is available but it should be noted that there may be a human health risk from ingestion of media such as fish, livestock or plants; in addition to water and soil.

Q25. What ecological risk assessment screening levels are available?
A25. Many scientific papers have been published that begin establishing potential values for ecotoxicity of some PFAS. If regulators provide or recommend ecological screening levels for any PFAS, it is recommended to check with an Army ecological risk assessor to vet those values.

<u>Applicable or Relevant and Appropriate Requirements (ARARs) and/or To-Be-Considered (TBC) Values</u>

Q26. Are there federal ARARs or TBCs for any PFAS?
A26. At this time, no federal ARARs have been identified for PFAS. The EPA's LHAs for PFOA and PFOS are not ARARs, because the LHAs are not promulgated, enforceable standards. The LHAs can be used either as TBCs, or as measures of

protectiveness. If the LHAs are identified as TBCs, they will have the effect of an ARAR when finalized in a decision document (DD); however, if the LHAs are cited in establishing a risk-based level for the protection of human health, they do not have the effect of an ARAR. Consequently, risk-based protective levels are more flexible than ARARs or TBCs.

References

a. Department of Defense Instruction (DoDI) 4715.18, Emerging Contaminants, 11 June 2009.

b. Memorandum, Office of the Assistant Secretary of Defense (OASD) for Energy, Installations and Environment, 10 June 2016, subject: Testing DoD Drinking Water for Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA).

c. Memorandum, OASD, 9 March 2012, subject: Revised Site Management procedures – Update to DoD Manual 4715.20, Defense Environmental Restoration Program Management.

d. Memorandum, Headquarters, Department of the Army (HQDA), Assistant Secretary of the Army for Installations, Energy and Environment (ASA IE&E), 10 June 2016, subject: Perfluorinated Compound (PFC) Contamination Assessment.

e. Memorandum, HQDA ACSIM, 29 August 2016, subject: Department of the Army Guidance to Address Perfluorooctane Sulfonate and Perfluorooctanoic Acid Contamination.

f. Memorandum, HQDA ACSIM, 21 June 2017, subject: Supplemental Drinking Water Monitoring Guidance for Perfluorooctane Sulfonate and Perfluorooctanoic Acid.

g. APHC Technical Information Paper No. 85-067-0117, 2017, Environmental Criteria Perfluorinated Alkyl Compounds.

h. APHC Chemical and Material Emerging Risk Alert, undated, Aqueous Film Forming Foam (AFFF).

i. EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-30, 1991, Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions.

j. EPA OSWER Directive 9285.7-53, 5 Dec 2003, Human Health Toxicity Values in Superfund Risk Assessments.

k. EPA OSWER 9285.7- 02EP, July 2004, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005.

l. EPA OSWER, 28 October 2009, The Toxicity of Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS).

m. EPA Fact Sheet, March 2014, Emerging Contaminants - Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA), (http://www2.epa.gov/sites/production/files/2014-04/documents/factsheet_contaminant/_pfos_pfoa_march2014.pdf).

n. EPA Office of Water, May 2016, Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA) EPA 822-R-16-005.

o. EPA Office of Water, May 2016, Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS).

p. EPA Technical Advisory, 2016. Laboratory Analysis of Drinking Water Samples for Perfluorooctanoic Acid (PFOA) Using EPA Method 537 Rev. 1.1.

q. EPA Office of Water, 15 November 2016, 2016. Clarification about the Appropriate Application of the PFOA and PFOS Drinking Water Health Advisories.

r. EDQW Fact Sheet, October 2016, Bottle Selection and other Sampling Considerations When Sampling for Per- and Poly-Fluoroalkyl Substances (PFASs)

