FORT DEVENS
REVISED FINAL SITE INVESTIGATION REPORT
GROUPS 2, 7 & HISTORIC GAS STATIONS

Volume I of IV
Report Text

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REVISED FINAL SITE INVESTIGATION REPORT
GROUPS 2, 7 AND HISTORIC GAS STATIONS
FORT DEVENS, MASSACHUSETTS

GROUP 2

STUDY AREA 13 -	LANDFILL NO. 9
STUDY AREA 45 -	LAKE GEORGE STREET VEHICLE WASH AREA
STUDY AREA 49 -	BUILDING 3602 LUST SITE
STUDY AREA 56 -	BUILDING 2417 LUST SITE
STUDY AREA 57 -	BUILDING 3713 FUEL OIL SPILL
STUDY AREA 58 -	BUILDING 2648/2650 FUEL OIL SPILLS

GROUP 7

STUDY AREA 12 -	LANDFILL NO. 8
STUDY AREA 14 -	LANDFILL NO. 10
STUDY AREA 27 -	WASTE EXPLOSIVES DETONATION RANGE (HOTEL)
STUDY AREA 28 -	WASTE EXPLOSIVES DETONATION RANGE (TRAINING AREA 14)
STUDY AREA 41 -	UNAUTHORIZED DUMPING AREA (SITE A)
STUDY AREA 42 -	POPPING FURNACE
STUDY AREA 43 -	HISTORIC GAS STATIONS (SITES 43A THROUGH 43S)

FORT DEVENS
REVISED FINAL SITE INVESTIGATION REPORT
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PREFACE

In 1991, the U.S. Department of the Army and U.S. Environmental Protection Agency signed a Federal Facility agreement under Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act for environmental investigations and remedial actions at Fort Devens. The agreement required that Site Investigations be undertaken at each Study Area to verify whether a release or potential release exists, to determine the nature of the associated risk to human health and the environment, and to determine whether further investigations or response actions may be required.

In 1991, Fort Devens was identified for closure, by July 1997, under Public Law 101-510, the Defense Base Closure and Realignment Act of 1990. This has resulted in accelerated schedules for the environmental investigations at Fort Devens.

In 1991, under contract DAAA15-91-D-0008, the U.S. Army Environmental Center (formerly U.S. Toxic and Hazardous Materials Agency) tasked ABB Environmental Services, Inc. to conduct site investigations at 31 Study Areas in Groups 2 and 7 and the Historic Gas Stations (19 sites), as described in the Fort Devens Master Environmental Plan (Biang et al., 1992). A site investigation field program was completed at each of the above mentioned Study Areas in the Summer and Fall of 1992. The results of these field programs was presented in the Final Site Investigation Report for Groups 2, 7 and Historic Gas Stations (ABB-ES, 1993).

Based on the finding and conclusions presented in the Final Site Investigation Report, additional field investigations were completed at 13 Study Areas (Study Area 12, 13, 14, 41, 42, 43B, 43D, 43G, 43H, 43I, 43J, 43N, and 43O) in the Fall and Winter of 1993.

This Revised Final Site Investigation Report summarizes the ABB Environmental Services, Inc. findings, conclusions and recommendations for each Study Area in Groups 2 and 7 and the Historic Gas Stations based on both phases of investigation.

EXECUTIVE SUMMARY

The U.S. Army Environmental Center (USAEC) contracted ABB Environmental Services, Inc. (ABB-ES), under Contract No. DAAA15-91-D-0008, to conduct site investigation (SI) activities at the following 31 Study Areas (SAs) at Fort Devens, Massachusetts. Under a modification to the above mentioned Contract No., USAEC tasked ABB-ES to perform a Supplemental SI (SSI) at 13 (SA 12, 13, 14, 41, 42, 43B, 43D, 43G, 43H, 43I, 43J, 43N, and 43O) of the original 32 SAs. The following is a list of SAs associated with Groups 2 and 7:

GROUP 2 (Main Post area of Fort Devens)

- SA 13 - Landfill No. 9
- SA 43 - Historical Gas Stations (19 Sites)
- SA 45 - Lake George Street Vehicle Wash Area
- SA 49 - Building 3602 leaking underground storage tanks (LUST) Site
- SA 56 - Building 2417 LUST Site
- SA 57 - Building 3713 Fuel Oil Spill
- SA 58 - Building 2648/2650 Fuel Oil Spills

GROUP 7 (South Post area of Fort Devens)

- SA 12 - Landfill No. 8
- SA 14 - Landfill No. 10
- SA 27 - Waste Explosive Detonation Range (Hotel)
- SA 28 - Waste Explosive Detonation Range (Training Area 14)
- SA 41 - Unauthorized Dumping Area (Site A)
- SA 42 - Popping Furnace

These SAs are identified in the Fort Devens Master Environmental Plan (MEP) and are included in the Federal Facility Agreement between U.S. Environmental Protection Agency (USEPA) and the U.S. Department of the Army (Army) (USEPA and Army, 1991).

The purpose of the SI at each SA, and the subsequent SSI at selected SAs, was to evaluate existing information and to identify and obtain additional information necessary to verify the absence or presence of environmental contamination and determine whether further investigation or response action was warranted.

ABB-ES prepared a Task Order Work Plan for both the SI and the SSI to establishing the specific scope for each phase of investigation at each SA. ABB-ES also prepared a Project Operations Plan (POP), which sets forth the health and safety, sampling and analysis, and quality assurance requirements and procedures. These documents were reviewed by Fort Devens, USAEC, USEPA, Massachusetts Department of Environmental Protection (MADEP), and other nonregulatory members of the Technical Review Committee (TRC). Upon completion of the review process, ABB-ES finalized the plans.

The SI field investigation program was conducted from June 1992 to January 1993, and the laboratory analyses were completed in February 1993. The SSI field investigation program was conducted from August 1993 to February 1994, and the laboratory analyses were completed in April 1994.

ABB-ES evaluated the chemical and physical data collected from each SA during the SI. For SAs at which contamination was found, ABB-ES evaluated the source, potential distribution and migration pathway, and potential receptors. ABB-ES then completed preliminary human health and ecological risk evaluations. In February 1993, ABB-ES issued SI Data Packages for the 32 SAs, summarizing the data, findings, and recommendations. The SI Data Package provided preliminary evaluations of the absence or presence of contamination, potential migration pathways, and potential risks to human and ecological receptors. These preliminary evaluations permitted the expediting of necessary next-phase planning and contracting for the implementation of the SSI program while the SI Report was under preparation. The Final SI Report was issued in May 1993.

Upon completion of the SSI sampling and analysis, ABB-ES evaluated the chemical and physical data collected from each SA during the SSI. ABB-ES further evaluated the source, potential distribution and migration pathway, and potential receptors. ABB-ES then revised the existing SI preliminary human health and ecological risk evaluations for the SAs investigated during the SSI. In January 1994, ABB-ES issued SSI Data Packages for the 13 SSI SAs, summarizing the data, findings, and recommendations. The SSI Data Package provided further evaluations of contamination, potential migration pathways, and potential risks to human and ecological receptors. The preliminary evaluations permitted the expediting of necessary next-phase planning and contracting at the SAs requiring further remedial investigation.

The SI Data Package, Final SI Report, and the SSI Data Package were reviewed by Fort Devens, USAEC, USEPA, and MADEP. This Revised Final SI Report combines the information, evaluations, and recommendations presented in each of the above mentioned documents and incorporates the modifications identified at review meetings and in formal written comments.

On the basis of the data and evaluations, ABB-ES has recommended No Further Action at 17 SAs, Remedial Investigation at six SAs, and a Removal Action at eight SAs. The findings and recommendations for Groups 2 and 7 SAs are summarized in Table ES-1.

TABLE ES-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SITE	MEDIUM	CONTAMINANTS	PRELIMINARY RISK EVALUATION		RECOMMENDATION
			HUMAN HEALTH	ECOLOGICAL	
SA 13 - LANDFILL NO. 9	Soil Groundwater Surface Water Sediment	Inorganic's in groundwater. PAHs in surface soil. Explosives in surface water. Pesticides in sediment.	Exceeds acceptable risk values for inorganics in groundwater and PAHs in surface soil.	Exceeds acceptable risk values for inorganics and explosives in surface water and pesticides and inorganics in sediment.	Remove landfill waste under Landfill Consolidation Activities.
SA 45 - LAKE GEORGE STREET VEHICLE WASH AREA	None	None	Not conducted	Not conducted	No Further Action
SA 49 - BUILDING 3602 LUST SITE	Groundwater	Lead and VOCs in groundwater. TPHC in subsurface soil.	Exceeds acceptable risk values for lead in groundwater and TPHC in subsurface soil.	No conducted	A removal action should be completed to remediate TPHC contaminated soil.
SA 56 - BUILDING 2417 LUST SITE	Soil	TPHC in subsurface soil.	Acceptable	Not conducted	A removal action has been completed to remediate TPHC contaminated soil.
SA 57 - BUILDING 3713 FUEL OIL SPILL	Surface Soil	Area 1 PAHs and TPHC in surface soil. Area 2 PAHs and TPHC in surface soil.	Acceptable	Acceptable	Area 1 Additional investigations was conducted in this area under the installation-wide AREE-70 storm water study. Area 2 A removal action was completed of known TPHC contaminated soil. Based on the results of the removal action, an RI/FS will be completed.

continued

TABLE ES-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SITE	MEDIUM	CONTAMINANTS	PRELIMINARY RISK EVALUATION		RECOMMENDATION
			HUMAN HEALTH	ECOLOGICAL	
SA 58 - BUILDING 2648/2650 FUEL OIL SPILLS	Soil Groundwater	VOCs and TPHC in soil, VOCs in groundwater.	Acceptable	Not conducted	No Further Action
SA 12 - LANDFILL NO. 8	Surface Soil Groundwater Surface Water Sediment	Inorganics, PCBs, and pesticides in surface soil and sediment; and inorganics in surface water.	Exceeds acceptable risk values for inorganics in surface water.	Exceeds acceptable risk values for inorganics, PCBs, and pesticides in surface soil and sediment. Exceeds acceptable risk values for inorganics in surface water.	Remove landfill waste material under Landfill Consolidation Activities.
SA 14 - LANDFILL NO. 10	Surface Water Sediment	Mercury in the surface water. TPHC, PAHs, explosives, inorganics, and pesticides in sediment.	Acceptable	Exceeds acceptable risk values for mercury in surface water. However, contaminants in sediment are not available to ecological receptors.	No Further Action

continued

TABLE ES-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SITE	MEDIUM	CONTAMINANTS	PRELIMINARY RISK EVALUATION		RECOMMENDATION
			HUMAN HEALTH	ECOLOGICAL	
SA 27 - WASTE EXPLOSIVE DETONATION RANGE (HOTEL)	Soil Groundwater Surface Water Sediment	Explosives and inorganics in groundwater. Pesticides and inorganics in surface water and sediment in Cranberry Pond.	Exceeds acceptable risk values for explosives and inorganics in groundwater.	Exceeds acceptable risk values for pesticides and inorganics (lead) in surface water and sediment in Cranberry Pond.	This SA was transferred to Group 1B and an RI/FS for Functional Area II should be completed.
SA 28 - WASTE EXPLOSIVE DETONATION RANGE (TRAINING AREA 14)	Soil Groundwater	None	Acceptable	Acceptable	No Further Action
SA 41 - Unauthorized Dumping Area (Site A)	Soil Groundwater Surface Water Sediment	PAHs and inorganics in surface soil. VOCs and inorganics in groundwater. Inorganics and pesticides in surface water and sediment in New Cranberry Pond.	Exceeds acceptable risk values for PAHs and inorganics in surface soil, and VOCs and inorganics in groundwater.	Exceeds acceptable risk values for inorganics (lead) in surface soil and inorganics and pesticides in surface water and sediment at one sample location. However, an average of all surface water and sediment sample results does not exceed acceptable risk values.	Complete an RI/FS focused on VOC contamination detected in groundwater. Remove waste material as part of base-wide Landfill Consolidation activities.

continued

TABLE ES-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SITE	MEDIUM	CONTAMINANTS	PRELIMINARY RISK EVALUATION		RECOMMENDATION
			HUMAN HEALTH	ECOLOGICAL	
SA 42 - POPPING FURNACE	Soil Surface Water Sediment	Inorganics and explosives in surface soil and pesticides in sediment.	Exceeds acceptable risk values for inorganics in surface soil.	Exceeds acceptable risk values for pesticides in sediment.	Conduct a removal action directed at excavation of inorganic soil contamination.
HISTORIC GAS STATIONS					
SA 43A	Soil	VOCs and TPHC in subsurface soil at the water table.	Acceptable	Not conducted	Conduct a Remedial Investigation focused on the subsurface soil, and apparent groundwater contamination detected during the SI. The Army recommends that this site be administratively transferred to Group 1B for further investigation.
SA 43B	Soil	TPHC in subsurface soil	Acceptable	Not conducted	No Further Action
SA 43C	Soil	TPHC in subsurface soil	Acceptable	No conducted	No Further Action
SA 43D	Soil	VOCs and TPHC in subsurface soil at the water table.	Acceptable	Not conducted	Conduct a removal action directed at excavation of TPHC contaminated subsurface soil detected during the SI and SSI.
SA 43E	Soil	TPHC in subsurface soil	Acceptable	Not conducted	No Further Action
SA 43F	Soil	TPHC in subsurface soil	Acceptable	Not conducted	No Further Action

continued

TABLE ES-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SITE	MEDIUM	CONTAMINANTS	PRELIMINARY RISK EVALUATION		RECOMMENDATION
			HUMAN HEALTH	ECOLOGICAL	
SA 43G	Soil	TPHC in subsurface soil	Acceptable	Not conducted	No Further Action is recommended for Area 1. Conduct an RI/FS focused on subsurface soil and groundwater contamination at Areas 2 and 3.
SA 43H and 43I	Soil	TPHC in subsurface soil	Acceptable	Not conducted	No Further action is recommended for the two historic gas stations and Areas 1a, 1b, 2, 3b, 3c, and 4. Conduct a removal action at Areas 1c to remediate TPHC contaminated subsurface soil.
SA 43J	Soil	VOCs and TPHC in subsurface soil. VOCs, SVOCs, and TPHC in groundwater.	Exceeds acceptable risk for petroleum contaminants in soil and groundwater.	Not conducted	Conduct an RI/FS focused on the subsurface soil and groundwater.
SA 43K	Soil	TPHC in subsurface soil	Acceptable	Not conducted	No Further Action
SA 43L	Soil	TPHC in subsurface soil	Acceptable	Not conducted	No Further Action
SA 43M	Soil	TPHC in subsurface soil	Acceptable	Not conducted	No Further Action
SA 43N	Soil	TPHC in subsurface soil and SVOCs and TPHC in groundwater.	Acceptable	Not conducted	No Further action

continued

TABLE ES-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SITE	MEDIUM	CONTAMINANTS	PRELIMINARY RISK EVALUATION		RECOMMENDATION
			HUMAN HEALTH	ECOLOGICAL	
SA 43O	Soil	VOCs and TPHC in subsurface soil. VOCs in groundwater.	Exceeds acceptable risks for TCE.	Not conducted	No Further Action
SA 43P	Soil	TPHC in subsurface soil	Acceptable	Not conducted	No Further Action
SA 43Q	Soil	None	Acceptable	Not conducted	No Further Action
SA 43R	Soil	TPHC in subsurface soil	Acceptable	Not conducted	No Further Action
SA 43S	Soil	TPHC in subsurface soil	Acceptable	Not conducted	No Further Action

Notes:

SA = Study Area
VOCs = Volatile Organic Compounds
TPHC = Total Petroleum Hydrocarbons
PAHs = Polycyclic Aromatic Hydrocarbons

1.0 INTRODUCTION

1.1 BACKGROUND

In accordance with the U.S. Army Environmental Center (USAEC) Contract DAAA15-91-D-0008, Task Order No. 5, ABB Environmental Services, Inc. (ABB-ES) conducted Site Investigations (SIs) at 31 Study Areas (SAs), and Supplemental SIs (SSIs) at 13 SAs, within Groups 2 and 7 at Fort Devens, Massachusetts (Table 1-1). SA 43, which is associated with Group 2, is comprised of 19 historic gas station sites (SA 43B through SA 43S) and the former central fuel distribution location (SA 43A). These sites are presented separately in Section 6.0 of this report. The locations of these SAs are shown in Figures 1-1 and 1-2, respectively.

In 1985, Fort Devens applied for a Resource Conservation and Recovery Act (RCRA) Part B Permit for its hazardous waste storage facility. The submission included a list of Solid Waste Management Units (SWMUs) that showed potential for the release of hazardous materials to the environment. Under the Federal Facility Agreement between the U.S. Army (Army) and the U.S. Environmental Protection Agency (USEPA) (USEPA and Army, 1991a), these potential areas of contamination are referred to as SAs. In cooperation with the Massachusetts Department of Environmental Protection (MADEP), USEPA Region I issued a draft permit and selected ten SAs for corrective action. In 1986, a final permit was issued along with a list of 40 SAs. At the request of Fort Devens, six additional SAs were added to the list, for a total of 46 SAs.

Argonne National Laboratory's (ANL) Environmental Assessment and Information Sciences Division conducted an environmental assessment of the 46 SAs in November 1988, as part of the environmental restoration of Fort Devens. The objective of the ANL assessment was to characterize on-site contamination and provide recommendations for potential response actions. In 1989, Fort Devens was placed on the National Priority List. During a subsequent site visit by ANL in 1990, eight more SAs were added, bringing the total to 54. Since that time, four more areas of potential contamination have been identified, for a current total of 58 SAs. Table 1-2 summarizes the 58 SAs by priority group.

1.2 PREVIOUS STUDIES

The results of ANL's assessment are reported in a document entitled the Master Environmental Plan (MEP) for Fort Devens, Massachusetts (Biang et al., 1992). The MEP summarizes preliminary assessment activities conducted by ANL and provides an historical summary of the installation, discusses the geologic and hydrologic setting, discusses the nature and distribution of contamination, and proposes response actions for each of the 58 SAs. The MEP provided the basis for much of the planning effort for the 1992 SIs and 1993 SSIs of each of the Groups 2 and 7 SAs.

1.3 PROJECT OBJECTIVES

The objective of the USAEC Task Order No. 5 project, and Modification No. 2, at Fort Devens was to perform SIs and SSIs in accordance with all relevant State and USEPA guidance and in compliance with USAEC-approved field methods and procedures. The purpose of the SIs and SSIs conducted at SAs in Groups 2 and 7 was to verify the presence or absence of environmental contamination and to determine whether further investigation or remediation is warranted.

1.4 PROJECT APPROACH

In order to meet the project objectives, a significant amount of effort was focused on the production of SI and SSI planning documents. The planning documents were developed in compliance with the appropriate regulatory guidance for site investigations through the review of pertinent data, interviews with site personnel, and information gathered during site visits.

After completion of the SIs at all 32 SAs included in Groups 2 and 7, ABB-ES prepared SI Data Packages for the Groups 2 and 7 SAs (ABB-ES, 1993a). These SI Data Packages presented the results of the site investigations and provided preliminary evaluations of the absence or presence of contamination, potential pathways of contaminant migration, and potential risks to human and ecological receptors. After USEPA, MADEP, Fort Devens, and USAEC review of the SI Data Packages ABB-ES produced the Final SI Report for Groups 2 and 7 (ABB-ES, 1993b). This report reiterated the findings, conclusions and recommendations presented in the SI Data Package as well as defining the procedures used during the SI field investigation and the methodology used in developing the human health and ecological preliminary risk evaluations (PREs).

Based on the recommendations presented in the Final SI Report, ABB-ES conducted the SSI field investigation at 13 SAs (SA 12, 13, 14, 41, 42, 43B, 43D, 43G, 43H, 43I, 43J, 43N, and 43O) from August 1993 to February 1994. After completion of the SSIs, ABB-ES prepared SSI Data Packages for the Groups 2 and 7 SAs (ABB-ES, 1994). These SSI Data Packages presented the results of the SSIs and provided additional evaluation of contamination, potential pathways of contaminant migration, and further evaluation of risks to human and ecological receptors.

1.4.1 Project Operations Plan

The principal planning document was the ABB-ES Fort Devens Project Operations Plan (POP) (ABB-ES, 1992a), which provides detailed descriptions and discussions of the elements essential to conducting field investigation activities. The purpose of this plan was to define responsibilities and authorities for data quality, and to define requirements for assuring that the site investigation activities undertaken by ABB-ES at Fort Devens were planned and executed in a manner consistent with USAEC quality assurance (QA) program objectives. The POP includes the specified elements of a Sampling and Analysis Plan (SAP) and Health and Safety Plan (HASP). The SAP includes the essential elements of the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP). USEPA has prepared guidance on the preparation of a POP in "Guidance for Preparation of Combined Work/Quality Assurance Project Plans for Environmental Monitoring" (OWRS QA-1: May, 1984). The guidance was designed to eliminate the necessity for preparation of multiple, redundant documents.

The requirements of the Fort Devens POP were applied to ABB-ES and subcontractor activities related to the collection of environmental data at Fort Devens. The POP adheres to the requirements and guidelines contained in the "USAEC QA Program, January 1990" for collection and analysis of samples and the USAEC "Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition, and Reports, March 1987" for the installation of borings and monitoring wells, and for land survey location. In addition, the POP meets guidelines of USAEC chain-of-custody (COC) procedures.

The ABB-ES Fort Devens POP provides guidance and specifications to ensure that samples are obtained under controlled conditions using appropriate, documented procedures; and samples are identified uniquely, and controlled through sample tracking systems and COC protocols. The POP also includes specifications to ensure that field determinations and laboratory analytical results are of known quality and are valid, consistent, and compatible with the USAEC chemical data base through the use of certified methods, preventive maintenance, calibration and analytical protocols, quality control (QC) measurements, review, correction of out-of-control situations, and audits. The POP also specifies the methods and procedures to be used to ensure that calculations and evaluations are accurate, appropriate, and consistent throughout the projects; generated data are validated and their use in calculations is documented; and records are retained as documentary evidence of the quality of samples, applied processes, equipment, and results.

The HASP was prepared as an integral element of the Fort Devens POP in accordance with the same schedule and review requirements (ABB-ES, December 1992d, Appendix A). The HASP complies with EM 385-1-1, AMC-R-385-100, and Fort Devens safety requirements, as well as Occupational Safety and Health Administration (OSHA) Regulations 29 CFR 1910.120. The HASP development was based on appropriate information contained in previous investigation documents from Fort Devens. The HASP portion of the Fort Devens POP ensures that health and safety procedures are maintained by requiring inclusion of the health and safety staff function in the project organization.

1.4.2 Task Order Work Plan

The background, rationale, and specific scope for the Groups 2 and 7 SI and SSI investigations were set forth in a second companion planning document, the Task Order Work Plan. Two separate Task Order Work Plans, one for SA 43 Historic Gas Stations and one for the remaining SAs in Groups 2 and 7, were prepared under Task Order No. 5 for the SI (ABB-ES, 1992b and 1992c). The Task Order Work Plan for the SSI was prepared under Modification No. 2 (ABB-ES, 1993b). These Task Order Work Plans were developed to comply with the Massachusetts Contingency Plan (310 Code of Massachusetts Regulations [CMR] 40.000); the

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986; the corrective action provisions of the Hazardous and Solid Waste Amendments; and the Toxic Substances Control Act. Work conducted under the Task Order Work Plans was performed in accordance with the provisions of the Federal Facility Agreement (USEPA and Army, 1991a).

The background information provided in the SI and SSI Task Order Work Plans for the Groups 2 and 7 SAs was based largely on information in the MEP, review of installation documents, observations made during site visits, SI results, and interviews with installation personnel. Summaries of information documented in the MEP for the selected SAs and discussions of specific field activities to be conducted under Task Order No. 5 were included in the SI Task Order Work Plans. This information and the results and findings of the SI were included in the SSI Task Order Work Plan. The discussions focused specifically on the objectives and scope of proposed SI and SSI activities.

1.4.3 Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative or quantitative statements developed by the data user to specify the quality of data needed from a particular activity to support specific decisions. The DQOs are the starting point in the design of the investigation. The DQO development process matches sampling and analytical capabilities to the data targeted for specific uses and ensures that the quality of the data does not underestimate project requirements. The USEPA has identified five general levels of analytical data quality as being potentially applicable to field investigations conducted at potential hazardous waste sites under CERCLA. These levels are summarized as follows:

- Level I - Field Screening. This level is characterized by the use of portable instruments which can provide real time data to assist in the optimization of sampling point locations and for health and safety support. Data can be generated regarding the presence or absence of certain contaminants (especially volatiles) at sampling locations.

- Level II - Field Analysis. This level is characterized by the on-site use of portable analytical instruments and mobile laboratories which can render qualitative and quantitative data.
- Level III - Laboratory analysis using methods other than the Contract Laboratory Program (CLP) Routine Analytical Services (RAS). This level is used primarily in support of engineering studies using standard USEPA-approved procedures. Some procedures may be equivalent to the USEPA RAS, without the CLP requirements for documentation.
- Level IV - CLP RAS. This level is characterized by rigorous QA/QC protocols and documentation, which provide qualitative and quantitative analytical data.
- Level V - Non-standard methods. This level includes analyses which may require modification and/or development. CLP Special Analytical Services (SAS) are considered Level V.

For the Fort Devens SI and SSI efforts, field measurements such as pH, temperature, conductivity, and readings from a photoionization detector (PID) and O_2/Explosimeter constituted Level I field analytical data. Field gas chromatograph (GC) and infrared (IR) spectrometer analysis constituted Level II field analytical data. Analyses of soil, groundwater, and surface water/sediments for organics, inorganics; total organic carbon (TOC), total petroleum hydrocarbons (TPHC), water quality parameters, pesticides and polychlorinated biphenyls (PCBs), and explosives were considered approximately equivalent to USEPA analytical support Level III. The sampling approaches and analytical procedures described in the POP have been selected to meet the Level III data quality.

DQOs were established to support the level of detail required for SI and SSI activities. Data generated during the field and off-site laboratory tasks were used to characterize SA conditions and to perform PREs. These data were also used to scope further investigations or to support decisions of no further action (NFA).

DQOs and quality control for field measurements and off-site laboratory analyses conform to USAEC and USEPA requirements (as specified in the USAEC

Quality Assurance Manual, 1990 and Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, 1988).

USAEC requirements and analytical processes used during the SI and SSI are discussed in Section 3.0 of this report. They focus on the use of off-site laboratory control spikes in associated data lots to measure the performance of the laboratory in the use of USAEC methods. Many of the USAEC methods are identical to standard USEPA methods. The certification process, required by off-site laboratories performing USAEC work, is discussed in Section 3.2.3.1. The data review and evaluation process are described in Section 3.2.3.6.

Off-site laboratory data was evaluated for precision, accuracy, representativeness, completeness and comparability (PARCC) in order to meet USEPA Level III requirements. This was accomplished through the collection of field quality control blanks such as field blanks, trip blanks and equipment rinsates and through the evaluation of off-site laboratory blanks such as method blanks. The specific purpose of collecting each of these is discussed in Section 3.2 of this report. Off-site laboratory control spikes are run in the certification process to generate control charts that help to establish control limits that are used to ensure accuracy of the results. This process is described in the text of the report in Section 3.2. Matrix spike/matrix spike duplicate samples and duplicate samples were also analyzed to meet PARCC data quality objectives. These are broken down by group and are presented in Appendix E.

The precision of the data is a measurement of the ability to reproduce a value under certain conditions. It is a quantitative measurement based on the differences of two values. Precision was evaluated using the relative percent difference (RPD) of matrix spike/matrix spike duplicate sample pairs and field duplicate sample pairs. Evaluations of the precision of the data are found for each of the groups in Section 2.0 of Appendix E.

Accuracy measurements identify the performance of a measurement system based on tests with known values. The off-site laboratory, sampling, and media effects on accuracy were assessed by reviewing the percent recoveries of spiked analytes for Matrix Spike/Matrix Spike Duplicates (MS/MSDs), off-site laboratory control samples, and surrogate compounds.

Representativeness refers to the extent to which a measurement accurately and precisely represents a given population within the accepted variation of off-site laboratory and sampling measurements. Collection techniques that obtained samples characteristic of the matrix and location being evaluated were chosen. Historic information was used to identify sample locations. Representativeness was also evaluated using method blanks and field quality control sample data. By evaluating method blank and field quality control samples false positive results should be identified. Representativeness was also measured by evaluating field duplicate pair precision.

Completeness refers to the percentage of usable, valid values obtained through data evaluation. Completeness was determined by the success rate in meeting holding time criteria and acceptance of sample lots by USAEC.

Comparability is a qualitative assessment describing the confidence with which one data set may be compared with another. Comparability was assured using standard operating procedures for sampling, and by reporting analytical results in standard units.

1.4.4 Data Packages

To meet critical deadlines for the hazardous waste projects at Fort Devens, the Data Packages concept was developed. The purpose of the SI and SSI Data Packages was to evaluate on a preliminary basis the absence or presence of contamination and, if present, the potential pathways of contaminant migration and potential risks to human and ecological receptors at each subject SA. This preliminary evaluation allowed expedited next-phase planning and contracting. The SI and SSI Data Package approach relied primarily on tables and figures with minimum supporting text.

The preliminary contamination assessments in the SI and SSI Data Packages for Groups 2 and 7 (ABB-ES, 1993a and 1994a) provided the interpretive link between the tabulated chemical data, field observations, and the hydrogeological and physical environment. The major outputs of the contamination assessments were the spatial distribution of chemical contaminants in each environmental medium and identification and characterization of contaminant sources (qualitative and, to the extent possible, quantitative). These data were used in assessments of contaminant migration potential.

The information from the contaminant assessment was then used to preliminarily assess human health risks and environmental impacts. The human health and environmental PRE was the basis for conclusions and recommendations concerning the study area. Based on the results of the preliminary evaluation, one of the following recommendations was made:

- Take no further action;
- Initiate an immediate removal or interim action; or
- Include in a Remedial Investigation/Feasibility Study (RI/FS).

The SI and SSI Data Packages also included lists of issues which should be considered when implementing the recommended actions.

The SI and SSI Data Packages for Groups 2 and 7 were reviewed by the Army, USEPA, MADEP, and the public Technical Review Committee (TRC). Several issues were identified, and they are addressed and incorporated as appropriate in the presentations for each of the Groups 2 and 7 SAs, in Sections 4.0, 5.0, and 6.0 of this report.

1.5 PROJECT ORGANIZATION AND RESPONSIBILITIES

Because of its importance to the success of project tasks, the following discussion focuses primarily on the QA/QC organization and responsibilities for the Fort Devens project. Emphasis is directed toward the chemical analysis program where accuracy and reliability were critical. Figure 1-3 illustrates the functional relationships (i.e., lines of authority/responsibility and communication) for QC and QA for the Fort Devens effort; a description of key project roles follows.

1.5.1 USAEC Commander

Ultimate responsibility for all activities conducted in support of USAEC projects rests with the Commander of USAEC and is delegated to an USAEC Contracting Officer's Representative (COR) and the Chemistry Branch.

1.5.2 USAEC Contracting Officer's Representative

During the Groups 2 and 7 SI effort, the duties of the USAEC COR have included acting as the principal contact between USAEC, ABB-ES, and Fort Devens; requiring effective implementation of the USAEC QA Program; providing ABB-ES' Project Operations Plan to the Chemistry Branch for review and approval; forwarding Chemistry Branch review comments to ABB-ES; and providing formal notification to the Contracting Officer of unapproved deviations from the QA Program. Other responsibilities have included informing the Chemistry Branch of difficulties and problems encountered by ABB-ES in implementing the QA Program; discussing proposed changes in approved sampling and analysis procedures with the Chemistry Branch; providing any ABB-ES/Subcontractor Laboratory certification documentation to the Chemistry Branch for review and approval; and notifying ABB-ES of certification status.

1.5.3 USAEC Chemistry Branch

The duties of the USAEC Chemistry Branch, Technical Support Division have included advising the Commander on QA/QC practices; recommending to the Commander QA practices to be used to support USAEC projects; reviewing and approving project plans; providing standardized analytical methods, as necessary; and providing analytical reference materials to the laboratory. Additional responsibilities have included supplying Target Reporting Limits to the USAEC COR based on the formal list of applicable analytes; reviewing and recommending approval of any proposed modifications to analytical methodology; recommending certification of laboratory analytical methods as necessary prior to collecting field samples; providing guidance to the USAEC COR on implementation of QA/QC by the laboratory; providing guidance to the USAEC COR on chemistry matters; and evaluating the quality of data generated by the laboratory. Other QA/QC Chemistry Branch responsibilities have included monitoring the effective implementation of QA/QC and reporting questionable practices to the Commander of USAEC; conducting on-site audits of laboratory and field sampling activities, if necessary; and coordinating data reporting requirements with the USAEC Data Management Group.

1.5.4 ABB-ES Program Manager

The ABB-ES Program Manager is responsible for the overall USAEC program at ABB-ES. During the Groups 2 and 7 SI and SSI efforts, specific responsibilities have included overall technical responsibility for the program; establishing and overseeing all subcontracts for support services; initiating program activities; and participating in the work plan preparation and staff assignments. Additional duties have included identifying and fulfilling equipment and other resource requirements; monitoring task activities to ensure compliance with established budgets, schedules, and the scope of work; regularly interacting with the client regarding the status of the project; coordinating and reviewing monthly performance and cost reports (PCRs); and ensuring that appropriate financial record and reporting requirements were met.

Within the overall technical responsibility for the program, the Program Manager has supported the ABB-ES QA Supervisor in the development of the Fort Devens POP and the enforcement of its requirements in the implementation of the project. The Program Manager has reviewed and resolved conflicts relative to corrective action.

1.5.5 ABB-ES QA Supervisor

Specific QA and QC tasks for the implementation of the Fort Devens POP have been assigned to quality assurance and management personnel in ABB-ES and the laboratory. Each member of the ABB-ES technical project team has been responsible for performing work in accordance with the approved Fort Devens POP and for providing required documentation. Management personnel have provided the overall QC documentation, control, and assessment/corrective action. QA and QC personnel have provided oversight and review of data quality.

For the Groups 2 and 7 SI and SSI efforts, project-specific responsibility for QA/QC within ABB-ES has occurred under the supervision of the ABB-ES Project QA Supervisor. The ABB-ES QA Supervisor has authority independent of the Fort Devens Project Manager and Program Manager to issue corrective actions up to and including cessation of work performed out of compliance with the approved Fort Devens POP. In one instance, the ABB-ES QA Supervisor required work (sampling and analysis) to be repeated with the concurrence of the

U.S. Army Armament, Munitions, and Chemical Command (AMCCOM) Contracting Officer, USAEC COR, and the Chemistry Branch.

The ABB-ES QA Supervisor has responsibility for establishing, overseeing, and auditing specific procedures for documenting and controlling analytical and field data quality. Many of the procedures were implemented by other individuals, but the QA Supervisor ensured that procedures were being implemented properly and the results interpreted correctly. The QA Supervisor's oversight function has included making unannounced inspection trips to the site to ensure that sampling and laboratory analysis were conducted in a manner consistent with the Fort Devens POP, the USAEC QA Program, and other USAEC guidelines.

1.5.6 ABB-ES Project Manager

The ABB-ES Project Manager is responsible for effective day-to-day management of all operations. The Project Manager has responsibilities which specifically include preparing work plans, including approval of monitoring locations, chemical analysis parameters, schedules, and labor allocations; managing all funds for labor and materials procurement; monitoring and controlling the schedule; managing the site team toward unified, productive project accomplishment; preparing PCRs; communicating directly with the USAEC COR; and reviewing all task deliverables and providing technical leadership. Within this framework, the Project Manager has supported the ABB-ES QA Supervisor in the development and implementation of the QA Program, and provided resources for review, audit, and corrective action.

1.5.7 Laboratory Program Manager

The laboratory analytical program for both the SI and the SSI was conducted by Environmental Science and Engineering, Inc. (ESE) of Gainesville, Florida; an USAEC-approved laboratory.

The Laboratory Program Manager has provided direction to the analysts at ESE and has been responsible for implementing the USAEC QA Program. Major Laboratory Program Manager responsibilities have included supporting the efforts of the ESE Laboratory Quality Assurance Coordinator (QAC) to ensure that the USAEC QA Program was being properly implemented; providing sufficient work space, instrumentation, resources, and personnel to conduct all analyses according to the USAEC QA Program requirements; ensuring that all purchased chemicals (i.e., standards, solvent, and reagents) were checked for proper identity and adequate purity; and ensuring the implementation of any corrective actions which were deemed necessary to mitigate QA/QC deficiencies.

1.5.8 Laboratory QA Coordinator

In the fulfillment of QC requirements, the Laboratory QAC has provided the ABB-ES QA Supervisor with all QC data for review and intermittent status reports.

The ABB-ES QA Supervisor and Project Manager have delegated implementation of analytical QC functions as appropriate to the ESE Laboratory QAC. Major activities in the continued implementation of the USAEC QA Program at ESE have include monitoring the QA/QC activities of the laboratory to ensure conformance with the established protocols and good laboratory practices, as appropriate; informing the Laboratory Program Manager, individual analysts, and ESE corporate management, as appropriate, of nonconformance to the QA Program and recommending corrective actions to reestablish conformance with the requirements of the QA Program; and requesting the appropriate Standard Analytical Reference Materials from USAEC upon receipt of delivery orders.

The QAC has also been responsible for ensuring that all documents pertaining to the Fort Devens effort (i.e., records, logs, standard procedures, project plans and analytical results) are maintained in a retrievable fashion and distributed to the appropriate personnel; establishing, with the analysts, the proper analytical lot size for daily analysis and correct daily QC samples to be included in each lot according to the established procedures for evaluating acceptable, in-control analytical performance (i.e., initial and daily calibration and appropriate control charts); and establishing, with the designated sample custodian, that samples received in the laboratory are logged in properly, and are the appropriate analytical lot size. In addition, it has been the QAC's responsibility to verify that sample numbers for the QC samples were allocated in the correct manner.

Other duties have included ensuring that analysts were preparing the proper QC samples, maintaining control charts, and implementing any recommended corrective actions; ensuring that instrument logs and QC documents were being maintained with all the required information documented; collecting control charts from the analysts, discussing the results with the analysts and Laboratory Program Manager, and submitting these control charts to ABB-ES on a regular basis; reviewing all laboratory data prior to the reporting of data to other project participants; and maintaining an awareness of the entire laboratory operation for adherence to the procedures specified in the USAEC QA Program.

1.5.9 Project Review Committee

A key component of ABB-ES' corporate QC policy is the designation of a Project Review Committee (PRC) for each project or task. The members of the PRC were assigned according to the technical functions to be conducted. During the Groups 2 and 7 SI and SSI efforts, the function of this group of senior technical and/or management personnel has been to provide guidance on the technical aspects of the project. This has been accomplished through periodic reviews of the services provided to ensure they (1) reflected the accumulated experience of the firm, (2) were being produced in accordance with corporate policy, and, most importantly, (3) met the objectives of the program as established by ABB-ES and USAEC.

1.6 REVISED FINAL SITE INVESTIGATION REPORT ORGANIZATION

After acquiring and evaluating the SI and SSI field and off-site laboratory data and identifying chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs), ABB-ES has prepared this Revised Final SI Report for the Groups 2 and 7 SAs in accordance with USEPA and USAEC guidance. The report describes the field methods employed and presents, summarizes, and evaluates the relevant background information and the field and off-site laboratory data collected during the SI and SSI.

Section 2.0 of this report describes the history and physical setting of Fort Devens. Section 3.0 summarized the site investigation program, including the field procedures, analytical program, quality assurance and quality control, data management, background concentrations of inorganic analytes, and preliminary risk evaluation methods. Sections 4.0, 5.0, and 6.0 present the site investigation data, evaluations, conclusions, and recommendations for Groups 2, 7 and Historic Gas Stations, respectively. Figures and tables associated with Sections 1.0, 2.0, and 3.0 are at the end of each section. The figures and tables associated with the individual SAs are at the end of each section presenting the data for that SA.