Useful Web Sites

https://army.deps.mil/army/cmds/imcom_USAEC/AEC/Emerging_Contaminants/Forms/AllItems.aspx?InitialTabId=Ribbon%2ERead&VisibilityContext=WSSTabPersistence#InplviewHash9309b17e-e1a0-46a0-bea5-5671276d1df7

https://www.epa.gov/pfas

http://pfas-1.itrcweb.org/

https://www.serdp-estcp.org/News-and-Events/Blog/Advances-in-Perfluoroalkyl-Chemicals-PFCs-Characterization-and-Remediation

https://www.serdp-estcp.org/Featured-Initiatives/Per-and-Polyfluoroalkyl-Substances-PFASs

http://www.awwa.org/portals/0/files/legreg/documents/awwapfcfactsheettreatmentandremoval.pdf

APPENDIX B

ACRONYMNS

ACSIM	Army Chief of Staff for Installation Management
AFFF	Aqueous Film Forming Foam
APHC	Army Public Health Center
ARAR	Applicable or Relevant and Appropriate Requirement
ARNG	Army National Guard
BRAC	Base Realignment and Closure
CC	Compliance Related Cleanup
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CoC	Constituents of Concern
CSM	Conceptual Site Model
CTC	Cost-To-Complete
DD	Decision Document
DENIX	DoD Environment, Safety and Occupational Health Network and Information Exchange
DERP	Defense Environmental Restoration Program
DERP	Defense Environmental Restoration Program
DoDI	Department of Defense Instruction
DoDM	Department of Defense Manual
DOEHRS	Defense Occupational Environmental and Health Readiness System
DWEL	Drinking Water Equivalent Level
EC	Emerging Contaminant
EDQW	Environmental Data Quality Workgroup
ELAP	Environmental Laboratory Accreditation Program
EPA	Environmental Protection Agency
ER,A	Environmental Restoration, Army
ESTCP	Environmental Security, Testing, and Certification Program
FAQs	Frequently Asked Questions
FID	Flame Ionization Detector
FTA	Fire Training Area
HA	Health Advisory
HDPE	High-Density Polyethylene
HQAES	Headquarters Army Environmental System
HRSC	High Resolution Site Characterization
IDW	Investigation Derived Waste
IRIS	Integrated Risk Information System
LC/MS/MS	Liquid Chromatography (LC) Tandem Mass Spectrometry (MS)
LHA	Lifetime Health Advisory
MIL-SPEC	Military Specification
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
OACSIM	Office of Army Chief of Staff for Installation Management
OMA	Operations and Maintenance, Army

OMAR	Operations and Maintenance, Army Reserve
OMNG	Operations and Maintenance, National Guard
OSF	Oral Slope Factor
PA	Preliminary Assessment
PFAAS	Perfluoroalkyyl Acids
PFAS	Per- and polyfluoroalkyl substances
PFBS	Perfluorobutane Sulfonate
PFC	Perfluorinated Compound
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PID	Photo-Ionization Detector
PIGE	Particle Induced Gamma Ray Emission
QPL	Qualified Products List
QSM	DoD Quality Systems Manual
RA-C	Remedial Action Construction
RA-O	Remedial Action Operation
RC	Response Complete
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RIP	Response in Place
RPM	Restoration Project Manager
RSL	Regional Screening Level
SC	Site Closure
SERDP	Strategic Environmental Research and Development
SI	Site Inspections
TBC	To Be Considered
TOP	Total Oxidizable Precursor
USAR	U.S. Army Reserve

Appendix E

Response to Comments

Response to Comments from USEPA

Subject: Seneca Army Depot, NYSDEC Site No. 850006
Draft PFAS ESI WP

SENECA ARMY DEPOT ACTIVITY
ROMULUS, NEW YORK

Comments Dated: 14 December 2018

Date of Comment Response: 08 February 2019

<u>**Response to Comments – "General Comments"**</u>

Comment 1: It does not appear that the deeper aquifer in the shale bedrock was ever investigated for PFAS impacts. Suggest installing some deep monitoring wells into the competent bedrock in order to confirm that there are no deep impacts.

Response 1: Currently, the Army does not have funding to address this request. The results of the previous RI/FS found no contamination in the lower aquifer therefore the ESI scope was focused to address the shallow aquifer only. Additional RI work efforts including this concern will be addressed in a future project.