TABLE 1-1
LIST OF STUDY AREAS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

GROUP	STUDY AREA NUMBER	STUDY AREA NAME
2	13	Landfill No. 9
	43	Historic gas stations (sites A Through S)
	45	Lake George Street Vehicle Wash Area
	49	Building 3602 LUST site
	56	Building 2417 LUST site
	57	Building 3713 fuel oil spill
	58	Buildings 2648 and 2650 fuel oil spill
7	12	Landfill No. 8
	14	Landfill No. 10
	27	Waste explosive detonation range (Hotel)
	28	Waste explosive detonation range (Training Area 14)
	41	Unauthorized dumping area (Site A)
	42	Popping furnace

TABLE 1-2
LIST OF INSTALLATION-WIDE STUDY AREAS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

GROUP NO.	STUDY AREA	GROUP NO.	STUDY AREA
1A	4 Sanitary landfill incinerator 5 Sanitary landfill 18 Sanitary landfill asbestos cell 40 Cold Spring Brook landfill	7	12 Landfill No. 8 14 Landfill No. 10 27 Waste explosives detonation range (Hotel) 28 Waste explosives detonation range (Training Area 14) 41 Unauthorized dumping area (Site A) 42 Popping furnace
1B	15 Landfill No. 11 24 Waste explosives storage bunker 187 25 Waste explosives detonation range(EOD range) 26 Waste explosives detonation range (Zulu I and II) 32 DRMO yard 48 Bldg. 202 LUST site		
2	13 Landfill No. 9 43 Historic gas station sites 45 Lake George Street vehicle wash area 49 Bldg. 3602 LUST site 54 Bldg. 2680 LUST site (same as 43-0) 56 Bldg. 2417 leaking underground storage tank site 57 Bldg. 3713 fuel oil spill 58 Bldgs. 2648 and 2650 fuel oil spills	8	16 Landfill No. 12 17 Little Mirror Lake (Landfill No. 13) 29 Transformer storage area 39 Transformer near Bldg. 4250
3	38 Battery repair area 44 Cannibalization yard 52 TDA maintenance yard	9	10 Landfill No. 6 11 Landfill No. 7 51 O'Neil building spill site 55 Shirley Housing Area trailer park fuel tanks
4	33 DEH entomology shop (Bldg. 262) 34 Former DEH entomology shop at Bldg. 245 35 Former DEH entomology shop at Bldg. 254 36 Former DEH entomology shop at Bldg. 2728 37 Golf course entomology shop (Bldg. 3622)	10	6 Landfill No. 2 7 Landfill No. 3 8 Landfill No. 4 46 Training Area 6c 53 South Post POL spill area
5	9 Landfill No. 5 19 Wastewater treatment plant 20 Rapid infiltration beds 21 Sludge drying beds	11	1 Cutler Army Hospital incinerator 2 Veterinary clinic incinerator 3 Intelligence School incinerator
6	30 Moore Army Airfield drum storage area 31 Moore Army Airfield fire-fighting training area 47 Moore Army Airfield LUST site (Bldg. 3816) 50 Moore Army Airfield WWII fuel point	12	22 Hazardous waste storage facility at Bldg. 1650 23 Paper recycling center

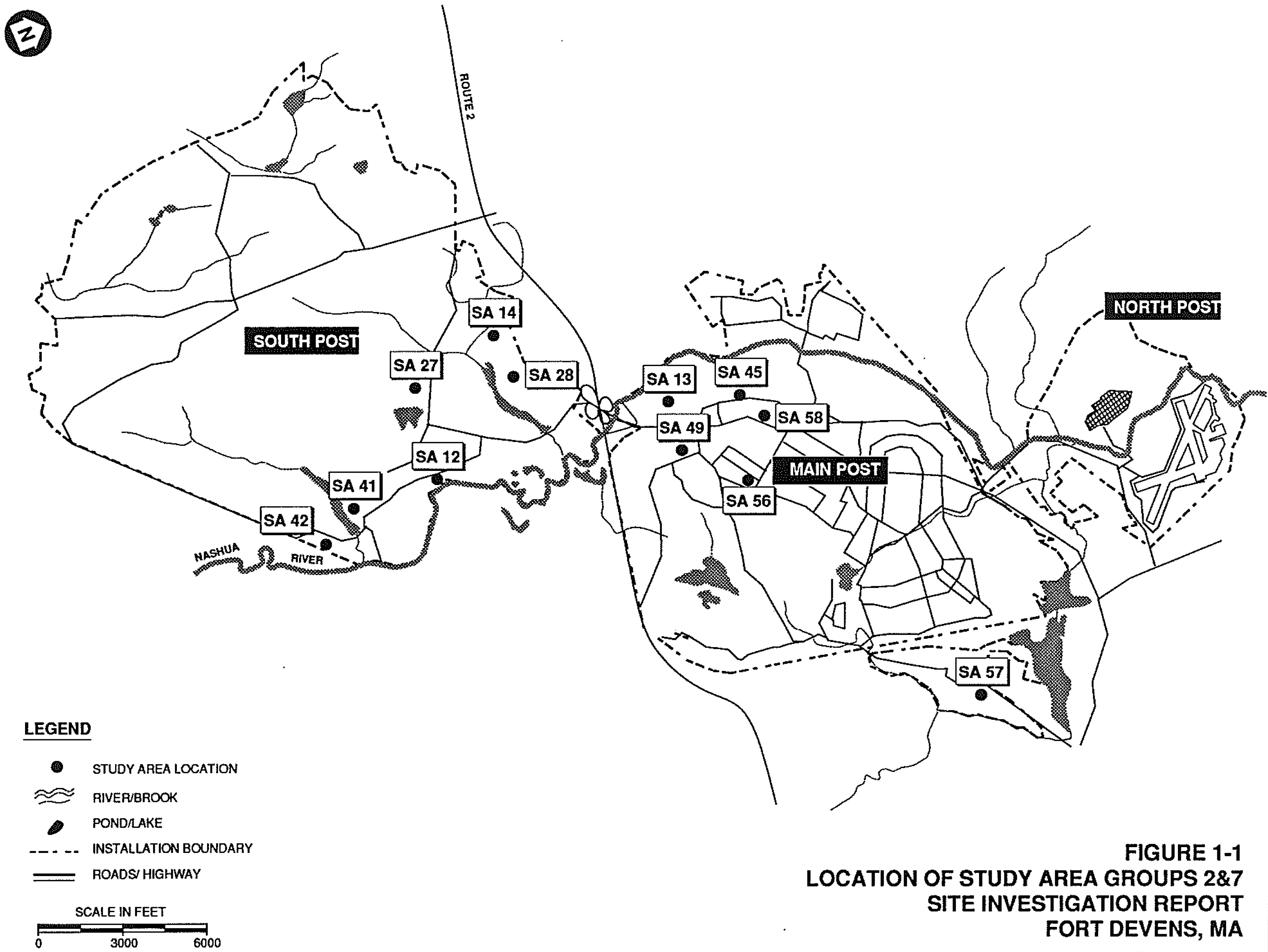


FIGURE 1-1
LOCATION OF STUDY AREA GROUPS 2&7
SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

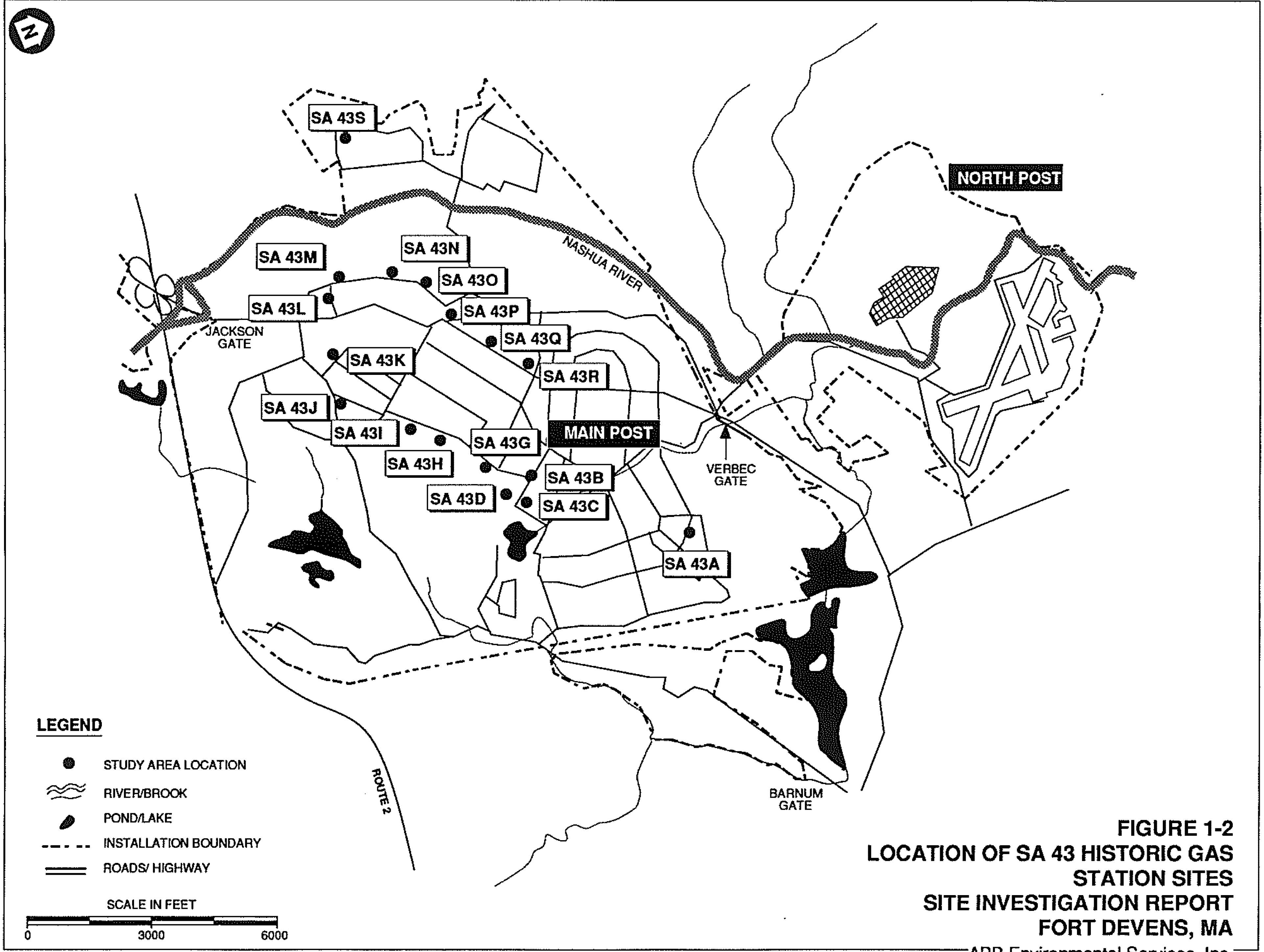


FIGURE 1-2
LOCATION OF SA 43 HISTORIC GAS STATION SITES
SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

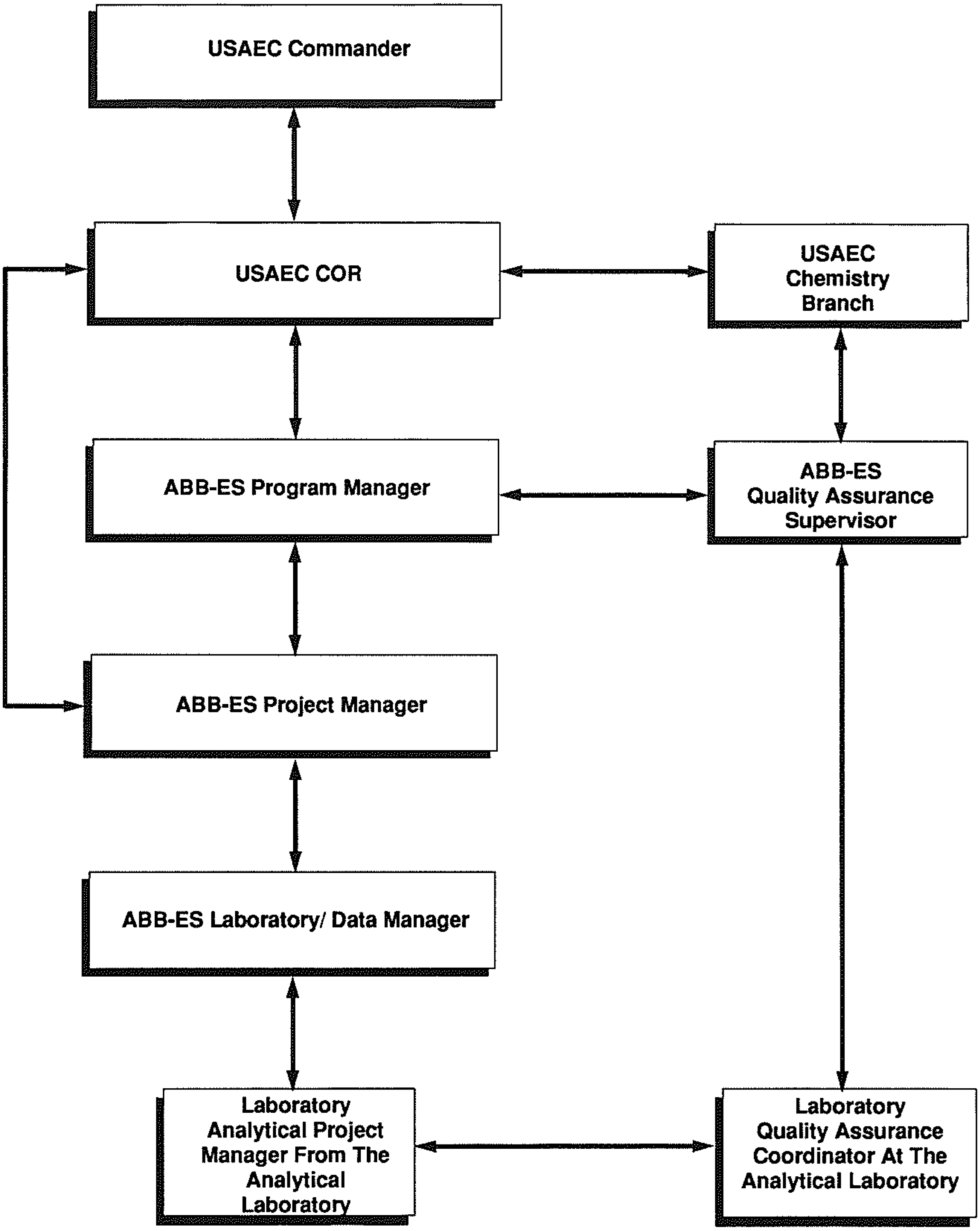


FIGURE 1-3
QA/QC FUNCTIONAL ORGANIZATIONAL CHART
SITE INVESTIGATION REPORT
FORT DEVENS, MA

2.0 INSTALLATION DESCRIPTION

Fort Devens is located in the towns of Ayer and Shirley (Middlesex County) and Harvard and Lancaster (Worcester County), approximately 35 miles northwest of Boston, Massachusetts. It lies within the Ayer, Shirley, and Clinton map quadrangles (7½-minute series). The installation occupies approximately 9,260 acres and is divided into the North Post, the Main Post, and the South Post (Figure 2-1).

Over 6,000 acres at Fort Devens are used for training and military maneuvers, and over 3,000 acres are developed for housing, buildings, and other facilities; the installation has been reported as the largest undeveloped land holding under a single owner in north-central Massachusetts (United States Fish and Wildlife Service [USFWS], 1992c).

The South Post is located south of Massachusetts Route 2 and is largely undeveloped. The Main Post and North Post primarily contain developed lands, including recreational areas (e.g., a golf course and Mirror Lake), training areas, and an airfield. All Groups 2 and 7 SAs are located on either the Main or South Posts.

The following sections describe the history and physical setting of Fort Devens.

2.1 HISTORY

Camp Devens was created as a temporary cantonment in 1917 for training soldiers from the New England area. It was named after Charles Devens -- a Massachusetts Brevet Major General in the Union Army during the Civil War who later became Attorney General under President Rutherford Hayes. Camp Devens served as a reception center for selectees, as a training facility, and, at the end of World War I, as a demobilization center (Marcoa Publishing Inc., 1990). At Camp Devens the 1918 outbreak of Spanish influenza infected 14,000 people, killed 800, and caused the installation to be quarantined (McMaster et al., 1982). Peak military strength during World War I was 38,000. After World War II, Camp Devens became an installation of the U.S. Army Field Forces, CONARC in 1962 and the U.S. Army Forces Command (FORSCOM) in 1973 (Biang et al., 1992).

In 1921, Camp Devens was placed in caretaker status. During summers from 1922 to 1931, it was used as a training camp for National Guard troops, Reserve units, Reserve Officer Training Corps (ROTC) cadets, and the Civilian Military Training Corps (CMTC). In 1929, Dr. Robert Goddard used Fort Devens to test his early liquid-fuel rockets, and there is a monument to him on Sheridan Road near Jackson Gate (Fort Devens Dispatch, 1992).

In 1931, troops were again garrisoned at Camp Devens. It was declared a permanent installation, and in 1932 it was formally dedicated as Fort Devens. During the 1930s, there was a limited building program, and beautification projects were conducted by the Works Progress Administration (WPA) and Civilian Conservation Corps (CCC).

In 1940, Fort Devens became a reception center for New England draftees. It expanded to more than 10,000 acres. Approximately 1,200 wooden buildings were constructed, and two 1,200-bed hospitals were built. In 1941, the Army Airfield was constructed by the WPA in a period of 113 days (Fort Devens Dispatch, 1992). In 1942, the Whittemore Service Command Base Shop for motor vehicle repair (Building 3713) was built, and at the time it was known as the largest garage in the world (U.S. Army, 1979). The installation's current wastewater treatment plant was also constructed in 1942 (Biang et al., 1992).

During World War II, more than 614,000 inductees were processed. Fort Devens' population reached a peak of 65,000. Three Army divisions and the Fourth Women's Army Corps trained at Fort Devens, and it was the location of the Army's Chaplain School, the Cook & Baker School, and a basic training center for Army nurses. A prisoner of war camp for 5,000 German and Italian soldiers was operated from 1944 to 1946. At the end of the war, Fort Devens again became a demobilization center, and in 1946 it reverted to caretaker status.

Fort Devens was reactivated in July 1948 and again became a reception center during the Korean Conflict. It has been an active Army facility since that time.

Currently the mission at Fort Devens is to command and train its assigned duty units, operate the South Boston Support Activity in Boston, Massachusetts, Sudbury Training Annex and Hingham USAR Annex and to support the 10th Special Forces Group (A), the U.S. Army Intelligence School, Fort Devens, the U.S. Army Reserves, Massachusetts Army National Guard, and Reserve Officer

Training Programs. No major industrial operations occur at Fort Devens, although several small-scale industrial operations are performed under (1) the Directorate of Plans, Training, and Security; (2) the Directorate of Logistics; and (3) the Directorate of Engineering and Housing. The major waste-producing operations performed by these groups are photographic processing and maintenance of vehicles, aircraft, and small engines. Past artillery fire, mortar fire, and waste explosive disposal at Fort Devens are potential sources for explosives contamination (AEC, 1993).

Under Public Law 101-510, the Base Closure and Realignment Act (BRAC) 1990, Fort Devens has been identified for closure by July 1997, and 4,600 acres are to be retained to establish a Reserve Component enclave and regional training center.

2.2 PHYSICAL SETTING

The climate, vegetation, ecology, physiography, soils, surficial and bedrock geology, and regional hydrogeology of Fort Devens are described in the sections that follow.

2.2.1 Climate

The climate of Fort Devens is typical of the northeastern United States, with long cold winters and short hot summers. Climatological data were reported for Fort Devens by U.S. Department of the Army (1979), based in part on a 16-year record from Moore Army Airfield (MAAF).

The mean daily minimum temperature in the coldest months (January and February) is 17 degrees Fahrenheit (°F), and the mean daily maximum temperature in the hottest month (July) is 83°F. The average annual temperature is 58°F. There are normally 12 days per year when the temperature reaches or exceeds 90°F and 134 days when it falls to or below freezing.

The average annual rainfall is 39 inches. Mean monthly precipitation varies from a low of 2.3 inches (in June) to a high of 5.5 inches (in September). The average annual snowfall is 65 inches, and snowfall has been recorded in the months of September through May (falling most heavily from December through March).

Wind speed averages 5 miles per hour (mph), ranging from the highest monthly average of 7 mph (March-April) to the lowest monthly average of 4 mph (September).

Average daytime relative humidities range from 71 percent (January) to 91 percent (August), and average nighttime relative humidities range from 46 percent (April) to 60 percent (January).

2.2.2 Vegetation

The Main and North Posts at Fort Devens are primarily characterized by urban and developed cover types. Approximately 56 percent of that area is covered by developed lands, the golf course, the airfield, and the wastewater infiltration beds. Early successional forest cover types (primarily black cherry-aspen hardwoods) encompass approximately 2 percent of the area, mixed oak-red maple hardwoods approximately 20 percent, and white pine-hardwood mixes approximately 11 percent. The rest of the North and Main Posts are characterized by various coniferous species, shrub habitat, and herbaceous cover types.

Much of the South Post is undeveloped forested land. The area includes approximately 8 percent early successional forest (black cherry, red birch, grey birch, quaking aspen, red maple); 26 percent mixed oak hardwoods; and 9 percent coniferous forest (white pine, pitch pine, red pine). Four percent of the area comprises a mixed shrub community. The 200-acre Turner Drop Zone is maintained as a grassland that represents a "prairie" habitat. Vegetative cover in the large "impact area" of the central South Post has not been mapped in detail. It is dominated by fire-tolerant species such as pitch pine and scrub oak.

Extensive sandy glaciofluvial soils are found in the Nashua River Valley, particularly in the South and North Post areas of Fort Devens. Extensive accumulations of these soils are unusual in Massachusetts outside of Cape Cod and adjacent areas of southeastern Massachusetts, and they account for some of the floral and faunal diversity at the installation.

2.2.3 Ecology

Fort Devens encompasses numerous terrestrial, wetland, and aquatic habitats in various successional stages. Floral and faunal diversity is strengthened by the installation's close proximity to the Nashua River; the amount, distribution, and nature of wetlands; and the undeveloped state and size of the South Post (USFWS, 1992). Much of Fort Devens was formerly agricultural land and included pastures, woodlots, orchards, and cropped fields. Existing habitat types reflect this agrarian history, ranging from abandoned agricultural land to secondary growth forested regions. Fort Devens is generally reverting back to a forested state.

There are 1,313 acres of wetlands at Fort Devens. The wetlands are primarily palustrine, although riverine and lacustrine types are also found. Forested palustrine floodplain wetlands associated with the Nashua River and its tributary Nonacoicus Brook are located on Fort Devens' Main and North Posts. These include 191 acres of flooded areas, emergent marsh, and shrub wetlands. Also present are 245 acres of isolated regions of palustrine wetlands and lacustrine systems. On the South Post, there are 877 acres of wetlands, consisting of deciduous forested wetlands, deciduous shrub swamps, emergent marsh, open lacustrine waters in ponds, and open riverine waters.

Approximately half of Fort Devens' land area abuts the northern boundary of the Oxbow National Wildlife Refuge (NWR), a federal resource administered as part of the Great Meadows NWR (USFWS, 1992c).

Fort Devens supports an abundance and diversity of wildlife. Identified taxa include 771 vascular plant species, 538 species of butterflies and moths, eight tiger beetle species, 30 vernal pool invertebrates, 15 amphibian species (six salamanders, two toads, seven frogs), 19 reptile species (seven turtles, 12 snakes), 152 bird species, and 42 mammal species. The status of fish populations in Fort Devens aquatic systems has not been fully defined.

Rare and endangered species at Fort Devens include the federally listed (endangered) bald eagle and peregrine falcon (both occasional transients); the state-listed (endangered) upland sandpiper, ovoid spike rush, and Houghton's flatsedge; the state-listed (threatened) Blanding's turtle, cattail sedge, pied-billed grebe, and northern harrier; and the state-listed (special concern) blue-spotted salamander, grasshopper sparrow, spotted turtle, wood turtle, water shrew, blackpoll warbler, American bittern, Cooper's hawk, sharp-shinned hawk, and Mystic Valley amphipod. Also state listed as rare or endangered are three Lepidoptera (butterfly and moth) species identified at Fort Devens.

The Massachusetts Natural Heritage Program has developed Watch Lists of unprotected species that are uncommon or rare in Massachusetts. From the Watch Lists 14 plant species, two amphibian species, and 15 bird species have been observed at Fort Devens.

Additional detail concerning the ecology of Fort Devens can be found in Section 3.6 and in the ecological risk evaluations of individual study areas presented in Sections 4.0, 5.0, and 6.0.

2.2.4 Physiography

Fort Devens is in a transitional area between the coastal lowland and central upland regions of Massachusetts. All of the landforms are products of glacial erosion and deposition on a crystalline bedrock terrain. Glacial erosion was superimposed on ancient bedrock landforms that were developed by the erosional action of preglacial streams. Generally, what were bedrock hills and ridges before the onset of Pleistocene glaciation were only moderately modified by glacial action, and they remain bedrock hills and ridges today. Similarly, preglacial bedrock valleys are still bedrock valleys. In post-glacial time, streams have locally modified the surficial glacial landforms but generally have not affected bedrock.

The predominant physiographic (and hydrologic) feature in the Fort Devens area is the Nashua River (see Figure 2-1). It forms the eastern installation boundary on the South Post, where its valley varies from a relatively narrow channel (at Still River Gate), to an extensive floodplain with a meandering river course and numerous cutoff meanders (at Oxbow National Wildlife Sanctuary). The Nashua River forms the western boundary of much of the Main Post, and there its valley is deep and comparatively steep-sided with extensive bedrock outcroppings on the eastern bank. The river flows through the North Post in a well defined channel within a broad forested floodplain.

Terrain at Fort Devens falls generally into three types. The least common is bedrock terrain, where rocks that have been resistant to both glacial and fluvial erosion remain as topographic highs, sometimes thinly veneered by glacial deposits. Shepley's Hill on the Main Post is the most prominent example.

A similar but more common terrain at Fort Devens consists of materials (tills) deposited directly by glaciers as they advanced through the area or as the ice masses wasted (melted). These landforms often conform to the shape of the underlying bedrock surface. They range from areas of comparatively low topographic relief (such as near Lake George Street on the Main Post) to elongated hills (drumlins) whose orientations reflect the direction of glacier movement (such as Whittemore Hill on the South Post).

The third type of terrain was formed by sediment accumulations in glacial-meltwater streams and lakes (glaciofluvial and glaciolacustrine deposits). This is the most common terrain at Fort Devens, comprising most of the North and South Posts and much of the Main Post. Its form bears little or no relationship to the shape of the underlying bedrock surface. Landforms include extensive flat uplands such as the hills on which Moore Army Airfield and the wastewater infiltration beds are located on the North Post. Those are large remnants of what was once a continuous surface that was later incised and divided by downcutting of the Nashua River. Another prominent glacial meltwater feature is the area around Cranberry Pond and H-Range on the South Post. This is classic kame-and-kettle topography formed by sand and gravel deposition against and over large isolated ice blocks, followed by melting of the ice and collapse of the sediments. The consistent elevations of the tops of these ice-contact deposits are an indication of the glacial-lake stage with which they are associated. Mirror Lake and Little Mirror Lake on the Main Post occupy another conspicuous kettle.

2.2.5 Soils

Fort Devens lies within Worcester County and Middlesex County in Massachusetts (see Figure 2-1). The soils of Worcester County have been mapped by the Soil Conservation Service (SCS) of the U.S. Department of Agriculture (USDA) (SCS, 1985). Mapping of the soils of Middlesex County has not been completed. However, an interim report (SCS, 1991), field sheet #19 (SCS, 1989), and an unpublished general soil map (SCS, undated) are available.

Soil mapping units ("soil series") that occur together in intricate characteristic patterns in given geographic areas are grouped into soil "associations." Soils in the Worcester County portions of Fort Devens consist generally of three associations. Three associations also have been mapped in the Middlesex County portions of Fort Devens. Although the mapped associations are not entirely the same on both sides of the county line, the differences reflect differences in definition and the interim status of Middlesex County mapping. The general distributions of the soil associations are shown in Figure 2-2, and descriptions of the soil series in those associations are provided below.

WORCESTER COUNTY (SCS, 1985)

Winooski-Limerick-Saco Association:

Winooski Series. Very deep; moderately well drained; slopes 0 to 3 percent; occurs on floodplains; forms in silty alluvium.

Limerick Series. Very deep; poorly drained; slopes 0 to 3 percent; occurs on floodplains; forms in silty alluvium.

Saco Series. Very deep; very poorly drained; slopes 0 to 3 percent; occurs on floodplains; derived mainly from schist and gneiss.

Hinckley-Merrimac-Windsor Association:

Hinckley Series. Very deep; excessively drained; slopes 0 to 35 percent; occurs on stream terraces, eskers, kames, and outwash plains.

Merrimac Series. Very deep; excessively drained; slopes 0 to 25 percent; occurs on stream terraces, eskers, kames, and outwash plains.

Windsor Series. Very deep; moderately well drained; slopes 0 to 3 percent; occurs on floodplains.

Paxton-Woodbridge-Canton Association:

Paxton Series. Very deep; well drained; slopes 3 to 35 percent; occurs on glacial till uplands; formed in friable till overlying firm till.

Woodbridge Series. Very deep; moderately well drained; slopes 0 to 15 percent; occurs on glacial till uplands; formed in firm till.

Canton Series. Very deep; well drained; slopes 3 to 35 percent; occurs on glaciated uplands; formed in friable till derived mainly from gneiss and schist.

MIDDLESEX COUNTY (SCS, 1991)

Hinckley-Freetown-Windsor Association (This is a continuation of the Hinckley-Merrimac-Windsor Association mapped in Worcester County):

> Hinckley Series. Deep; excessively drained; nearly level to very steep; occurs on glacial outwash terraces, kames, and eskers; formed in gravelly and cobbley coarse textured glacial outwash.
>
> Freetown Series. Deep; very poorly drained; nearly level, organic; occurs in depressions and on flat areas of uplands and glacial outwash plains.
>
> Windsor Series. Deep; excessively drained; nearly level to very steep; occurs on glacial outwash plains, terraces, deltas, and escarpments; formed in sandy glacial outwash.

Quonset-Carver Association:

> Quonset Series. Deep; excessively drained; nearly level to very steep; occurs on glacial outwash plains, terraces, eskers, and kames; formed in water-sorted sands derived principally from dark phyllite, shale, or slate.
>
> Carver Series. Deep; excessively drained; nearly level to steep; occurs on glacial outwash plains, terraces, and deltas; formed in coarse, sandy, water-sorted material.

Winooski-Limerick-Saco Association (This is a continuation of the same association mapped along the Nashua River floodplain in Worcester County).

2.2.6 Surficial Geology

Fort Devens lies in three topographic quadrangles: Ayer, Clinton, and Shirley. The surficial geology of Fort Devens has been mapped only in the Ayer quadrangle (Jahns, 1953) and Clinton quadrangle (Koteff, 1966); the Shirley quadrangle is unmapped.

Unconsolidated surficial deposits of glacial and postglacial origin comprise nearly all of the exposed geologic materials at Fort Devens. The glacial units consist of till, deltaic deposits of glacial Lake Nashua, and deposits of glacial meltwater streams.

The till ranges from unstratified gravel to silt, and it is characteristically bouldery. Jahns (1953) and Koteff (1966) recognize a deeper unit of dense, subglacial till, and an upper, looser material that is probably a slightly younger till of englacial or superglacial origin. Till is exposed in ground-moraine areas of the Main Post (such as in the area of Lake George Street) and on the South Post at and south of Whittemore Hill. It also underlies some of the water-laid deposits (Jahns, 1953). Till averages approximately 10 feet in thickness but reaches 60 feet in drumlin areas (Koteff, 1966).

Most of the surficial glacial units in the Nashua Valley are associated with deposition in glacial Lake Nashua, which formed against the terminus of the Wisconsinan ice sheet as it retreated northward along the valley. Successively lower outlets were uncovered by the retreating glacier, and the lake level was correspondingly lowered. Koteff (1966) and Jahns (1953) recognize six lake levels (stages) in the Fort Devens area, distinguished generally by the elevations and distribution of their associated deposits. The stages are, in order of development: Clinton Stage; Pin Hill Stage; Old Mill Stage; Harvard Stage; Ayer Stage; and Groton Stage.

The glacial lake deposits consist chiefly of sand and gravelly sand. Coarser materials are found in topset beds of deltas built out into the lakes and in glacial stream beds graded to the lakes. Delta foreset beds are typically composed of medium to fine sand, silt, and clay. Lake-bottom deposits, which consist of fine sand, silt, and clay, are mostly covered by delta deposits and are seldom observed in glacial Lake Nashua deposits. One of the few known exposures of glacial lake-bottom sediments in the region is on the South Post near A- and C-Ranges. There a section of more than 14 feet of laminated clay was mined for brick-making in the early part of this century (Alden, 1925, pp. 70-71). The general physical characteristics of glacial lake deposits are the same regardless of the particular lake stage in which the deposits accumulated (Koteff, 1966; Jahns, 1953). Although glaciofluvial and glaciolacustrine sediments are typically well stratified, correlations between borings are difficult because of laterally abrupt changes characteristic of these generally high-energy depositional environments.

Postglacial deposits consist mostly of river-terrace sands and gravels; fine alluvial sands and silts beneath modern floodplains; and muck, peat, silt, and sand in swampy areas.

Jahns (1953) also observed a widespread veneer of windblown sand and ventifacts above the glacial materials (and probably derived from them in the brief interval between lake drainage and the establishment of vegetative cover).

2.2.7 Bedrock Geology

Fort Devens is underlain by low-grade metasedimentary rocks, gneisses, and granites. The rocks range in age from Late Ordovician to Early Devonian (approximately 450 million to 370 million years old). The installation is situated approximately 2 miles west of the Clinton-Newbury-Bloody Bluff fault zone, which developed when the ancestral European continental plate collided with and underthrust the ancestral North American plate. The continents reseparated in the Mesozoic to form the modern Atlantic Ocean. Fort Devens is located on the very eastern edge of the ancestral North American continental plate. A piece of the ancestral European continent (areas now east of the Bloody Bluff fault) broke off and remained attached to North America.

Preliminary bedrock maps (at scale 2,000 feet/inch) are available for the Clinton quadrangle (Peck, 1975 and 1976) and Shirley quadrangle (Russell and Allmendinger, 1975; Robinson, 1978). Bedrock information for the Ayer quadrangle is from the Massachusetts state bedrock map (at a regional scale of 4 miles/inch) (Zen, 1983) and in associated references (Robinson and Goldsmith, 1991; Wones and Goldsmith, 1991). Among these sources, there is some disagreement about unit names and stratigraphic sequence; however, there is general agreement about the distribution of rock types.

In contrast to the high metamorphic grade and highly sheared rocks of the Clinton-Newbury zone, the rocks in the Fort Devens area are low grade metamorphics (generally below the biotite isograd) and typically exhibit less brittle deformation. Major faults have been mapped, however, including the Wekepeke fault exposed west of Fort Devens (in an outcrop 0.25 mile west of the old Howard Johnson rest stop on Route 2).

Figure 2-3 is a generalized summary of the bedrock geology of Fort Devens. It is compiled from Peck (1975), Robinson (1978), Russell and Allmendinger (1975), and Zen (1983), and it adopts the nomenclature of Zen (1983). Because of limited bedrock exposures, the locations of mapped contacts are considered approximate, and the mapped faults are inferred. Rock units strike generally northward to northeastward but vary locally. The bedrock units underlying Fort Devens are as follows:

DSw **WORCESTER FORMATION** (Lower Devonian and Silurian) Carbonaceous slate and phyllite, with minor metagraywacke to the west (Zen, 1983; Peck, 1975). Bedding is typically obscure due to a lack of compositional differences. It is relatively resistant to erosion and forms locally prominent outcrops. The abandoned Shaker slate quarry on the South Post is in rocks of the Worcester Formation. The unit corresponds to the "DSgs" and "DSs" units of Peck (1975) and the "e3" unit of Russell and Allmendinger (1975).

So **OAKDALE FORMATION** (Silurian) Metasiltstone and phyllite. It is fine-grained and consists of quartz and minor feldspar and ankerite, and it is commonly deformed by kink banding (Zen, 1983; Peck, 1975; Russell and Allmendinger, 1975). In outcrop it has alternating layers of brown siltstone and greenish phyllite. The Oakdale Formation crops out most visibly on Route 2 just east of the Jackson Gate exit. It corresponds to the "DSsp" unit of Peck (1975), the "e2" unit of Russell and Allmendinger (1975), and "ms" unit of Robinson (1978).

Sb **BERWICK FORMATION** (Silurian) Thin- to thick-bedded metamorphosed calcareous metasiltstone, biotitic metasiltstone, and fine-grained metasandstone, interbedded with quartz-muscovite-garnet schist and feldspathic quartzite (Zen, 1983; Robinson and Goldsmith, 1991). In areas northwest of Fort Devens, cataclastic zones have been observed (Robinson, 1978).

Dcgr **CHELMSFORD GRANITE** (Lower Devonian) Light-colored and gneissic, even and medium grained, quartz-microcline-plagioclase-muscovite-biotite, pervasive ductile deformation visible in elongate quartz grains aligned parallel to mica. It intrudes the Berwick Formation and Ayer granite (Wones and Goldsmith, 1991).

AYER GRANITE

Sacgr **Clinton facies** (Lower Silurian) Coarse-grained, porphyritic, foliated biotite granite with a nonporphyritic border phase; it intrudes the Oakdale and Berwick Formations and possibly the Devens-Long Pond Facies (Zen, 1983; Wones and Goldsmith, 1991).

SOad **Devens-Long Pond facies** (Upper Ordovician and Lower Silurian) Gneissic, equigranular to porphyoblastic biotite granite and granodiorite. Its contact relationship with the Clinton facies is unknown (Wones and Goldsmith, 1991). Observations of mapped exposures of this unit on Fort Devens indicate that it may not be intrusive.

Bedrock is typically unweathered to only slightly weathered at Fort Devens. Glaciers stripped away virtually all of the preglacially weathered materials, and there has been insufficient time for chemical weathering of rocks in the comparatively brief geologic interval since glacial retreat.

2.2.8 Regional Hydrogeology

Fort Devens is in the Nashua River drainage basin, and the Nashua River is the eventual discharge locus for all surface water and groundwater flow at the installation.

The water of the Nashua River has been assigned to Class B under Commonwealth of Massachusetts regulations. Class B surface water is "designated for the uses of protection and propagation of fish, other aquatic life and wildlife, and for primary and secondary contact recreation" (314 CMR 4.03).

The principal tributaries of the north-flowing Nashua River at Fort Devens are Nonacoicus Brook and Walker Brook on the North Post; Cold Spring Brook (which is a tributary of Nonacoicus Brook) on the Main Post; and Spectacle Brook and Ponakin Brook (tributaries of the North Nashua River), Slate Rock Brook, and New Cranberry Pond Brook on the South Post (Figure 2-4).

There are two ponds on Fort Devens' South Post that are called Cranberry Pond. For the purpose of the SIs, the isolated kettle pond located east of H-Range is referred to as Cranberry Pond, and the pond impounded in the 1970s 0.5-mile west of the Still River gate is referred to as New Cranberry Pond.

Glacial meltwater deposits constitute the primary aquifer at Fort Devens. In aquifer tests performed as part of the SIs (refer to Appendix A), measured hydraulic conductivities in meltwater deposits were comparatively high-- typically 10^{-3} to 10^{-2} centimeters per second (cm/sec). In till and in clayey lake-bottom sediments, measured hydraulic conductivities were lower and ranged generally from 10^{-6} to 10^{-4} cm/sec. Groundwater also occurs in the underlying bedrock; however, flow is limited because the rocks have no primary porosity and water moves only in fractures and dissolution voids.

Groundwater in the surficial aquifer at Fort Devens has been assigned to Class I under Commonwealth of Massachusetts regulations. Class I consists of groundwaters that are "found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated as a source of potable water supply" (314 CMR 6.03).

The transmissivity of an aquifer is the product of its hydraulic conductivity and saturated thickness, and as such it is a good measure of groundwater availability. Figure 2-4 shows aquifer transmissivities at Fort Devens, based on the regional work of Brackley and Hansen (1977). Transmissivities in the meltwater deposits range from 10 square feet per day (ft^2/day) to more than 4,000 ft^2/day. Aquifer transmissivities between 10 and 1,350 ft^2/day correspond to potential well yields generally between 10 and 100 gallons per minute (gpm); transmissivities from 1,350 to 4,000 ft^2/day typically yield from 100 to 300 gpm; and where transmissivities exceed 4,000 ft^2/day, well yields greater than 300 gpm can be expected. (Most domestic wells in the area are drilled 100 to 200 ft into bedrock and yield less than 10 gpm. Higher yields are associated with deeper bedrock wells.)

In Figure 2-4, the zones of highest transmissivity are found in areas of thick glacial meltwater deposits on the North and Main Posts, and these encompass the Sheboken, Patton, and McPherson production wells and the largely inactive Grove Pond well-field. The zones of lowest transmissivity are associated with exposed till and bedrock and are located on the Main Post surrounding Shepley's Hill and between Jackson Gate and the parade ground, and on the South Post at Whittemore Hill and isolated areas to the north and west.

A regional study of water resources in the Nashua River basin was reported by Brackley and Hansen (1977). A digital model of groundwater flow at Fort Devens is available in a draft final report by Engineering Technologies Associates, Inc. (1992).

According to Engineering Technologies Associates, Inc. (1992), in the absence of pumping or other disturbances, groundwater recharge occurs in upland areas (e.g., the high ground on the Main Post between Queenstown, Givry, and Lake George Streets, and on the South Post the area around Whittemore Hill). The groundwater flows generally from the topographic highs to topographic lows. It discharges in wetlands, ponds, streams, and directly into the Nashua River. Groundwater discharge maintains the dry-weather flow of the rivers and streams.