Comment 2: The Work Plan indicates that soil was removed from both Sead 25 and Sead 26 to address BTEX and cPAH contamination, respectively. Since the 2017 PFAS SI identified PFAS impacts in the groundwater, was there ever an investigation conducted to determine the presence or absence of PFAS contamination in the soil? If not, EPA requests that the Army conduct an investigation as soon as possible to determine the presence or absence of PFAS contamination in soil, especially at Sead 25, since the PFAS concentrations (92,900 ppb?) are indicative of a residual source area.

Response 2: As stated above, The Army currently does not have funding to address this. The ESI scope addresses the shallow aquifer only since the previous RIFS found no contamination in the lower aquifer. Additional RI work efforts including this concern will be addressed in a future project

Comment 3: As we have been discussing, a formal groundwater supply well (potable and non-potable) survey needs to be conducted by the Army for the entire former Depot property. Although EPA is in receipt of your 12/10/18 email, which discusses the aquifers located on the former depot property (and we appreciate that information), your email does not appear to directly address any potential groundwater supply wells. Only past and current monitoring wells are discussed, not supply wells. While it may be unlikely that there are any groundwater supply wells on the former depot property, as the former depot was supplied with drinking water from the local municipal water supply, there is still the potential that some individual groundwater supply wells were installed and utilized, especially in the more remote areas of the former depot. In light of the current and planned PFAS investigations (which are obviously not yet completed), the existence of any potential groundwater supply wells needs to be documented at this time through a formal study. Such studies have already been conducted by other branches of DoD at numerous installations. Historic records of former base facilities need to be consulted. These could include documents related to closure of the depot, such as a Base-wide

Environmental Baseline Survey (EBS) Report (if such a survey was conducted), and the Base-wide Environmental Impact Statement (EIS). Both documents should have addressed depot water supplies. An EBS would have identified environmental factors, which could include any individual groundwater supply wells that may have been installed and utilized. Lastly, historic depot utility maps can be consulted. These could show any groundwater supply wells that may have been installed and utilized.

Response 3: There are no active drinking water wells at the Depot. When the installation was active, a drinking water well was used at the OBOD Grounds and at buildings that are currently abandoned and on the Prison parcel.

Comment 4: As we have also been discussing, an off-depot private groundwater supply well survey also needs to be conducted by the Army. The off depot area surveyed should extend out to 1 (one) mile from the former depot boundary. The purpose of the survey should be to establish the locations of private groundwater supply wells. Such surveys have already been conducted by other branches of DoD at numerous installations. Please note that EPA is only requesting that an off-depot private well survey be conducted at this time. EPA is not requesting that all private wells within one mile of the former base boundary be sampled at this time. Once the private wells are identified, EPA, the Army, NYSDEC and NYSDOH can then discuss the areas in which sampling for PFAS should be conducted. With respect to how such a survey is conducted, some suggestions include GIS, municipal tax records, and water supply company records. EPA has been told that the Seneca County Department of Health does not require the issuance or approval of well drilling permits. If this is true, conducting the survey may be a little more difficult. Nonetheless, a survey is needed. When initial results are compiled, and the Army and regulatory agencies reach agreement on areas that would require sampling, letters should be sent to the identified property owners. In addition, the Army may ultimately need to "knock on doors". Mark Sergott of NYSDOH (cc'd above) can probably be of some assistance in explaining how to conduct the well survey. He may also be of some assistance in identifying the off-depot wells already identified and sampled by NYSDOH, but it is my understanding that there are privacy issues which may make it difficult for NYSDOH to directly share that information.