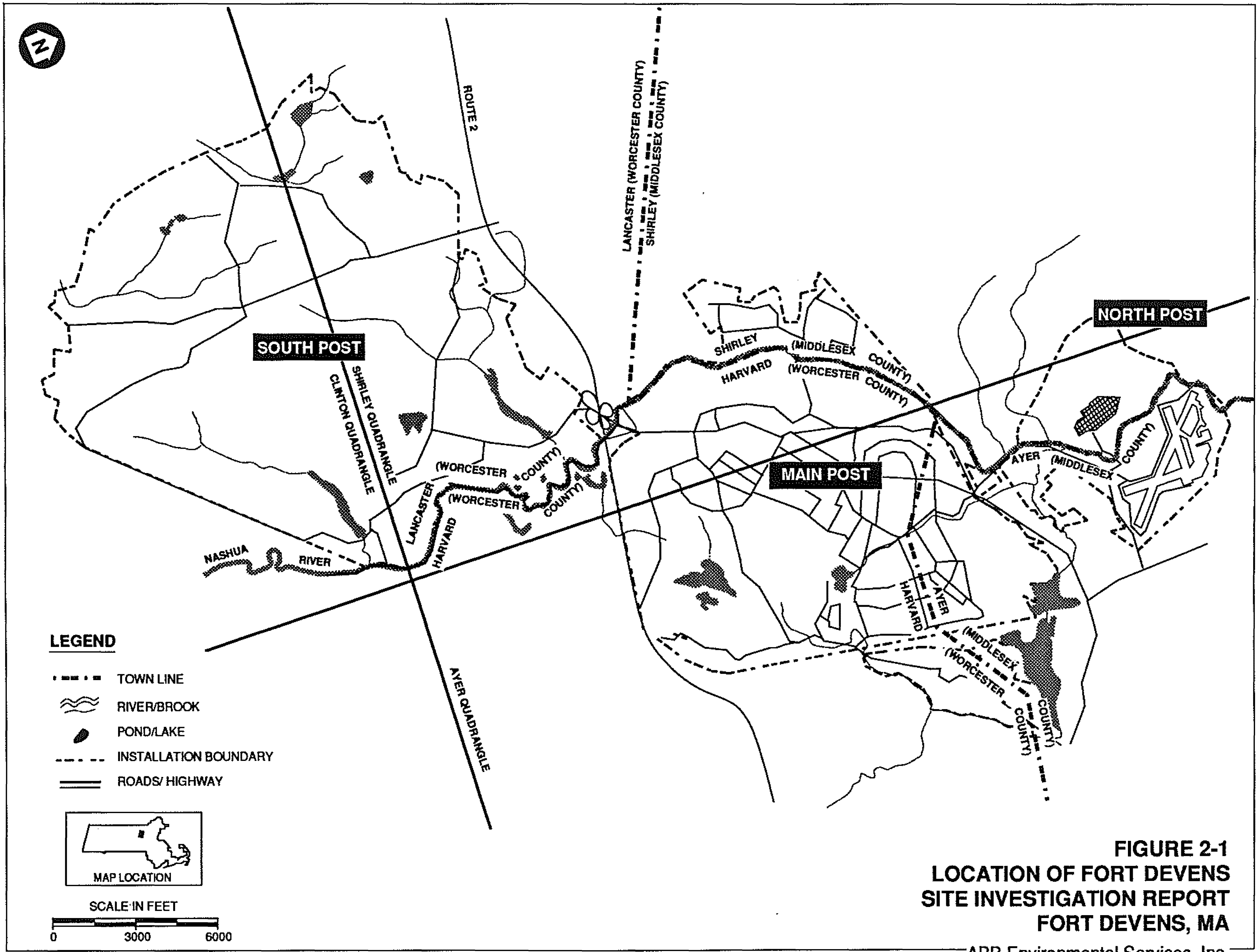
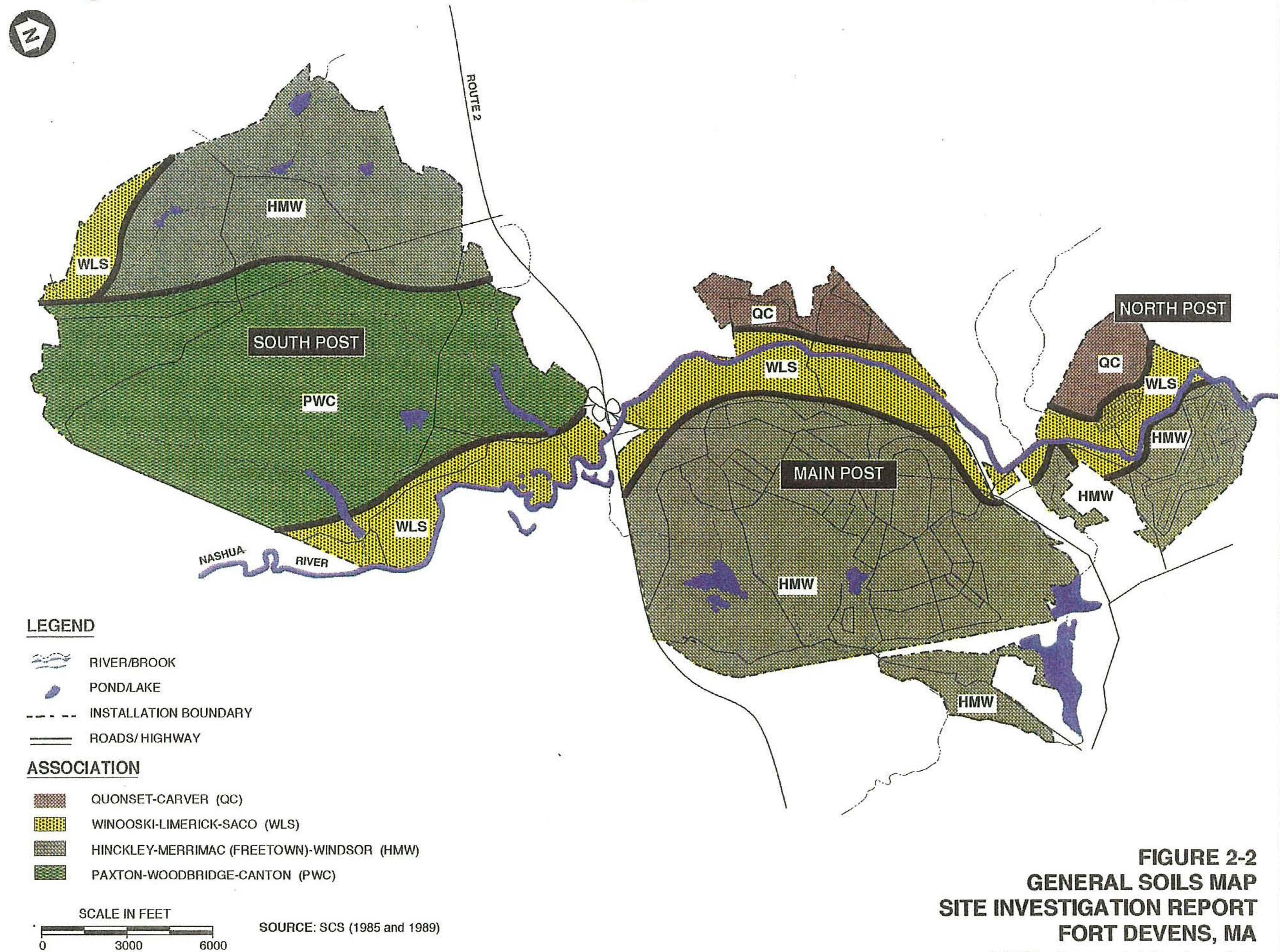


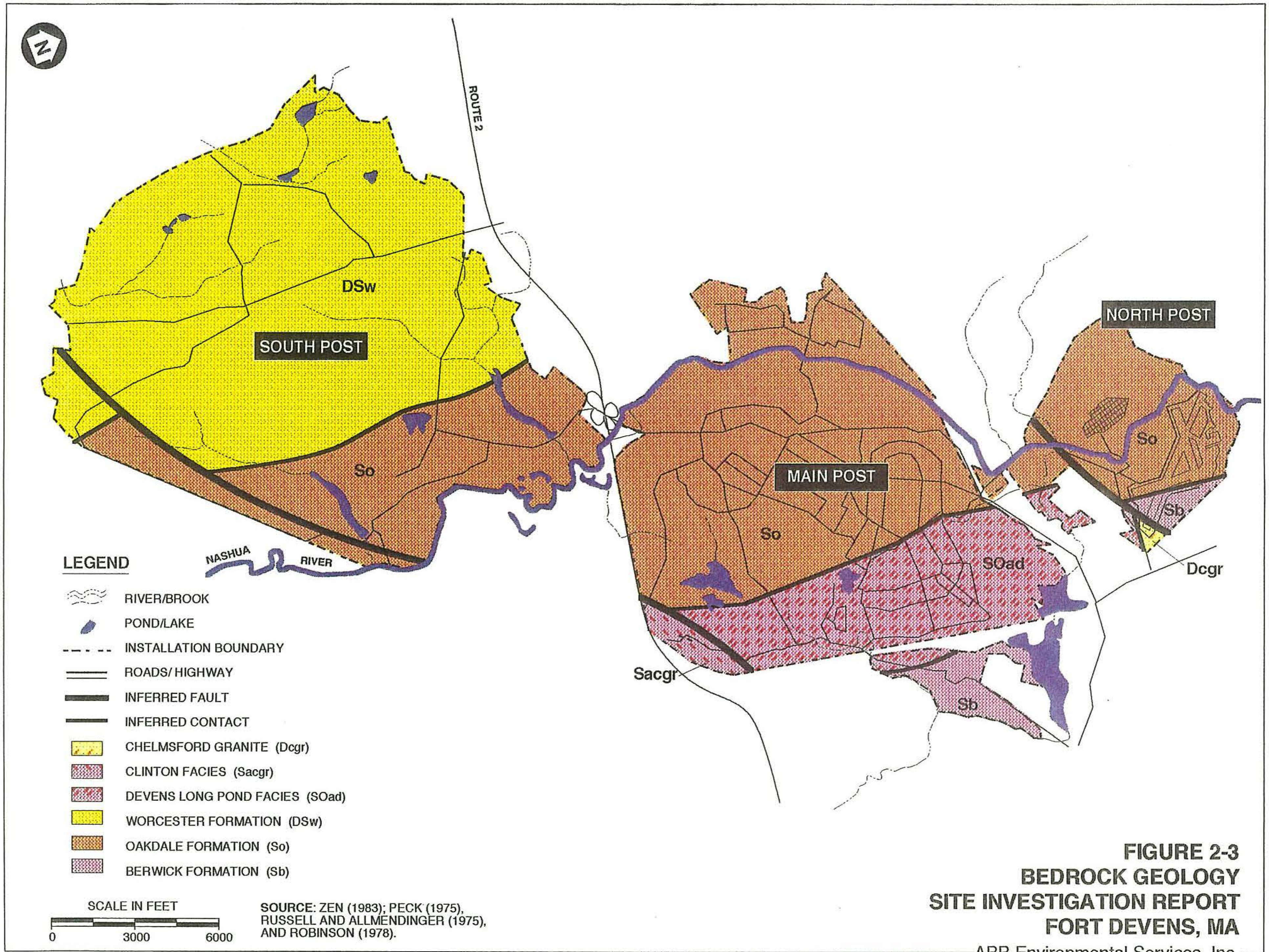
FIGURE 2-1
LOCATION OF FORT DEVENS
SITE INVESTIGATION REPORT
FORT DEVENS, MA



SOURCE: SCS (1985 and 1989)

FIGURE 2-2
GENERAL SOILS MAP
SITE INVESTIGATION REPORT
FORT DEVENS, MA

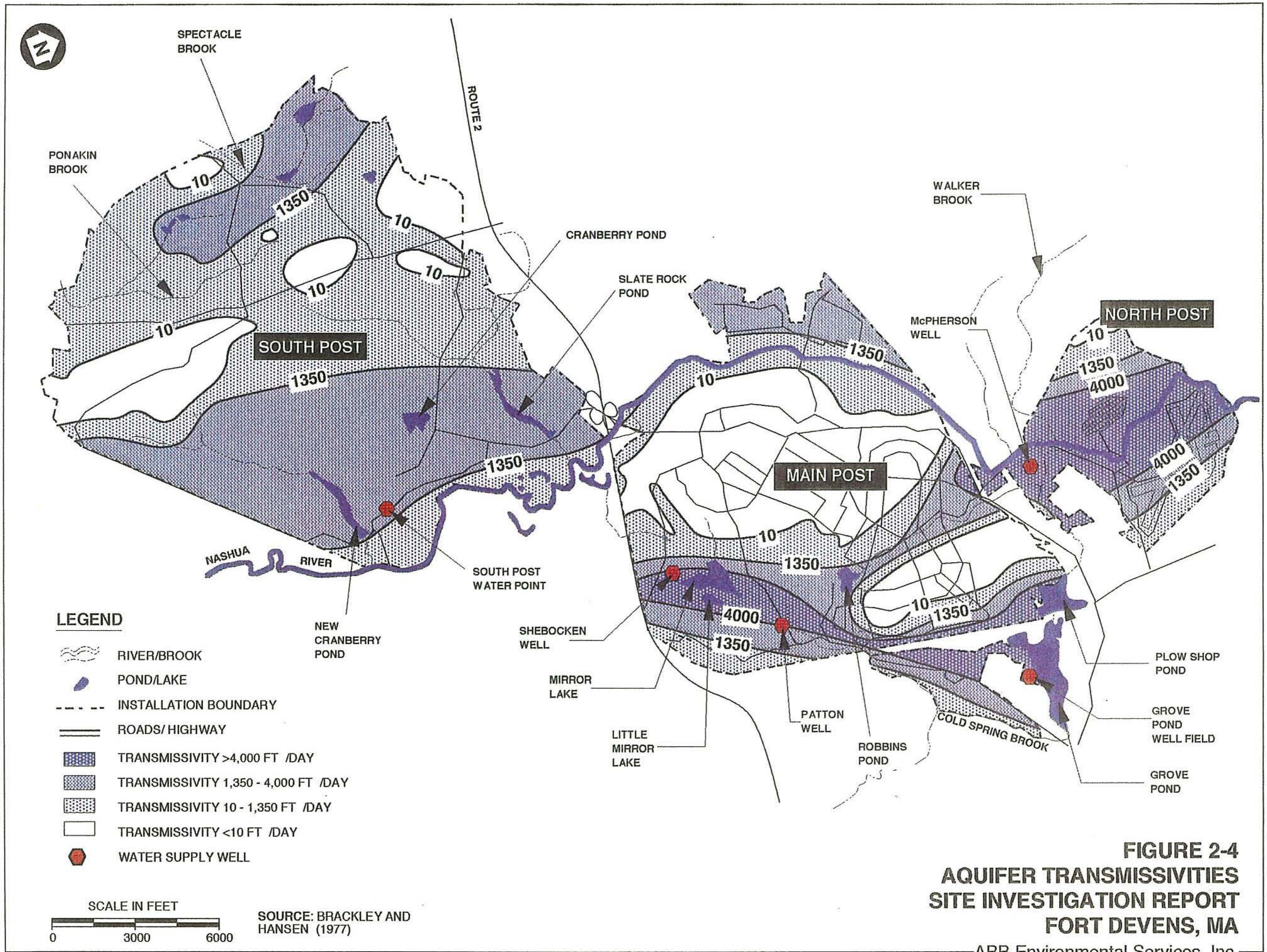
ABB Environmental Services, Inc.



SOURCE: ZEN (1983); PECK (1975), RUSSELL AND ALLMENDINGER (1975), AND ROBINSON (1978).

FIGURE 2-3
BEDROCK GEOLOGY
SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.



SOURCE: BRACKLEY AND HANSEN (1977)

FIGURE 2-4
AQUIFER TRANSMISSIVITIES
SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(wc) 3 6 B

3.0 SITE INVESTIGATION PROGRAM SUMMARY

The SI and SSI field investigations were conducted in conformance with the SI Final Task Order Work Plans and SSI Final Task Order Work Plans for Groups 2 and 7 and the Historic Gas Station (ABB-ES, 1992b and 1993a) and the Final POP (ABB-ES, 1992d and 1993c).

The SI and SSI field programs for the Groups 2 and 7 SAs consisted of:

- geophysical surveys for clearing utilities, for locating underground storage tanks (USTs), and identifying potential groundwater contaminant source areas;
- monitoring for unexploded ordnance (UXO);
- drilling soil borings;
- installing monitoring wells;
- completing TerraProbe™ points;
- subsurface soil sampling;
- soil vapor sampling;
- surface water and sediment sampling;
- two rounds of groundwater sampling for each phase of investigation;
- field analysis of environmental samples using a GC and an IR;
- off-site laboratory analysis of environmental samples;
- well development;
- aquifer conductivity testing;

- horizontal and vertical survey of explorations; and
- eight rounds of synoptic (installation-wide) water-level measurements.

ABB-ES established a project field office in Building 201 on Carey Street in Fort Devens' Main Post. The same field office was used during both the SI and SSI field programs. The field office was used for equipment storage and maintenance, sample management, shipping and receiving, staff meetings, and communications. A radio base-station and telephone were maintained in the field office; each field crew was issued a hand-held radio. An equipment decontamination pad was constructed near the field office. ABB-ES and subcontractor staff were briefed about the nature of the SAs, health and safety information, Fort Devens traffic regulations, and key technical requirements.

ABB-ES began implementation of the SI for the Groups 2 and 7 field program in April 1992, with geophysical surveys at the Historic Gas Station sites to identify and locate potential abandoned USTs. TerraProbe sampling and field analysis began in July 1992, and the drilling program began in August 1992. Round One groundwater sampling was completed in September 1992 and Round Two was completed in December 1992.

ABB-ES began implementation of the SSI field program for the Groups 2 and 7 field program in August 1993, with geophysical surveys to identify utilities and locate potential groundwater contaminant source area(s) at SA 41. TerraProbe sampling and field analysis began in August 1993, and the drilling program began in September 1993. Round Three groundwater sampling was completed in October 1993 and Round Four was completed in January 1994.

DIGSAFE was notified more than three days before drilling and excavation were undertaken. Where installation records indicated the presence of buried utilities, or where buried utilities were otherwise considered possible, a ground-penetrating radar (GPR) survey was conducted by ABB-ES to clear the proposed explorations.

The subcontractors used by ABB-ES in conducting the SI program were as follows:

- Soil Exploration Corp., Leominster, MA - Drilling and monitoring well installation.
- ESE, Gainesville, FL - Chemical analysis of environmental samples.
- Civiltest Laboratories, Inc., Needham, MA - Grain size tests of soil and sediment samples.
- Environmental Hazards Specialists International (EHSI), Belvidere, NC - Clearance of unexploded ordnance.
- Golden Land Survey, Plymouth, MA - Surveying of site explorations.

The subcontractors used by ABB-ES in conducting the SSI program were as follows:

- New Hampshire Boring, Inc., Portsmouth, NH - Drilling and monitoring well installation.
- ESE, Gainesville, FL - Chemical analysis of environmental samples.
- Civiltest Laboratories, Inc., Needham, MA - Grain size tests of soil and sediment samples.
- UXB International, Inc., Alexandria, VA - Clearance of unexploded ordnance.
- Howe Surveying, Inc., Waltham, MA - Surveying of site explorations.

3.1 FIELD INVESTIGATION PROCEDURES

The following sections provide summaries of the procedures used by ABB-ES and its subcontractors in performing the investigations and related activities. The results of these investigations are summarized in Sections 4.0, 5.0, and 6.0.

3.1.1 Geophysical Surveying

Surficial geophysical methods were employed to locate buried utilities and underground storage tank (USTs). The principal methods used were magnetometry, ground-penetrating radar, and metal detector. In some applications a combination of these techniques was used to correlate geophysical anomalies and provide a more comprehensive interpretation. For magnetic surveys, grids were laid out and marked by stakes and wire flags or by spray-painting (on pavement). Geophysical measurements were made and recorded at the grid nodes.

3.1.1.1 Magnetometry. Magnetometers measure variations in the Earth's magnetic field and are used to identify anomalies caused by buried ferrous-metal objects. Fences, power lines, and ferrous metal objects at or above the ground surface can cause interference, and such conditions were avoided.

At Fort Devens, ABB-ES used a magnetic gradiometer consisting of two total-field magnetic sensors mounted on a pole that was held vertically. Simultaneous total-field measurements were made at each station, and from those the magnetic gradient was calculated. Data were recorded on a portable data-logging device and were later down-loaded to a personal computer.

The data were processed by establishing uniform-grid data sets and contouring the total field and gradients. Anomalies were identified and were compared to the results of other geophysical techniques for interpretation.

Since magnetic fields are subject to diurnal variations, measurements of total field were made periodically during the survey at a base station to monitor variations and provide a basis for correcting total field data from the survey.

3.1.1.2 Ground-Penetrating Radar. The GPR transmits electromagnetic waves in the frequency range of 80 to 1,000 megahertz (radio waves) directly into the ground. The waves are reflected back to a receiver from interfaces between materials of differing electromagnetic properties (including buried objects and changes in geologic materials).

At Fort Devens, GPR was used to check for buried utilities at proposed drilling and excavating locations and to identify and locate USTs at Historic Gas Station sites. A radar transceiver was pulled slowly by hand along parallel traverse lines. Reflected radar signals were recorded on a graphic strip-chart and were interpreted in the field. Additional GPR traverses were conducted as needed to clarify the interpretations.

3.1.1.3 Metal Detector. A metal detector is a hand-held instrument that responds to the electrical conductivity of metal targets. A primary magnetic field is generated by the instrument's transmitter coil, which is balanced (nulled) in the receiver coil to cancel the effect of the primary field. The primary magnetic field creates eddy currents in nearby metal objects, and the eddy currents induce magnetic fields that interfere with the existing null condition in the metal detector and set off an audio signal.

At Fort Devens the metal detector was used where there was uncertainty about the actual location of a UST. Large areas could be screened in a comparatively short time by walking in a series of parallel lines. Responses from the metal detector were regarded as possible evidence of a tank, associated piping, or reinforcing steel in a foundation. Significant anomalies were flagged and were further investigated by GPR, a magnetic survey, or both.

3.1.1.4 Terrain Conductivity. The terrain conductivity survey was conducted using a Geonics™ EM-31 terrain conductivity meter and Polycorder™ data logger. The EM-31 unit consists of a transmitter/receiver array which can simultaneously measure both components of the electromagnetic magnetic field induced by the instrument when it is coupled with the polycorder (digital data logger).

At Fort Devens terrain conductivity has been used to further assess the lateral extents of landfill waste and locate potential contaminant source areas.

3.1.2 Soil Borings

Soil borings were drilled during both the SI and SSI at Fort Devens to determine the nature of the subsurface geologic materials, to collect subsurface soil samples for chemical analysis, and in some cases, to install monitoring wells. Soil boring advancement and subsurface soil sampling was completed in accordance with the requirements of the Fort Devens POP (ABB-ES, 1992a, Section 4.5.1.3).

Procedures for handling investigation-derived waste (IDW) consisting of drill cuttings are described in Section 4.10 of the Fort Devens POP (ABB-ES, 1992a). Field boring logs for the Groups 2 and 7 SI and SSI are provided in Appendix B.

3.1.3 TerraProbe Surveys

ABB-ES' van-mounted TerraProbe™ System was used during both the SI and SSI to collect soil and soil-vapor samples for chemical analysis. TerraProbe™ sampling was completed in accordance with the requirements of the Fort Devens POP (ABB-ES, 1992a, Section 4.4.5).

The TerraProbe pushed (hydraulically) and hammered (with a vibratory hammer) a 1-inch-diameter steel probe into the ground which allowed the collection of subsurface soil samples from discrete depths. Where conditions permitted, the TerraProbe System collected soil samples from specified depths at a comparatively high rate. Soil vapor samples were collected by evacuating the TerraProbe rods with a pump, and drawing samples from the connecting tubing, using a syringe. Soil samples were analyzed in the field on a GC for benzene, toluene, ethylbenzene, and xylenes (BTEX), as well as an IR unit for TPHC.

3.1.4 Surface Soil Sampling

Soil grab samples were collected during the SI at locations of visible or suspected contamination, using a stainless steel spoon. Care was taken not to collect vegetative material. Samples were placed in pre-labeled sample jars and were stored on ice in coolers. Sampling information was recorded on soil-sampling data sheets. Surface soil sampling was completed in accordance with the requirements of the Fort Devens POP (ABB-ES, 1992a, Section 4.5.1.1).

3.1.5 Groundwater Monitoring Wells

Monitoring wells were installed as part of both the SI and SSI field investigations to provide a means of sampling groundwater, measuring water-table depths, and determining aquifer conductivities. Monitoring well installation was completed in accordance with the requirements of the Fort Devens POP (ABB-ES, 1992a, Section 4.4.6.4).

Monitoring well completion diagrams for the Groups 2 and 7 SI and SSI are provided in Appendix C.

3.1.6 Well Development

Newly installed wells were developed with a submersible pump beginning between 48 hours and seven days after well completion. Development was conducted to remove foreign substances potentially introduced during drilling, to increase efficiency of the wells, and to reduce the turbidity of the groundwater. The pump and hose were decontaminated before use in each well. For wells that were slow to recharge, development was accomplished using dedicated Teflon™ bailers. Well development was completed in accordance with the requirements of the Fort Devens POP (ABB-ES, 1992a, Section 4.4.6.5).

3.1.7 Groundwater Sampling

Groundwater samples were collected from the monitoring wells completed during the SI and SSI, no sooner than two weeks after completion of well development. (Groundwater samples were also collected from designated pre-existing on-site wells.) Groundwater sampling was completed in accordance with the requirements of the Fort Devens POP (ABB-ES, 1992a, Section 4.5.2.2).

3.1.8 Aquifer Characterization

In-situ measurements were made during the SI and SSI to evaluate groundwater flow patterns and aquifer conductivities.

Groundwater flow patterns were determined from water-level measurements made installation-wide in monitoring wells and surface water bodies. Measurements in wells were made from surveyors' marks (typically at the top of the polyvinyl chloride [PVC] risers), using electronic water-level meters. Surface water measurements were made by measuring from survey marks on stakes installed in the water or by measuring with the aid of an optical level from nearby on-shore survey pins. Water levels were measured to the nearest 0.01 foot and were referenced to the National Geodetic Vertical Datum (NGVD).

Slug tests were performed on all monitoring well installed during the SI and the SSI to determine aquifer conductivities. The tested wells included the newly installed wells and designated preexisting on-site wells. At least two tests were performed in each well. The water table was displaced (usually in a rising-head mode) using a solid PVC cylinder approximately 3 feet long. An In-Situ™ Hermit 1000B Datalogger and 10 pound-per-square-inch (psi) down-hole pressure transducer were used to record head recovery. Slug tests were completed in accordance with the requirements of the Fort Devens POP (ABB-ES, 1992a, Section 4.8).

The slug test data was downloaded to a personal computer, and aquifer conductivities were calculated based on the method of Hvorslev (1951) and the method of Bouwer and Rice (1976). Aquifer test data collected as part of the Groups 2 and 7 SI and SSI are provided in Appendix A.

3.1.9 Surface Water and Sediment Sampling

Surface water and sediment samples were collected during the SI and SSI from each of several predesignated locations in streams, wet areas, the Nashua River, and ponds at Fort Devens. In all cases, the water sample was collected before the sediment sample.

Total volatile organic compounds (VOCs) were measured by PID above the surface water, and temperature, pH, and specific conductance were monitored in-situ. Prior to sample collection, water-sample jars (except VOC vials) were triple-rinsed with sample water. The appropriate pre-labeled sample jars were then filled with water by direct immersion immediately below the surface of the water. Water samples were preserved and sediment samples were collected in the field in accordance with the requirements of the POP (ABB-ES, 1992a, Section 4.5.2).

3.1.10 Elevation and Location Survey

The elevation and location survey was completed in accordance with the requirements of the Fort Devens POP (ABB-ES, 1992a, Section 4.9). Elevations were referenced to the NGVD of 1929. Elevations were measured to the nearest 0.01 foot for monitoring well casings and risers and for surface water reference points. Ground surface was measured to the nearest 0.1 foot.

Horizontal locations were surveyed with reference to the Massachusetts Coordinate System grid to an accuracy of ±1.0 foot.

3.1.11 Decontamination

Field equipment was decontaminated with USAEC-approved water from the South Post Water Point. Decontamination was completed in accordance with the requirements of the Fort Devens POP (ABB-ES, 1992a, Section 4.3).

Drilling and excavating equipment was decontaminated before arriving and prior to leaving the installation, and before each new exploration location. For on-site decontamination, high-pressure hot water was used.

Miscellaneous tools, samplers, and certain monitoring probes were brushed off and rinsed with USAEC-approved water and then were thoroughly scrubbed, triple-rinsed with USAEC-approved water, and air-dried.

After being filled, sample containers were wiped and cleaned as necessary in the field to prevent contamination of the sample handling/shipping area.

3.1.12 Investigation-Derived Waste

IDW was generated in association with personal protection, drilling, well construction and development, sampling, and decontamination. The IDW was handled in accordance with the requirements of the Fort Devens POP (ABB-ES, 1992a, Section 4.10).

3.2 ANALYTICAL PROGRAM

The analytical program for the SI and the SSI were designed to identify contaminants that were expected, based on available information about conditions and operations, to be encountered at the SAs. The program included an extensive range of organic and inorganic analytes. The specific analyses performed on samples from the individual SAs are discussed in the respective subsections of Sections 4.0, 5.0, and 6.0 of this report.

3.2.1 Analytical Parameters

Soil, sediment, and groundwater samples collected at the SAs during the SI and SSI were analyzed for Fort Devens Project Analyte List (PAL) analytes. Off-site laboratory analyses for the PAL organics, inorganics, and explosives is considered approximately equivalent to USEPA analytical support Level III quality data (Contract Laboratory Program Routine Analytical Services). The Fort Devens PAL is presented in Appendix D.

The off-site laboratory used for the SI and the SSI analytical program was ESE, an USAEC-certified laboratory of Gainesville, Florida.

A list of USAEC-certified methods used for analysis of PAL compounds during the SI and the SSI are provided in Table 3-1. The table includes a description of the methods used as well as equivalent USEPA methods where they exist. The method numbers (i.e., method JS16) are specific to the project and to the particular laboratory performing the analyses.

3.2.2 Field Laboratory Analyses

To develop screening information to aid in the placement and selection of boring, monitoring well, and sample locations, selected soil, sediment, and liquid samples were analyzed in the field to evaluate the extent of contamination. Field analyses were conducted in accordance with ABB-ES guidelines outlined in Section 4.6 of the Fort Devens POP (ABB-ES, 1992d). A field laboratory was used on-site for the analysis of BTEX and TPHC. Results of soil field analyses were reported in micrograms per kilogram (μg/kg) dry weight. Liquid results were reported in micrograms per liter (μg/L).

3.2.3 Quality Assurance/Quality Control

Off-site laboratories performing the analytical work for the Groups 2 and 7 SI and SSI have been required to implement the USAEC QA Program. The following section describes the procedures implemented to achieve the objectives of the AEC QA Program.

3.2.3.1 Laboratory Certification. In accordance with the USAEC QA Program, laboratories require formal certification for the PAL analytical methods conducted in association with site investigations. The PAL is provided in Appendix D. USAEC requires that a laboratory must demonstrate proficiency in performing USAEC methods for specific analytes. Laboratories become certified by submitting data from runs of pre-certification calibration standards. Performance samples are then sent for analysis to the laboratory from USAEC. The concentrations of the analytes in these samples are unknown by the laboratory. The data are then sent to USAEC where the precision and accuracy of the analyses are determined. Certification is either awarded to or denied the laboratory based on this performance. A certification method code is assigned to each method and reported with results.

Some methods such as alkalinity, total organic carbon, total suspended solids do not require certification. USAEC recognizes standard USEPA protocols or internal laboratory methods for these parameters. Laboratories are required to submit information on procedures for analyzing samples using these methods to the USAEC Chemistry Branch before they are implemented.

3.2.3.2 Laboratory Methods Quality Control. All Fort Devens samples submitted to the off-site laboratory were organized into lots which were assigned a three digit code using letters of the alphabet. Each lot consisted of the maximum number of samples, including QC samples that can be processed through the rate limiting step of the method during a single time period (not exceeding 24 hours).

Associated with each lot were laboratory control samples. Control samples were spikes of both high and low concentration of specific analytes that help monitor laboratory precision and accuracy. The recoveries of these spikes were plotted on control charts generated by the laboratory and submitted to USAEC. Data generated from the certification process was used to calculate a mean of the recoveries. Control and warning limits were statistically generated by the USAEC Chemistry Branch to help measure laboratory data quality. Certified Reporting Limits (CRLs) were also determined from this process. CRLs for each particular analyte are listed on the PAL in Appendix D.

Method blanks were also run at the laboratory to evaluate the potential for target analytes to be introduced during the processing and analysis of samples. One method blank was included in each analytical lot. The method blank sampling results are summarized in Table E-1 and discussed in Section 1.2 and 1.3 of Appendix E.

3.2.3.3 Data Reduction and Validation. Initial responsibility for accuracy and completeness of Fort Devens analytical data packages rested with the laboratory itself. All data submissions to USAEC first underwent the review process. This review included checks on the data quality which evaluated completeness of laboratory data, accuracy of reporting limits, compliance with quality control limits and holding times, and correlation of laboratory data to associated laboratory tests.

The following items were also validated by the laboratories before being submitted to USAEC:

- Chain of custody records.
- Instrument printouts for agreement with handwritten results.
- Calibration records to ensure a particular lot is associated with only one calibration.
- Chromatograms and explanations for operator corrective actions (such as manual integrations).
- Standard preparation and documentation of source.
- Calculations on selected samples.
- Notebooks and sheets of paper to ensure all pages were dated and initialed, and explanations of procedure changes.
- GC/MS library search of unknown compounds.
- Transfer files and records to ensure agreement with analysis results.

To document the data review and validation process, a data-review checklist was submitted as part of each data package.

3.2.3.4 Data Reporting. After review and validation by the laboratory, the dates were encoded for transmission into USAEC's Installation Restoration Data Management Information System (IRDMIS) as Level 1 data. IRDMIS, a computerized data management system used by USAEC, is described in detail in Section 3.3.2. Once into the system, the data were subjected to a group and records check.

Data were then transferred to the USAEC data management contractor. During this phase, the data were considered to be Level 2. Another group and records check was performed and data were reviewed by the USAEC Chemistry Branch. When errors were identified, the data were returned to the laboratory for correction. Once data were reviewed by the USAEC Chemistry Branch, the determination was made on a lot-by-lot basis whether the data were acceptable. The data that were accepted were then elevated to Level 3 and made available to USAEC personnel and contractors by modem to a main frame computer.

3.2.3.5 Field Quality Control Samples. During the Groups 2 and 7 SI and SSI efforts, quality control samples collected in the field included MS/MSD, rinsate blanks, trip blanks, one field blank (source water), and duplicate samples.

MS/MSDs were collected at a rate of one set per 20 samples, and as specified in the Fort Devens POP, MS/MSDs were analyzed for PAL inorganics, explosives, and PCBs/pesticides. Site investigators made the determination of which samples were to be designated as MS/MSDs. This was noted on the chain of custody forms submitted to the off-site laboratory. The samples designated as MS/MSDs were spiked at the laboratory with analytes that were requested for the regular field samples in order to determine matrix effects. MS/MSD sampling results are presented in Tables E-8, E-10, and E-12 and discussed in Section 2.0 of Appendix E.

As required by the Fort Devens POP, duplicate samples were collected at the same rate as MS/MSDs. The samples were submitted to the laboratory to be analyzed for the same compounds as the corresponding regular field samples. The purpose of submitting these samples was to assess laboratory precision for a particular method. Duplicate sampling results are summarized in Tables E-9, E-11, and E-13 and discussed in Section 2.0 of Appendix E.

At the beginning of the Groups 2 and 7 SI and SSI efforts, a sample of USAEC-approved water was collected. For the purpose of off-site laboratory QC, this was identified as the field blank. The information gained from the analysis of this blank provided data on the quality of the USAEC-approved water used in the decontamination of the sampling equipment. Field blank information was also used to explain the presence of certain analytes or compounds in rinsate blanks.

Rinsate blanks were collected and analyzed for VOCs, semivolatile organic compounds (SVOCs), and inorganics. They were collected by running laboratory "chemically pure" deionized water through the sampling apparatus that was used to collect the samples. Analysis of this water provided information used to evaluate the potential for sample contamination during sample collection. The results were also used to assess whether an adequate job was done during the decontamination of the equipment. As required by the Fort Devens POP, rinsate blanks were also collected at a rate of one per 20 samples per decontamination event.

For every shipment of VOC samples to the laboratory there was an accompanying pair of trip blanks that traveled with the samples. The trip blank was a VOC sample container previously filled at the laboratory. Once the trip blanks were received at ESE, they were analyzed for VOCs to assess cross contamination during shipment.

Quality control blank results are summarized in Tables E-1 through E-7 in Appendix E. Interpretations of field blank results (including field blanks, rinsate blanks, and trip blanks) for each SA Group are summarized in Section 3.0 of Appendix E.

3.2.3.6 Analytical Data Quality Evaluation. Groups 2 and 7 laboratory data collected during the SI and SSI sampling efforts at Fort Devens were evaluated for possible off-site laboratory or sampling-related contamination. This evaluation did not include validation by USEPA guidelines. Sample results reported and discussed in this Revised Final SI Report were not adjusted for reported analytes that were also detected at similar concentrations in blanks associated with that sample; action levels were not established, and the 10X rule was not applied to compounds considered common laboratory contaminants by the USEPA. These contaminants include the VOCs acetone, methylene chloride, toluene and SVOC phthalate esters (i.e., BIS). Likewise, action levels for other analytes using the 5X rule application were not established. Analytes which would have been below these action levels were not removed from the data as they would be in the USEPA validation process.

General trends relating to blank and sample contamination were examined. Comparison of blank data with results from the entire data set are discussed as a data assessment. Assessments are made based on analyte detection in blanks, the frequency of this detection and the concentrations of these analytes. These assessments are made in Sections 4.0, 5.0, and 6.0 of this report.

3.3 CHEMICAL DATA MANAGEMENT

Chemical data from the SI and SSI were managed by ABB-ES' Sample Tracking System and the USAEC's IRDMIS. These systems are described in the following sections.

3.3.1 Sample Tracking System

ABB-ES employed its computerized Sample Management System to track environmental samples from field collection to shipment to the laboratory. ABB-ES also tracked the status of analyses and reporting by the off-site laboratory.

Each day the field sampling teams carried computer-generated sample labels into the field that stated the sample control number, sample identification, size and type of container, sample preservation summary, analysis method code, and sample medium. The labels also provided space for sampling date and time and the collector's initials to be added at the time of collection.

Samples were temporarily stored in the ABB-ES field office refrigerator. They were checked-in on the computer, and the collector's initials and the sampling date and time were entered. The system would then indicate the sample status as "COLLECTION IN PROGRESS."

When the samples were prepared for shipment, they were "RELEASED" by the sample management system. Upon request, the system printed an Analysis Request Form (ARF) and a COC, which were signed and included with the samples in the shipment. The system would then indicate the sample status as "SENT TO LAB."

This system substantially reduced the time required for preparation of sample tracking documentation, and it provided an automated record of sample status.

After shipment of samples to the laboratory, ABB-ES continued to track and record the status of the samples, including the date analyzed (to determine actual holding times), the date a transfer file was established by ESE, and the date the data were sent to IRDMIS (Section 3.3.2)

3.3.2 Installation Restoration Data Management Information System

IRDMIS is an integrated system for collection, validation, storage, retrieval, and presentation of data of the USAEC's Installation Restoration and Base Closure Program. It uses personal computers (PCs), a UNIX-based minicomputer, printers, plotters, and communications networks to link these devices.

For each sample lot, ABB-ES developed a "provisional" map file for the sample locations, which was entered into IRDMIS by Potomac Research, Inc. (PRI), USAEC's data management contractor.

Following analysis of the sample lot, the off-site laboratory (ESE) created chemical files using data codes provided by ABB-ES, and entered the analytical results (Level 1) on a PC in accordance with the User's Manual (PRI, 1993). For each sample lot, a hard copy was printed and was reviewed and checked by ESE's Laboratory Program Manager. ESE created a transfer file from accepted records which was sent to ABB-ES (Level 2). ABB-ES performed a group and record check and sent approved records in a chemical transfer file to PRI. PRI checked the data and, if accepted, entered it into the IRDMIS minicomputer (Level 3). Level 3 chemical data are the data used for evaluating site conditions and are the data used in SA reports and decision-making.

3.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS IDENTIFICATION

The general purpose of an SI is to determine whether contamination exists at the site and whether there is a potential threat to human health or the environment. An extensive evaluation of background conditions and ARARs is not specifically required for an SI, but such a comparison can be used to evaluate the need for additional investigative work and/or cleanup.

Applicable requirements are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or Massachusetts law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at the Fort Devens site. Relevant and appropriate requirements are also clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or Massachusetts law. These standards, however, are not "applicable" to a specific hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at Fort Devens, but address problems or situations sufficiently similar to those encountered at the Fort Devens site.

Selection of ARARs is dependent on the hazardous substances present at a site, site characteristics and location, and the actions selected for a remedy. Thus, ARARs can be location-specific, chemical-specific, and/or action-specific. Location-specific requirements involve restrictions established for specific substances or activities based on their location. They address circumstances such as the presence of an endangered species on the site or the location of the site in a 100-year flood plain. These requirements have already been preliminarily identified for the Fort Devens site by the Oak Ridge National Laboratory Chemical Hazard Evaluation Program, Health and Safety Research Division, and are summarized in a draft report dated April 28, 1992 and entitled "Assessment of Location-Specific ARARs for Ft. Devens, Massachusetts". A copy of this report is included in Appendix F. Chemical-specific requirements generally involve health- or risk-based numerical values or methodologies that determine site-specific acceptable chemical concentrations and/or amounts. Chemical-specific ARARs are used to establish the need for cleanup (i.e., action levels) as well as to define cleanup goals. Action-specific requirements involve performance, design, or other action-specific requirements and are generally technology- or activity-based. They are used to control or restrict particular types of remedial actions selected as alternatives for cleanup of a site. Action-specific requirements were not evaluated as a part of this Revised Final SI Report, as possible remedial actions have not yet been identified.

Where chemical-specific ARARs do not exist or would not be sufficiently protective of human health or environment for the given circumstances (e.g., aggregate risk considerations), non-promulgated advisories or to be considered (TBC) guidance and risk evaluation-based data are used to establish action levels and cleanup goals. TBC guidance, although not enforceable, can be used to indicate that adverse environmental or human health effects could occur under certain circumstances if concentrations listed are exceeded. Background samples have also been used for comparison in this investigation to identify those cases where samples collected in a particular SA are actually within the naturally occurring range for Fort Devens, but may exceed some ARAR. In such an instance, it may not be appropriate to conduct remedial actions because the SA is not contributing to, or the source of the apparent contamination or the concentrations detected are within a site-specific naturally occurring range.

ABB-ES has completed a preliminary evaluation of background conditions and has also compiled a list of chemical-specific ARARs and TBC guidance by matrix. Further discussion of ABB-ES' evaluation of background conditions is found in Section 3.5. A summary of chemical-specific ARARs and/or TBC guidance follows.

Groundwater: ARARs and TBC guidance for chemicals detected in groundwater at Fort Devens SA Groups 2 and 7 are listed in Tables F-1 and F-2 of Appendix F. In summary, the evaluation criteria adopted by ABB-ES for groundwater include federal Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) including primary and secondary MCLs and proposed MCLs and MCLGs; federal Ambient Water Quality Criteria (AWQC); Massachusetts Maximum Contaminant Levels (MMCL) and Office of Research and Standards Guidelines (ORSGs); Massachusetts Class I groundwater quality standards; and/or the October 1992 USEPA Region III risk table for tap water.

Surface Water: ARARs and TBC guidance for chemicals detected in surface water at or associated with Fort Devens SA Groups 2 and 7 are listed in Tables F-1 and F-2 of Appendix F. Summarizing, the evaluation criteria adopted by ABB-ES for surface water include federal AWQC and Massachusetts Class B Surface Water Quality Standards.

Soil and Sediment: ARARS and TBC guidance for chemicals detected in soil and groundwater at or associated with Fort Devens SA Groups 2 and 7 are listed in Table F-3 of Appendix F. Currently, there are no set maximum allowable residual levels for chemicals in soil or sediments under federal or Massachusetts law. ABB-ES has used site-specific background data for comparison purposes in this report. In addition, New York State Department of Environmental Conservation (NYSDEC) sediment criteria and the National Oceanic and Atmospheric Administration's (NOAA) National Status and Trends Program document entitled "Biological Effects of Sediment-sorbed Contaminants" are used for comparison of analytical results for sediment samples collected. The USEPA "Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites" OSWER Directive 19355.4-02) has also been used for comparison of analytical results for soil samples collected.

Significant amendments to Massachusetts General Law Chapter 21E (the Massachusetts Superfund Law) were passed in July 1992. These amendments required that new regulations be drafted to amend the Massachusetts Contingency Plan (MCP) (310 CMR 40.00) accordingly. The MADEP revised the MCP and published the amended regulations in a final format on July 1, 1993 (effective October 1, 1993). The revised regulations contain reportable concentrations, action levels, and cleanup standards for many specific contaminants in groundwater and soil using various site-use scenarios (e.g., residential, industrial, etc.).

Additional discussion of ARARs and TBC guidance used by ABB-ES for comparison and evaluation of analytical results obtained during the Groups 2 and 7 SI is included in Section 3.6 (Preliminary Risk Evaluation Methodology) of this report.

3.5 BACKGROUND CONCENTRATIONS

As a means to evaluate concentrations of inorganic analytes detected in samples collected as part of the SI and SSI, background concentrations of these analytes were calculated for the Fort Devens installation. Background concentration calculations were based on analytical data results gathered from soil and groundwater samples collected throughout the Fort Devens installation, selected as representative of background (non-contaminated) conditions. Though most of the calculations include assumptions on both the distribution of chemical concentrations and on the selection of representative samples that are not statistically rigorous, the results are considered conservatively representative of actual background concentrations at Fort Devens.

For soil, chemical data gathered from 20 soil samples collected by Ecology & Environment, Inc. (E&E) as part of their Group 1A and 1B investigation activities were used. The samples were collected from the major soil associations throughout Fort Devens specifically to establish background concentrations of inorganic analytes in soil. After these data were reviewed, apparent statistical outliers were eliminated from the data sets, and the 95th percentile concentrations (the mean value plus two standard deviations) were calculated. Though environmental data are rarely truly "normally distributed", it was assumed that the resulting 95th percentile concentrations were conservative representatives of installation-wide background concentrations. Outlier values were identified in the data sets using both graphical observation and relative changes to recalculated 95th percentile values (i.e outliers were removed from the data sets only if a significant decrease in the recalculated 95th percentiles was observed).