Response 4: An off-Depot survey of private wells, extending out one mile from the Depot boundary, will be conducted as part of the ESI. The NYSDOH has not provided any data on private wells near the Depot to the Army. The text in Section 3.1 and Chapter 4 – Reporting was revised as follows: "*A survey of private groundwater supply wells within one mile of the SEDA boundary will be conducted to determine if any potential groundwater receptors are present.*"

Comment 5: It has come to EPA's attention that the current owner of much of the former depot property, approximately 7,000 acres, plans to subdivide and sell much of his property for re-development. In fact, the potential exists that some of this property has already been resold. It is EPA's understanding that the current owner of this property is an individual named Earl Martin. In light of the status of previous and planned PFAS investigations, EPA hereby requests that the Army formally notify Mr. Martin in writing regarding the potential for PFAS contamination in groundwater beneath his property. The notification should include a request that Mr. Martin also notify any recent owners he may have transferred property to, as well as any potential future owners he may eventually discuss property transfer with, regarding the potential for PFAS contamination in groundwater beneath the properties. While your 11/30/18 email to EPA documents your prior discussions with Mr. Martin, it does not indicate that you formally notified him in writing. EPA considers the formal notification to Mr. Martin essential at this time, and requests that you cc us on your letter. Your 11/30/18 email to EPA also included an attachment with proposed subdivision plots of Mr. Martin's property. Also included on that attached figure are existing municipal water lines as well as proposed water lines.

While this implies that no groundwater supply wells will be installed by Mr. Martin or future property owners, there is no guarantee of this. Some of the proposed lines are somewhat long, and could potentially be somewhat difficult and/or expensive to install. You have indicated that Mr. Martin intends to install the proposed lines, but again, there is no guarantee that all of the proposed lines will be installed. Hence the need for the notification letter that EPA is requesting at this time. The letter should discourage the installation of any groundwater supply wells until such time as PFAS studies related to the former depot have been completed and it has been shown either that there is no actual PFAS contamination beneath any of the properties, or no reason to suspect that any PFAS contamination might exist beneath the properties. In addition, should any groundwater supply wells be installed on the properties prior to the completion of PFAS studies related to the former depot, they should be sampled for PFAS prior to use, and face the potential that point of entry treatment (POET) systems would need to be installed to treat any groundwater found to be contaminated with PFAS above EPA's Health Advisory Level (HAL) of 70 parts per trillion (ppt) for combined and/or individual PFOS and PFOA.

Response 5: NYSDEC notified Seneca County Industrial Development Authority (SCIDA) in writing on 09 November 2018 regarding their review of the Seneca PFAS SI results. NYSDEC informed the SCIDA that the potential receptors in the future farming use area may be exposed to unacceptable concentrations of PFAS compounds and that they would be requesting that the Army perform a RI. The Army will formally notify the reusers and the SCIDA of potential and existing PFAS contamination.

Comment 6: Please note that EPA expects that at some point in the future the Army will conduct a full RIFS for PFAS at the former depot, to include sampling of all media, as well as human health and ecological risk assessments. This would be followed by the issuance of a Proposed Plan and ROD for PFAS at the former depot.

Response 6: The Army will continue the CERCLA process to include an RI of the known sites and PA of the installation.

<u>**Response to Comments – "Specific Comments"**</u>

Comment 1: Section 3.01 indicates that the proposed wells will be installed to refusal or top of competent bedrock. Please include a range of depth to bedrock in this section or Section 2.3.

Response 1: During the 1997 RI at SEAD 25, competent shale was encountered 3.5 to 12.2 feet bgs. At SEAD 26, competent shale was encountered at depths ranging from 6 to 18 ft bgs. These depths to bedrock are noted in Section 2.3 (second and fourth paragraphs).

Comment 2: Section 3.0.5.3 indicates that the gw samples will be submitted to a DoD approved and NYS certified laboratory for analysis. Please confirm that the gw samples will analyzed in accordance with EPA Method 537.1.1, modified if needed.

Response 2: The laboratory contracted (TestAmerica-Sacramento) has current DoD ELAP and NY State certifications for PFAS analysis. We are tracking the status of the labs certification and if available the groundwater samples will be analyzed using modified EPA Method 537.1 (effective November 2018).

Comment 3: Section 3.1.1.1 indicates that there is an open drainage ditch located at Sead 25. Suggest collecting a water sample from the drainage ditch to confirm that PFAS contamination does not exist in the local surface water flow regime.

Response 3: A surface water sample will be collected at the drainage ditch at SEAD-25. The workplan was revised to add this request.

Comment 4: Figure 2 depicts gw contours and the proposed well locations. Suggest installing two (2) additional wells in the E-SE quadrant since the gw flow is radial around MW25-2 (which contains the highest concentrations of PFAS) and gw contours appear to have a steep gradient towards the E-SE direction.

Response 4: Wells MW25-23 and MW25-24 were moved to a location more to the east and southeast of SEAD 25. If detections of PFAS are found in these wells, additional secondary wells will be added to further delineate the extent of potential contamination in this area.

Response to Comments from NYSDEC

Subject: Seneca Army Depot, NYSDEC Site No. 850006
Draft PFAS ESI WP

SENECA ARMY DEPOT ACTIVITY
ROMULUS, NEW YORK

Comments Dated: 16 January 2018

Date of Comment Response: 08 February 2019

<u>Response to Comments – "General Comments"</u>

Comment 1: Soil sampling was included in the Expanded Site Investigation description in Section 3. Details were not provided on the sampling methodology. At each drilling location collect continuous split spoons during drilling. The top of the native soils (determined through visual characterization), the groundwater interface, and the soils at the top of the bedrock should have one soil sample collected at each location. In those locations where RA excavation did not take place a surficial soil sample (0-2") should also be collected. Each of these soil samples above should be submitted for laboratory analysis via Modified EPA Method 537.

Response 1: Currently, the Army does not have funding to address this request. The ESI is focused on determining the extent of contamination in the shallow aquifer. Additional RI work efforts including this concern will be addressed in a future project.

Comment 2: The number of proposed points for evaluation of the PFAS is not adequate to determine the extent to which the plume may have impacted surrounding and downgradient groundwater of SEAD-25 and SEAD-26. Section 3.1.1.1 and 3.1.1.2 propose secondary groundwater monitoring wells given that the objectives of the ESI, determining the fate and transport of the PFAS, are not achieved. Please present, in Figures 2 and 3, the proposed locations of those secondary wells. It is our understanding that locations may be modified based on results from the primary wells.

Response 2: Additional text was added to Chapter 1 to explain the objectives of the ESI.

> The objectives of the ESI are to further characterize and document the source(s) and fate and transport of PFAS in groundwater at the SEAD 25 and SEAD 26 sites as initially delineated in the 2017 PFAS Site Inspection (SI) (Parsons, 2018). The ESI falls between the SI and Remedial Investigation (RI) in the regulatory pathway and will further characterize the potential sources, groundwater direction, and pathways for contaminant spread near the suspected source areas.

The number of secondary wells is presented in the work plan (Section 3.1.1.1 last paragraph and Section 3.1.1.2 second paragraph). Five optional secondary wells are proposed at SEAD 25 and six optional wells are proposed at SEAD 26. The locations of the secondary wells are dependent on the concentrations found in the primary wells. The Army will present the analytical results of the primary wells with NYSDEC and EPA, and the selection of secondary wells will be discussed together and determined together.

Comment 3: When characterizing deeper subsurface geological units as part of the expanded site investigation, please implement safe drilling procedures (e.g., monitoring wells using double casing & proper grouting) when penetrating bedrock and/or other subsurface confining units to prevent any site-related PFAS contamination from migrating to underlying ground water aquifers that are used by the surrounding area.

Response 3: Currently, the Army does not have funding to address the lower aquifer. The ESI is focused on determining the extent of contamination in the shallow aquifer. Additional RI work efforts including this concern will be addressed in a future project. Safe drilling practices will be implemented as suggested when drilling into bedrock.

Comment 4: Who comprises the PDT?