The calculations were performed on 19 of the 23 PAL inorganic analytes (no data were available for antimony, cobalt, selenium, and thallium). In special cases, where an analyte was not detected in a given sample, ABB-ES used a conservative value of one half the detection limit of the analyte in the statistical analysis. For analytes that were not detected in the majority of soil samples, the detection limit for that analyte was selected as the background concentration. Data ranges, mean values, and calculated background concentrations are summarized in Appendix G. Details of the calculations are also provided in Appendix G.

For groundwater, ABB-ES selected ten representative groundwater samples collected from the Round 1 groundwater sampling events for SA Groups 2, 3, 5, 6 and 7 for the purpose of calculating background inorganic analyte concentrations in groundwater. Representative groundwater samples were selected from SA-specific monitoring wells located upgradient of an SA, exhibiting low total suspended solids (TSS) and/or low aluminum concentrations. Aware that elevated TSS concentrations artificially elevate inorganic analyte concentrations, ABB-ES selected samples that exhibited TSS concentrations on the same order of magnitude as the South Post Water Supply Well (i.e., representative of typical TSS concentrations in potable groundwater). Because a close correlation between

TSS concentrations and aluminum concentrations was observed in all the groundwater samples analyzed, the aluminum concentration was used as an alternate selection criterion in the absence of TSS data. The concentration values detected in the ten samples were calculated using the same assumptions on outliers and detection limits applied to the soils background concentration calculations. The statistical analysis calculations for groundwater inorganics, and the resulting background concentrations are provided in the summary table in Appendix G. Data ranges, mean values, calculated background concentrations, and details of the calculations are also provided in Appendix G.

3.6 PRELIMINARY RISK EVALUATION METHODOLOGY

This section presents the approach employed for the Public Health and Ecological PREs completed for each SA. The PREs for SAs included in the SSI program have been modified to include the SSI data. The PREs for non-SSI SAs have only been modified base on comments pertaining to the Final SI Report (ABB-ES, 1993a). SA-specific PREs are presented in the respective SA discussions of Sections 4.0, 5.0, and 6.0. PREs were completed to help to establish whether environmental contamination at an SA will require one of the following actions:

- Nomination for NFA
- SI Removal Action (with/without subsequent NFA nomination)
- RI/FS

As presented in the Final SI Report (ABB-ES, 1993a) and the SSI Data Package (ABB-ES, 1994), environmental sampling conducted during the Groups 2 and 7 field programs at Fort Devens has revealed the presence of organic and inorganic contaminants in the following environmental media:

- Surface soil (defined as soil to a depth of 3 feet)
- Subsurface soil (defined as soil between 3 and 15 feet deep)
- Wetland sediments
- Wetland surface water
- Nashua River, Cranberry and New Cranberry Ponds, a kettle pond at SA 42, and Cold Spring Brook Sediments

- Nashua River, Cranberry and New Cranberry Ponds, a kettle pond at SA 42, and Cold Spring Brook Surface Water
- Groundwater

Human health and ecological PREs were conducted for contaminants detected in wetland sediments and wetland surface water. Because analytes detected in Cold Springs Brook (SA 57) and the Nashua River (SA 12) are not specifically derived from the Groups 2 and 7 SAs, the Army and regulatory authorities have previously agreed that surface water and sediment from these water bodies will be evaluated in a separate study (Area Requiring Environmental Evaluation [AREE] 70). Therefore, Cold Spring Brook and Nashua River contaminants have not been considered in these PREs.

At the time of the SSI Data Package no background database has been established for surface water and sediment for Fort Devens. Therefore, all VOCs, SVOCs, and pesticides/PCBs detected in wetland sediment were evaluated as Chemicals of Potential Concern (CPCs) in the SA Groups 2 and 7 PREs. A number of essential inorganic nutrients (i.e., calcium, iron, magnesium, sodium, and potassium) in environmental media were not evaluated in the ecological PREs because they have low relative toxicity at high concentrations. Because secondary drinking water standards exist for some of these nutrients, they were evaluated in the human health PREs.

Human health and ecological PREs were conducted to evaluate contamination in surface soil; only the human health PRE was conducted to evaluate contamination in subsurface soils. For the purposes of selecting soil inorganic CPCs at the Groups 2 and 7 SAs, and SA-specific maximum soil inorganic analyte concentrations were screened against the Fort Devens background database. Inorganic analytes in soil were retained for evaluation in the ecological PREs only if their maximum concentrations exceeded the Fort Devens background values; they were carried through the human health PREs because of the existence of risk-based soil concentrations for some inorganic analytes.

ABB-ES also calculated arithmetic averages of soil inorganic analytes. Because repeated exposure to maximum concentrations is unlikely, averages are also used in the PREs to represent likely exposure point concentrations. The PRE are screening evaluations. Therefore, the averages include only detects (i.e., samples whose concentrations are above detection limits). These arithmetic means of detects represent overestimates of SA averages. For quantitative risk assessments, following both USEPA and MADEP guidance, averages should include non-detect samples with their concentrations set at one-half the sample quantitation limit.

VOCs, SVOCs and pesticides/PCBs detected in soil were evaluated as CPCs in the Groups 2 and 7 PREs.

Only the human health PRE was conducted to evaluate contamination in groundwater. VOCs and SVOCs, inorganics, PCBs/pesticides detected in groundwater were evaluated as CPCs in the Groups 2 and 7 PREs.

3.6.1 Human Health Risk Evaluations

The Human Health PREs at the Groups 2 and 7 SAs include the following elements:

- **Current and Future Land Use**: Current and foreseeable future land use at the individual SAs are considered in the PREs and are particularly relevant with respect to the applicability of soil screening values used in the PREs. Two sets of soil screening values are used in the evaluation. One set, USEPA Region III risk-based concentrations for residential soil, is appropriate when the current and/or foreseeable future use of the SA is residential. It is used for comparison to contaminant concentrations in the top three feet of soil. The other set, USEPA Region III risk-based concentrations for commercial/industrial soil, is appropriate when the current and/or foreseeable future use of the SA is commercial or industrial. This set is used for comparison to contaminant concentrations at soil depths of 3 to 15 feet.

- **Comparison to Public Health Standards and Guidelines**: For soil and groundwater, human health standards and/or guidelines exist which can be used as screening criteria for the evaluation of the significance of sampling data at the individual SAs. To evaluate the concentrations of compounds detected in the groundwater, federal and Massachusetts drinking water standards and guidelines are used. Although MADEP is currently developing soil cleanup standards as part of its Waste Site Cleanup Program Redesign, these standards are in draft form (in MADEP's proposed regulations) and are not to be cited or quoted. Therefore, USEPA's Region III risk-based concentrations are used to evaluate the results of the soil sampling programs. The human health standards and guidelines used in the PREs are presented in Section 3.4 (ARARs) and summarized in Table 3-2. The basis and applicability of these standards and guidelines are discussed below.

USEPA Region III Risk-Based Concentration Table (First Quarter, 1993 and Fourth Quarter, 1993). These tables are used by USEPA Region III toxicologists as a risk-based screening tool for Superfund sites, as a benchmark for evaluation preliminary site investigation data and preliminary remediation goals. Although it has no official status either as regulation or guidance, it is useful as a screening tool. The table is updated quarterly and therefore regularly incorporates new USEPA toxicity constants as they are developed. The PREs completed for SAs which did not require SSI activities use the First Quarter values, while the SAs requiring SSI activities used Fourth Quarter values.

The table contains References Doses, and Cancer Slope Factors for nearly 600 chemicals. These toxicity constants have been combined with "standard" exposure scenarios to calculate chemical concentrations corresponding to fixed levels of risk (i.e., a hazard quotient of 1, or lifetime cancer risk of 10^{-6}, whichever occurs at a lower concentration) in water, air, fish tissue, and soil. The use of 10^{-6} as a target cancer risk level is consistent with both USEPA and MADEP risk management guidelines. USEPA has established a cumulative site target cancer risk range of 10^{-4} to 10^{-6} for Superfund sites while MADEP has established a total site cancer risk limit of 10^{-5}. For noncarcinogenic health effects, USEPA has set a hazard index limit of one; MADEP has set a total site noncarcinogenic site risk limit of 0.2. While Region III's hazard index of one exceeds MADEP's limit of 0.2, MADEP has proposed in its draft waste site cleanup regulations to change its total noncancer risk limit to one.

For the SA Groups 2 and 7 Human Health PREs, Region III risk-based concentrations for tap water, commercial/industrial soil, and residential soil are used. Risk-based concentrations for tap water assume daily consumption of two liters of water for a residential lifetime of 30 years; these also assume exposure from the inhalation of volatiles from household water uses (including showering, laundering, and dish washing). The derivation of the volatilization factor used to address inhalation risks is provided in USEPA's "Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)", December 1991.

For soil, Region III risk-based concentrations have been developed for commercial/industrial soil exposure as well as residential exposure. Risk-based concentrations for commercial/industrial soil assume that a worker ingests soil 250 days per year for 25 years, at an ingestion rate of 100 milligrams per day (mg/day). Risk-based concentrations for residential soil assume that an individual ingests soil 350 days per year for a residential lifetime of 30 years, an age-adjusted ingestion rate of 100 mg/day.

For SAs which did not require SSI activities, ABB-ES developed screening values for several petroleum products in soils commonly associated with USTs; gasoline, diesel, No. 2 fuel oil, and No. 4 fuel oil. To evaluate the health risk associated with petroleum products measured as TPHC in soil, ABB-ES developed risk-based concentrations. These concentrations were calculated using the same exposure assumptions as those used by USEPA toxicologists in the USEPA Region III Risk-Based Concentration Table, First Quarter, 1993 for commercial/industrial soils and residential soils. Dose response values for gasoline and marine diesel used in the calculations are provisional values developed by USEPA, Environmental Criteria and Assessment Office (USEPA, 1992). USEPA suggests using the reference dose value for diesel oil as a surrogate for No. 2 fuel oil. No. 4 fuel oil is a residual fuel oil that contains higher molecular weight compounds (particularly polynuclear aromatic hydrocarbon [PAHs]) then diesel oil. The use of diesel oil (by itself) as a surrogate could underestimate the true risk associated with No. 4 oil. To account for this, the risks associated with diesel oil, as well as individual PAHs, are evaluated. By considering both TPHC and PAHs, the screening evaluation is considered to be health-protective.

The table below presents the risk-based concentrations for petroleum products:

Analyte	USEPA Provisional Dose-Response Value	Residential Soil ($\mu g/g$)	Commercial/Industrial Soil ($\mu g/g$)
Gasoline	1.7×10^{-3} $(mg/kg/day)^{-1}$	1,000	1,800
Diesel	8×10^{-3} mg/kg/day	630	8,180
No. 2 fuel oil	8×10^{-3} mg/kg/day	630	8,180
No. 4 fuel oil	8×10^{-3} mg/kg/day	630	8,180

A dose/response value identified by USAEC and the U.S. Army Environmental Hygiene Agency (AEHA) in their Explosives Information Briefing (March 18, 1993) was used to derive a risk-based soil concentration for nitroglycerin. A cancer slope factor of 1.66 E-2 milligrams per kilogram per day $(mg/kg/day)^{-1}$ was used. As above, USEPA Region III exposure assumptions for residential soil were used.

For PREs which included SSI data, risk-based concentrations for gasoline and diesel fuel have been recalculated based on new parameters used in the USEPA Region III Risk-Based Concentration Table. Since the Final SI Report, the MADEP has revised the Massachusetts Contingency Plan (MCP) and promulgated Method 1 Soil Standards (MADEP, 1993b). For a Method 1 Risk Characterization under the MCP, compliance with these soil standards constitutes a demonstration of no significant health risk from exposure to oil or hazardous material in soil. For this PRE, Method 1 and S-2/GW-1 soil standards are used as screening guidelines along with the USEPA Region III Risk-Based Concentrations. Study area subsurface soil (i.e., 3 to 15 feet) and sediment are presumed to be Category S-2 Soil, soil that is less accessible and has a lower frequency or lower intensity of possible contact than Category S-1 Soil. Concentrations used at each specific SA are presented in the human health PRE tables associated with that SA.

Surrogate Values. In the absence of the dose-response value for a particular compound, a surrogate value for a related (i.e., structurally similar) compound was used. For the PREs, naphthalene will be used as a surrogate for 2-methylnaphthalene, chlordane for alpha- and gamma-chlordane, and the general PCB value for Aroclor 1254, 1248, and 1260.

The human health standards and guidelines used in the PREs are presented in Section 3.4 (ARARs) and summarized in Table 3-2.

USEPA Drinking Water Regulations and Health Advisories. Federal drinking water standards (both final and proposed) are used to evaluate the significance of the groundwater sampling data for Groups 2 and 7. These standards have been extracted for the USEPA Office of Water's "Drinking Water Regulations and Health Advisories", December 1992. This publication is updated periodically by USEPA to reflect any changes in federal drinking water standards and guidelines.

Massachusetts Drinking Water Standards and Guidelines, Autumn 1992. For some compounds, MADEP has promulgated drinking water standards that are more stringent then the federal drinking water standards. MADEP has also developed drinking water guidelines for compounds for which no federal standards exist.

OSWER Lead Guidance (OSWER Directive: 9355.4-02). USEPA has set forth an interim soil cleanup level for total lead which is protective for direct contact exposure at residential settings. The interim guidance was published in September 1988. Further guidance will be developed after the USEPA has developed a verified Cancer Potency Factor and/or a Reference Dose for lead.

3.6.2 Ecological Risk Evaluations

The ecological PREs at the Groups 2, 7, and Historic Gas Stations SAs include the following elements:

- **Ecological Characterization**: The purpose of the ecological characterization is to identify ecological receptors potentially exposed to contamination at the Groups 2 and 7 SAs. Section 2.0 of this report presents general descriptions of vegetative cover-types at Fort Devens, based upon a review of scientific literature and other published accounts, site-specific reports and records, contact with regional authorities, and observations made during site inspections.

  The presence or absence of any rare and endangered flora and fauna at the site, as well as information regarding any other critical ecological receptors (e.g., wetlands, surface water bodies, Areas of Critical

Environmental Concern [ACECs], wildlife refuges, etc.) is also reviewed in Section 2.0. Under contract to the U.S. Army Corps of Engineers, ABB-ES has developed a database of all flora and fauna known to seasonally or permanently occur at, or migrate through, Fort Devens (ABB-ES, November 1992). Particular emphasis has been given to rare and endangered biota; the term "rare and endangered" is used to refer to those species with protected status under the Federal Endangered Species Act (FESA) of 1973, as amended in 1988, and the Massachusetts Endangered Species Act (MESA) of 1990. The Fort Devens biological database contains current information from the Massachusetts Natural Heritage Program (MNHP) and the USFWS regarding all rare and endangered species known to occur at Fort Devens. In addition, the ABB-ES database contains records that have not yet been incorporated into the MNHP database. In order to ascertain whether or not rare and endangered species habitat is present at each SA, the ABB-ES master biological database has been reviewed for each SA.

Information regarding rare and endangered species at individual SAs can be found in the respective SA discussions. Additional detail regarding the ecological characterization of the individual SAs can also be found in the respective SA discussions.

- **Comparison to Ecological Standards and Criteria**: This element of the ecological PRE identifies possible ecological exposure pathways, and serves to characterize the risk to terrestrial and aquatic receptors potentially exposed to environmental contamination at the Groups 2 and 7 SAs.

  Exposure pathways describe the mechanism(s) by which ecological receptors are exposed to contaminated media, and consist of a: (1) contaminant source; (2) environmental transport medium; (3) point of receptor contact; and (4) the exposure route (e.g., ingestion of prey items that have bioaccumulated contaminants in their tissues, drinking of contaminated surface water, incidental sediment ingestion, dermal absorption, inhalation, etc.). Potential receptors at Fort Devens include:

  - Terrestrial biota in uplands
  - Aquatic biota in wetlands
  - Semi-terrestrial biota in wetlands (i.e., wetlands flora and fauna)

The screening-level evaluation of exposure to aquatic and semi-terrestrial receptors in these PREs has been conducted through direct comparison of maximum concentrations of detected CPCs in Fort Devens sediments and surface water to state and federal standards and guidance values. Limited data are available to evaluate the potential for toxic effects of Fort Devens wetland sediment contaminants on aquatic and semi-terrestrial life. Available information includes state and federal sediment quality criteria and guidance, laboratory-derived toxicity data, and toxicity threshold values developed using toxicological extrapolation techniques. Sediment standards and guidelines used for the PREs are presented in Section 3.4, summarized in Table 3-3, and discussed below.

USEPA Sediment Quality Criteria. Sediment Quality Criteria (SQC) for several hydrophobic organic compounds have been developed and published by the USEPA (1988a). No USEPA SQC are available to evaluate the effects of inorganic constituents on aquatic life. The USEPA SQC are intended to protect benthic organisms which are primarily impacted by contaminants in the interstitial water between sediment particles. USEPA developed SQC using an equilibrium partitioning approach to identify sediment concentrations which could be associated with interstitial water concentrations equal to chronic federal AWQC. When available, USEPA SQC were preferentially chosen as the benchmark value for the Fort Devens PREs.

For non-polar, hydrophobic organic compounds, such as PCBs, the degree to which compounds are released from sediment particles into the interstitial water is strongly influenced by their low solubility and strong binding affinity to TOC within the sediment particle. The higher the TOC content of the sediments, the lower the potential for contaminant release to the interstitial water. Therefore, the toxicity of sediments containing hydrophobic compounds (and hence the associated sediment toxicity criteria) varies on a site-specific basis in an inverse relationship with the fraction of sediment that is organic carbon. For this reason, when appropriate, Fort Devens sediment toxicity threshold criteria were TOC normalized. Carbon-normalized criteria were calculated by multiplying the mean TOC content of the sediments at a SA by the appropriate SQC. Ecological risk was evaluated through direct comparison of this carbon-normalized value with the sediment analytical data.

N.Y. State Department of Environmental Conservation Sediment Quality Criteria. The NYSDEC Bureau of Environmental Protection, Division of Fish and Wildlife of NYSDEC has published a document entitled "Sediment Criteria - December 1989" (NYSDEC, 1989). This report is a guidance document, not a NYSDEC standard or policy. The NYSDEC SQC document contains a methodology for developing sediment criteria, a description of the use of these criteria in risk management decision-making processes, and a table of sediment criteria derived for various human and ecological receptors. Organic contaminant sediment criteria developed in NYSDEC (1989) are based on the TOC equilibrium partitioning approach. The NYSDEC (1989) guidance document contains recommended criteria for several organic and inorganic constituents found in Fort Devens sediments. When (i.e., for all organic analytes) NYSDEC values were carbon-normalized to reflect SA-specific TOC. When USEPA SQC were unavailable, the NYSDEC freshwater criteria were used as the sediment benchmark values for these PREs.

National Oceanographic and Atmospheric Administration Sediment Threshold Values. Long and Morgan (1990) have developed biological effects-based criteria for evaluating sediment contaminant data. Although this NOAA study is designed primarily for evaluating the toxicity of marine and estuarine sediments, USEPA has suggested that Long and Morgan (1990) criteria may also be used as a source of information for the evaluation of freshwater sediments at hazardous waste sites. The Effects Range-Median (ER-M) of Long and Morgan (1990) represents the 50th percentile concentration of contamination in estuarine sediments with observed (or predicted) effects. The Effects Range-Low (ER-L) of Long and Morgan (1990) represents the 10th percentile concentration of contamination in estuarine sediments with observed (or predicted) effects. When neither USEPA or NYSDEC freshwater sediment quality guidelines were available, the NOAA ER-L was used as a sediment screening tool for the Fort Devens PREs.

Information available to evaluate the toxicity of Fort Devens surface water contaminants include state and federal water quality criteria, laboratory-derived toxicity data, and toxicity threshold values developed using toxicological extrapolation techniques. Surface water standards and guidance values used for the SA Groups 2, 7 and Historic Gas Stations ecological PREs are presented in Section 3.4, summarized in Table 3-3, and discussed below.

USEPA Ambient Water Quality Criteria. AWQC have been developed and published by the USEPA for the protection of aquatic life and human health. The aquatic life AWQC are intended to be protective of all life stages of aquatic animals and plants. These criteria specify the contaminant concentration in ambient surface water that, if not exceeded, should protect most species of aquatic life and their uses. The chronic criterion represents the contaminant concentration that should not be exceeded by the four-day average chemical concentration more than once every three years (USEPA, 1983). In developing a chronic AWQC, USEPA estimates protective contaminant levels based on chronic toxicological data for animals, plants, and on residue levels in aquatic organisms. The acute criterion represents the level that should not be exceeded by the one-hour average concentration more than once every three years. For the purpose of the Fort Devens PREs, the chronic AWQC was used as a screening tool for evaluation of risk in surface waters. USEPA has not yet developed national AWQC for all contaminants detected at Fort Devens. When USEPA Water Quality documents did not contain chronic AWQC, the Lowest Observed Effects Level (LOEL) was identified from USEPA Water Quality Criteria documents and used as the screening tool for Fort Devens surface water. When hardness data were available at the SAs, hardness-dependent chronic AWQC were adjusted to account for the site-specific conditions.

No state or federal standards or guidelines exist for surface soil exposure, so this pathway has been evaluated through comparison of maximum analyte concentrations in surface soils to protective contaminant levels (PCLs) obtained through a computer-generated chronic exposure food web model. In order to establish conservative PCLs for the screening level PREs, an acceptable level of risk associated with chronic exposure to each surface soil contaminant isolated at Fort Devens was established. Surface soil ecological PCLs are summarized in Table 3-4. These PCLs are similar to protective guidelines available in the literature (i.e., Beyer, 1990; Fitchko, 1989). The food web model is further described in Appendix H.

Collectively, the state and federal standards and guidance values for surface water and sediment, as well as the surface soil PCLs, have been referred to as benchmark values. When more than one benchmark value is available per analyte per medium, professional judgment has been used to select the appropriate value for use in the PRE. A summary of ecological benchmark values is presented in Table 3-5.

Screening of ecological risk at each SA is based on establishing a contaminant-specific ratio between the average exposure concentrations and the benchmark values. This comparison of the exposure concentration with the appropriate benchmark results in an index of potential impact associated with exposure to environmental contaminants. When the maximum exposure concentration is less than the benchmark value (i.e., the ratio of the exposure concentration to the benchmark value < 1), ecological risk has been assumed to be insignificant. When the maximum value exceeds the exposure concentration (i.e., the ratio of the exposure concentration to the benchmark value > 1), a discussion of the ecological significance of this exceedance has been included in the individual PREs. This conservative approach provides a screening-level evaluation of potential effects of individual CPCs on ecological receptors.

Several of the SAs have little to no ecological habitat; for instance, several SAs are in light industrial use and contain no open space. Other SAs may provide limited ecological habitat, but no ecological exposure pathways exist (i.e., subsurface contamination in the vicinity of former USTs). PREs conducted at these SAs reflect the lack of habitat or ecological exposure pathways and do not include all sections outlined above.

3.6.3 General PRE Uncertainties

The evaluation of human health and ecological risks at the SAs in Groups 2 and 7 involves numerous uncertainties and assumptions. Although many of the assumptions and uncertainties at Fort Devens are inherent in the human health and ecological assessment process (i.e., are inherent in development and formulation of the conceptual model), others are related to data limitations and natural environmental stochasticity (USEPA, 1992b).

A list of general assumptions and uncertainties for the Fort Devens PREs has been included in Appendix H.

TABLE 3-1
LIST OF AEC METHODS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

AEC METHOD NUMBER	COMPARABLE USEPA METHOD NUMBER	METHOD DESCRIPTION
JB01	7471	Mercury in Soil by CVAA.
JD15	7740	Selenium in Soil by GFAA.
JD16	7911	Vanadium in Soil by GFAA.
JD17	7421	Lead in Soil by GFAA.
JD18	7761	Silver in Soil by GFAA.
JD19	7060	Arsenic in Soil by GFAA.
JS16	6010	Metals in Soil by ICP.
LH10	8080	Organochlorine Pesticides in Soil by GC-EC.
LH11	8150	Herbicides in Soil by GC-EC.
LH16	8080	PCBs in Soil by GC-EC.
LM18	8270	Extractable Organics in Soil by GC/MS.
LM19	8240	Volatile Organics in Soil by GC/MS.
LW12	8090	Nitroaromatics in Soil by HPLC.
SB01	245.1	Mercury in Water by CVAA.
SD20	239.2	Lead in Water by GFAA.
SD21	270.2	Selenium in Water by GFAA.
SD22	206.2	Arsenic in Water by GFAA.
SD23	272.2	Silver in Water by GFAA.
SS10	200.7	Metals in Water by ICAP.
TF22	300.0	Nitrate/Nitrite in Water by Auto Analyzer.
TF26	351.2	TKN in Water by Autoanalyzer.
TF27	365.1	Total Phosphate in Water by Autoanalyzer.
TT10	300.0	Anions in Water by IC.
UH02	608	PCBs in Water by GC.
UH13	608	Organochlorine Pesticides in Water by GC.
UH14	615	Herbicides in Water by HPLC.
UM18	625	Extractable Organics in Water by GC/MS.
UM20	624	Volatiles in Water by GC/MS.
UW19		PETN/Nitroglycerin in Water.
UW32	609	Nitroaromatics in Water by HPLC.

TABLE 3-2
HEALTH RISK-BASED GUIDELINES FOR INORGANIC ANALYTES

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	MCP S-1/GW-1 SOIL(mg/kg)	MCP GW-1 (ug/l)	REGION III RESIDENTIAL SOIL(mg/kg)	REGION III COMM/IND SOIL(mg/kg	REGION III TAP WATER (ug/l)	EPA DRINKING WATER REGS. (ug/l)	MASS. DRINKING WATER STAND. (ug/l)
ALUMINUM	–	–	230,000	3,000,000	110,000	50 - 200(3)	–
ANTIMONY	–	6	31	410	15	6(4)	6(8)
ARSENIC	–	50	0.97	1.6	0.049	50(5)	50(9)
BARIUM	–	2,000	5,500	72,000	2,600	2,000(4)	2,000(9)
BERYLLIUM	–	4	0.4	0.67	0.02	4(5)	4(8)
CADMIUM	–	5	39	510	18	5(4)	5(9)
CALCIUM	–	–	–	–	–	–	–
CHROMIUM	–	100	390(1)	5,100(1)	180(1)	100(2,4)	100(2,9)
COBALT	–	–	–	–	10	–	–
COPPER	–	–	2,900	38,000	1,400	1,300(6)	1,300(8)
IRON	–	–	–	–	–	300(3)	–
LEAD	300	15	500(10)	–	–	15(7)	50(9)
MAGNESIUM		–	–	–	–	–	–
MANGANESE	–	–	7,800	100,000	3,700	50(3)	–
MERCURY	10	2	23	310	11	2(4)	2(9)
NICKEL	300	100	1,600	20,000	730	100(4)	100(8)
NITRATE	–	–	130,000	1,600,000	58,000	10,000(As N)(4)	10,000(As N)(9)
NITRATE/NITRITE (As N)	–	–	–	–	–	10,000(4)	10,000(9)
NITRITE	–	–	7,800	100,000	3,700	1,000(As N)(4)	1,000(As N)(9)
POTASSIUM	–	–	–	–	–	–	–
SELENIUM	300	50	390	5,100	180	50(4)	50(9)
SILVER	100	40	390	5,100	180	100(3)	50(9)
SODIUM	–	–	–	–	–	–	28,000(8)
VANADIUM			550	7,200	260	–	–
ZINC	2,500	2,000	23,000	310,000	11,000	5,000(3)	–
VOLATILES							
ACETONE	3	3,000	7,800	100,000	3,700	–	3,000(5)
BENZENE	100	5	59	99	0.35	5(1)	5(6)
CARBON TETRACHLORIDE	100	5	13	22	0.22	5(1)	5(6)
CHLOROFORM	0.1	5	280	470	0.21	100(2)	5(5)
ETHYLBENZENE	80	700	7,800	100,000	1,300	700(1)	700(6)
STYRENE	2	100	57	95	0.47	100(1)	100(6)
1,1,2,2-TETRACHLOROETHANE	2	2	8.5	14.0	0.07	–	–
TETRACHLOROETHYLENE	50	5	33	55	1.4	5(1)	5(6)
TOLUENE	9000	1,00	16,000	200,000	750	1,000(1)	1,000(6)
1,1,1-TRICHLOROETHANE	300	200	7,000	92,000	1,300	200(1)	200(6)
TRICHLOROETHYLENE	40	5	150	260	2.1	5(1)	5(6)
1,2,4-TRIMETHYLBENZENE	10000	70	–	–	–	–	–
1,3,5-TRIMETHYLBENZENE	–	–	–	–	–	–	–
XYLENES	8000	10,000	160,000	2,000,000	12,000	10,000(1)	10,000(6)

TABLE 3-2
HEALTH RISK-BASED GUIDELINES FOR INORGANIC ANALYTES

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	MCP S-1/GW-1 SOIL(mg/kg)	MCP GW-1 (ug/l)	REGION III RESIDENTIAL SOIL(mg/kg)	REGION III COMM/IND SOIL(mg/kg	REGION III TAP WATER (ug/l)	EPA DRINKING WATER REGS. (ug/l)	MASS. DRINKING WATER STAND. (ug/l)
SEMIVOLATILES							
ACENAPHTHENE	200	20	4,700	61,000	2,200	--	--
ACENAPHTHYLENE	1000	300	--	--	--	--	--
ANTHRACENE	10,000	600	23,000	310,000	11,000	--	--
BIS(2-ETHYLHEXYL)PHTHALATE	1000	6	120	200	6.1	--	--
BENZO[A]ANTHRACENE	7	1	1.6	2.7	0.08	0.1(3)	--
BENZO[A]PYRENE	7	0.2	0.23	0.39	0.012	0.2(1)	0.2(5)
BENZO[B]FLUORANTHENE	7	1	1.9	3.2	0.095	0.2(3)	--
BENZO[G,H,I]PERYLENE	--	0.5	11	18	0.55	--	--
BENZO[K]FLUORANTHENE	70	--	4.4	7.4	0.22	0.2(3)	--
CARBAZOLE	--	--	85	140	4.3	--	--
CHRYSENE	70	2	--	--	--	0.2(3)	--
DIBENZO[A,H]ANTHRACENE	7	--	0.21	0.35	0.011	0.3(3)	--
DIBENZOFURAN	--	0.5	--	--	--	--	--
DI-N-BUTYLPHTHALATE	--	--	7,800	100,000	--	--	--
2,4-DINITROTOLUENE	7	30	160	2,000	73	--	--
2,6-DINITROTOLUENE	--	--	2.5	4.2	0.13	--	--
1-ETHYL-2-METHYLBENZENE	--	--	--	--	--	--	--
FLUORANTHENE	6,000	100	3,100	41,000	1,500	--	--
FLUORENE	4,000	300	3,100	41,000	1,500	--	--
INDENO[1,2,3-C,D]PYRENE	7	0.5	0.84	1.4	0.042	0.4(3)	--
2-METHYLNAPHTHALENE	7	10	--	--	--	--	--
NAPHTHALENE	40	20	3,100	41,000	1,500	--	--
N-NITROSODIPHENYLAMINE	--	--	350	580	17	--	--
PHENANTHRENE	7,000	300	2,300	30,000	1,100	--	--
PYRENE	5,000	80	2,300	31,000	1,100	--	--
PESTICIDES/PCBs							
4,4'-DDD	20		7.1	12	0.35	--	0.5(6)
4,4'-DDE	20		5	8.4	0.25	--	0.5(6)
4,4'-DDT	20		5	8.4	0.25	--	0.5(6)
CHLORDANE	10		1.3	2.2	0.066	2(1)	0.5(6)
ENDRIN	6		23	310	11	2(1)	2(6)
HEPTACLOR	1		0.38	0.64	0.003	0.4(1)	0.4(6)
PCBs	20	0.5	0.22	0.37	0.011	0.5(1)	0.5(6)
OTHER							
CYCLONITE (RDX)	--	--	15	26	0.77	--	--
CYCLOTETRAMETHYLENETETRANITRAMINE (HMX)	--	--	--	--	--	--	--
NITROGLYCERINE	--	--	391	3,650	--	5(4)	--
TRICHLOROFLUOROMETHANE	--	--	23,000	310,000	1,300	--	--
2,4,6-TRINITROTOLUENE	--	--	39	95	2.8	--	--

NOTES:
(1) CHROMIUM (VI) VALUES
(2) TOTAL CHROMIUM VALUES
(3) SECONDARY MCLs (FINAL)
(4) PRIMARY MCL (FINAL)
(5) PRIMARY MCL (UNDER REVIEW)
(6) COPPER ACTION LEVEL

TABLE 3-2
HEALTH RISK-BASED GUIDELINES FOR INORGANIC ANALYTES

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	MCP S-1/GW-1 SOIL (mg/kg)	MCP GW-1 (ug/l)	REGION III RESIDENTIAL SOIL (mg/kg)	REGION III COMM/IND SOIL (mg/kg	REGION III TAP WATER (ug/l)	EPA DRINKING WATER REGS. (ug/l)	MASS. DRINKING WATER STAND. (ug/l)

(7) LEAD ACTION LEVEL
(8) MASSACHUSETTS GUIDELINE
(9) MASSACHUSETTS STANDARD
(10) LEAD VALUE FROM INTERIM GUIDANCE ON ESTABLISHING SOIL LEAD CLEANUP LEVELS
AT SUPERFUND SITES (OSWER DIRECTIVE 9355.4-02)
MCP= MASSACHUSSETTS CONTINGENCY PLAN

Table 3–3
Ecological Surface Water and Sediment Benchmark Values

Site Investigation Report
Fort Devens

Analyte	USEPA Chronic AWQC (ug/l)	[a]	USEPA Interim Sediment Criteria (ug/gC) [b]	NOAA Sediment Guideline (ug/g) [c]	NYSDEC Sediment Criteria (ug/g) [d]
Inorganics					
aluminum	87	[e]	NA	NA	NA
antimony	30	[f]	NA	2	NA
arsenic	190	[g]	NA	33	5
barium	NA		NA	NA	NA
beryllium	---		NA	NA	NA
cadmium	---		NA	5	0.8
chromium	11	[h]	NA	80	26
cobalt	---		NA	NA	NA
copper	12	[i]	NA	70	19
iron	1,000		NA	NA	24,000
lead	3.2	[i]	NA	35	27
manganese	NA		NA	NA	428
mercury	0.012		NA	0.15	0.11
nickel	---		NA	30	22
selenium	---		NA	NA	NA
silver	---		NA	1	NA
vanadium	NA		NA	NA	NA
zinc	110	[i]	NA	120	85
Organics					
VOCs					
acetone	---		NA	NA	NA
benzene	---		NA	NA	NA
toluene	1,750	[j,k]	NA	NA	NA
xylenes	---		NA	NA	NA
SVOCs [L]					
acenaphthylene	---		732	0.15	730
anthracene	---		NA	0.085	NA
benzo[a]anthracene	---		1,317	0.23	NA
benzo[a]pyrene	---		1,063	0.40	NA
benzo[b]fluoranthene	---		NA	NA	NA
benzo[g,h,i]perylene	---		NA	NA	NA
benzo[k]fluoranthene	---		NA	NA	NA
bis(2–ethylhexyl)phthalate	360	[j]	NA	NA	119.7
chloroform	1,240	[h]	NA	NA	NA
chrysene	---		NA	NA	NA
di–n–butylphthalate	---		NA	NA	NA
2,4–dinitrotoluene	---		NA	NA	NA
fluoranthene	---		1,883	0.6	NA
fluorene	---		NA	0.035	NA

Table 3-3
Ecological Surface Water and Sediment Benchmark Values

Site Investigation Report
Fort Devens

Analyte	USEPA Chronic AWQC (ug/l) [a]	USEPA Interim Sediment Criteria (ug/gC) [b]	NOAA Sediment Guideline (ug/g) [c]	NYSDEC Sediment Criteria (ug/g) [d]
indeno[1,2,3-c,d]pyrene	---	NA	NA	NA
nitroglycerine	NA	NA	NA	NA
n-nitrosodiphenylamine	---	NA	NA	NA
phenanthrene	---	139	0.23	139
pyrene	---	1,311	0.35	NA
tetrachloroethylene	---	NA	NA	NA
styrene	---	NA	NA	NA
Pesticides/PCBs [L]				
alpha-chlordane	---	NA	0.0005	0.006
gamma-chlordane	---	NA	0.0005	0.006
DDT	---	0.828	0.001	0.828
DDE	---	NA	0.002	0.828
DDD	---	NA	0.002	0.828
heptachlor	---	0.11	NA	0.1
aroclor 1248	---	19.5 [m]	0.05 [n]	1.4
aroclor 1260	---	19.5 [m]	0.05 [n]	1.4

Notes:

[a] USEPA, 1991a.

[b] "Interim Sediment Criteria Values for Nonpolar Hydrophobic Organic Contaminants"; USEPA, 1988.

[c] "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program"; Long and Morgan, 1990. NOAA Technical Memorandum NOS OMA 52 (1990). Effects Range-Low values.

[d] New York State Department of Environmental Conservation, 1989; organics as ug/gC

[e] pH-dependent value; pH assumed to be between 6.5 and 9.0 (USEPA, 1988a).

[f] Proposed criterion.

[g] Trivalent arsenic criterion.

[h] Hexavalent chromium criterion.

[i] Hardness-dependent criterion. Value presented is at 100 mg/l hardness as CaCO3. SA-specific criteria were calculated as described in Section 3.6.2.

[j] Lowest-Observed Effect Level.

[k] Acute criterion divided by 10 to estimate chronic value.

[l] NYSDEC and USEPA values for organics in ug/g carbon; The values require normalization to reflect SA-specific TOC values, calculated as described in Section 3.6.2.

[m] Criterion for aroclor 1254.

[n] Criterion for total PCBs.

NA = Not available.

--- = Analyte not a CPC for this medium.

Table 3–4
Surface Soil Ecological Protective Contaminant Levels [a]

Site Investigation Report
Fort Devens

Analyte	Background Concentration	Ecological Receptors [b,c,d]					
		Short–tailed shrew	White–footed mouse	American robin	Garter snake	Red fox	Red–tailed hawk
		Protective Contaminant Level (mg/kg)					
Inorganics [e]							
aluminum	**15000**	1700	2800	3800	52000	NEL	NEL
antimony		**7**	11.7	15.5	210	33000	35000
arsenic	21	**33**	160	81	650	NEL	220000
barium	**42.5**	41	68	90	1200	190000	200000
berylium	0.347	**0.88**	1.5	2	27	4200	4400
cadmium	**2.00**	0.44	0.8	4.5	40	1400	1900
chromium	31	830	18000	**180**	2100	NEL	280000
cobalt		**50**	83	110	1500	94000	250000
copper	8.39	**34**	54	28	400	170000	69000
lead	**48.4**	4	31	13.7	240	44000	110000
manganese	300	**1500**	2500	3300	45000	470000	NEL
mercury	0.22	5	**3.6**	22	480	1600	23000
nickel	14	**100**	110	35	680	640000	120000
selenium		**0.48**	0.8	15.5	210	2300	35000
silver	0.086	**72**	120	160	2200	34000	360000
vanadium	**28.7**	10	17	18	240	47000	40000
zinc	35.5	**640**	1100	1400	20000	NEL	NEL
Organics							
acenaphthylene		**2600**	13500	9800	75000	NEL	NEL
acetone		**2000**	3130	4430	61000	NEL	NEL
anthracene		**14000**	92000	58000	410000	NEL	NEL
benzo(a)anthracene		**8.9**	79	38	250	53000	610000
benzo(a)pyrene		**5.5**	52	24	160	33000	380000
benzo(b)fluoranthene		**180**	1700	780	5000	NEL	NEL
benzo(g,h,i)perylene		**440**	4300	1900	12000	NEL	NEL
benzo(k)fluoranthene		**320**	3000	1400	9100	NEL	NEL
bis(2–ethylhexyl)phthalate		**84**	710	360	2400	500000	570000
carbazole		**43**	175	150	1200	240000	270000
chloroform		**676**	1060	1500	20600	240000	NEL
chrysene		**440**	3900	1900	12000	NEL	NEL
dibenzofuran		**10**	24	27	290	510000	56000
di–n–butylphthalate		**2650**	18300	11000	75300	NEL	NEL

Table 3–4
Surface Soil Ecological Protective Contaminant Levels [a]

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Analyte	Background Concentration	Ecological Receptors [b,c,d]					
		Short–tailed shrew	White–footed mouse	American robin	Garter snake	Red fox	Red–tailed hawk
		Protective Contaminant Level (mg/kg)					
2,4–dinitrotoluene		**270**	422	599	8230	189000	NEL
2,6–dinitrotoluene		**270**	422	599	8230	189000	NEL
fluoranthene		**1100**	9400	4700	31000	NEL	NEL
fluorene		**1100**	6000	4200	31000	NEL	NEL
indeno(1,2,3–cd)pyrene		**320**	3100	1400	9100	NEL	NEL
2–methylnaphthalene		**143**	601	509	4120	NEL	NEL
naphthalene		**170**	520	540	5100	NEL	NEL
nitroglycerine		**240**	375	532	7320	NEL	NEL
n–nitrosodiphenylamine		**200**	313	444	6100	NEL	NEL
phenanthrene		**510**	1600	1600	15000	NEL	NEL
pyrene		**550**	4200	2300	16000	NEL	NEL
tetrachloroethylene		**280**	470	630	8300	NEL	NEL
toluene		**1800**	3000	4000	52000	NEL	NEL
trichlorofluoromethane		**2000**	3300	4300	57000	NEL	NEL
Pesticides/PCBs							
alpha–chlordane		**0.29**	0.8	4.7	43	2500	4100
gamma–chlordane		**0.3**	1.3	5.9	43	2800	4600
DDD		**1.07**	10.5	2.5	451	341000	1720
DDE		**1.07**	10.5	2.5	451	341000	1720
DDT		**1.07**	10.5	2.5	451	341000	1720
heptachlor		**0.64**	1.7	1.9	17	3300	1600
aroclor–1254		**3.10**	33.0	8.4	49	11000	5810

Notes:

[a] All Protective Contaminant Levels (PCLs) in surface soil were calculated through the use of a computer–generated chronic exposure food web model. Assumptions incorporated in the model can be found in Section 3.6.2 and in Appendix H.

[b] Ecological receptors were chosen to represent diverse trophic levels, feeding strategies, and taxa.

[c] Shaded values indicate the lowest PCL calculated through the terrestrial food web model; in the case were the lowest PCL is less than the background concentration, the background value was used.

[d] Based on the exposure assumptions incorporated in the food web model, several analytes are not likely to have an adverse effect on higher trophic level ecological receptors. The PCLs for these analytes have been denoted NEL (No Effect Likely).

[e] Because the back–calculated food web models employ a number of conservative assumptions, the background levels of four inorganics (Al, Ba, V, and Pb) exceed the lowest PCL. Therefore, for these compounds, background concentrations were selected as the PCLs for the Groups 2 and 7 PREs.

Table 3–5
Ecological Benchmark Values for PREs

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Analyte	Surface Soil Benchmark [a] (ug/g)	Surface Water Benchmark [b] (ug/l)	Sediment Benchmark [b] (ug/g)
Inorganics			
aluminum	15,000	87	NA
antimony	7	30	2
arsenic	33	190	5
barium	42.5	NA	NA
beryllium	0.88	---	NA
cadmium	2	---	0.8
chromium	180	11	26
cobalt	50	---	NA
copper	34	12 [c]	19
iron	---	1000	24000
lead	48.4	3.2 [c]	27
manganese	1500	NA	428
mercury	3.6	0.012	0.11
nickel	100	---	22
selenium	0.48	---	NA
silver	72	---	1
vanadium	28.7	NA	NA
zinc	640	110 [c]	85
Organics			
VOCs			
acetone	2000	---	NA
benzene	---	---	NA
toluene	1800	1750	NA
xylenes	---	---	NA
SVOCs			
acenaphthylene	2600	---	732 [d]
anthracene	14000	---	0.085
benzo[a]anthracene	8.9	---	1,317 [d]
benzo[a]pyrene	5.5	---	1,063 [d]
benzo[b]fluoranthene	180	---	NA
benzo[g,h,i]perylene	440	---	NA
benzo[k]fluoranthene	320	---	NA
bis(2–ethylhexyl)phthalate	84	360	119.7 [d]
carbazole	43	---	---
chloroform	676	1,240	NA
chrysene	440	---	NA
dibenzofuran	10	---	---
di–n–butylphthalate	2650	---	NA
2,4–dinitrotoluene	270	---	NA
2,6–dinitrotoluene	270	---	---
fluoranthene	1100	---	1,883 [d]
fluorene	1100	---	0.035
indeno[1,2,3–cd]pyrene	320	---	NA
2–methylnaphthalene	143	---	---
naphthalene	170	---	---
nitroglycerine	240	NA	NA
n–nitrosodiphenylamine	200	---	NA
phenanthrene	510	---	139 [d]
pyrene	550	---	1,311 [d]
styrene	---	---	NA

Table 3–5
Ecological Benchmark Values for PREs

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Analyte	Surface Soil Benchmark [a] (ug/g)	Surface Water Benchmark [b] (ug/l)	Sediment Benchmark [b] (ug/g)
tetrachloroethylene	280	---	NA
trichlorofluoromethane	2,000	---	---
Pesticides/PCBs			
alpha–chlordane	0.29	---	0.006 [d]
gamma–chlordane	0.3	---	0.006 [d]
DDT	1.07	---	0.828 [d]
DDE	1.07	---	0.828 [d]
DDD	1.07	---	0.828 [d]
heptachlor	0.64	---	0.11 [d]
aroclor 1248	---	---	19.5 [d]
aroclor 1254	3.1	---	---
aroclor 1260	---	---	19.5 [d]

Notes:

[a] Protective Contaminant Levels (PCLs) for surface soil analytes are presented in Table 3–4.

[b] Surface water and sediment benchmark values are presented in Tables 3–3.

[c] Hardness–dependent criterion. Value presented is at 100 mg/l hardness as CaCO3. SA–specific criteria were calculated as described in Section

[d] Criterion in ug/g carbon. Criterion requires normalization to relect SA–specific TOC values, calculated as described in Section 3.6.2

NA = Not available.

--- = Analyte not a CPC for this medium.

4.0 GROUP 2 STUDY AREA INVESTIGATIONS

The Group 2 SAs, all of which are located on the Main Post area of Fort Devens (Figure 4.1-1), include:

- SA 13 - Landfill No. 9
- SA 45 - Lake George Street Vehicle Wash Area
- SA 49 - Building 3602 leaking underground storage tank (LUST) Site
- SA 56 - Building 2417 LUST Site
- SA 57 - Building 3713 Fuel Oil Spill
- SA 58 - Building 2648 and 2650 Fuel Oil Spills

The historic gas station sites (SA 43) are included in Group 2. The investigation findings at the historic gas station sites are presented in Section 6.0 of this Revised Final SI Report. The following subsections present the findings of the SI and SSI field investigation conducted at Group 2 SAs during the 1992 and 1993 field programs.

4.1 SA 13 - LANDFILL NO. 9

4.1.1 Study Area Background and Conditions

This landfill occupies approximately 1-acre of land west of Lake George Street on the Main Post (Figure 4.1-2). This SA was used from 1965 to 1970 for the disposal of construction debris, tree trunks, stumps, and possibly waste oil (McMaster et al., 1982). It appears that the landfill was covered when filling operation ceased; therefore, the only evidence of a landfill is a small mound now overgrown with trees and bushes. In addition, the area west of the abandoned landfill has more recently been used as a dumping ground for trees, stumps and brush for an unknown period. The landfill is located approximately 2,100 feet east of the Nashua River. It does not appear that any surface water drainage ways are directly connected to the Nashua River. A small (approximately 1-acre) wet area is located down slope or south of the waste material. This area appears to be a localized area of surface water caused by construction of an electric power line located south of SA 13. The only surface water drainage from this wet area is along a dirt access road which runs along the east side of SA 13 (see Figure 4.1-2). No detailed records are available concerning the nature or quantities of the material disposed of at this facility.

4.1.2 Site Investigation Program Summary

The SI at SA 13 was completed in June 1992, and was conducted in accordance with the Final SI Task Order Work Plan (ABB-ES, 1992c) and in conformance to the provisions of the Project Operations Plan (ABB-ES, 1992a). The field sampling program conducted at SA 13 was designed to assess whether the historic use of the landfill and surrounding area had generated conditions that pose a risk to human health or ecological receptors. Table 4.1-1 summarizes the scope of the SI.

This program consisted of the collection of three surface water and sediment samples, four surface soil samples, two subsurface soil samples, the installation of one groundwater monitoring well upgradient of the SA, two groundwater samples from the wetland south of the landfill, and two rounds of groundwater sampling from an upgradient groundwater monitoring well. The areal extent of the landfill was staked based on visible observations of apparent waste materials, and surveyed for an accurate measurement of the size of the waste material.

One soil boring (13M-92-01X) was drilled using 6¼-inch ID HSAs for the installation of a 4-inch ID PVC monitoring well to assess the condition of upgradient groundwater quality (Figure 4.1-3). Existing monitoring wells in the vicinity of the SA and topography suggests that groundwater flows to the west-southwest toward the Nashua River on this portion of the installation. Soil samples were collected continuously from 13M-92-01X using a 2-inch OD split-spoon sampler. One soil sample from the boring was collected from the water table and analyzed for TOC. In addition to the analytical sample, soil samples were obtained from the above mentioned split-spoons for grain size analysis to verify field classifications of soil. Two surface soil samples were collected from two sumps dug in the wetland south of the landfill (13D-92-04X and 13D-92-05X). These soil samples were collected from 0 feet to 2 feet below ground surface (bgs) to define downgradient soil quality. The soil samples were collected from the side wall of the sump using a stainless steel spoon. These samples were submitted for off-site laboratory chemical analysis of PAL VOCs, SVOCs, pesticides/PCBs, TPHC, explosives, and grain size.

One monitoring well (13M-92-01X) was installed in the soil boring described previously (see Figure 4.1-3). This monitoring well was screened across the water table to allow for the detection of floating contaminants, and seasonal fluctuation in the water table. The monitoring well was developed between two and seven days after completion. Aquifer hydraulic conductivities, of the soil at the water table, were measured and evaluated by performing two rising-head tests after development and between the first and second rounds of groundwater sampling. Table 4.1-2 summarizes the well construction.

Two rounds of groundwater samples were collected from 13M-92-01X. The Round One of sampling was conducted in September 1992 and the Round Two was completed in January 1993. In addition to these samples, two groundwater samples were collected from the sumps dug south of the landfill (13D-92-04 and 13D-92-05) and submitted to the laboratory (see Figure 4.1-3). These sumps were dug using a standard post hole digger and a shovel to a depth of approximately 4 feet bgs. Each sump was approximately 1.5 feet in diameter. The groundwater from the soil was allowed to collect in the sump and then sample bottles were submerged in the water and allowed to fill. The samples were submitted to the laboratory for analysis of PAL VOCs, SVOCs, pesticides/PCBs, inorganics, TPHC, anions and cations, and explosives.

Three surface water and sediment sample pairs (13D-92-01X through 13D-92-03X) were collected from the well-defined wetland at the toe of the landfill (as close to the slope as possible) to assess whether surface water and sediments had been adversely impacted by surface water runoff from the landfill (see Figure 4.1-3). The surface water samples were analyzed for PAL VOCs, SVOCs, pesticides/PCBs, inorganics, TPHC, water quality parameters, and explosives. The sediment samples were analyzed for PAL VOCs, SVOCs, pesticides/PCBs organics, TPHC, TOC, explosives, and grain size.

Two surface soil samples (13S-92-03X and 13S-92-04X) were collected from visibly stained areas on top of the fill material. Both samples were submitted for analysis of PAL VOCs, SVOCs, pesticides/PCBs, inorganics, and TPHC.

4.1.3 Supplemental Site Investigation Program Summary

The SSI at SA 13 was completed in August 1993, and was conducted in accordance with the Final SSI Task Order Work Plan (ABB-ES, 1993b) and in conformance to the provisions of the Project Operations Plan (ABB-ES, 1992a). The SSI was designed to determine whether the shallow downgradient groundwater had been impacted by contaminants emanating from the landfill material. Two shallow well points were installed in the wet area at the base of the waste material at SA 13 (Figure 4.1-3). The objective of the SSI sampling program was to investigate the presence or absence of landfill related contamination in the shallow groundwater and soil downgradient of SA 13. Table 4.1-1 summarizes the scope of the SSI.

One soil sample from each well point boring was collected and submitted for off-site laboratory analysis consisting of PAL VOCs, SVOCs, inorganics, explosives, pesticides/PCBs, and TOC.

The borings for the well points were drilled using a gas driven power auger. Both well points were advanced to between 3 and 5 feet bgs. The well points were constructed of 2-inch inside diameter (ID) PVC with a 0.010-inch machine slotted section. The well points were placed into the boring and the annulus around the well point was backfilled with silica sand. One foot of bentonite pellets was then placed on top of the sand and hydrated. The top 0.5 feet of each well point was backfilled with cement/bentonite grout and the top of the well point was secured with a locking cap. Table 4.1-2 summarizes the construction of the well points. The new well points installed as part of the SSI have been surveyed.

After both well points were developed and allowed to equilibrate, two rounds (Round Three and Four) of groundwater samples were collected from the newly installed well points and from the existing upgradient monitoring well (13M-92-01X). The groundwater samples from both rounds were submitted to an off-site laboratory and analyzed for PAL VOCs, SVOCs, inorganics (both filtered and unfiltered), explosives, water quality parameters, TPHC, and TSS. Round Three groundwater sampling was completed in October 1993 and Round Four was completed in January 1994.

4.1.4 Field Investigation Results and Observations

The surficial geology of the Shirley quadrangle, in which SA 13 is located, has not been mapped. However, the Main Post areas east of SA 13 have been mapped and the soil encountered appears to be similar to that identified at SA 13. The area is largely blanketed by unconsolidated surficial deposits of glacial and post-glacial origin. No bedrock is exposed at SA 13. Russell and Allmendinger (1975) mapped thin (less than 10 feet) surficial cover south and west of SA 13, and Jahns (1953) mapped ground moraine (till) approximately 2,000 feet to the east.

Locally, bedrock was not encountered during the SI or SSI programs but, it has been mapped as the generally north-south striking Merrimack Formation, consisting of low grade (below biotite isograd) calcareous and ankeritic metasiltstone and phyllite and commonly deformed by kink banding (Russell and Allmendinger, 1975; G.R. Robinson, 1978). The rock unit is called Oakdale Formation by Zen (1983) and Robinson and Goldsmith (1991). The Merrimack (Oakdale) Formation crops out along strike south of SA 13, most visibly on Route 2 just east of the Jackson Gate exit. A detailed description of the Main Post geology is presented in Section 2.0.

The soils encountered in the SI soil boring for monitoring well 13M-92-01X consisted of loose, silty and occasionally cobbley sand was encountered from the ground surface to 14 feet bgs, beneath which there is a denser silty sand (Table 4.1-3). Grain size testing of a sample from depth 20 to 22 feet bgs revealed 48.0 percent sand, 28.2 percent gravel, and 23.8 percent silts and clays, with a moisture content of 10.3 percent (Table 4.1-4). These materials are likely tills, with the deeper unit representing an older subglacial till and the upper unit representing a slightly younger till of englacial or superglacial derivation (Jahns, 1953).

The soils encountered in the well point borings completed during the SSI included silt and sandy clay at 13M-93-02X to gravelly sand at 13M-93-03X. The soils appear to be native to this portion of Fort Devens, however, the soil does appear to have been reworked due to the landfill operations (see Table 4.1-3). The boring log for 13M-92-01X, 13M-93-02X, and 13M-93-03X are provided in Appendix B, and grain size results are provided in Appendix J.

Grain size tests were also run on two SI sediment samples (13D-92-02X and 13D-92-03X) collected from the base of the slope below the landfill and two surface soil samples collected from shallow sumps farther to the southwest of the landfill (13D-92-04X and 13D-92-05X) (see Figure 4.1-2). These soils were classified as silty sands, with 14.7 to 17.8 percent fines and 6.1 to 20.6 percent gravel. Organics (vegetative matter) were present in sample 13D-92-02X, which had a water content of 197.8 percent. Water content of the other samples ranged from 26.6 to 35.0 percent (see Table 4.1-4). Grain size results are provided in Appendix J.

Monitoring well 13M-92-01X and well points 13M-93-02X and 13M-93-03X, were installed as part of the SI and SSI field investigations at a location presumed to be upgradient and downgradient of the landfill material (see Figure 4.1-2). Well completion details are provided in Appendix C.

Installation-wide water-level surveys of monitoring wells and surface-water stations have been conducted quarterly since May of 1992. One or all of the SA 13 monitoring well/well points (13M-92-01X, 13M-93-02X, and 13M-93-03X) have been included in each of these surveys. The data from these installation-wide water level rounds is provided in Appendix I.

Based on the several rounds of water level data collected and the location of the Nashua River, it appears that groundwater below SA 13 would flow toward the south- south-west, and discharge into, the Nashua River (Figure 4.1-4).

The groundwater flow model of Engineering Technologies Associates, Inc. (1992, Figures III-22 and III-23), which is based on regional data, assumes that the water table in the vicinity of SA 13 is in bedrock. The regional scale of the installation-wide model required modeling of thin saturated overburden as being entirely within the bedrock. These modeling requirements caused the regional groundwater flow model to indicate that the groundwater should be found in the bedrock at this SA. Nevertheless, the model shows groundwater flow directly westward toward the river.

Based on *in-situ* aquifer testing, hydraulic conductivities of 2×10^{-5} centimeters per second (cm/sec) and 4×10^{-5} cm/sec were measured in the soil at the water-table during two hydraulic conductivity tests performed in monitoring well 13M-92-01X. The results of the hydraulic conductivity tests are provided in Appendix A.

Groundwater in the surficial aquifer at the facility has been assigned to Class I under Commonwealth of Massachusetts regulations. Class I consists of groundwaters that are "found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated as a source of potable water supply" (314 CMR 6.03).

4.1.5 Nature and Distribution of Contaminants (Laboratory Results)

The objective of the sampling program at SA 13 was to investigate the presence or absence of contamination caused by the landfilling operation and/or subsequent degradation of the waste material in the various environmental media. The primary concern at SA 13 was that contaminants generated from the waste material were impacting the quality of the groundwater, surface water, sediment, and surface soil on and around SA 13. In considering the potential contaminant migration pathways, surface soil samples were collected from the soil cover present on top of the waste material. Additionally, surface water and sediment samples were collected from the wet area at the toe of the waste material to assess the potential for downgradient contaminant migration in surface water and sediment. Four rounds of groundwater samples were collected from 13M-92-01X installed upgradient of the waste material and two rounds of sampling was conducted at the two well points located in the wet area at the toe of the waste material, and only one round (Round One) was collected from the hand dug sumps also located in the wet area southwest of SA 13 (see Figure 4.1-2).

4.1.5.1 Soil. Off-site laboratory results for soil samples collected during the SI and SSI are presented in Table 4.1-5 and Table 4.1-6, and Figure 4.1-5 and Figure 4.1-6. Two surface soil samples (13S-92-03X and 13S-92-04X) were collected from landfill's soil cover material that appeared to be stained by possible contaminant release. Sampling locations were reduced from the planned four to two because of the lack of observable surface contamination. Two additional surface soil samples were collected from two sumps (13D-92-04X and 13D-92-05X) dug in the wet area southwest of the landfill material (see Figure 4.1-2). These sumps were dug to a depth of approximately 4 feet bgs with a post hole digger.

VOCs were not detected in any of the surface soil samples collected from the landfill soil cover. PAHs were detected in only one of the two surface samples (13S-92-04X) collected. The total PAH concentration in this sample was 32.5 μg/g. TPHC was detected in both surface soil samples collected from the soil cover material on the landfill. The concentrations of TPHC at 13S-92-03X was 150 μg/g and at 13S-92-04X the concentration was 251 μg/g. Pesticide residues of dichlorodiphenyl dichloroethylene (4,4'-DDE) and dichlorodiphenyl trichloroethane (4,4'-DDT) were also detected in both surface soil samples collected from the landfill cover material and dichlorodiphenyl dichloroethane (4,4'-DDD) was only detected in 13S-92-04X. Gamma-chlordane and heptachlor were detected in 13D-92-04X (see Table 4.1-5 and Figure 4.1-5).

Several inorganic analytes were detected in the surface soil samples collected from SA 13 at concentrations above the established Fort Devens background concentrations. Concentrations of lead and zinc were particularly elevated in 13S-92-03X. The remaining inorganic analytes detected above the established Fort Devens background concentration were all within the same order of magnitude as the background concentration (Table 4.1-6; see Figure 4.1-5).

Off-site laboratory results for the well points surface soil samples collected from SA 13 during the SSI, are presented in Tables 4.1-5 and 4.1-6, and Figure 4.1-6. Because the soil samples were collected from the upper 3 feet of soil, they will be classified as surface soil. No VOCs, explosives, or pesticides were detected in the soil samples collected from the well point borings. Di-n-butylphthalate (a common laboratory contaminant) was the only SVOC detected in both soil samples. PCB 1260 was detected at 0.216 μg/g in the soil sample collected from 13M-93-03X. Manganese (304 μg/g) was detected above the established Fort Devens background in the soil sample collected from 13M-93-02X; nickel was detected above background in both samples (19.2 μg/g and 18.6 μg/g, respectively); sodium was detected above background in both samples (383 μg/g and 339 μg/g, respectively), and zinc (41.7 μg/g) was detected above background in the soil sample collected from 13M-93-03X.

4.1.5.2 Groundwater. The results of the four rounds (Round One through Four) of groundwater sampling are presented in Table 4.1-7 and Figure 4.1-7 and Figure 4.1-8. Two rounds of unfiltered and one round of filtered groundwater samples were collected from 13M-92-01X during Rounds One and Two and only unfiltered samples were collected from the two sump locations during Round One. No organic compounds were detected in either of the groundwater samples collected from 13M-92-01X. Several inorganic analytes were detected above the established Fort Devens background concentration, copper, iron, lead, and zinc were detected at notable concentrations above their individual background concentration during Round One. Only lead and zinc were detected at notable concentrations above their background in Round Two. TSS results were measured in the Round Two groundwater sample collected from 13M-92-01X at 202 milligrams per liter (mg/L) (Table 4.1-7; Figure 4.1-7).

Because the water samples collected from the sump locations (13D-92-04X and 13D-92-05X) were collected from below grade, the contaminants detected in these samples were considered a reflection of downgradient groundwater quality. No organic analytes were detected in these two samples. Inorganic analyte concentrations were detected significantly above the established Fort Devens background in both samples. TSS were measured at 296 mg/L in 13D-92-05X and 948 mg/L in 13D-92-04X, and may be a likely contributor of the inorganic concentrations (see Table 4.1-7; see Figure 4.1-7).

No PAL VOCs, explosives, or TPHC were detected in the two rounds of groundwater samples collected during the SSI. Bis(2-ethylhexyl)phthalate (a common laboratory contaminant) was the only SVOC detected. Several inorganic analytes were detected above their Fort Devens background in the unfiltered samples, however only calcium, manganese, magnesium, potassium, sodium, and vanadium were detected above the Fort Devens background in the filtered samples. TSS results for unfiltered samples from Rounds Three ranged from 91 mg/L at 13M-92-01X to 3,650 mg/L at 13M-93-02X; while in Round Four TSS results ranged from 192 mg/L at 13M-92-01X to 4,640 mg/L at 13M-93-02X (see Table 4.1-7 and Figure 4.1-7 and Figure 4.1-8).

4.1.5.3 Surface Water and Sediment. Three surface water samples (13D-92-01X through 13D-92-03X) were collected during the SI from the toe of the waste material in the wet area immediately southwest of SA 13. No additional surface water or sediment samples were collected during the SSI. These samples were collected to assess potential for contaminant migration from the landfill material to the wet area surface water and/or sediment (see Figure 4.1-8). Bis (2-ethylhexyl) phthalate (a common laboratory contaminant) was detected at 6.9 micrograms per liter (μg/L) and nitroglycerine was detected at 38.5 μg/L in 13D-92-03X. No other organic compounds were detected in any of the surface water samples collected from SA 13. Mercury was the only inorganic analyte detected at notable concentrations (1.25 μg/L at 13D-92-02X) (Table 4.1-8; Figure 4.1-8).

Three sediment samples were collected in conjunction with the surface water samples mentioned above. A trace concentration of chloroform

(0.004 micrograms per gram [μg/g]) was detected in 13D-92-02X. Chloroform is a common laboratory contaminant and should not be considered as a site contaminant. No other VOCs were detected in the sediment sample collected. PAHs were detected in one sediment sample (13D-92-01X), and the total concentration of PAHs was 0.237 μg/g. TPHC and pesticide compounds were detected in all three sediment samples. Concentrations of TPHC ranged from 41.6 μg/g at 13D-92-03X to 164 μg/g at 13D-92-01X. Inorganic analytes were detected in each of the sediment samples collected (Table 4.1-9; Figure 4.1-9).

4.1.6 Source Evaluation and Migration Potential

PAHs, TPHC, pesticides, and inorganics (above the calculated Fort Devens background concentrations) were detected in both of the surface soil samples collected from the landfill cover material during the SI. These samples were collected from stained or apparently contaminated areas, therefore the results of these samples may represent "hot spots" and not the overall quality of the soil cover. The only organic contaminant detected in the soil samples collected during the SSI was PCB 1260 (0.216 μg/g) in the soil sample collected from the downgradient well point 13M-93-03X. Manganese, nickel, sodium, and zinc were the only inorganic analytes detected above the Fort Devens soil background.

PAHs, TPHC, pesticide residue, and inorganics were detected in the three sediment samples collected from the wetlands area during the SI. The sediment samples with the highest contaminant concentrations were located closest to the waste material. The presence of these analytes in the sediment samples from the wetland may represent the migration of similar analytes, detected in the surface soil samples collected from the soil cover on the landfill waste.

No organic compounds were detected in the upgradient groundwater sample collected during the two SI rounds of sampling. Lead and zinc were detected in both rounds of groundwater samples. These samples were unfiltered and contained TSS which may have resulted in the above background concentrations of inorganics. No organic compounds were detected in the downgradient groundwater samples collected from sumps at 13D-92-04X and 13D-92-05X. Several inorganic analyte concentrations were detected above the calculated Fort Devens background concentration in these samples. However, these concentrations were likely the results of TSS measurements due to the sampling methodology. These results suggest no groundwater impacts due to the landfill.

Bis(2-ethylhexyl)phthalate (a common laboratory contaminant) was the only SVOC detected in the groundwater samples collected during the SSI. The only other organic compound detected was nitroglycerine, which was detected in the duplicate sample collected during Round Four from 13M-93-02X (77.9 μg/g). However, no nitroglycerine was detected the normal sample collected from this well point nor was it detected in the Round Three sample collected from this well point. Based on this and the findings of the off-site laboratory quality control assessment, it appears that the concentration of nitroglycerine is attributable to off-site laboratory error rather then SA-related groundwater contamination. Several inorganic analytes were detected above their Fort Devens background in the unfiltered groundwater samples, however, only calcium, manganese, potassium, sodium, and vanadium were detected above background in the filtered sample.

Nitroglycerine was detected in the surface water sample collected from 13D-92-03X collected during the SI. The detection of this explosive compound in the surface water at this SA is unusual based on the type of waste reportedly disposed of in this landfill. No other organic compounds were detected in the surface water samples collected during the SI. Notable concentrations of lead, arsenic, and mercury were also detected in surface water samples.

Based on the results of the groundwater samples collected from the downgradient well points, it appears that landfill-derived contaminants have not impacted the groundwater quality at SA 13.

4.1.7 Preliminary Human Health Risk Evaluation

A preliminary human health risk evaluation was prepared for SA 13 to determine if contaminants detected at this SA pose a risk to human receptors. The landfill is not currently in use. For this PRE, the future use of SA 13 is assumed to be residential. Tables 4.1-10 through 4.1-13 present summary statistics and human health standards and guidelines used in the PRE for SA 13.

4.1.7.1 Soils. As discussed in Section 3.5 (Preliminary Risk Evaluation Methodology), all soils to a depth of 3 feet are classified as surface soil and considered to be accessible under a residential future use exposure scenario.

Table 4.1-10 presents summary statistics on surface soil at SA 13 and USEPA Region III residential soil concentrations for comparison. Surface soil at SA 13 is represented by samples 13S-92-03X and 13S-92-04X collected from stained surficial soils, and 13D-92-04X and 13D-92-05X collected from shallow soil depths in a wet area downslope of the landfilled material. An assessment of the organic compound data for SA 13 surface soils shows that there is some contamination from TPHC, pesticide residues, and PAHs. The levels of the detected organic analytes in the surface soils are below the USEPA Region III residential soil concentrations, with the exception of benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, and indeno[1,2,3-c,d]pyrene. While the detected concentrations of these four PAHs slightly exceed their respective USEPA Region III residential soil concentrations, each was detected in only one of four samples collected (13S-92-04X). No liquid or semi-liquid materials were observed on the landfill, nor were chlorinated solvents detected.

An assessment of the inorganic data for SA 13 surface soils shows that there is elevated inorganic analyte surface contamination particularly in the visually contaminated soils directly on top of the landfill (13S-92-03X and 13D-92-04X). When comparing concentrations of the surface soils at SA 13 to the established Fort Devens background, there are a number of compound exceedances, most notably lead, manganese, and zinc. This was not unexpected since the soil samples were collected from visually stained areas. There are few exceedances above established Fort Devens background in the surface soil samples collected from 13D-92-04X and 13D-92-05X.

Of the thirteen inorganic analytes detected above the established background concentrations, only two analytes were detected at concentrations above their respective health-based soil guideline. Arsenic was detected at concentrations above the USEPA Region III residential soil concentrations in two of four samples. The maximum detected concentration of arsenic (38 μg/g) exceeded the base-wide background concentration (21 μg/g); however, the average concentration of arsenic (17.4 μg/g) did not exceed the base-wide background concentration. The maximum detected concentration of beryllium (1.18 μg/g) and the average (0.9 μg/g) are above the USEPA Region III residential soil concentration of 0.4 μg/g. Beryllium was detected in two of four samples (see Table 4.1-10).

4.1.7.2 Groundwater. Table 4.1-11 presents summary statistics on groundwater samples collected during the SI and SSI at SA 13 and applicable drinking water standards/guidelines. Only one organic compound (bis(2-ethylhexyl)phthalate) was detected in the groundwater sampled at SA 13, and it has been attributed to laboratory contamination. When comparing unfiltered groundwater concentrations to the Fort Devens background, the inorganic data for SA 13 groundwater shows that the maximum detected concentration of every analyte exceeds the background concentration.

A drinking water standard or guideline is available for thirteen of the sixteen inorganic analytes detected above the established Fort Devens background levels. Four analytes were detected in unfiltered samples at concentrations above their respective drinking water standard/guideline. Aluminum, manganese, and iron were detected in six of six samples collected and their average concentrations exceeded their respective USEPA secondary Maximum Concentration Limit (MCL). (Secondary MCLs are set for aesthetic or economic reasons, not health reasons.) The maximum detected concentration of lead (17.7 μg/L) exceeded the lead action level (15 μg/L); however, the average concentration of lead (8.8 μg/L) did not exceed the action level. Based on the unfiltered data, groundwater would not be suitable as a drinking water source.

The filtered samples, in general, showed significantly lower concentrations than the unfiltered samples. In the four filtered samples, the concentrations of aluminum, lead, and iron were below the detection limits. In three of the four filtered samples, the concentrations of manganese dropped below its secondary MCL.

4.1.7.3 Surface Water and Sediment. Tables 4.1-12 and 4.1-13 present summary statistics on surface water and sediment associated with SA 13. Three sampling locations (13D-92-01X through 13D-92-03X) were established in the wetland area immediately southwest of SA 13. Two organic compounds were detected in the surface waters associated with SA 13: bis (2-ethylhexyl) phthalate and nitroglycerine. The maximum concentration of bis (2-ethylhexyl) phthalate detected in surface waters (6.9 μg/L at 13D-92-03X) slightly exceeds its USEPA Region III tap water concentration of 6.1 μg/L; it was detected in only one of four samples collected (three samples and one duplicate). Bis (2-ethylhexyl) phthalate is a common laboratory contaminant and is not considered to be a SA related contaminant. Nitroglycerine was detected in one of four samples at 38.5 μg/L. This concentration exceeds the USEPA lifetime Health Advisory of 5 μg/L.

The concentrations of four inorganic analytes that were detected in the surface water exceed their respective drinking water standard/guideline. The maximum concentration of lead detected at location 13D-92-02X (18.9 μg/L) exceeds the USEPA lead action level of 15 μg/L; however, the average concentration of lead in the four surface water samples (10.5 μg/L) does not exceed the lead action level. Aluminum, iron, and manganese were detected in all samples collected and each exceeded its respective USEPA secondary MCL. (Secondary MCLs are set for aesthetic or economic reasons, not health reasons.)

The magnitude and frequency of exposure to surface water associated with SA 13 would be expected to be much less than that upon which drinking water guidelines are based. The use of drinking water guidelines for comparison to surface water concentrations in a wetland is a conservative approach and is used due to a lack of available health-based guidelines for exposure to surface water. Because exposure to surface waters in the wetlands is anticipated to be restricted to wading in the future, it is not likely that an individual would encounter inorganic analyte concentrations that would pose a threat to public health.

Three sediment collection locations (12D-92-01X through 12D-92-03X) were established in the wetland area immediately southwest of SA 13. The sediment samples were collected in conjunction with the surface water samples mentioned above. Several organic analytes were detected in these samples. The analytes include pesticide residues, PAHs, and chloroform. The levels of all detected organic analytes in the sediment are below the USEPA Region III residential soil concentration.

Of the inorganic analytes detected in the sediment, only arsenic and beryllium exceed their respective USEPA Region III residential soil concentration. The use of residential soil concentrations for comparison to sediment concentrations in the surface water is a conservative approach and is used due to a lack of available health-based guidelines for exposure to sediment. The USEPA Region III residential soil concentration is designed to be protective for exposures that could occur 350 days per year for a residential lifetime of 30 years. Exposure to sediment in the wetlands would be much less than that expected in a residential setting. The concentrations of arsenic and beryllium detected in sediment associated with SA 13 are not expected to present a risk to public health under present or foreseeable future uses of the SA.

4.1.8 Preliminary Ecological Risk Evaluation

The purpose of the PRE at SA 13 is to provide a screening-level evaluation of actual and potential risks that environmental contaminants may pose to the resident and migratory ecological receptors at the site.

The landfill is located in a gently sloping white pine (*Pinus strobus*)/oak (*Quercus* sp.) woodland, with a fairly open understory. A low, wet region occurs at the toe of the approximately 15-foot-high landfill slope, where apparent groundwater discharges to the surface and pools. A roadside rivulet flows from this wet area downhill, towards the Nashua River.

Much of the wet area at the toe of the landfill is typical of a wet meadow, characterized by plants such as cattails (*Typha latifolia*), sensitive fern (*Onoclea sensibilis*), hydrophytic grasses (Gramineae), tussock sedge (*Carex stricta*), and soft rush (*Juncus effusus*). Species located in wooded regions directly to the east and north of the landfill include white ash (*Fraxinus americana*), red maple (*Acer rubrum*), gray birch (*Betula populifolia*), swamp white oak (*Quercus bicolor*), speckled alder (*Alnus rugosa*), and skunk cabbage (*Symplocarpus foetidus*).

Although the landfill probably provides minimal habitat for ecological receptors, the low area downgradient from the landfill may provide limited wildlife habitat for species such as the raccoon (*Procyon lotor*), amphibians (e.g., the green frog (*Rana clamitans*)), or reptiles such as the garter snake (*Thamnophis sirtalis*).

No records exist documenting the current or historical presence of rare and endangered species in the region of SA 13. However, the Commonwealth of Massachusetts has established a "Watch List" of uncommon or rare plants (Massachusetts Natural Heritage Program, 1990). This list includes Massachusetts flora which are believed to be uncommon, but for which insufficient information exists documenting the true status of the plant in the state. One Watch List plant species is known to occur in the vicinity of SA 13 (Hunt and Zaremba, 1992).

Two surface soil samples were collected from the landfill surface, and two additional shallow soil samples from the slope portions of the site. In general, concentrations of analytes were higher in the two samples from the landfill than they were in the downgradient samples. Twenty-two organic analytes were detected in surface soils at SA 13. With the exception of three pesticide analytes (4,4-DDT, 4,4-DDE, and heptachlor), the frequency of detection for all organic analytes was one in four. The three pesticide analytes were detected in two of the four samples. All detected organic analytes were chosen as surface soil CPCs for SA 13.

Inorganic analytes were detected in the two surface soil samples collected from the landfill surface, as well as in the two additional surface soil samples from downgradient portions of the site. The maximum concentrations of arsenic, barium, beryllium, cadmium, copper, lead, manganese, nickel, silver and zinc were higher than background and these analytes were therefore chosen as surface soil CPCs. No background data were available for cobalt or selenium, therefore, these two analytes were also chosen as CPCs. Lead was detected in all samples at a maximum concentration of 330 μg/g. Copper was detected at all locations at a maximum concentration of 17 μg/g (Table 4.1-14).

Three surface water samples, and one duplicate, were collected from the wet area located at the toe of the SA 13 landfill. Two organic compounds and ten inorganic compounds were detected and chosen as CPCs for surface water. Aluminum was detected in all samples at a maximum concentration of 5,060 μg/L. Mercury was detected in one of the three samples (and in the duplicate), at a concentration of 1.25 μg/L. Bis (2-ethylhexyl) phthalate and nitroglycerine were both detected in a single sample, and were also chosen as CPCs (Table 4.1-15).

Three sediment samples were collected at SA 13 at the identical sampling locations as the surface water samples. Fourteen inorganic compounds were detected and chosen as CPCs for sediment. Arsenic was detected in all samples, at a maximum concentration of 22 μg/g. Lead was detected in all samples, at a maximum concentration of 41 μg/g. Seven organic compounds, including three pesticide analytes (4,4-DDE, gamma-chlordane, and heptachlor) were detected in sediments at SA 13. All were chosen as CPCs. Heptachlor was detected in all samples, at a maximum concentration of 0.07 μg/g (Table 4.1-16).

Potential contaminant exposure pathways exist at SA 13 for terrestrial receptors via incidental soil ingestion and terrestrial food web exposure. In addition, semi-terrestrial receptors in the site's wet areas may be exposed to environmental contaminants in surface water and sediment.

4.1.8.1 Surface Soils. A screening-level evaluation of potential effects from surface soil exposure was conducted by comparing the maximum concentrations of all CPCs to their respective surface soil benchmark values (see Table 4.1-14). No organic analytes at SA 13 were found to exceed their ecological benchmark values. However, the maximum concentrations of arsenic, barium, beryllium, cadmium, lead and selenium were greater than their respective surface soil benchmarks. Lead was detected at a maximum concentration of 330 μg/g, and at an average concentration of 102.6 μg/g. The maximum lead concentration was approximately 6.5 times greater than the lead background concentration, which was established as the benchmark for lead in surface soils. However, the average lead concentration was only approximately twice the background concentration. The maximum concentrations of arsenic, barium, beryllium, cadmium, and selenium were only slightly higher than their respective surface soil benchmark values.

4.1.8.2 Surface Water and Sediments. Risks to aquatic receptors in surface water were evaluated through comparison of maximum CPC concentrations to aquatic benchmark values (USEPA chronic AWQC). Risks to ecological receptors from sediments were evaluated through comparison of maximum CPC concentrations to sediment benchmark values. The maximum concentrations of aluminum, iron, lead and mercury in the surface water at SA 13, and the maximum concentrations of copper, lead, arsenic, 4,4'-DDE, gamma-chlordane and heptachlor in wetlands sediments were detected at levels greater than their respective benchmark values (see Tables 4.1-15 and 4.1-16).

Mercury was detected in one of the three surface water samples analyzed, at a concentration of 1.25 μg/L. Mercury was also detected in the duplicate surface water sample. Although the maximum mercury concentration is less than the acute AWQC for mercury (2.4 μg/L), it is approximately an order of magnitude greater than the chronic AWQC. No AWQC are available for nitroglycerine, and this explosive was not evaluated in this PRE.

Aluminum was detected in all surface water samples at a maximum concentration of 5,060 μg/L, well above the acute and chronic AWQC for this inorganic. Aluminum is naturally present at high levels in background soils and groundwater at Fort Devens, and the presence of aluminum in the SA 13 surface water may be reflective of background conditions, and not of landfill impacts. Furthermore, a review of the aluminum AWQC document (USEPA, 1988c) indicates that larval trout are among the most sensitive ecological receptors with regard to aluminum exposure. Because no salmonids (e.g., trout) occur in the SA 13 wet areas, it is unlikely that the levels of aluminum in surface water will have an adverse effect on the site's ecological receptors, which are likely to be considerably more tolerant of aluminum than larval trout.

The maximum lead concentrations in the SA 13 surface water samples was 18.9 μg/L, approximately three times the hardness-adjusted chronic AWQC for lead. Lead is present at only slightly lower then the established background Fort Devens concentration in groundwater, and it is possible that the lead in the SA 13 surface water is reflective of background, rather than landfill-related conditions. However, this value is an order of magnitude below the acute AWQC, calculated as 169.4 μg/L, based on the measured hardness of 117.5 mg/L. A review of the lead AWQC document (USEPA, 1984) indicates that early life stages of trout are among the most sensitive ecological receptors with regard to lead exposure. Because no salmonids occur in the site's surface water, it is unlikely that the low levels of lead in surface water will have an adverse effect on the site's ecological receptors, which are likely to be more tolerant of lead than early life stages of trout.

Iron was found in surface water samples at a maximum concentration of 3610 μg/L, and at an average of 3,115 μg/L. Although these concentrations are in excess of the chronic AWQC (1,000 μg/L), iron is present at similar levels in background soils and groundwater at Fort Devens, and it is likely that the presence of iron in the SA 13 wetlands sediments is reflective of background conditions, and not of landfill impacts. Furthermore, many surface water samples collected in other studies at Fort Devens (i.e., Cold Spring Brook and the Nashua River) contained iron in excess of 1,000 μg/L; this finding supports the contention that iron is present at background conditions in excess of the chronic AWQC.

Maximum lead, copper, arsenic, 4,4-DDE, gamma-chlordane and heptachlor concentrations in SA 13 sediments exceeded the screening level benchmark toxicity values. Lead was present at a maximum concentration of 41 μg/g, and at an average concentration of 19.7 μg/g. The average lead concentration is lower than the NYSDEC sediment quality guideline (27 μg/g) and is lower than 35 μg/g, the ER-L of NOAA (Long and Morgan, 1990). Therefore, lead in SA 13 sediments is not considered to be causing significant ecological risk. Arsenic was present at a maximum concentration of 22 μg/g, and at an average concentration of 9.8 μg/g. Copper was present at an average concentration of 11.2, and a maximum of 25.9 μg/g. The average arsenic and copper concentrations in SA 13 sediments are only slightly greater than the NYSDEC sediment quality guidelines, and are considerably less than their respective NOAA ER-L (Long and Morgan, 1990). Therefore, neither arsenic nor copper is considered to be causing significant ecological risk in SA 13 sediments. Although the maximum 4,4-DDE concentration is approximately twice the TOC-normalized USEPA SQC (USEPA, 1989), the concentration of this analyte is approximately an order of magnitude greater than the NOAA ER-L (Long and Morgan, 1990). Heptachlor and gamma-chlordane are also present in SA 13 sediments at concentrations at least an order of magnitude greater than their respective sediment benchmark values.

4.1.9 Conclusions and Recommendations

The results of human health PRE indicate that inorganics detected in the unfiltered groundwater samples (aluminum, iron, lead, and manganese) exceed the appropriate action levels. However, the results of the filtered inorganic analysis and the TSS results indicate that these inorganic concentrations are a result of suspended solids in the samples, not landfill-derived contaminants. The ecological risk at SA 13 is limited to exposures associated with mercury in surface water and pesticides in sediment.

Based on the results of the SI and the SSI, no further hazardous waste action is recommended for Landfill No. 9, SA 13. However, it is recommended that the study area be considered for closure under applicable solid waste regulations and standards and that the waste material should be included in the basewide landfill consolidation program. This recommendation is based on historical information on the use of the SA as confirmed by physical observations and sampling and chemical analysis.