Response 4: The sentence was revised to state "*The Army (USACE-Huntsville and USACE-New York), EPA, and NYSDEC will be notified if a boring exceeds 15ft bgs.*" All references to PDT were replaced with "*The Army (USACE-Huntsville and USACE-New York), EPA, and NYSDEC*".

Comment 5: No Schedule was provided on this project in the work plan. Please provide a schedule for this project.

Response 5: A proposed schedule was added to the end of Chapter 3 and is presented below. Note that each work activity is connected to the next activity, and this schedule is subject to change if any delays are encountered.

ACTIVITIES	EXPECTED START DATE	TIMELINE
Field Work 1	May 2019	Approximately 4 weeks to install, develop and sample primary wells
Receipt of the Laboratory Data	June 2019	10-15 days after sampling completed
Conference call with Army, EPA, NYSDEC	June 2019	Discuss results and secondary well locations, if needed
Field Work 2	July 2019	Remobilize to install and sample secondary wells, if needed
Receipt of the Laboratory Data	August 2019	30 days after demobilization
Prepare and Submit Draft ESI Report	November 2019	60 days after receipt of the laboratory data
Prepare and Submit Draft Final ESI Report	January 2019	30 days after receipt of review comments
Prepare and Submit Final ESI Report	March 2019	30 days after receipt of Regulatory review comments

Response to Comments – "Specific Comments"

Comment 1: Section 3.1.1, Monitoring Well Locations: The proposed primary monitoring well locations (per Figures 2 & 3) for the Fire Training and Demonstration Pad (SEAD-25) and the Fire Training Pit and Area (SEAD-26) do not adequately characterize the geographical areas that are located hydraulically downgradient (west) of the referenced sites. Based on the proposed redevelopment plans (farming, homesteads) in areas located west of the two sites, additional downgradient monitoring wells in these areas should be included as part of defining the nature and extent of any site-related PFAS contamination.

Response 1: Currently, the Army does not have funding to address this request. The ESI is focused on determining the extent of contamination in the shallow aquifer. Additional RI work efforts including this concern will be addressed in a future project.

Note: Right of entry was granted for the property east of SEAD 25. Two of the proposed well installation locations (MW25-24 and MW25-25) were moved further east to better delineate the plume in this direction. Proposed change below.

Comment 2: Section 3.0.1, 2nd bullet: Soil samples should be screened both visually and with a PID.

Response 2: A PID will be used to monitor the airspace for VOCs (fuel constituents) while drilling and will be used while logging the soil cores to determine if any VOC impacted soils are present. Section 3.0.1, second bullet was updated to include *"PID screening of soil samples for VOC impacts."*

Comment 3: Section 3.1: Provide more details on the well survey of the drinking water wells within ½ mile of each SEAD. What activities will be conducted as part of the survey?

Response 3: The well survey will include a review of the Depot Environmental Baseline Survey and Environmental Condition of Property Reports, establish the locations of private groundwater supply wells out to 1 mile (as requested by EPA) from the Depot boundary, gather well boring logs or other well construction data (if available), and contacting the Towns of Romulus/Varick for any available data (e.g., GIS, well logs, well locations). To date, the NYSDOH has not provided any data on private wells near the Depot to the Army. The NYSDOH will be contacted to determine if any records of private wells already exist in this area.

Comment 4: The UFP-QAPP Worksheet 15 has a list of 14 PFAS compounds to be evaluated. The NYSDEC requires the full list of 21 PFAS compounds (attached) via Modified EPA Method 537 be analyzed for by the laboratory.

Response 4: The reference to the EPA method in Chapter 3 was updated to reflect modified method 537.1. The UFP-QAPP will be updated to reflect the 21 PFAS compound list and the use of modified EPA method 537.1 (effective November 2018).

Comment 5: The UFP-QAPP states that the laboratory chosen for PFAS sampling accreditation expired January 31, 2017. Please provide the laboratory information including new accreditation expiration date.

Response 5: An updated laboratory accreditation will be provided in an update to the UFP-QAPP.