TABLE 4.1-1
SUMMARY OF TECHNICAL APPROACH
SA 13 - LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ACTIVITY	PURPOSE	SITE IDENTIFICATION	RATIONALE FOR SELECTED LOCATIONS
SI PROGRAM			
SOIL BORING AND SUBSURFACE SOIL SAMPLING	* INSTALL MONITORING WELL * CHARACTERIZE SOIL	13M-92-01X	* APPARENT UPGRADIENT LOCATION * OUTSIDE OF LANFILL WASTE
MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING	* MONITOR GROUNDWATER LEVELS * MONITOR GROUNDWATER QUALITY * DETERMINE AQUIFER CONDUCTIVITIES	13M-92-01X	* APPARENT UPGRADIENT LOCATION * UPGRADIENT GROUNDWATER QUALITY
SURFACE WATER AND SEDIMENT SAMPLING	* COLLECT SAMPLES FOR OFF-SITE LABORATORY ANALYSIS * DETERMINE PHYSICAL CHARACTERISTICS OF SEDIMENT * SAMPLE DOWNGRADIENT GROUNDWATER	13D-92-01X 13D-92-02X 13D-92-03X	* BASE OF THE LANDFILL MATERIAL
		13D-92-04X 13D-92-05X	* WETLAND DOWN-SLOPE OF THE LANDFILL MATERIAL * THESE SAMPLES ARE USED AS DOWNGRADIENT GROUNDWATER
SURFACE SOIL SAMPLING	* COLLECT SAMPLES FOR OFF-SITE LABORATORY ANALYSIS	13S-92-03X 13S-92-04X	* APPARENT STAINED AREAS
SSI PROGRAM			
SOIL BORING AND SUBSURFACE SOIL SAMPLING	* INSTALL WELL POINTS * CHARACTERIZE SOIL	13M-92-02X 13M-92-03X	* APPARENT DOWNGRADIENT LOCATION * OUTSIDE OF LANFILL WASTE
WELL POINT INSTALLATION AND GROUNDWATER SAMPLING	* MONITOR GROUNDWATER LEVELS * MONITOR GROUNDWATER QUALITY * DETERMINE AQUIFER CONDUCTIVITIES	13M-92-01X 13M-92-02X 13M-92-03X	* UPGRADIENT AND DOWNGRADIENT GROUNDWATER QUALITY

TABLE 4.1-2
MONITORING WELL COMPLETION DETAILS
SA 13 - LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

WELL IDENTIFICATION	SOIL DRILLING METHOD	BEDROCK DRILLING MEHTOD	MEDIA SCREENED	WELL SCREEN DEPTH (Feet bgs)	WELL SCREEN ELEVATION (Feet NGVD)	COMPLETION DEPTH (Feet bgs)	CONSTRUCTION MATERIAL
13M-92-01X	HOLLOW STEM AUGER	NA	SOIL	11-21	320.3 - 310.3	22	4" ID PVC
13M-93-02X	POWER AUGER	NA	SOIL	1.0-4.7	298.3-294.3	4.7	2" ID PVC
13M-93-03X	POWER AUGER	NA	SOIL	1.0-3.0	297.7-295.7	3.0	2" ID PVC

Notes: bgs = below ground surface
NGVD = National geodetic vertical datum

TABLE 4.1-3
SUMMARY OF SOIL BORINGS
SA 13 - LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

EXPLORATION ID	COMPLETION DEPTH (Feet bgs)	REFERENCE SAMPLE INTERVALS (Feet bgs)	ANALYTICAL SAMPLES COLLECTED	SOIL TYPE (USCS)	TOTAL VOCs BY PID (ppm)
13M-92-01X	22	0-2		SM	BKG
		2-4		SM	BKG
		4-6		SM	BKG
		6-8		SM	BKG
		8-10		SM	BKG
		10-12		SM	BKG
		12-14		SM	BKG
		14-16	14-16	SP	BKG
		16-18		ML	BKG
		18-20		SM	BKG
		20-22		SM	BKG
13M-93-02X	4.7	4-6	4-6	CL	BKG
13M-93-03X	3.0	3-5	3-5	SW	BKG

Notes: bgs = below ground surface
VOCs = Volatile organic compounds
USCS = Unified soil classification system
ppm = parts per million

13TAB412.WK1

TABLE 4.1–4
SOIL CLASSIFICATION AND GRAIN SIZE RESULTS
SA 13 – LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SAMPLE ID	USCS SYMBOL	WATER CONTENT	GRAVEL (2) DRY WT %	SAND (2) DRY WT %	FINES (2) DRY WT %	COMMENTS
13D–92–02X	SM	61.5	11.9	70.9	17.2	
13D–92–03X	SM	23.1	6.1	76.1	17.8	
13D–92–04X	SM	16.7	13.7	70.6	15.7	
13D–92–05X	SM	18.5	20.6	64.7	14.7	
13M–92–01X	SM	10.3	28.2	48.0	23.8	

USCS = Unified soil classification system

DRY WT % = Dry weight percentage

(1) Water content = 100 x weight of water / dry weight of soil

(2) Weight percentage of soil fraction = 100 x dry weight of soil fraction / total dry weight of soil

TABLE 4.1–5
ORGANIC ANALYTES IN SURFACE SOIL
SA 13 – LANDFILL NO. 9

SUPPLEMENTAL SITE INVESTIGATION DATA PACKAGE
FORT DEVENS, MA

	SSI		SI			
ANALYTE SITE ID:	13M–93–02X	13M–93–03X	13D–92–04X	13D–92–05X	13S–92–03X	13S–92–04X
ORGANICS (ug/g)						
2–METHYLNAPHTHALENE	< 0.049	< 0.049	< 0.049	< 0.049	< 0.1	3
ACENAPHTHYLENE	< 0.033	< 0.033	< 0.033	< 0.033	< 0.07	1
ANTHRACENE	< 0.033	< 0.033	< 0.033	< 0.033	< 0.07	0.7
BENZO [A] ANTHRACENE	< 0.17	< 0.17	< 0.17	< 0.17	< 0.3	3
BENZO [A] PYRENE	< 0.25	< 0.25	< 0.25	< 0.25	< 0.5	2
BENZO [B] FLUORANTHENE	< 0.217	< 0.21	< 0.21	< 0.21	< 0.4	4
BENZO [G,H,I] PERYLENE	< 0.25	< 0.25	< 0.25	< 0.25	< 0.5	0.9
BENZO [K] FLUORANTHENE	< 0.066	< 0.066	< 0.066	< 0.066	< 0.1	1
CHRYSENE	< 0.12	< 0.12	< 0.12	< 0.12	< 0.2	3
DI–N–BUTYL PHTHALATE	0.39	0.24	< 0.061	< 0.061	< 0.1	< 0.1
DIBENZOFURAN	< 0.0357	< 0.035	< 0.035	< 0.035	< 0.07	0.3
FLUORANTHENE	< 0.068	< 0.068	< 0.068	< 0.068	< 0.1	7
FLUORENE	< 0.033	< 0.033	< 0.033	< 0.033	< 0.07	0.2
INDENO [1,2,3–C,D] PYRENE	< 0.29	< 0.29	< 0.29	< 0.29	< 0.6	1
NAPHTHALENE	< 0.037	< 0.037	< 0.037	< 0.037	< 0.07	1
PHENANTHRENE	< 0.033	< 0.033	< 0.033	< 0.033	< 0.07	2
PYRENE	< 0.033	< 0.033	< 0.033	< 0.033	< 0.07	3
4,4'–DDT	< 0.007	< 0.007	< 0.007	< 0.007	0.38	0.7
4,4'–DDD	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008	0.03
4,4'–DDE	< 0.008	< 0.008	< 0.008	< 0.008	0.1	0.16
HEPTACHLOR	< 0.006	< 0.006	0.035	0.024	< 0.006	< 0.006
PCB 1260	< 0.08	0.216	< 0.08	< 0.08	< 0.08	< 0.08
OTHER (ug/g)						
TOTAL ORGANIC CARBON	3790	9020	1080	4320		
TOTAL PETROLEUM HYDROCARBONS	NA	NA	< 27.9	< 27.9	150	251

Notes:
< = Less than detection limit
NA = not available

TABLE 4.1-6
INORGANIC ANALYTES IN SURFACE SOIL
SA 13 – LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		SSI		SI			
ANALYTE	**BACKGROUND**	**13M-93-02X**	**13M-93-03X**	**13D-92-04X**	**13D-92-05X**	**13S-92-03X**	**13S-92-04X**
INORGANICS (ug/g)							
ALUMINUM	15000.0	6220	5800	4740	8360	8600	8510
ARSENIC	21.0	10	6.11	4.7	10	38	16.7
BARIUM	42.5	24.5	15.5	26.9	30.4	52.2	43.8
BERYLLIUM	0.347	< 0.5	< 0.5	< 0.5	1.18	0.664	< 0.5
CADMIUM	2.0	< 0.7	< 0.7	< 0.7	< 0.7	2.08	< 0.7
CALCIUM	1400.0	1210	1210	1040	1390	1780	5960
CHROMIUM	31.0	12.5	17.3	9.25	23	29	18.8
COBALT	NA	6.82	4.42	4.32	7.02	9.34	5.07
COPPER	8.39	8.18	6.48	3.45	5.12	17.1	12.6
IRON	15000.0	9720	8470	5720	12600	16200	12900
LEAD	36.9	7.95	14	6.34	10.1	330	64
MAGNESIUM	5600.0	2260	2990	1810	3880	4350	3110
MANGANESE	300.0	304	168	218	1080	362	500
MERCURY	0.22	< 0.05	< 0.05	< 0.05	< 0.05	0.159	0.084
NICKEL	14.0	19.2	18.6	15	18.3	34.6	17.3
POTASSIUM	1700.0	639	448	456	472	1050	1200
SELENIUM	NA	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	0.9
SILVER	0.86	< 0.589	< 0.589	< 0.589	< 0.589	0.676	< 0.589
SODIUM	131.0	383	339	193	191	191	269
VANADIUM	28.7	8.78	9.51	6.31	12.5	15.6	18.3
ZINC	35.3	27.9	41.7	24.3	38.6	480	71.1

Notes:

< = Less than detection limit

Shaded values exceed background limit.

TABLE 4.1-7
ANALYTES IN GROUNDWATER
SA 13 - LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		SSI								SSI			
		13M-93-02X				13M-93-02X				13M-93-03X		13M-93-03X	
ANALYTE	BACKGROUND	Filtered ROUND 3	Unfiltered ROUND 3	DUP Filtered ROUND 3	DUP Unfiltered ROUND 3	Filtered ROUND 4	Unfiltered ROUND 4	DUP Filtered ROUND 4	DUP Unfiltered ROUND 4	Filtered ROUND 3	Unfiltered ROUND 3	Filtered ROUND 4	Unfiltered ROUND 4
ORGANICS (ug/L)													
BIS (2-ETHYLHEXYL) PHTHALATE		NA	< 4.8	NA	10	NA	< 4.8	NA	< 4.8	NA	31	NA	6.7
NITROGLYCERIN		NA	< 10.0	NA	< 10.0	NA	< 10.0	NA	77.9	NA	< 10.0	NA	< 10.0
INORGANICS (ug/L)													
ALUMINUM	6870	< 141	17400	< 141	11700	< 141	63800	< 141	70600	< 141	1670	< 141	25700
ANTIMONY	3.03	< 3.03	2.77	< 3.03	5.45	< 3.03	6.8	< 3.03	5.36	< 3.03	< 3.03	< 3.03	< 3.03
ARSENIC	10.5	< 2.54	24.9	< 2.54	12.3	< 2.54	10	< 2.54	11.2	< 2.54	< 2.54	< 2.54	12.4
BARIUM	39.6	< 5	81.2	< 5	61.1	< 5	256	< 5	265	26.2	32	11.6	104
CALCIUM	14700	29800	32700	30300	31500	32400	48200	29900	50300	58800	61700	54900	61400
CHROMIUM	14.7	< 6.02	25.7	< 6.02	16.6	< 6.02	96.2	< 6.02	110	< 6.02	< 6.02	< 6.02	54.6
COBALT	25.0	< 25	< 25	< 25	< 25	< 25	89.2	< 25	140	< 25	< 25	< 25	< 25
COPPER	8.09	< 8.09	25.7	< 8.09	25.2	< 8.09	140	< 8.09	125	< 8.09	< 8.09	< 8.09	40
IRON	9100	< 38.8	26400	< 38.8	18200	< 38.8	99300	348	119000	< 38.8	1160	80.2	27400
LEAD	4.25	< 1.26	17.7	< 1.26	12.9	< 1.26	68.9	< 1.26	74.3	< 1.26	1.95	< 1.26	35.9
MAGNESIUM	3480	7590	12200	7730	10700	8520	28200	8010	32000	17200	18500	17300	26400
MANGANESE	291	7.47	668	8.64	537	4.8	2970	5.4	3280	564	798	845	1320
MERCURY	0.243	< 0.243	< 0.243	< 0.243	< 0.243	< 0.243	0	< 0.243	< 0.243	< 0.243	< 0.243	< 0.243	< 0.243
NICKEL	34.3	< 34.3	47.1	< 34.3	< 34.3	< 34.3	199	< 34.3	235	< 34.3	< 34.3	< 34.3	75.5
POTASSIUM	2370	1230	4440	1240	3440	1380	10600	1460	10900	4120	4460	3310	6380
SODIUM	10800	22200	24000	22600	23400	26500	27400	24600	27900	24100	25600	17800	19000
VANADIUM	11.0	< 11	28.3	< 11	18.5	< 11	75.9	< 11	88.4	12.2	< 11	< 11	35.3
ZINC	21.1	< 21.1	80.3	< 21.1	62.8	58.5	314	53.4	410	< 21.1	< 21.1	< 21.1	211
OTHER (ug/L)													
ALKALINITY		NA	95000	NA	99000	NA	95000	NA	110000	NA	152000	NA	12000
NITRITE, NITRATE-NON SPECIFIC		NA	360	NA	350	NA	580	NA	360	NA	12.5	NA	< 10
NITROGEN BY KJELDAHL METHOD		NA	476	NA	476	NA	2860	NA	2670	NA	248	NA	1520
PHOSPHATE		NA	358	NA	391	NA	4300	NA	4200	NA	47.5	NA	670
TOTAL HARDNESS		NA	118000	NA	133000	NA	160000	NA	170000	NA	218000	NA	23000
TOTAL SUSPENDED SOLIDS		NA	3650000	NA	3110000	NA	150000	NA	280000	NA	84000	NA	13000
BICARBONATE		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHLORIDE		NA	40000	NA	40000	NA	49000	NA	49000	NA	35000	NA	66000
SULFATE		NA	15900	NA	15500	NA	14000	NA	17000	NA	95700	NA	73000

Notes:
< = Less than detection limit
Shaded values exceed background limit.

TABLE 4.1-7
ANALYTES IN GROUNDWATER
SA 13 – LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		SI		SSI			
		13M-92-01X		13M-92-01X			
ANALYTE	BACKGROUND	Unfiltered ROUND 1	Unfiltered ROUND 2	Filtered ROUND 3	Unfiltered ROUND 3	Filtered ROUND 4	Unfiltered ROUND 4
ORGANICS (ug/L)							
BIS (2-ETHYLHEXYL) PHTHALATE		< 4.8	< 4.8	NA	< 4.8	NA	< 4.8
NITROGLYCERIN		< 10.0	< 10.0	NA	< 10.0	NA	< 10.0
INORGANICS (ug/L)							
ALUMINUM	6870	7270	3180	< 141	1490	< 141	3780
ANTIMONY	3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03
ARSENIC	10.5	10.9	2.98	< 2.54	3.41	< 2.54	8.1
BARIUM	39.6	44.5	27.8	8	19.6	6.1	29.6
CALCIUM	14700	16100	12200	11800	12600	12700	14300
CHROMIUM	14.7	16.9	12.2	< 6.02	6.5	< 6.02	11.8
COBALT	25.0	< 25	< 25	< 25	< 25	< 25	< 25
COPPER	8.09	18.6	< 8.09	< 8.09	< 8.09	< 8.09	< 8.09
IRON	9100	12900	6460	< 38.8	3030	154	7250
LEAD	4.25	12.1	5.53	< 1.26	2.71	< 1.26	4.2
MAGNESIUM	3480	4500	2220	2400	2470	2450	3290
MANGANESE	291	227	75.7	11.7	34.8	13.2	81.6
MERCURY	0.243	< 0.243	< 0.24	< 0.243	< 0.243	< 0.243	< 0.243
NICKEL	34.3	< 34.3	< 34.3	< 34.3	< 34.3	< 34.3	< 34.3
POTASSIUM	2370	2570	1270	1740	1410	900	1750
SODIUM	10800	18000	19900	25100	27800	16500	18000
VANADIUM	11.0	< 11	< 11	< 11	< 11	< 11	< 11
ZINC	21.1	78.5	87.2	< 21.1	< 21.1	49.8	117
OTHER (ug/L)							
ALKALINITY		44000	30000	NA	42000	NA	3000
NITRITE, NITRATE-NON SPECIFIC		290	1500	NA	400	NA	980
NITROGEN BY KJELDAHL METHOD		NA	NA	NA	< 183	NA	190
PHOSPHATE		NA	NA	NA	42.4	NA	89.9
TOTAL HARDNESS		NA	NA	NA	43600	NA	45000
TOTAL SUSPENDED SOLIDS		NA	202000	NA	91000	NA	200000
BICARBONATE		53700	36600	NA	NA	NA	NA
CHLORIDE		32300	32700	NA	37000	NA	33000
SULFATE		< 10000	< 10000	NA	< 10000	NA	< 10000

Notes:
< = Less than detection limit
Shaded values exceed background limit.

TABLE 4.1-8
ANALYTES IN SURFACE WATER
SA 13 - LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	13D-92-01X	13D-92-02X	13D-92-02X DUP	13D-92-03X
ORGANICS (ug/L)				
BIS(2-ETHYLHEXYL)PHTHALATE	< 4.8	< 4.8	< 4.8	6.9
INORGANICS (ug/L)				
ALUMINUM	2510.0	5060.0	4040.0	2270.0
ARSENIC	6.29	3.84	< 2.5	< 2.5
BARIUM	29.4	28.3	26	21.9
CALCIUM	61700.0	47200.0	47200.0	46500.0
COPPER	< 8.0	< 8.0	15.7	< 8.0
IRON	3610.0	3530.0	3570.0	1750.0
LEAD	10.5	18.9	9.65	2.93
MAGNESIUM	11600.0	14200.0	14000.0	12800.0
MANGANESE	1020.0	601.0	605.0	746.0
MERCURY	< 0.2	1.25	1.17	< 0.2
POTASSIUM	6710.0	3200.0	2950.0	2490.0
SODIUM	18700.0	26700.0	26100.0	26900.0
VANADIUM	< 11.0	< 11.0	12.6	< 11.0
ZINC	< 21.0	< 21.0	31.8	37.6
ANIONS/CATIONS (ug/L)				
KJELDAHL NITROGEN	457.0	4380.0	3240.0	371.0
NITRATE/NITRITE	78.5	11.3	26.3	134.0
CHLORIDE	26800.0	40000.0	40000.0	27300.0
SULFATE	43500.0	64300.0	63700.0	46300.0
ALKALINITY	157000.0	112000.0	113000.0	126000.0
EXPLOSIVES (ug/L)				
NITROGLYCERINE	< 10.0	< 10.0	< 10.0	38.5
OTHER (ug/L)				
HARDNESS	198000.0	179000.0	172000.0	161000.0
PHOSPHATE	99.0	475.0	406.0	42.6
TOTAL SUSPENDED SOLIDS	65000.0	160000.0	80000.0	46000.0

NOTES:
TABLE LISTS DETECTED ANALTES ONLY -
SEE PROJECT ANALYTE LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN
DUP = DUPLICATE SAMPLE

TABLE 4.1-9
ANALYTES IN SEDIMENT
SA 13 - LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	13D-92-01X	13D-92-02X	13D-92-03X
INORGANICS (ug/g)			
ALUMINUM	6660.0	21900.0	4430.0
ARSENIC	22.0	4.2	3.34
BARIUM	29.5	58.4	20.7
BERYLLIUM	< 0.5	2.52	< 0.5
CALCIUM	1170.0	5440.0	1030.0
CHROMIUM	18.9	21.0	10.5
COBALT	3.76	4.1	2.7
COPPER	6.13	25.9	1.55
IRON	11000.0	6430.0	5030.0
LEAD	13.0	41.0	5.23
MAGNESIUM	3400.0	2540.0	1630.0
MANGANESE	146.0	137.0	213.0
NICKEL	17.7	16.6	8.52
POTASSIUM	931.0	491.0	262.0
SELENIUM	< 0.2	1.68	< 0.2
SODIUM	219.0	561.0	219.0
VANADIUM	11.1	11.9	5.03
ZINC	29.3	46.5	21.1
ORGANICS (ug/g)			
CHLOROFORM	< 0.0008	0.004	< 0.0008
FLUORANTHENE	0.12	< 0.068	< 0.068
PHENANTHRENE	0.048	< 0.033	< 0.033
PYRENE	0.069	< 0.033	< 0.033
GAMMA-CHLORDANE	0.018 S	0.049 S	0.011 S
HEPTACHLOR	0.038	0.07	0.03
4,4'-DDE	< 0.008	0.059	0.009
OTHER (ug/g)			
TOTAL ORGANIC CARBON	3160.0	91700.0	4450.0
TOTAL PETROLEUM HYDROCARBONS	164.0	83.1	41.6

NOTES:
TABLE LISTS DETECTED ANALYTES ONLY -
SEE PROJECT LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN
S = RESULTS BASED ON INTERNAL STANDARD

TABLE 4.1-10
HUMAN HEALTH PRE EVALUATION OF SURFACE SOIL
SA 13 - LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	SOIL BACKGROUND CONCENTRATION [a] (ug/g)	DETECTED CONCENTRATION [b]		FREQUENCY OF DETECTION	MAXIMUM EXCEEDS BACKGROUND ?	REGION III RESIDENTIAL SOIL CONCENTRATION (ug/g)	MAXIMUM EXCEEDS REGION III CONCENTRATION ?
		AVERAGE (ug/g)	MAXIMUM (ug/g)				
ORGANICS							
4,4'-DDT		0.5	0.7	2/4		5	NO
4,4'-DDD		0.03	0.03	1/4		7.1	NO
4,4'-DDE		0.1	0.16	2/4		5	NO
2-METHYLNAPHTHALENE		3	3	1/4		NA	NA
ACENAPHTHYLENE		1	1	1/4		NA	NA
ANTHRACENE		0.7	0.7	1/4		23000	NO
BENZO [a] ANTHRACENE		3	3	1/4		1.6	YES
BENZO [a] PYRENE		2	2	1/4		0.23	YES
BENZO [b] FLUORANTHENE		4	4	1/4		1.9	YES
BENZO [g,h,i] PERYLENE		0.9	0.9	1/4		11	NO
BENZO [k] FLUORANTHENE		1	1	1/4		4.4	NO
CARBAZOLE		0.2	0.2	1/4		85	NO
GAMMA-CHLORDANE [c]		0.007	0.007	1/4		1.3	NO
CHRYSENE		3	3	1/4		NA	NA
DIBENZOFURAN		0.3	0.3	1/4		NA	NA
FLUORANTHENE		7	7	1/4		3100	NO
FLUORENE		0.2	0.2	1/4		3100	NO
HEPTACHLOR		0.03	0.035	2/4		0.38	NO
INDENO [1,2,3-c,d] PYRENE		1	1	1/4		0.84	YES
NAPHTHALENE		1	1	1/4		3100	NO
PHENANTHRENE		2	2	1/4		2300	NO
PYRENE		3	3	1/4		2300	NO
INORGANICS							
ALUMINUM	15000	7552.5	8600	2/4	NO	230000	NO
ARSENIC	21	17.4	38	2/4	YES	0.97	YES
BARIUM	42.5	38.3	52.2	2/4	YES	5500	NO
BERYLLIUM	0.347	0.9	1.18	2/4	YES	0.4	YES
CADMIUM	2.0	2.08	2.08	1/4	YES	39	NO
CALCIUM	1400	2542.5	5960	4/4	YES	NA	NA
CHROMIUM	31	20	29	4/4	NO	390	NO
COBALT	NA	6.4	9.34	4/4	NA	NA	NA
COPPER	8.39	9.6	17.1	4/4	YES	2900	NO

TABLE 4.1–10
HUMAN HEALTH PRE EVALUATION OF SURFACE SOIL
SA 13 – LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	SOIL BACKGROUND CONCENTRATION [a] (ug/g)	DETECTED CONCENTRATION [b]		FREQUENCY OF DETECTION	MAXIMUM EXCEEDS BACKGROUND ?	REGION III RESIDENTIAL SOIL CONCENTRATION (ug/g)	MAXIMUM EXCEEDS REGION III CONCENTRATION ?
		AVERAGE (ug/g)	MAXIMUM (ug/g)				
IRON	15000	11855	16200	4/4	YES	NA	NA
LEAD	48.4	102.6	330	4/4	YES	500	NO
MAGNESIUM	5600	3287.5	4350	4/4	NO	NA	NA
MANGANESE	300	540	1080	4/4	YES	7800	NO
MERCURY	0.22	0.122	0.159	2/4	NO	23	NO
NICKEL	14	21.3	34.6	4/4	YES	1600	NO
POTASSIUM	1700	794.5	1200	4/4	NO	NA	NA
SELENIUM	NA	0.9	0.9	1/4	NA	390	NO
SILVER	0.086	0.676	0.676	1/4	YES	390	NO
SODIUM	131	211	269	4/4	YES	NA	NA
VANADIUM	28.7	13.2	18.3	4/4	NO	550	NO
ZINC	35.5	191.8	480	3/3	YES	23000	NO
OTHER							
TOTAL PETROLEUM HYDROCARBONS	NA	200.5	251	2/4	NA	NA	NA

Notes:

[a] Base–wide background soil inorganics database
[b] Surface soil samples from sampling stations 13S–92–03X, 13S–92–04X, 13D–92–04X, and 13D–92–05X
[c] The Region III residential soil concentration for chlordan was used as a surrogate for gamma–chlordane.
NA = not available, not applicable
ug/g = micrograms per gram

TABLE 4.1-11
HUMAN HEALTH PRE EVALUATION OF GROUNDWATER
SA 13 - LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a]		GROUNDWATER BACKGROUND CONCENTRATION (ug/L)	MAXIMUM EXCEEDS BACKGROUND?	DRINKING WATER STANDARD/ GUIDELINE [b] (ug/L)	MAXIMUM EXCEEDS STANDARD/ GUIDELINE ?
		AVERAGE (ug/L)	MAXIMUM (ug/L)				
ORGANICS							
BIS (2-ETHYLHEXYL) PHTHALATE	2/6	20.5	31	NA	-	6	YES
INORGANICS							
ALUMINUM	6/6	7118.3	17400	6870	YES	50-200	YES
ANTIMONY	2/6	4.11	5.45	3.03	YES	6	NO
ARSENIC	5/6	10.9	24.9	10.5	YES	50	NO
BARIUM	6/6	44.4	81.2	39.6	YES	2000	NO
CALCIUM	6/6	27800	61700	14700	YES	NA	-
CHROMIUM	5/6	15.6	25.7	14.7	YES	100	NO
COPPER	3/6	23.2	25.7	8.09	YES	1300	NO
IRON	6/6	11358.3	26400	9100	YES	300	YES
LEAD	6/6	8.8	17.7	4.25	YES	15	YES
MAGNESIUM	6/6	8431.7	18500	3480	YES	NA	-
MANGANESE	6/6	390	798	291	YES	50	YES
NICKEL	1/6	-	47.1	34.3	YES	100	NO
POTASSIUM	6/6	2931.7	4460	2370	YES	NA	-
SODIUM	6/6	23116.7	27800	10800	YES	28000	NO
VANADIUM	2/6	23.4	28.3	11	YES	260	NO
ZINC	6/6	77.2	87.2	21.1	YES	5000	NO
ANION/CATION							
NITRITE/NITRATE-NON SPECIFIC	6/6	485.4	1500	NA	-	10000	NO

Notes:

[a] Unfiltered samples from 13M-92-01X (3 rounds), 13M-93-02X (and duplicate), and 13M-93-03X.
[b] Includes the lowest of either the EPA or MA drinking water standards, or if no federal standard or guideline is available, the Region III tap water concentration.
NA = not available.
ug/L = micrograms per liter.
- = not applicable.
Shaded compounds exceed standard or guideline.

TABLE 4.1–12
HUMAN HEALTH PRE EVALUATION OF SURFACE WATER
SA 13 – LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	DETECTED CONCENTRATION [a] AVERAGE (µg/L)	DETECTED CONCENTRATION [a] MAXIMUM (µg/L)	FREQUENCY OF DETECTION	DRINKING WATER STANDARD/GUIDELINE (b) (µg/L)	MAXIMUM EXCEEDS DRINKING WATER STANDARD/ GUIDELINE?
ORGANICS					
BIS (2–ETHYLHEXYL) PHTHALATE	6.9	6.9	1/4	6.1	YES
NITROGLYCERINE	38.5	38.5	1/4	5	YES
INORGANICS					
ALUMINUM	3470	5060	4/4	50 – 200	YES
ARSENIC	5.065	6.29	2/4	50	NO
BARIUM	26.4	29.4	4/4	2,000	NO
CALCIUM	50650	61700	4/4	NA	NA
COPPER	15.7	15.7	1/4	1,300	NO
IRON	3115	3610	4/4	300	YES
LEAD	10.5	18.9	4/4	15	YES
MAGNESIUM	13150	14200	4/4	NA	NA
MANGANESE	743	1020	4/4	50	YES
MERCURY	1.21	1.25	2/4	2	NO
POTASSIUM	3837.5	6710	4/4	NA	NA
SODIUM	24600	26900	4/4	28,000	NO
VANADIUM	12.6	12.6	1/4	260	NO
ZINC	34.7	37.6	2/4	5,000	NO
ANIONS/CATIONS					
NITRITE/NITRATE	62.525	134	4/4	10,000	NO
OTHER					
TOTAL SUSPENDED SOLIDS	87750	160000	4/4	NA	NA

Notes:
[a] Surface water samples from sampling stations 13D–92–01X to 13D–92–03X (including one duplicate)
[b] Includes the lowest of either the EPA or MA drinking water standards, or if no federal or state standard or guideline is available, the Region III tap water concentration.
NA = not available
ug/L = micrograms per Liter

Table 4.1–13
Human Health PRE Evaluation of Sediment
SA 13 – Landfill No. 9

Site Investigation Report
Fort Devens, MA

ANALYTE	DETECTED CONCENTRATION [a]		FREQUENCY DETECTION	REGION III RESIDENTIAL SOIL CONCENTRATION (ug/g)	MAXIMUM EXCEEDS REGION III CONCENTRATION?
	AVERAGE (ug/g)	MAXIMUM (ug/g)			
ORGANICS					
4,4'–DDE	0.03	0.059	2/3	5	NO
CHLOROFORM	0.004	0.004	1/3	280	NO
FLUORANTHENE	0.12	0.12	1/3	3,100	NO
GAMMA–CHLORDANE[b]	0.03	0.049	3/3	1.3	NO
HEPTACHLOR	0.05	0.07	3/3	0.38	NO
PHENANTHRENE	0.048	0.048	1/3	2,300	NO
PYRENE	0.069	0.069	1/3	2,300	NO
INORGANICS (ug/g)					
ALUMINUM	10996.7	21900	3/3	230,000	NO
ARSENIC	9.8	22	3/3	0.97	YES
BARIUM	36.2	58.4	3/3	5,500	NO
BERYLLIUM	2.52	2.52	1/3	0.4	YES
CALCIUM	2546.7	5440	3/3	NA	NA
CHROMIUM	16.8	21	3/3	390	NO
COBALT	3.5	4.1	3/3	NA	NA
COPPER	11.2	25.9	3/3	2,900	NO
IRON	7486.7	11000	3/3	NA	NA
LEAD	19.7	41	3/3	500	NO
MAGNESIUM	2523.3	3400	3/3	NA	NA
MANGANESE	165.3	213	3/3	7,800	NO
NICKEL	14.3	17.7	3/3	1,600	NO
POTASSIUM	561.3	931	3/3	NA	NA
SELENIUM	1.68	1.68	1/3	390	NO
SODIUM	333	561	3/3	NA	NA
VANADIUM	9.3	11.9	3/3	550	NO
ZINC	32.3	46.5	3/3	23,000	NO
OTHER (ug/g)					
TOTAL PETROLEUM HYDROCARE	96.2	164	3/3	NA	NA

Notes:

[a] Sediment samples from sampling stations 13D–92–01X to 13D–92–03X

[b] The Region III residential soil concentration for chlordane was used as a surrogate for gamma–chlordane.

NA = not available

ug/g = micrograms per gram

TABLE 4.1-14
ECOLOGICAL PRE EVALUATION OF SURFACE SOIL
SA 13 - LANDFILL NO. 9

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	SOIL BACKGROUND CONCENTRATION [a (ug/g)	CONCENTRATION [b] AVERAGE (ug/g)	MAXIMUM (ug/g)	FREQUENCY OF DETECTION	MAXIMUM EXCEEDS BACKGROUND?	ECOLOGICAL BENCHMARK (ug/g)	MAXIMUM EXCEEDS BENCHMARK?
ORGANICS							
4,4'-DDT	NA	0.5	0.7	2/4	NA	1.07	NO
4,4'-DDD	NA	0.03	0.03	1/4	NA	1.07	NO
4,4'-DDE	NA	0.1	0.16	2/4	NA	1.07	NO
2-METHYLNAPHTHALENE	NA	3	3	1/4	NA	143	NO
ACENAPHTHYLENE	NA	1	1	1/4	NA	2600	NO
ANTHRACENE	NA	0.7	0.7	1/4	NA	14000	NO
BENZO [a] ANTHRACENE	NA	3	3	1/4	NA	8.9	NO
BENZO [a] PYRENE	NA	2	2	1/4	NA	5.5	NO
BENZO [b] FLUORANTHENE	NA	4	4	1/4	NA	180	NO
BENZO [g,h,i] PERYLENE	NA	0.9	0.9	1/4	NA	440	NO
BENZO [k] FLUORANTHENE	NA	1	1	1/4	NA	320	NO
CARBAZOLE	NA	0.2	0.2	1/4	NA	43	NO
GAMMA-CHLORDANE	NA	0.007	0.007	1/4	NA	0.3	NO
CHRYSENE	NA	3	3	1/4	NA	440	NO
DIBENZOFURAN	NA	0.3	0.3	1/4	NA	10	NO
FLUORANTHENE	NA	7	7	1/4	NA	1100	NO
FLUORENE	NA	0.2	0.2	1/4	NA	1100	NO
HEPTACHLOR	NA	0.03	0.035	2/4	NA	0.64	NO
INDENO [1,2,3-c,d] PYRENE	NA	1	1	1/4	NA	320	NO
NAPHTHALENE	NA	1	1	1/4	NA	170	NO
PHENANTHRENE	NA	2	2	1/4	NA	510	NO
PYRENE	NA	3	3	1/4	NA	550	NO
INORGANICS							
ALUMINUM	15000	7552.5	8600	2/4	NO		
ARSENIC	21	17.4	38	2/4	YES	33	YES
BARIUM	42.5	38.3	52.2	2/4	YES	42.5	YES
BERYLLIUM	0.347	0.9	1.18	2/4	YES	0.88	YES
CADMIUM	2	2.08	2.08	1/4	YES	2	YES
CHROMIUM	31	20	29	4/4	NO		
COBALT	NA	6.4	9.34	4/4	NA	50	NO
COPPER	8.39	9.6	17.1	4/4	YES	34	NO
LEAD	48.4	102.6	330	4/4	YES	48.4	YES
MANGANESE	300	540	1080	4/4	YES	1500	NO
MERCURY	0.22	0.122	0.159	2/4	NO		
NICKEL	14.0	21.3	34.6	4/4	YES	100	NO
SELENIUM	NA	0.9	0.9	1/4	NA	0.48	YES
SILVER	0.086	0.676	0.676	1/4	YES	72	NO
VANADIUM	28.7	13.2	18.3	4/4	NO		
ZINC	35.5	191.8	480	3/3	YES	640	NO

Notes:
[a] Base-wide background soil inorganics database
[b] Surface soil samples from sampling stations 13S-92-03X, 13S-92-04X, 13D-92-04X, and 13D-92-05X
NA = not available
ug/g = micrograms per gram

Table 4.1-15
Ecological PRE Evaluation of Surface Water
SA 13 - Landfill No. 9

Site Investigation Report
Fort Devens, MA

ANALYTE	CONCENTRATION [a] AVERAGE (ug/L)	CONCENTRATION [a] MAXIMUM (ug/L)	FREQUENCY OF DETECTION	ECOLOGICAL BENCHMARKS (ug/L)	MAXIMUM EXCEEDS BENCHMARK?
Organics					
bis (2-ethylhexyl) phthalate	6.9	6.9	1/4	360	NO
nitroglycerine	38.5	38.5	1/4	NA	NA
Inorganics					
aluminum	3470	5060	4/4	87	YES
arsenic	5.1	6.29	2/4	190	NO
barium	26.4	29.4	4/4	NA	NA
copper	15.7	15.7	1/4	19.3[b]	NO
iron	3115	3610	4/4	1000	YES
lead	10.5	18.9	4/4	6.61[b]	YES
manganese	743	1020	4/4	NA	NA
mercury	1.2	1.25	2/4	0.012	YES
vanadium	12.6	12.6	1/4	NA	NA
zinc	34.7	37.6	2/4	172[b]	NO
Other					
total hardness	177500	198000	4/4	---	---
total suspended solids	87750	160000	4/4	---	---

Notes:
[a] Surface water samples from sampling stations 13D-92-01X to 13D-92-03X plus one duplicate
[b] Hardness-dependent criterion. See Section 3.6.2 for methodology used to calculate site-specific hardness-dependent benchmark values
ug/L = micrograms per Liter

Table 4.1–16
Ecological PRE Evaluation of Sediment
SA 13 – Landfill No. 9

Site Investigation Report
Fort Devens, MA

Analyte	Concentration [a] Average (µg/g)	Concentration [a] Maximum (µg/g)	Frequency of Detection	Ecological Benchmark (µg/g)	Maximum Exceeds Benchmark?
Organics					
4,4'–DDE	0.03	0.059	2/3	0.0274[b]	YES
chloroform	0.004	0.004	1/3	NA	NA
fluoranthene	0.12	0.12	1/3	62.3[b]	NO
gamma–chlordane	0.03	0.049	3/3	0.00020[b]	YES
heptachlor	0.05	0.07	3/3	0.00364[b]	YES
phenanthrene	0.048	0.048	1/3	4.60[b]	NO
pyrene	0.069	0.069	1/3	43.4[b]	NO
Inorganics					
aluminum	10996.7	21900	3/3	NA	NA
arsenic	9.8	22	3/3	5	YES
barium	36.2	58.4	3/3	NA	NA
beryllium	2.52	2.52	1/3	NA	NA
chromium	16.8	21	3/3	26	NO
cobalt	3.5	4.1	3/3	NA	NA
copper	11.2	25.9	3/3	19	YES
iron	7486.7	11000	3/3	24000	NO
lead	19.7	41	3/3	27	YES
manganese	165.3	213	3/3	428	NO
nickel	14.3	17.7	3/3	22	NO
selenium	1.68	1.68	1/3	NA	NA
vanadium	9.3	11.9	3/3	NA	NA
zinc	32.3	46.5	3/3	85	NO
Other					
total organic carbon	33103.3	91700	3/3	---	---

Notes:
[a] Sediment samples from sampling stations 13D–92–01X to 13D–92–03X
[b] Benchmark is carbon–normalized using site–specific total organic carbon data (see Section 3.6.2)
NA = not available
µg/g = micrograms per gram
--- = Analyte not a CPC for this medium

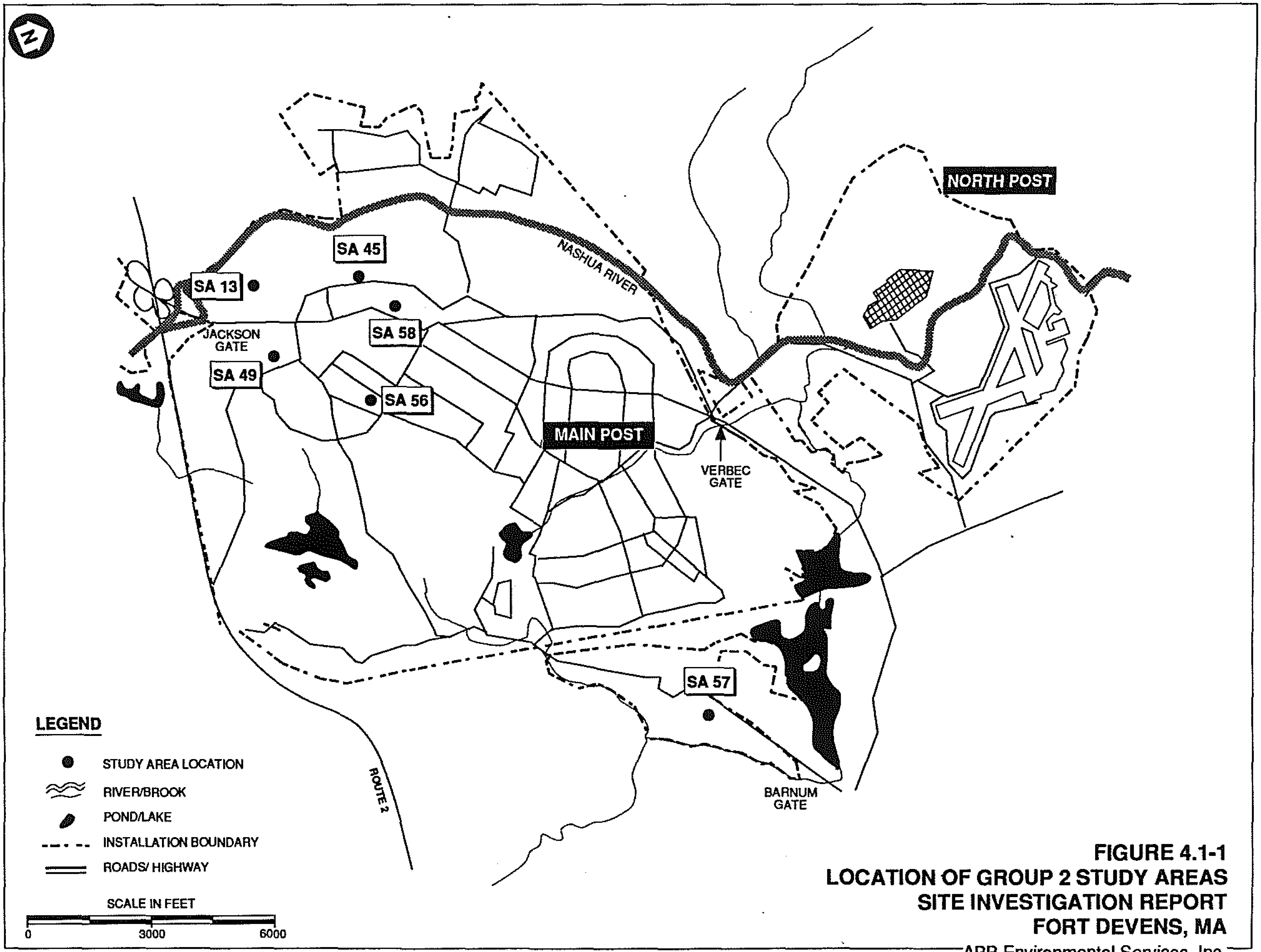

FIGURE 4.1-1
LOCATION OF GROUP 2 STUDY AREAS
SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

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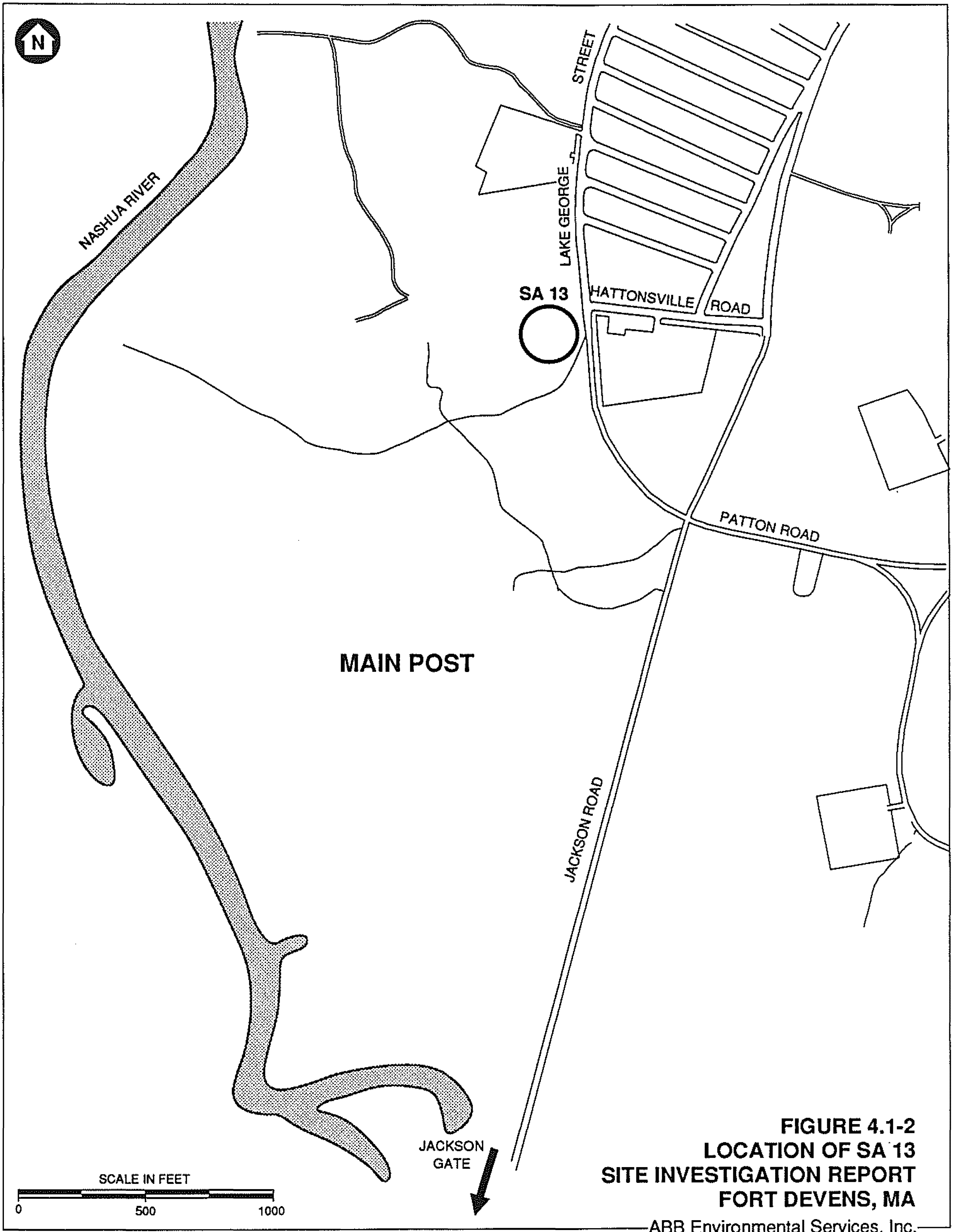

FIGURE 4.1-2
LOCATION OF SA 13
SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

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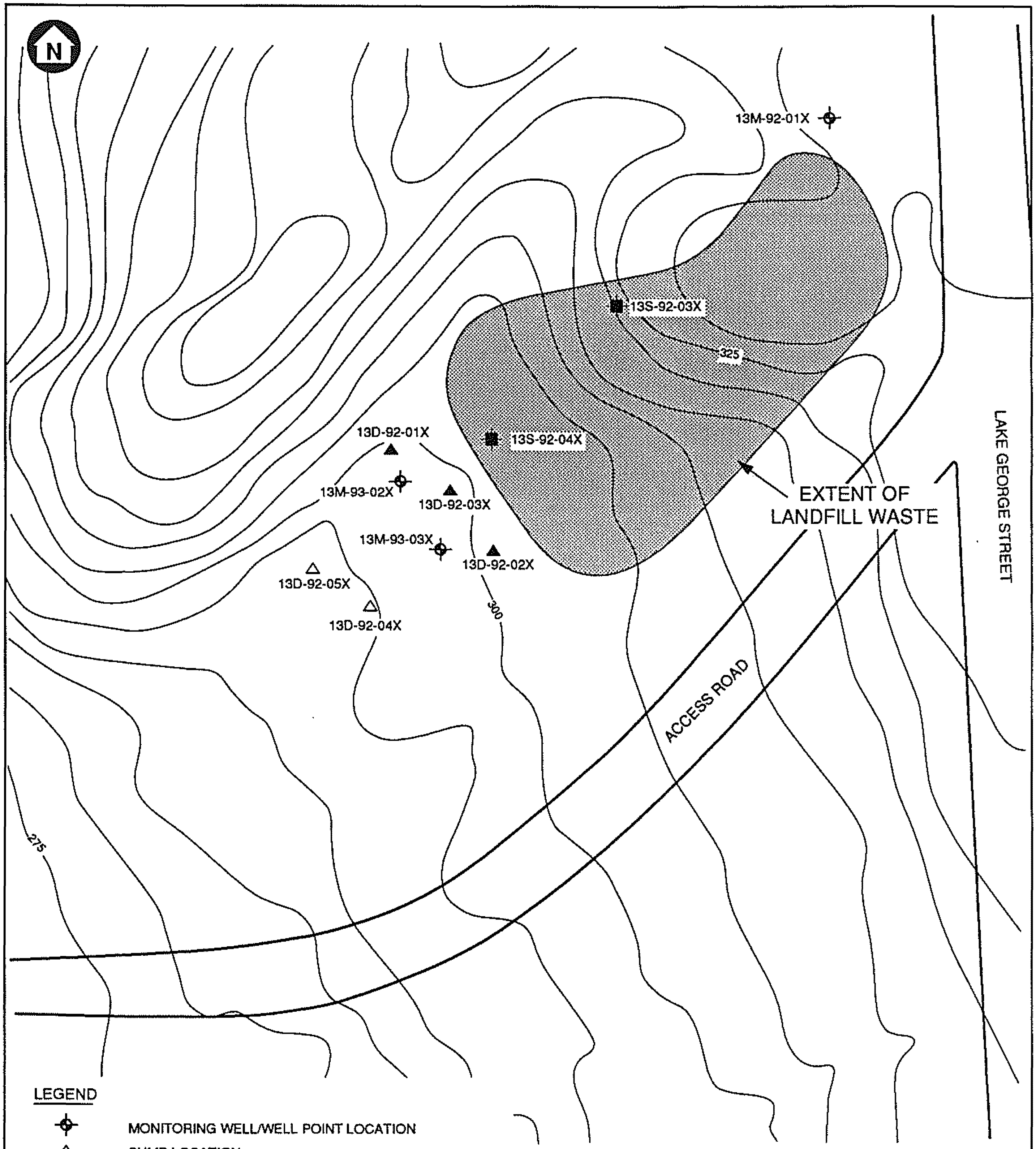


LEGEND

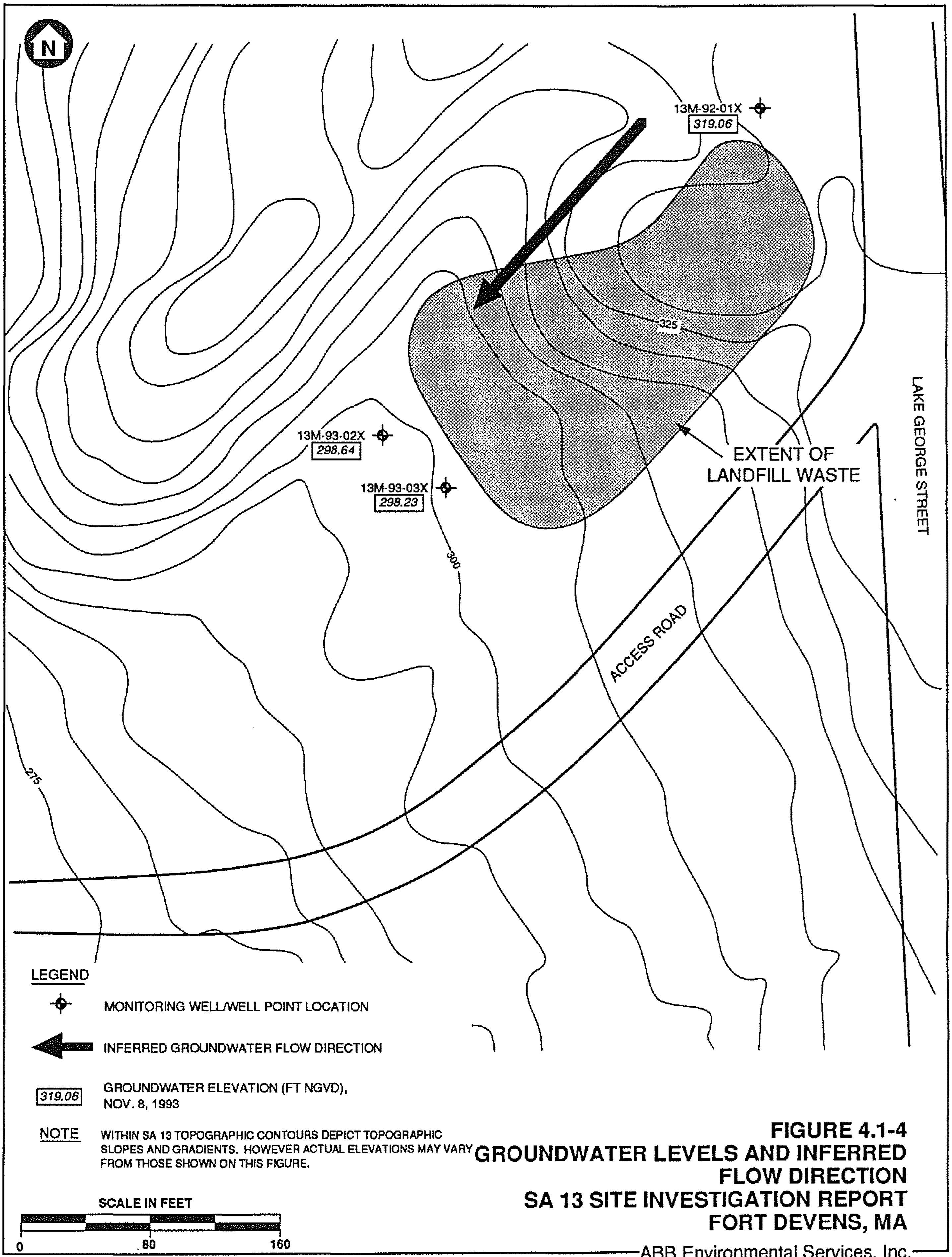
⌖	MONITORING WELL/WELL POINT LOCATION
△	SUMP LOCATION
▲	SURFACE WATER/SEDIMENT SAMPLE LOCATION
■	SURFACE SOIL SAMPLE LOCATION

NOTE WITHIN SA 13 TOPOGRAPHIC CONTOURS DEPICT TOPOGRAPHIC SLOPES AND GRADIENTS. HOWEVER ACTUAL ELEVATIONS MAY VARY FROM THOSE SHOWN ON THIS FIGURE.

SCALE IN FEET

0 80 160

FIGURE 4.1-3
LOCATION OF EXPLORATIONS
SA 13 SITE INVESTIGATION REPORT
FORT DEVENS, MA



NOTE WITHIN SA 13 TOPOGRAPHIC CONTOURS DEPICT TOPOGRAPHIC SLOPES AND GRADIENTS. HOWEVER ACTUAL ELEVATIONS MAY VARY FROM THOSE SHOWN ON THIS FIGURE.

FIGURE 4.1-4
GROUNDWATER LEVELS AND INFERRED FLOW DIRECTION
SA 13 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

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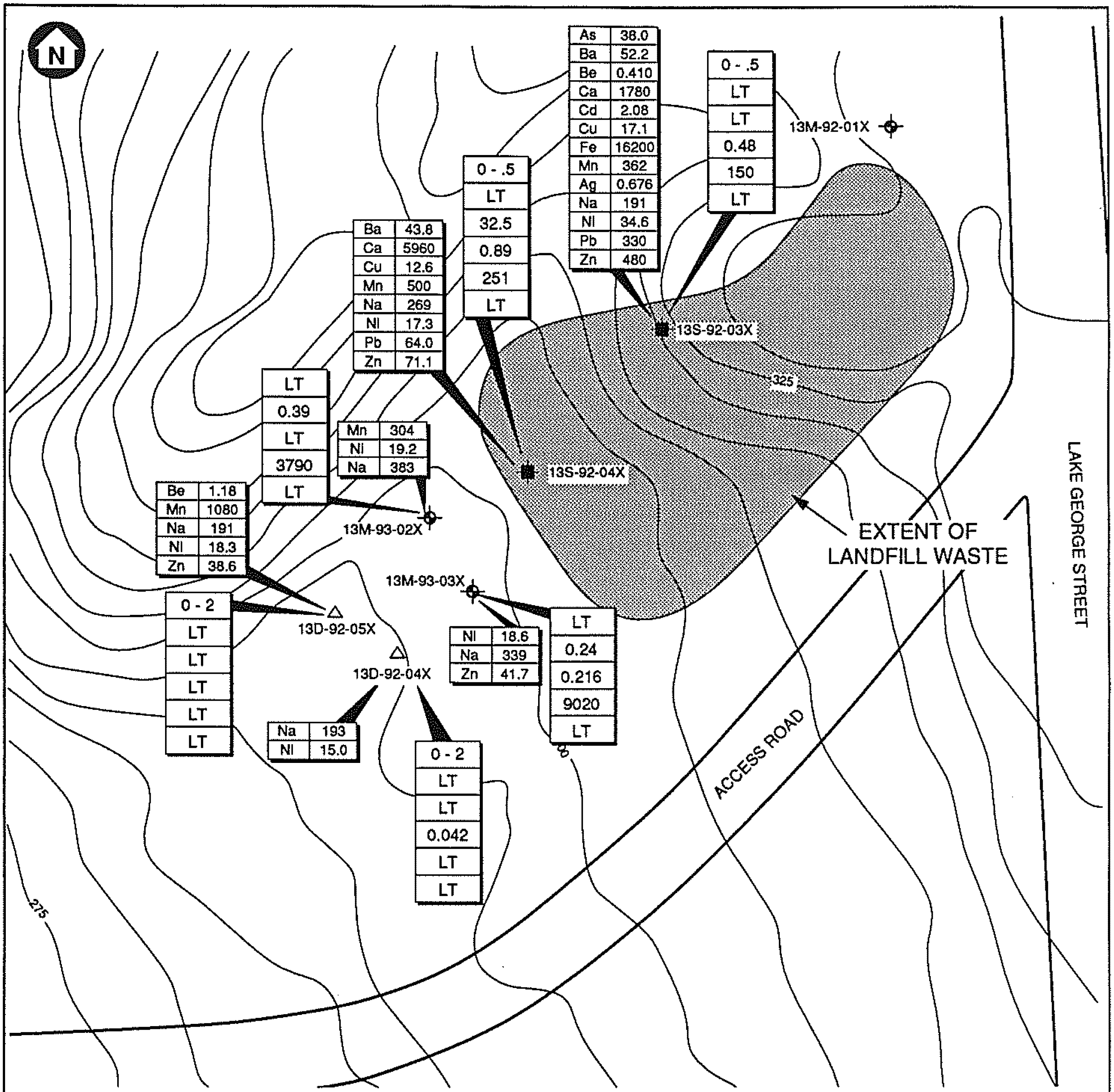

LEGEND

■ SURFACE SOIL SAMPLE LOCATION

⌖ MONITORING WELL/WELL POINT LOCATION

△ SUMP LOCATION

LT LESS THAN DETECTION LIMIT

| Al | 3610 | CONCENTRATION (µg/g)

INORGANIC ANALYTE (ABOVE BACKGROUND)

0 - .5	DEPTH IN FT
LT	TOTAL VOCs in µg/g
9.1	TOTAL SVOCs in µg/g
LT	TOTAL PESTICIDES / PCBs in µg/g
LT	TPHC in µg/g
LT	TOTAL EXPLOSIVES in µg/g

NOTE WITHIN SA 13 TOPOGRAPHIC CONTOURS DEPICT TOPOGRAPHIC SLOPES AND GRADIENTS. HOWEVER ACTUAL ELEVATIONS MAY VARY FROM THOSE SHOWN ON THIS FIGURE.

SCALE IN FEET

0 80 160

FIGURE 4.1-5
ANALYTES IN SURFACE SOIL
SA 13 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

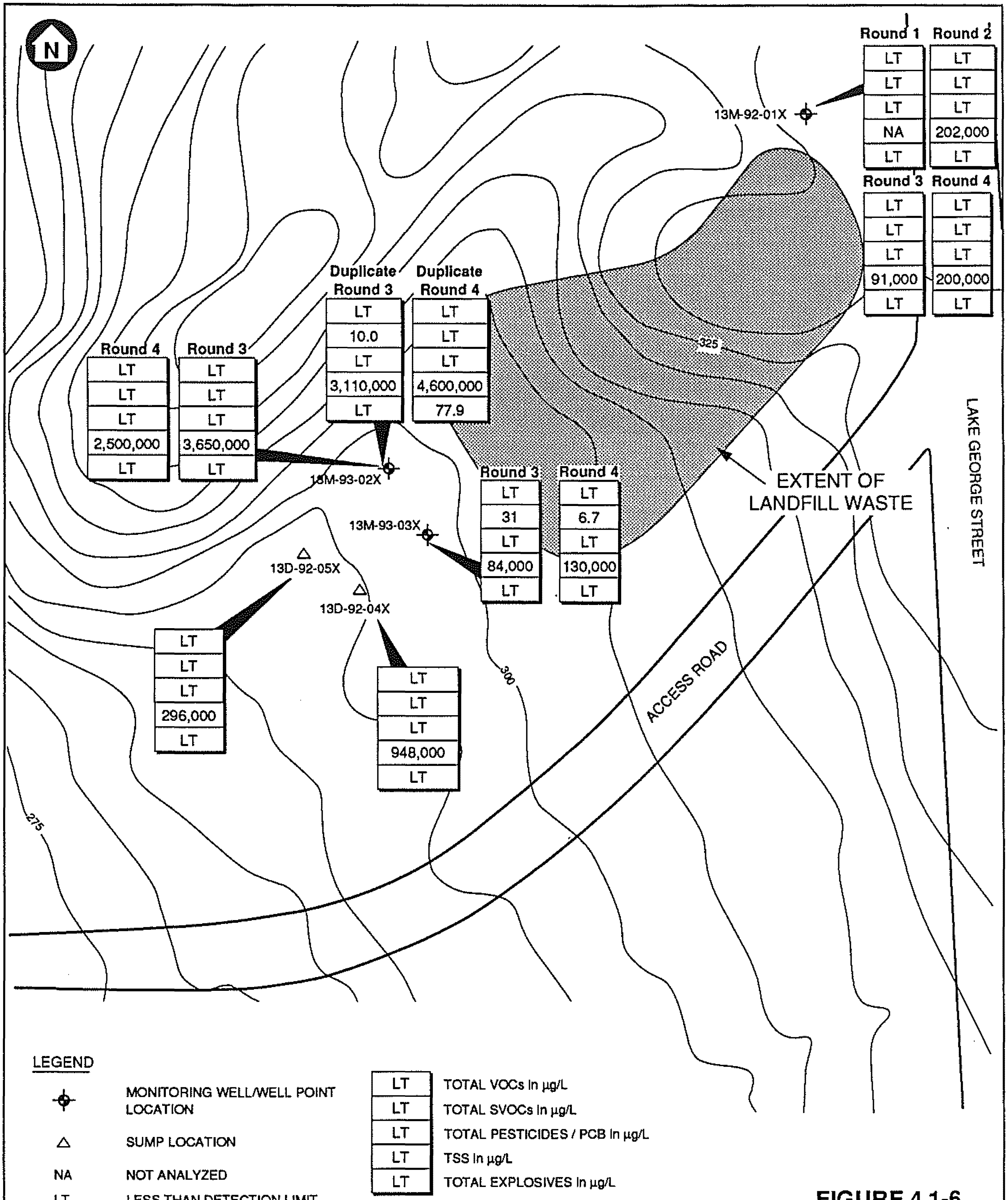

FIGURE 4.1-6
ORGANIC ANALYTES IN GROUNDWATER
DECISION DOCUMENT
SA 13-LANDFILL NO. 9
FORT DEVENS, MA

ABB Environmental Services, Inc.

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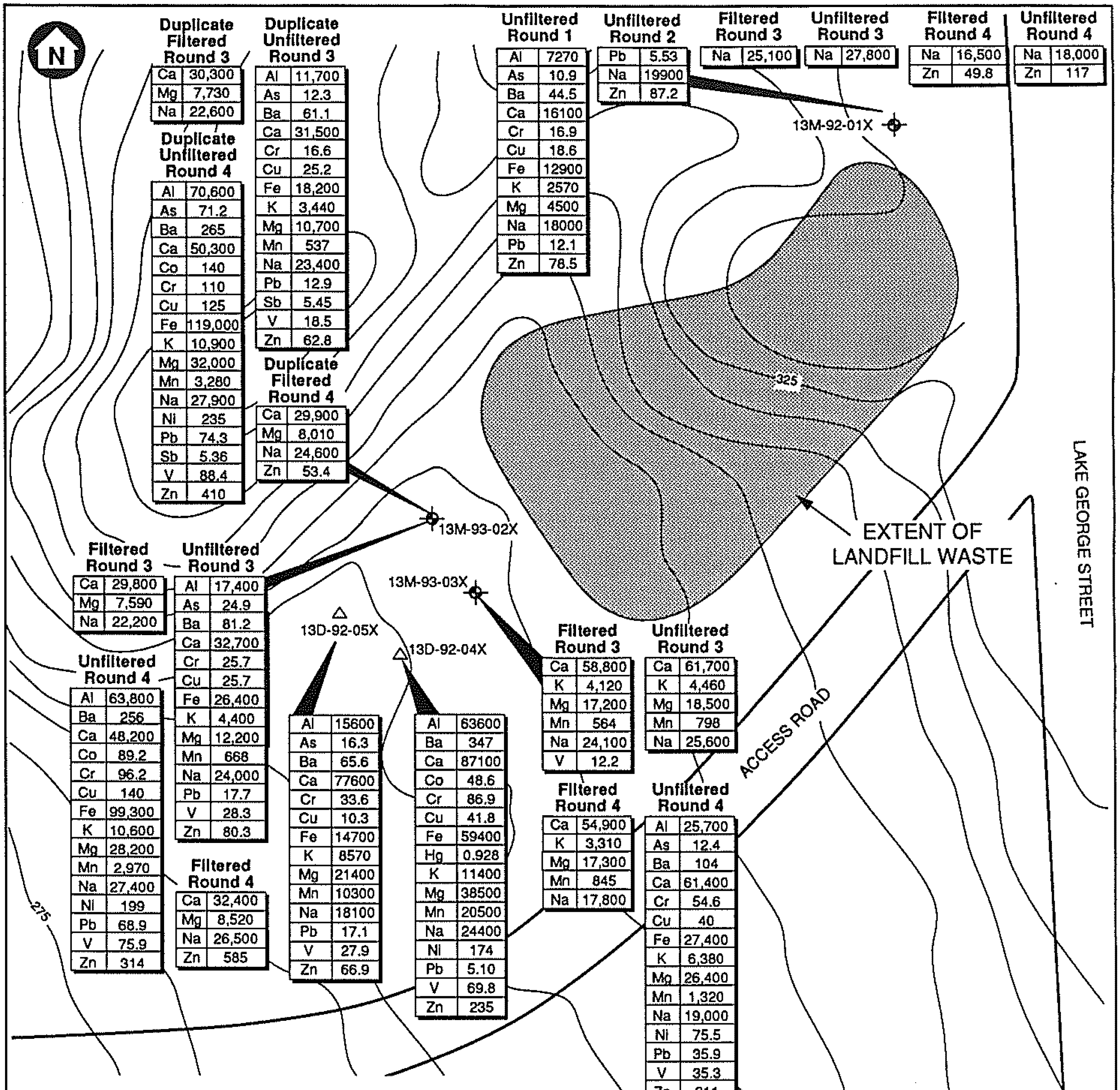


13M-92-01X

Unfiltered Round 1

Al	7270
As	10.9
Ba	44.5
Ca	16100
Cr	16.9
Cu	18.6
Fe	12900
K	2570
Mg	4500
Na	18000
Pb	12.1
Zn	78.5

Unfiltered Round 2

Pb	5.53
Na	19900
Zn	87.2

Filtered Round 3

Na	25,100

Unfiltered Round 3

Na	27,800

Filtered Round 4

Na	16,500
Zn	49.8

Unfiltered Round 4

Na	18,000
Zn	117

13M-93-02X

Duplicate Filtered Round 3

Ca	30,300
Mg	7,730
Na	22,600

Duplicate Unfiltered Round 3

Al	11,700
As	12.3
Ba	61.1
Ca	31,500
Cr	16.6
Cu	25.2
Fe	18,200
K	3,440
Mg	10,700
Mn	537
Na	23,400
Pb	12.9
Sb	5.45
V	18.5
Zn	62.8

Duplicate Unfiltered Round 4

Al	70,600
As	71.2
Ba	265
Ca	50,300
Co	140
Cr	110
Cu	125
Fe	119,000
K	10,900
Mg	32,000
Mn	3,280
Na	27,900
Ni	235
Pb	74.3
Sb	5.36
V	88.4
Zn	410

Duplicate Filtered Round 4

Ca	29,900
Mg	8,010
Na	24,600
Zn	53.4

Filtered Round 3

Ca	29,800
Mg	7,590
Na	22,200

Unfiltered Round 3

Al	17,400
As	24.9
Ba	81.2
Ca	32,700
Cr	25.7
Cu	25.7
Fe	26,400
K	4,400
Mg	12,200
Mn	668
Na	24,000
Pb	17.7
V	28.3
Zn	80.3

Unfiltered Round 4

Al	63,800
Ba	256
Ca	48,200
Co	89.2
Cr	96.2
Cu	140
Fe	99,300
K	10,600
Mg	28,200
Mn	2,970
Na	27,400
Ni	199
Pb	68.9
V	75.9
Zn	314

Filtered Round 4

Ca	32,400
Mg	8,520
Na	26,500
Zn	585

13D-92-05X

Al	15600
As	16.3
Ba	65.6
Ca	77600
Cr	33.6
Cu	10.3
Fe	14700
K	8570
Mg	21400
Mn	10300
Na	18100
Pb	17.1
V	27.9
Zn	66.9

13D-92-04X

Al	63600
Ba	347
Ca	87100
Co	48.6
Cr	86.9
Cu	41.8
Fe	59400
Hg	0.928
K	11400
Mg	38500
Mn	20500
Na	24400
Ni	174
Pb	5.10
V	69.8
Zn	235

13M-93-03X

Filtered Round 3

Ca	58,800
K	4,120
Mg	17,200
Mn	564
Na	24,100
V	12.2

Unfiltered Round 3

Ca	61,700
K	4,460
Mg	18,500
Mn	798
Na	25,600

Filtered Round 4

Ca	54,900
K	3,310
Mg	17,300
Mn	845
Na	17,800

Unfiltered Round 4

Al	25,700
As	12.4
Ba	104
Ca	61,400
Cr	54.6
Cu	40
Fe	27,400
K	6,380
Mg	26,400
Mn	1,320
Na	19,000
Ni	75.5
Pb	35.9
V	35.3
Zn	211

LEGEND

⌖	MONITORING WELL/WELL POINT LOCATION
△	SUMP LOCATION
Al | 3610	CONCENTRATION (µg/L)
└	INORGANIC ANALYTE (ABOVE BACKGROUND)
NA	NOT ANALYZED
LT	LESS THAN DETECTION LIMIT

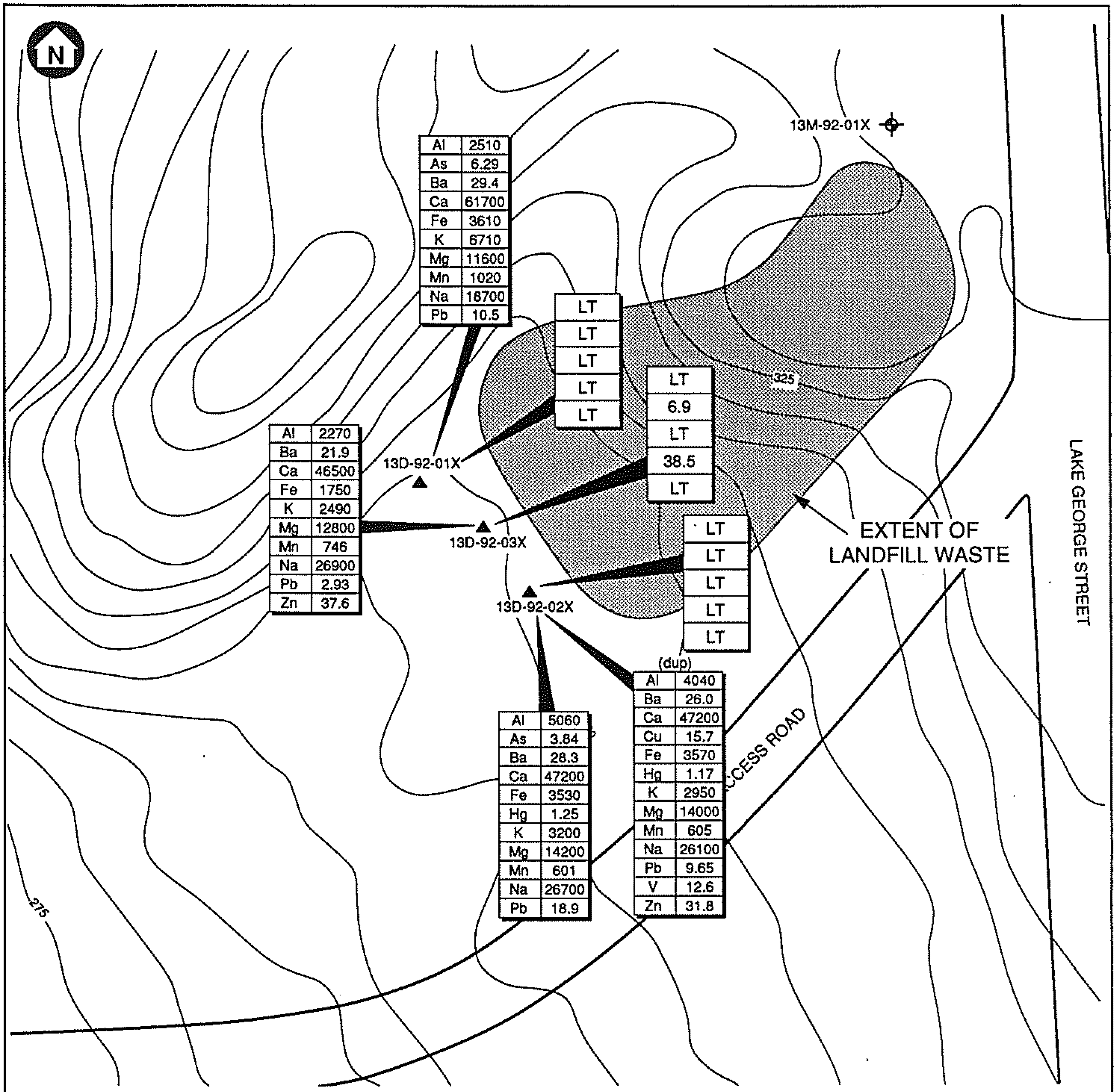
NOTE WITHIN SA 13 TOPOGRAPHIC CONTOURS DEPICT TOPOGRAPHIC SLOPES AND GRADIENTS. HOWEVER ACTUAL ELEVATIONS MAY VARY FROM THOSE SHOWN ON THIS FIGURE.

SCALE IN FEET

0 80 160

FIGURE 4.1-7
INORGANIC ANALYTES IN GROUNDWATER
SA13 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.



LEGEND

▲ SURFACE WATER SAMPLE LOCATION

Al | 3610 – CONCENTRATION (µg/L)

INORGANIC ANALYTE

LT LESS THAN DETECTION LIMIT

(dup) DUPLICATE SAMPLE

LT	TOTAL VOCs in µg/L
9.1	TOTAL SVOCs in µg/L
LT	PESTICIDES / PCBs in µg/L
LT	EXPLOSIVES in µg/L
LT	TPHC in µg/L

NOTE WITHIN SA 13 TOPOGRAPHIC CONTOURS DEPICT TOPOGRAPHIC SLOPES AND GRADIENTS. HOWEVER ACTUAL ELEVATIONS MAY VARY FROM THOSE SHOWN ON THIS FIGURE.

SCALE IN FEET

0 80 160

FIGURE 4.1-8
ANALYTES IN SURFACE WATER
SA 13 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

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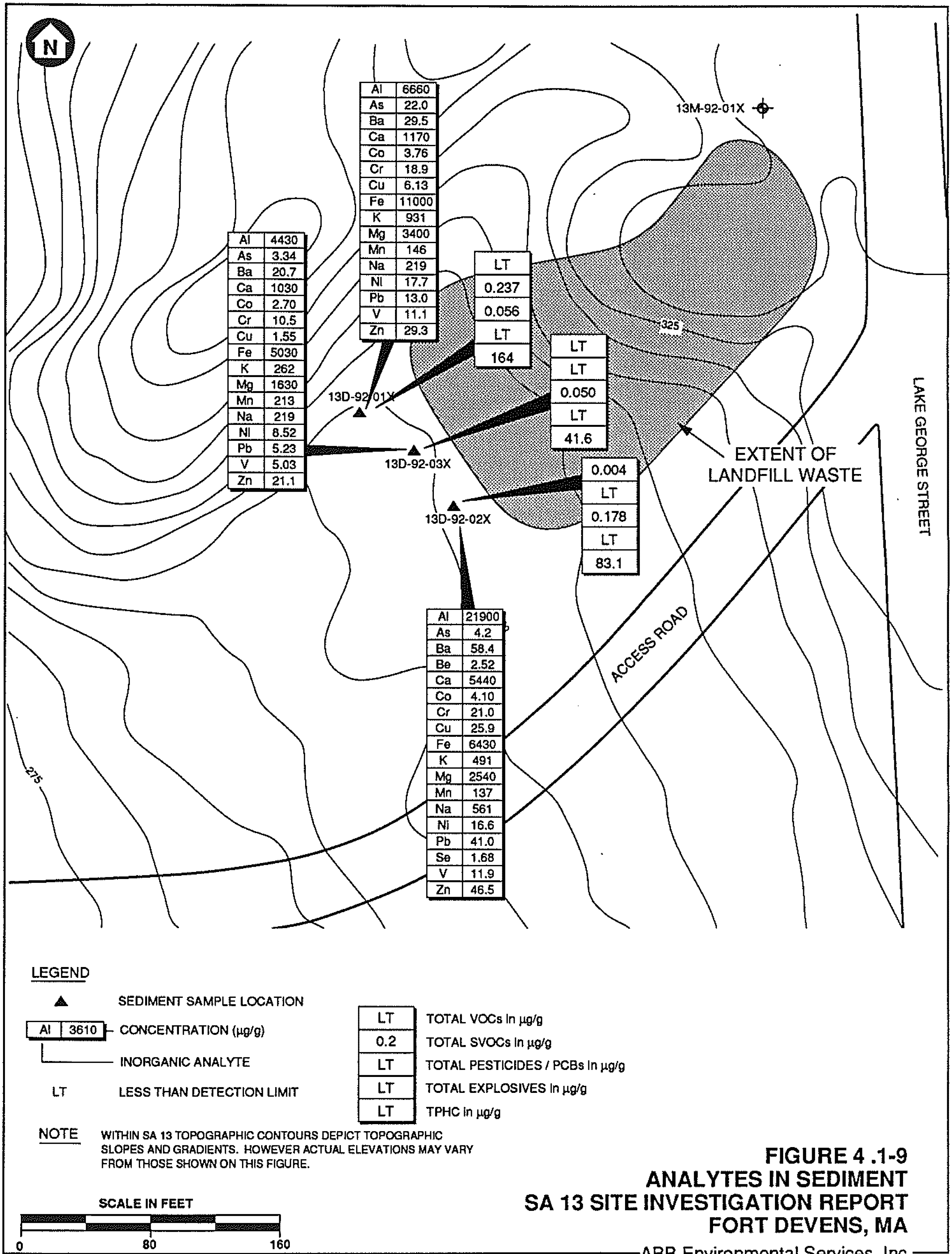

NOTE WITHIN SA 13 TOPOGRAPHIC CONTOURS DEPICT TOPOGRAPHIC SLOPES AND GRADIENTS. HOWEVER ACTUAL ELEVATIONS MAY VARY FROM THOSE SHOWN ON THIS FIGURE.

FIGURE 4 .1-9
ANALYTES IN SEDIMENT
SA 13 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

4.2 SA 45 - LAKE GEORGE STREET VEHICLE WASH AREA

4.2.1 Study Area Background and Conditions

The Lake George Street vehicle wash area (SA 45) is located on Lake George Street on the western side of the Main Post. SA 45 consists of a concrete pad, with drains, located within an asphalt-paved area (Figure 4.2-1). It is no longer in operation.

The wash facility was originally identified as a SA because of concern that discharge through a possible uncontrolled outfall might have impacted wetlands adjacent to the Nashua River, prior to what was understood to be a more recent connection to the sanitary sewer.

> *A site inspection revealed no additional information about the outfall from this site. . . A new sewer connection has been installed near the sump. . . The topography of the area suggests that the site is directly upgradient of the Nashua River, and that an uncontrolled outfall could have an impact on the wetland adjacent to the river.* (Biang et al., 1992, p. 4-120).

Inquiries made during the planning of the Site Investigation revealed the following:

- The facility was designed in 1977 and was constructed between 1977 and 1980 (Hagstrom, 1977; Coffin & Richardson, 1980; Detrick, 1991, Figure 12).
- Its design included the collection of wastewater in drains and discharge, through an oil-water separator, to the sanitary sewer. (That wastewater-handling system was part of the original construction and was not added later.)
- The as-built facility differs from the design plan in that it was rotated 90 degrees to take advantage of an existing sewer line near the lower side of the paved area (see Figure 4.2-1).

- After the construction of the wash facility, a grit removal chamber was added to the wastewater handling system between the lower end of the wash facility and the existing oil-water separator (Coffin & Richardson, 1980).
- There is not (and according to the records there never was) an outfall for surface discharge from the vehicle wash facility.

This facility was designated an SA based upon understandings that have been shown to be incorrect. The wash facility would not have caused discharges of oil or hazardous materials to the environment.

Therefore, no Site Investigations were planned or carried out.

4.2.2 Study Area Investigation Program Summary

No investigation activities are required for this SA because of the discovery of the engineering construction diagram that shows the floor drains from the eight bays are connected to the installation's sanitary sewer system. Visual inspection of the facility shows structures and piping consistent with the drawings. Available information indicates that the historic use of this SA has not generated conditions that might pose a threat to human health or the environment. The engineering drawings of the system are included in Appendix N.

4.2.3 Conclusions and Recommendations

Based on ABB-ES' visual inspection of the wash rack facility at SA 45, and review of engineering drawings of the facility, this SA has not generated conditions that might pose a threat to human health or the environment. Insofar as there is no evidence of environmental contamination, no further investigation is necessary. However, ABB-ES recommends that the Army clean the grit chamber and oil/water separators and close the entire system.

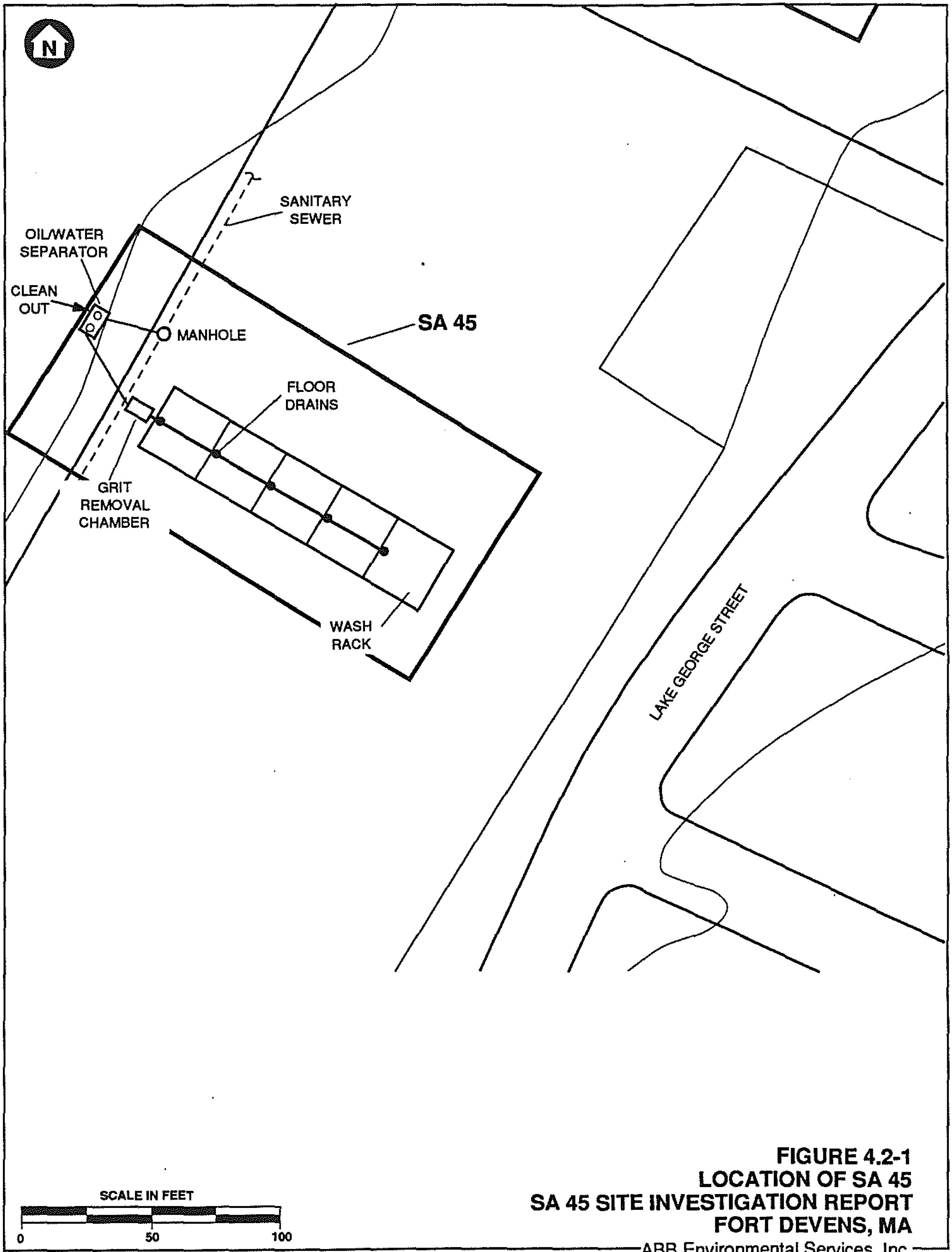

FIGURE 4.2-1
LOCATION OF SA 45
SA 45 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

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4.3 SA 49 - BUILDING 3602 LUST SITE

4.3.1 Study Area Background and Conditions

SA 49 is located in the southern portion of the Main Post on the west side of Sheridan Road, and approximately 100 feet east of Building T-3601 (Figure 4.3-1).

The site was originally a gasoline-dispensing station of the same design and age as numerous other historic gas stations at Fort Devens that have collectively been included in SA 43. Building 3602, which still exists at the site, appears to be the original gas station pumphouse (U.S. Engineer Office, 1952) (see Figure 4.3-1). The station had two 5,000-gallon USTs that were used from 1942 to 1975 to store gasoline for a motor pool. They had been used more recently for storing diesel fuel and No. 2 fuel oil (Biang et al., 1992).

The USTs were removed in December 1989 by Franklin Environmental Services, Inc. under direction of Kurz Associates. Petroleum contamination of the soil around the USTs was identified from a depth of approximately 6 feet bgs to the bottom of the excavation (12-13 feet bgs). Approximately 250 cubic yards of contaminated soil were removed. The soil remaining in the excavation had elevated levels of VOCs as determined by a PID (Kurz Associates, 1991).

Due to the presumed large extent of soil contamination, detected by Kurz, the excavation was backfilled with clean fill, and four monitoring wells (3602W-01 through 3602W-04) were installed to evaluate the impact on groundwater, which was approximately 9 feet bgs at the time of UST removal. These monitoring wells were not sampled prior to this investigation. The motor pool is currently under the control of an Army Reserve unit and is used by the 10th Special Forces Headquarters Support Group for vehicle storage. Some maintenance operations may still take place in the area around Building 3602. The motor pool is paved except for the former UST location, and it is surrounded by a chain-link fence with a locked gate on the east side of the motor pool (see Figure 4.3-1).

4.3.2 Site Investigation Program Summary

The SI at SA 49 was completed in accordance with the Final SI Task Order Work Plan (ABB-ES, 1992a) and in conformance with the provisions of the Project Operations Plan (ABB-ES, 1992b). The field investigation program at SA 49 consisted of drilling one soil boring (49M-92-01X) for the installation of one groundwater monitoring well (49M-92-01X) directly downgradient of the former UST locations (Figure 4.3-2). Monitoring well 49M-92-01X was used in conjunction with the four existing monitoring wells to assess whether the historic use of the SA had adversely impacted groundwater quality and therefore posed a risk to human health or the environment. Review of existing information indicated that groundwater flows to the north, and that the four existing monitoring wells were located upgradient and cross-gradient of the former UST location and were not adequate to assess whether the leaking USTs had impacted the groundwater quality downgradient of the SA.

Soil samples were obtained continuously from 49M-92-01X using a 2-inch outside diameter (OD) split-spoon sampler. The samples were screened with a PI meter and described using the U.S. Geologic Survey (USGS). One sample was collected at the water table from the boring for laboratory analysis of TOC. In addition to the analytical sample, two of the soil samples from this boring were selected for grain size analysis to verify field classifications of soil.

One monitoring well (49M-92-01X) was installed in the completed soil boring mentioned above. The monitoring well was constructed of 4-inch ID PVC and the well screen was installed across the water table to monitor for floating contaminants and allow for seasonal fluctuations of the water table. The new monitoring well was developed within seven days after completion. The four existing monitoring wells were also redeveloped. Aquifer hydraulic conductivity tests were performed in the newly installed monitoring well after development and the first round of groundwater sampling.

Two rounds of groundwater samples were collected from all five monitoring wells. The Round One was conducted in September 1992 and the Round Two was collected in January 1993. The samples were analyzed for PAL VOCs, TPHC, lead, and PAL anions and cations. The newly installed monitoring well was surveyed to establish its horizontal and vertical location. Table 4.3-1 summarizes the scope of the SI.

4.3.3 Supplemental Site Investigation Program Summary

The SSI at SA 49 was completed in accordance with the Final SSI Task Order Work Plan (ABB-ES, 1993a) and in conformance with the provisions of the Project Operations Plan (ABB-ES, 1992b). The SSI was focused at the former UST grave to determine the vertical and horizontal distribution of residual VOCs and TPHC contamination in the subsurface soil. A total of 28 subsurface soil samples were collected from 15 TerraProbe points, and analyzed in the field for VOCs, using a GC, and for TPHC using an IR (see Figure 4.3-2). The GC was used to determine the concentration of BTEX in each sample. One soil sample was collected from the water table (13 feet bgs) and another was collected from just above the water table (12 feet bgs) at each TerraProbe point. These depths were chosen so that the residual fuel contamination in the capillary zone and at the water table could be determined. Each of the TerraProbe points was surveyed.

One additional round of groundwater samples (Round Three) was collected from the existing monitoring wells to further define the groundwater contamination identified during the SI. The groundwater samples were collected in October 1993 and submitted for off-site laboratory analysis consisting of PAL VOCs, Lead, TPHC, and TSS. Table 4.3-1 summarizes the scope of the SSI.

4.3.4 Field Investigation Results and Observations

SA 49 is located in the Shirley Quadrangle. The surficial geology in this quadrangle has not been mapped. The area appears to be blanketed by unconsolidated surficial deposits of glacial and post-glacial origin. Mapping to the east by Jahns (1953) suggests that SA 49 may by underlain by deltaic sands and pebble- to cobble-gravels of the Pin Hill stage of glacial Lake Nashua, local thin glacial-stream deposits of sand and gravel, and possibly artificial fill. Ground moraine tills are also possible in the area.

Bedrock at SA 49 has been mapped as the generally north-south striking Merrimack Formation, consisting of low grade (below biotite isograd) calcareous and ankeritic metasiltstone and phyllite and commonly deformed by kink banding (Russell and Allmendinger, 1975; G.R. Robinson, 1978). The rock unit was called Oakdale Formation by Zen (1983) and Robinson and Goldsmith (1991). The Merrimack (Oakdale) Formation crops out along strike south of SA 49, most visibly on Route 2 just east of the Jackson Gate exit. A complete description of the Main Post geology is presented in Section 2.0.

Monitoring well 49M-92-01X was installed north and outside of the motor pool compound, to provide a locally downgradient location for groundwater sampling. The boring at this location encountered silty and occasionally gravelly fine sand to a depth of approximately 10 feet bgs. Below 10 feet the soil consisted of gravelly silt. Grain size analysis of a sample from depth 10 to 12 feet bgs revealed a clay or silt with 89.2 percent fines and 10.8 percent fine sand. This material appears to be glacial tills. Bedrock was not encountered in this boring. Four monitoring wells (3602W-01 through 3602W-04) were installed surrounding the excavation in 1990 as part of the UST removal operation. Below the artificial fill, the borings penetrated clayey silts that were described as till (Kurz Associates, Inc., 1991). The boring log for 49M-92-01X is in Appendix B, monitoring well completion diagrams are presented in Appendix C, and grain size results are provided in Appendix J.

Monitoring well 49M-92-01X was installed downgradient of the SA based on the hydraulic gradients measured in the 3602W-series monitoring wells. This monitoring well was installed in the overburden soils. Well completion details are provided in Appendix C.

Installation-wide water-level surveys of monitoring wells and surface-water stations have been conducted quarterly since May of 1992. All of the SA 49 monitoring wells (49M-92-01X and 3602W-1 through 3602W-4) have been included in each of these surveys. The data from these installation-wide water level rounds is provided in Appendix I.

The water table was encountered in overburden at depths ranging approximately from 5.6 feet to 11.4 feet bgs. Groundwater flows generally northward across the study area, past well 49M-92-01X, toward a drainage swale north of the SA (Figure 4.3-3). It appears that the groundwater flows north of the site and may turn westward toward the Nashua River, which is the major surface-water body in the region.

The groundwater flow model of Engineering Technologies Associates, Inc. (1992, Figures III-20 and III-21), which is based on regional data, assumes that the water table in the vicinity of SA 49 is in bedrock beneath the till. The regional scale of the installation-wide model required modeling of thin saturated overburden as being entirely within the bedrock. This modeling requirement caused the regional groundwater flow model to indicate that the groundwater should be found in the bedrock at this SA. The flow model of Engineering Technologies Associates, Inc. nevertheless indicates groundwater flow toward the river.

Hydraulic conductivity tests were performed in two monitoring wells at SA 49 with sufficient water for testing (49M-92-01X and 3602W-01). The hydraulic conductivities of the soil at the water table in 49M-92-01X were determined to be 2×10^{-6} cm/sec and 7×10^{-6} cm/sec. These are low conductivities and reflect the silty/clayey glacial till soils logged in the boring. At monitoring well 3602W-01 the hydraulic conductivities of the soil were measured at 1×10^{-3} cm/sec and 3×10^{-3} cm/sec. The other 3602W-series monitoring wells were not tested for hydraulic conductivities, however, they are partially screened in silty sands characterized as fill and appear to have similar hydraulic conductivities to 3602W-01 (Kurz Associates, Inc., 1991). The higher conductivities are characteristic of those more granular soils. The results of the hydraulic conductivity tests are presented in Appendix A.

A likely groundwater flow path across the site is approximately from monitoring well 3602W-04 to 49M-92-01X, and the average hydraulic gradient between those two points on December 22, 1992 was 0.019 feet per foot (ft/ft). The geometric average of the measured hydraulic conductivities at SA 49 is 8.05×10^{-5} cm/sec. Assuming that conductivity is representative of average conditions along the flow path, and assuming an average soil porosity of 0.40, the average groundwater flow velocity is approximately 4 feet per year (ft/yr). Velocities within the artificial fill area are probably higher than that, and velocities to the north and west, if the till continues, may be slower than 4 ft/yr.

Groundwater in the surficial aquifer at the facility has been assigned to Class I under Commonwealth of Massachusetts regulations. Class I consists of groundwaters that are "found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated as a source of potable water supply" (314 CMR 6.03).

4.3.5 Nature and Distribution of Contamination

The objective of SI and SSI sampling programs was to investigate the presence or absence of residual contamination in the groundwater and soil at SA 49. The primary concern at SA 49 was that the fuel in the former USTs, removed from the site in 1989, had leaked and adversely impacted groundwater and soil quality at this SA.

4.3.5.1 Soil. The results of the SI soil sampling and off-site laboratory analysis indicated that TOC concentrations at the water table in soil boring 49M-92-01X was 889.0 μg/g. No VOCs were detected, with the PID, during the headspace screening of subsurface soil samples collected from 49M-92-01X.

Round 1

The results of the field analyses conducted during the SSI, indicated that residual fuel contamination was present at the water table and also in the capillary zone above the water table. Benzene was not detected in any of the soil samples collected. However, results of soil samples collected from the capillary zone (12 feet bgs), showed toluene, ethylbenzene, and xylenes (TEX) in the soil samples collected from the center and east side of the former UST grave (Table 4.3-2; Figure 4.3-4). Total concentrations of TEX ranged from 1.9 parts per billion (ppb) at TP-12 to 56.4 ppb at TP-08. TPHC was detected in soil samples collected from TP-06, TP-08, TP-09, TP-10, TP-12, TP-13, and TP-14. Concentrations of TPHC ranged from 63 to 120 ppm.

Round 2

The results of the field analysis for the soil samples collected from 13 feet bgs (water table) indicated the presence of TEX and TPHC. The residual contamination appears to be limited to the center and east side of the UST grave. Soil samples collected from the west and south sides of the UST grave show non detect (ND) for both TEX and TPHC. Total concentrations of TEX in the samples collected from the center and east side of the former excavation, ranged from 1.1 ppb at TP-15 to 311,000 ppb at TP-09. TPHC concentrations ranged from 61 ppm at TP-10 to 15,000 ppm at TP-09 (see Table 4.3-2; Figure 4.3-5).

4.3.5.2 Groundwater. Results for the Round One groundwater samples indicated that VOCs (ethylbenzene and total xylenes) were present at total concentrations ranging from 17 μg/L at 3602W-03 to 96 μg/L at 3602W-02. Lead was detected above the established Fort Devens background groundwater concentration in four of the five monitoring wells ranging from 18.4 μg/L at 3602W-02 and 3602W-01 to 47.8 μg/L at 3602W-03. Other soluble inorganic analyte (calcium, potassium, and magnesium) concentrations were also detected above the established background. The inorganic analysis for Round One was performed on unfiltered samples. The results of the Round Two groundwater sampling showed similar results. VOCs (ethylbenzene, toluene, and total xylenes) were detected in 3602W-02 and 3602W-03, ranging from 210 μg/L total VOCs to 220 μg/L, respectively. TPHC was also detected in 3602W-02 at a concentration of 213 μg/L. TPHC was not detected in the samples collected during Round Two. Lead was detected at concentrations ranging from 27.9 μg/L at 3602W-03 to 49.5 μg/L at 3602W-01. However, as part of the Round Two groundwater sampling a filtered sample was collected from 3602W-04 and analyzed for lead, only. The results of this analysis showed the lead concentration in the filtered sample to be below the detection limit (<1.26 μg/L), while the unfiltered sample had a lead concentration of 42.2 μg/L. TSS analysis was also performed on each groundwater sample collected during Round Two. These results showed TSS concentrations ranging from 129 μg/L to 1820 μg/L. The results of the filtered and the unfiltered analysis, as well as the TSS analyses, appear to indicate that lead concentrations detected in the unfiltered samples, are caused by suspended solids in the groundwater samples, not contamination from SA 49. Figure 4.3-6 shows the distribution of organic and contaminants and lead detected in the groundwater samples collected at SA 49. The analytical results are presented in Table 4.3-3.

The results of the Round Three SSI groundwater sampling were consistent with the Rounds One and Two collected during the SI. VOCs (ethylbenzene, toluene, and xylenes) were detected in monitoring wells 3602W-02 and 3602W-03. Xylenes were the major contaminant detected ranging from 9.8 μg/L at 3602W-02 to 53.0 μg/L at 3602W-03. TPHC was not detected in any of the Round Three groundwater samples. Lead was detected above the Fort Devens background groundwater concentration (4.25 μg/L) in four of the five unfiltered groundwater samples collected during Round Three. Lead was also detected above the Fort Devens background concentration in one filtered groundwater sample, 3602W-03 at 7.0 μg/L (see Table 4.3-3 and Figure 4.3-6).

4.3.6 Source Evaluation and Migration Potential

VOCs and TPHC were detected during field analysis in the soil samples collected from the capillary zone and water table in and around the former UST excavation. These contaminants appear to be confined to the central and eastern side of the former excavation. It appears that the contaminants detected have migrated in the groundwater east of the former UST excavation.

VOCs were detected in groundwater samples collected during all three rounds of groundwater sampling conducted at SA 49. Concentrations were generally low, but were highest in the nearest monitoring wells downgradient of the former UST location (3602W-02 and 3602W-03). Lead was detected consistently above the Fort Devens background concentration in the unfiltered groundwater samples (two of which were found to contain VOCs). However, lead was only detected above background in one of the filtered samples collected during Round Three. It does not appear that the former UST excavation is the source of the lead.

The VOCs detected in soil and in the downgradient groundwater monitoring wells are likely the result of releases from the former UST. The VOC contamination appears to be migrating from the contaminated soil identified in the former excavation, with the groundwater flow. The lateral distribution of the VOC contamination has not been fully defined. Lead, and other inorganic analytes, by the nature of their distribution, are not likely the result of releases from the former UST.

4.3.7 Preliminary Human Health Risk Evaluation

A preliminary human health risk evaluation was prepared for SA 49 to determine if the contaminants detected at this SA pose a risk to human receptors. For this PRE, the future use of SA 49 is assumed to be residential.

Table 4.3-4 and 4.3-5 presents summary statistics and human health standards and guidelines used in the PRE for SA 49.

4.3.7.1 Soil. Table 4.3-4 contains summary statistics from the field analytical subsurface soil program at SA 49 and health standards and guidelines for comparison. Toluene, ethylbenzene, and xylenes were detected in the soil but at concentrations less than both the USEPA Region III commercial/industrial soil concentrations and the MCP Method 1 S-2/GW-1 soil standards. TPHC was detected in 15 of 27 samples. While the maximum detected concentration (15,000 milligrams per kilogram (mg/kg)) exceeds the Method 1 S-2/GW-1 soil standard of 2500 mg/kg, the average concentration (1,141 mg/kg) is below this standard.

In fact, except for the concentration at sampling location TP-09 (at 13 feet), the concentrations at the other sampling locations are less than the MCP standard. It does not appear, therefore, that exposure to subsurface soil at SA 49 would pose a significant public health risk.

4.3.7.2 Groundwater. Table 4.3-5 presents summary statistics on groundwater associated with SA 49 and drinking water standards/guidelines for comparison. Monitoring well locations 3602W-01 through 3602W-04 and 49M-92-01X were established to define the groundwater quality in the vicinity of the former USTs. It should be noted that the construction of the four 3602-series wells may allow for surface water to enter the well casing and that all of the data reported in Table 5 is based on unfiltered samples. Three organic compounds were detected in the groundwater associated with SA 49 (ethylbenzene, toluene, and xylenes). The maximum detected concentration for each of these compounds is below its respective drinking water standard/guideline. An assessment of the inorganic data for SA 49 unfiltered groundwater shows that there is inorganic analyte contamination surrounding the SA at concentrations above the Fort Devens background levels. When comparing groundwater concentrations to the statistical background, the inorganic data for SA 49 groundwater shows that there are several compound exceedances, most notably, lead, magnesium, potassium, and calcium. A drinking water standard or guideline is available for one of these four inorganic analytes. The maximum (50.8 μg/L) and the average concentration (28.1 μg/L) of lead at SA 49 exceeds the USEPA lead action level of 15 μg/L. Based on the results of the unfiltered groundwater data, it appears that lead concentrations represent a potential human health risk.

A comparison of the unfiltered and filtered samples, however, shows that the concentrations of lead decrease significantly in the filtered samples. The concentrations either are below the detection limit in filtered samples or are below the action level. In addition, in monitoring well 3602W-04 (Round Two), in which a filtered sample was also analyzed for calcium, magnesium, and potassium, the concentrations fall below the reported detection limits.

4.3.8 Conclusions and Recommendations

The contaminant profile determined during the SI and SSI is consistent with the reported military activity and UST removal report for the study area. As noted above, the primary concern at SA 49 has been the possible residual contamination due to releases from LUSTs which have been removed. Sampling and analysis of subsurface soil and groundwater during the SI and SSI found contaminants derived from petroleum hydrocarbons associated with fuel. The human health PRE for soil indicated that an isolated area of the former UST excavation was above the S-2 MCP guidelines for TPHC, and therefore must be removed. However, the PRE showed that VOC contaminant concentrations in groundwater do not pose an unacceptable risk to public health. Lead concentrations in the unfiltered groundwater samples were found to pose a potential risk to human health. However, the results of the filtered lead analysis indicated that lead was not detected above the risk-based action limits. Based on the filtered results, it appears that the lead concentration detected are caused by particulate (TSS) matter in the groundwater samples not SA-derived contaminants.

Based on the results and findings mentioned above, a soil removal is recommended for SA 49 to address the isolated high TPHC soil contaminated area (TP-09). This recommendation is based on historical information regarding the use of the SA, as confirmed by physical observations, sampling, and chemical analysis. It is also based on the results of the human health PRE.

TABLE 4.3-1
SUMMARY OF TECHNICAL APPROACH
SA 49 - BUILDING 3602 LUST SITE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ACTIVITY	PURPOSE	SITE IDENTIFICATION	RATIONALE FOR SELECTED LOCATIONS
SI PROGRAM			
SOIL BORINGS AND SUBSURFACE SOIL SAMPLING	* INSTALL MONITORING WELL * CHARACTERIZE SOILS	49M-92-01X	* APPARENT DOWNGRADIENT LOCATION * OUTSIDE UST GRAVE
MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING	* MONITOR GROUNDWATER LEVELS * MONITOR GROUNDWATER QUALITY * CHARACTERIZE AQUIFER CONDUCTIVITIES	49M-92-01X 3602W-01 3602W-02 3602W-03 3602W-04	* TO ASSESS GROUNDWATER QUALITY UPGRADIENT AND DOWN-GRADIENT OF SA 49
SSI PROGRAM			
TERRAPROBE SURVEY, SUBSURFACE SOIL SAMPLING AND FIELD ANALYSIS	* CHARACTERIZE RESIDUAL SOILS CONTAMINATION	TP-01 THRU TP-15	* IN AND AROUND FORMER UST GRAVE
GROUNDWATER SAMPLING	* MONITOR GROUNDWATER LEVELS * MONITOR GROUNDWATER QUALITY * CHARACTERIZE AQUIFER CONDUCTIVITIES	49M-92-01X 3602W-01 3602W-02 3602W-03 3602W-04	* TO ASSESS GROUNDWATER QUALITY UPGRADIENT AND DOWN-GRADIENT OF SA 49

TABLE 4.3-2
SUMMARY OF FIELD ANALYTICAL RESULTS
SA 49 - BUILDING 3602 LUST SITE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	TP-01	TP-02	TP-02	TP-03	TP-04	TP-04	TP-05	TP-05	TP-06
	TS90112F	TS90212F	TS90213F	TS90313F	TS90412F	TS90413F	TS90512F	TS90513F	TS90611F
ANALYTE	12 FT	12 FT	13 FT	13 FT	12 FT	13 FT	12 FT	13 FT	11 FT
ORGANICS (ppb)									
BENZENE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TOLUENE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
ETHYLBENZENE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
m/p-XYLENE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
o-XYLENE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
OTHER (ppm)									
TOTAL PETROLEUM HYDROCARBONS	60	< 57	< 57	< 56	< 56	< 56	< 59	< 63	64

Notes:

< = Less than detection limit

TABLE 4.3-2
SUMMARY OF FIELD ANALYTICAL RESULTS
SA 49 - BUILDING 3602 LUST SITE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	TP-07	TP-07	TP-08	TP-08	TP-09	TP-09	TP-10	TP-10	TP-11
	TS90712F	TS90713F	TS90812F	TS90813F	TS90912F	TS90913F	TS91012F	TS91013F	TS91112F
ANALYTE	12 FT	13 FT	12 FT	13 FT	12 FT	13 FT	12 FT	13 FT	12 FT
ORGANICS (ppb)									
BENZENE	< 0.1	< 0.1	< 0.1	< 0.6	< 0.1	< 150	< 0.1	< 0.1	< 0.1
TOLUENE	< 0.1	< 0.1	3.4	< 0.6	< 0.1	28000	< 0.1	7.8	< 0.1
ETHYLBENZENE	< 0.1	< 0.1	12	4.8	< 0.1	57000	< 0.1	16	< 0.1
m/p-XYLENE	< 0.1	< 0.1	30	12	1.2	160000	0.6	51	< 0.1
o-XYLENE	< 0.1	< 0.1	11	5.0	< 0.1	66000	< 0.1	10	< 0.1
OTHER (ppm)									
TOTAL PETROLEUM HYDROCARBONS	< 58	< 59	120	600	63	15000	61	61	< 54

Notes:

< = Less than detection limit

TABLE 4.3-2
SUMMARY OF FIELD ANALYTICAL RESULTS
SA 49 - BUILDING 3602 LUST SITE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	TP-11	TP-12	TP-12	TP-13	TP-13	TP-14	TP-14	TP-15	TP-15
	TS91113F	TS91212F	TS91213F	TS91312F	TS91313F	TS91412F	TS91413F	TS91512F	TS91513F
ANALYTE	13 FT	12 FT	13 FT	12 FT	13 FT	12 FT	13 FT	12 FT	13 FT
ORGANICS (ppb)									
BENZENE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.6	< 0.1	< 0.1	< 0.1	< 0.1
TOLUENE	< 0.1	< 0.1	< 0.1	4.2	31	1.9	2.2	< 0.1	< 0.1
ETHYLBENZENE	< 0.1	< 0.1	< 0.1	6.5	50	2.3	1.6	< 0.1	0.7
m/p-XYLENE	< 0.1	< 0.1	< 0.1	20	190	12	11	0.6	4.5
o-XYLENE	< 0.1	1.9	< 0.1	8.1	100	14	8.6	0.5	4.3
OTHER (ppm)									
TOTAL PETROLEUM HYDROCARBONS	290	66	110	63	370	63	120	< 59	< 61

Notes:

< = Less than detection limit

TABLE 4.3-3
ANALYTES IN GROUNDWATER
SA 49 - BUILDING 3602 LUST SITE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		ROUND 1	ROUND 2	ROUND 3	ROUND 3	ROUND 1	ROUND 2
ANALYTE	BACK-GROUND	3602W-01	3602W-01	3602W-01	3602W-01 FILTERED	3602W-02	3602W-02
ORGANICS (Âg/L)							
ETHYLBENZENE		< 0.5	< 0.5	< 0.5	NA	45.0	100.0
XYLENES		< 0.8	< 0.84	< 0.84	NA	51.0	110.0
TOLUENE		< 0.5	< 0.5	< 0.5	NA	< 0.5	< 0.5
INORGANICS (Âg/L)							
CALCIUM	14700.0	19200.0	20200.0	NA	NA	32300.0	38400.0
LEAD	4.25	18.4	49.5	17.1	1.4	18.4	43.6
MAGNESIUM	3480.0	4830.0	13200.0	NA	NA	2820.0	11500.0
POTASSIUM	2370.0	3980.0	7580.0	NA	NA	2170.0	5530.0
ANIONS/CATIONS (Âg/L)							
NITRATE/NITRITE		4000.0	3600.0	NA	NA	840.0	690.0
CHLORIDE		12400.0	11100.0	NA	NA	< 2120.0	< 2120.0
SULFATE		< 10000	< 10000.0	NA	NA	13300.0	11400.0
BICARBONATE		47600.0	46300.0	NA	NA	86600.0	85400.0
OTHER (mg/L)							
TOTAL PETROLEUM HYDROCARBONS		< 27.9	< 27.7	< 27.7	NA	< 26.9	213.0
TOTAL SUSPENDED SOLIDS		NA	1820.0	248	NA	NA	177.0

Notes:
Table lists detected analytes only -
see Project Analyte List for summary
< = Less than detection limit
NA = Not analyzed
Shaded values exceed background limit

TABLE 4.3-3
ANALYTES IN GROUNDWATER
SA 49 - BUILDING 3602 LUST SITE

SUPPLEMENTAL SITE INVESTIGATION DATA PACKAGE
FORT DEVENS, MA

		ROUND 3	ROUND 3	ROUND 1	ROUND 2	ROUND 3	ROUND 3
ANALYTE	**BACK-GROUND**	**3602W-02**	**3602W-02 FILTERED**	**3602W-03**	**3602W-03**	**3602W-03**	**3602W-03 FILTERED**
ORGANICS (Åg/L)							
ETHYLBENZENE		5.8	NA	< 0.5	20.0	7.8	NA
XYLENES		9.8	NA	17.0	200.0	53	NA
TOLUENE		1.98	NA	< 0.5	< 0.5	5.55	NA
INORGANICS (Åg/L)							
CALCIUM	14700.0	NA	NA	21600.0	18300.0	NA	NA
LEAD	4.25	3.0	< 1.26	47.8	27.9	20.8	7.0
MAGNESIUM	3480.0	NA	NA	15300.0	9280.0	NA	NA
POTASSIUM	2370.0	NA	NA	10700.0	4990.0	NA	NA
ANIONS/CATIONS (Åg/L)							
NITRATE/NITRITE		NA	NA	108.0	27000.0	NA	NA
CHLORIDE		NA	NA	24800.0	21100.0	NA	NA
SULFATE		NA	NA	< 10000	< 10000.0	NA	NA
BICARBONATE		NA	NA	30500.0	23200.0	NA	NA
OTHER (mg/L)							
TOTAL PETROLEUM HYDROCARBONS		< 27.7	NA	< 27.9	< 27.9	< 27.9	NA
TOTAL SUSPENDED SOLIDS		131	NA	NA	151.0	545	NA

Notes:
Table lists detected analytes only -
see Project Analyte List for summary
< = Less than detection limit
NA = Not analyzed
Shaded values exceed background limit

TABLE 4.3-3
ANALYTES IN GROUNDWATER
SA 49 - BUILDING 3602 LUST SITE

SUPPLEMENTAL SITE INVESTIGATION DATA PACKAGE
FORT DEVENS, MA

		ROUND 1	ROUND 2	ROUND 2	ROUND 3	ROUND 3	ROUND 1
ANALYTE	**BACK-GROUND**	**3602W-04**	**3602W-04**	**3602W-04 FILTERED**	**3602W-04**	**3602W-04 FILTERED**	**49M-92-01X**
ORGANICS (Ág/L)							
ETHYLBENZENE		< 0.5	< 0.5	NA	< 0.5	NA	< 0.5
XYLENES		< 0.8	< 0.8	NA	< 0.8	NA	< 0.8
TOLUENE		< 0.5	< 0.5	NA	1.49	NA	< 0.5
INORGANICS (Ág/L)							
CALCIUM	14700.0	31500.0	24800.0	NA	NA	NA	23100.0
LEAD	4.25	47.6	42.2	< 1.26	50.8	1.6	3.5
MAGNESIUM	3480.0	13500.0	12700.0	NA	NA	NA	3100.0
POTASSIUM	2370.0	6630.0	5450.0	NA	NA	NA	2400.0
ANIONS/CATIONS (Ág/L)							
NITRATE/NITRITE		1300.0	1100.0	NA	NA	NA	29.7
CHLORIDE		48000.0	28800.0	NA	NA	NA	33000.0
SULFATE		< 10000	< 10000.0	NA	NA	NA	13900.0
BICARBONATE		67100.0	96300.0	NA	NA	NA	57300.0
OTHER (mg/L)							
TOTAL PETROLEUM HYDROCARBONS		< 27.9	< 27.9	NA	< 27.9	NA	< 27.9
TOTAL SUSPENDED SOLIDS		NA	1570.0	NA	481	NA	NA

Notes:
Table lists detected analytes only -
see Project Analyte List for summary
< = Less than detection limit
NA = Not analyzed
Shaded values exceed background limit

TABLE 4.3-3
ANALYTES IN GROUNDWATER
SA 49 - BUILDING 3602 LUST SITE

UPPLEMENTAL SITE INVESTIGATION DATA PACKAGE
FORT DEVENS, MA

		ROUND 2	ROUND 3	ROUND 3
ANALYTE	BACK-GROUND	49M-92-01X	49M-92-01X	49M-92-01X FILTERED
ORGANICS (Ág/L)				
ETHYLBENZENE		< 0.5	< 0.5	NA
XYLENES		< 0.8	< 0.8	NA
TOLUENE		< 0.5	< 0.5	NA
INORGANICS (Ág/L)				
CALCIUM	14700.0	26500.0	NA	NA
LEAD	4.25	3.47	5.4	< 1.26
MAGNESIUM	3480.0	2840.0	NA	NA
POTASSIUM	2370.0	1650.0	NA	NA
ANIONS/CATIONS (Ág/L)				
NITRATE/NITRITE		15.4	NA	NA
CHLORIDE		27100.0	NA	NA
SULFATE		21700.0	NA	NA
BICARBONATE		65800.0	NA	NA
OTHER (mg/L)				
TOTAL PETROLEUM HYDROCARBONS		< 27.9	< 27.9	NA
TOTAL SUSPENDED SOLIDS		129.0	184.0	NA

Notes:

Table lists detected analytes only -
see Project Analyte List for summary
< = Less than detection limit
NA = Not analyzed
Shaded values exceed background limit

TABLE 4.3–4
HUMAN HEALTH PRE EVALUATION OF SUBSURFACE SOIL
SA 49 – BUILDING 3602 LUST SITE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a]		REGION III COMMERCIAL/INDUSTRIAL SOIL CONCENTRATION	MCP S–2 STANDARD	MAXIMUM EXCEEDS STANDARD/ GUIDELINE?
		AVERAGE	MAXIMUM			
ORGANICS (μg/kg)						
ETHYLBENZENE	9/27	6300	57000	200,000,000	80000	NO
TOLUENE	7/27	4000	28000	100,000,000	90000	NO
m/p–XYLENES	12/27	13400	160000	1,000,000,000	800000	NO
o–XYLENES	10/27	6600	66000	1,000,000,000	800000	NO
OTHER (mg/kg)						
TOTAL PETROLEUM HYDROCARBONS	15/27	1141	15000	NA	2500	YES

Notes:

[a] Field analytical subsurface soil sampling locations TS–01 to TS–15; at some locations, samples were collected at more then one depth.

NA = Not available

μg/kg = micrograms per kilogram; mg/kg = milligram per kilogram

MCP = Massachusetts Contingency Plan

Shaded values exceed background limit

TABLE 4.3-5
HUMAN HEALTH PRE EVALUATION OF GROUNDWATER
SA 49 - BUILDING 3602 LUST SITE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	GROUNDWATER BACKGROUND CONCENTRATION (µg/L)	DETECTED CONCENTRATION [a]		FREQUENCY OF DETECTION	MAXIMUM EXCEEDS BACKGROUND?	DRINKING WATER STANDARD/GUIDELINE [b] (µg/L)	MAXIMUM EXCEEDS STANDARD/ GUIDELINE?
		AVERAGE (µg/L)	MAXIMUM (µg/L)				
ORGANICS							
ETHYLBENZENE		35.7	100	5/14		700	NO
TOLUENE		3	40	3/14		1000	NO
XYLENES		73.5	200	6/14		10000	NO
INORGANICS							
CALCIUM	14700	25590	38400	10/10	YES	NA	NA
LEAD	4.25	28.1	50.8	14/14	YES	15	YES
MAGNESIUM	3480	8907	15300	10/10	YES	NA	NA
POTASSIUM	2370	5108	10700	10/10	YES	NA	NA
ANIONS/CATIONS							
NITRITE/NITRATE	NA	3868.3	27000	10/10	NA	10000	YES
OTHER							
TOTAL PETROLEUM HYDROCARBONS	NA	213	213	1/5	NA	1000	NO
TOTAL SUSPENDED SOLIDS	NA	583000	1820000	9/9	NA	NA	NA

Notes:

[a] Based on unfiltered samples from Round 1 and Round 2

[b] Includes the lowest of either the USEPA or MADEP drinking water standards, or if no federal standard or guideline is available, the Region III tap water concentration

SA 49 is represented by the following monitoring wells: 49M-92-01X, 3602W-01, 3602W-02, 3602W-03, 3602W-04.

NA = Not available

µg/L = micrograms per liter

Shaded values exceed background limit

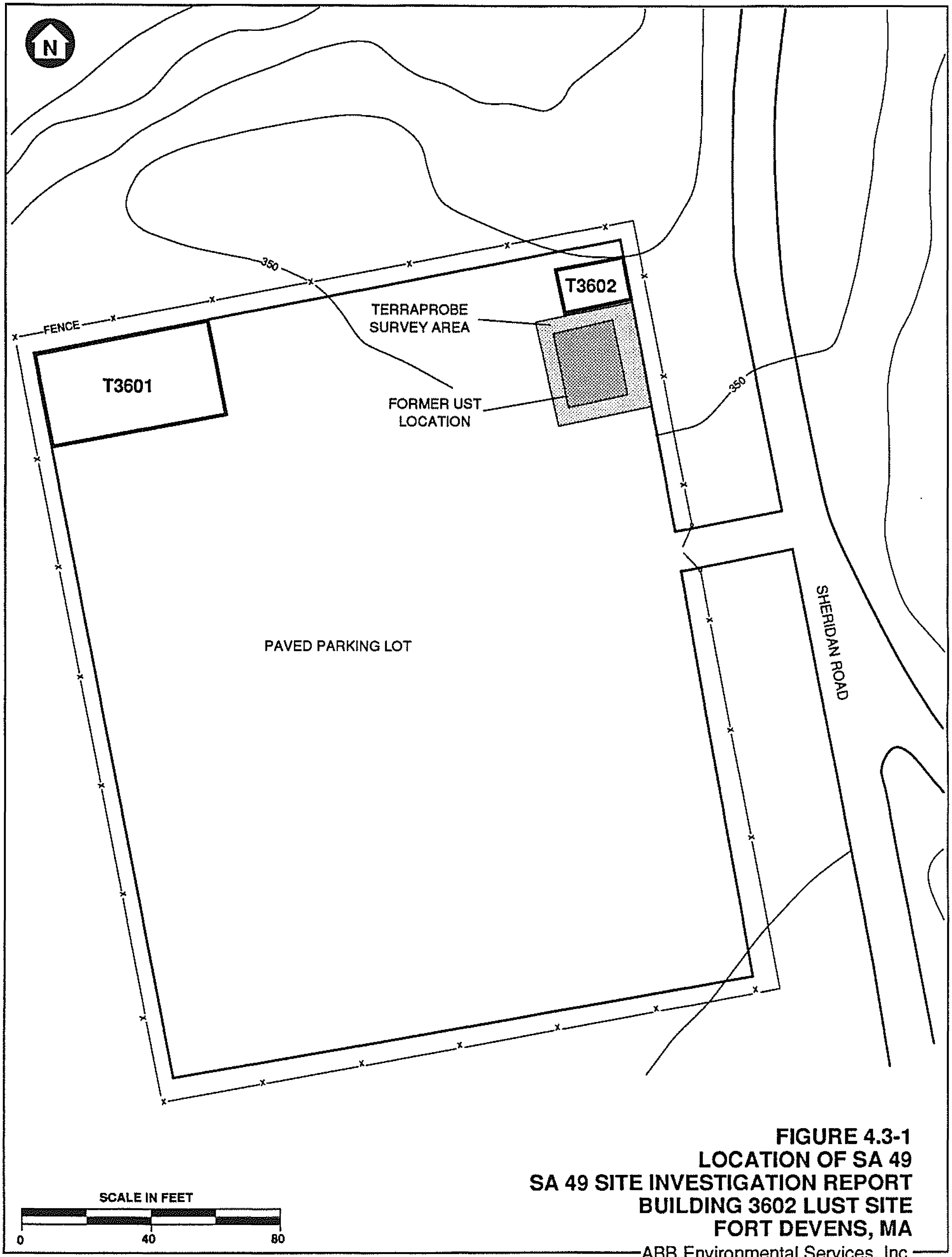

FIGURE 4.3-1
LOCATION OF SA 49
SA 49 SITE INVESTIGATION REPORT
BUILDING 3602 LUST SITE
FORT DEVENS, MA

ABB Environmental Services, Inc.

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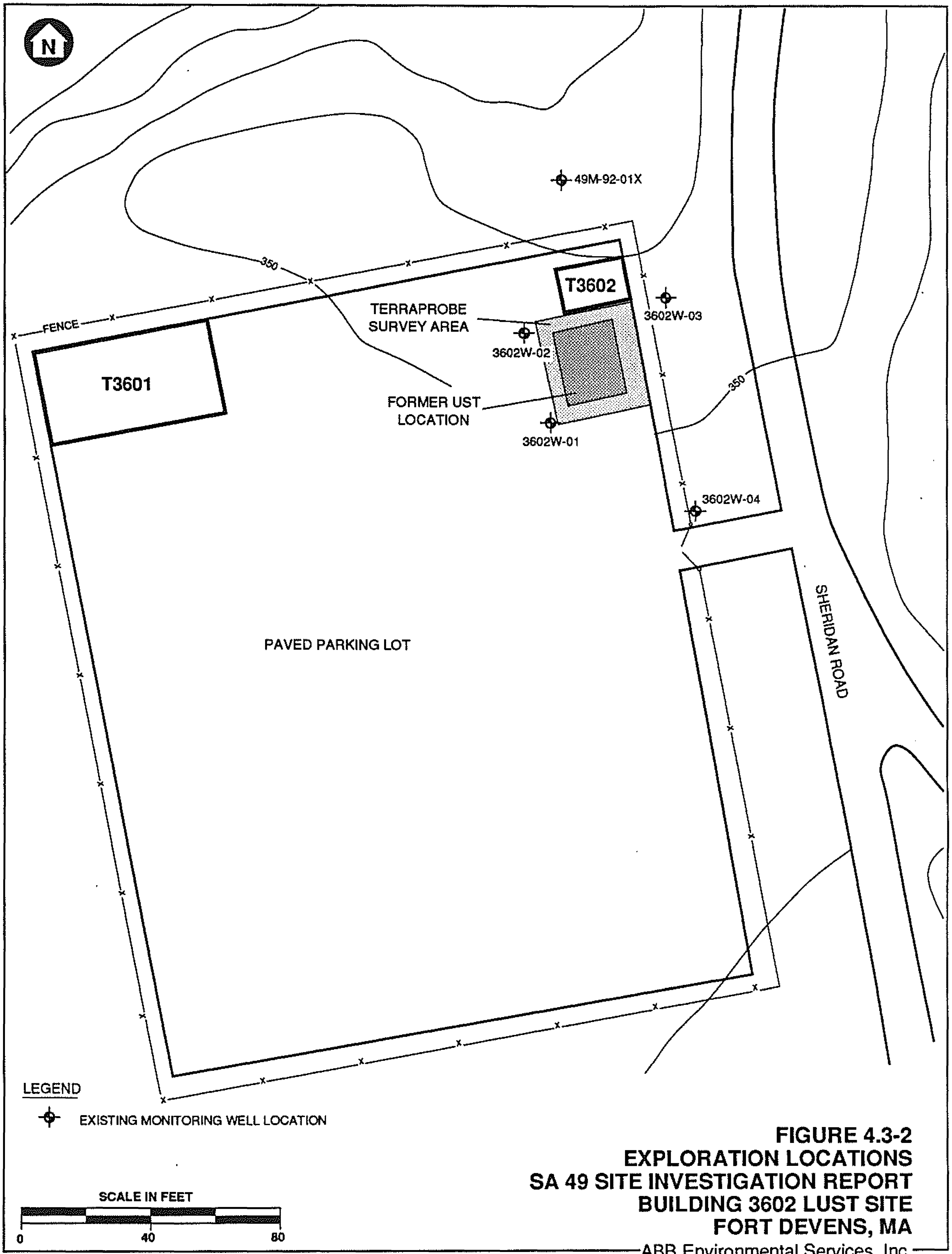


FIGURE 4.3-2
EXPLORATION LOCATIONS
SA 49 SITE INVESTIGATION REPORT
BUILDING 3602 LUST SITE
FORT DEVENS, MA

ABB Environmental Services, Inc.

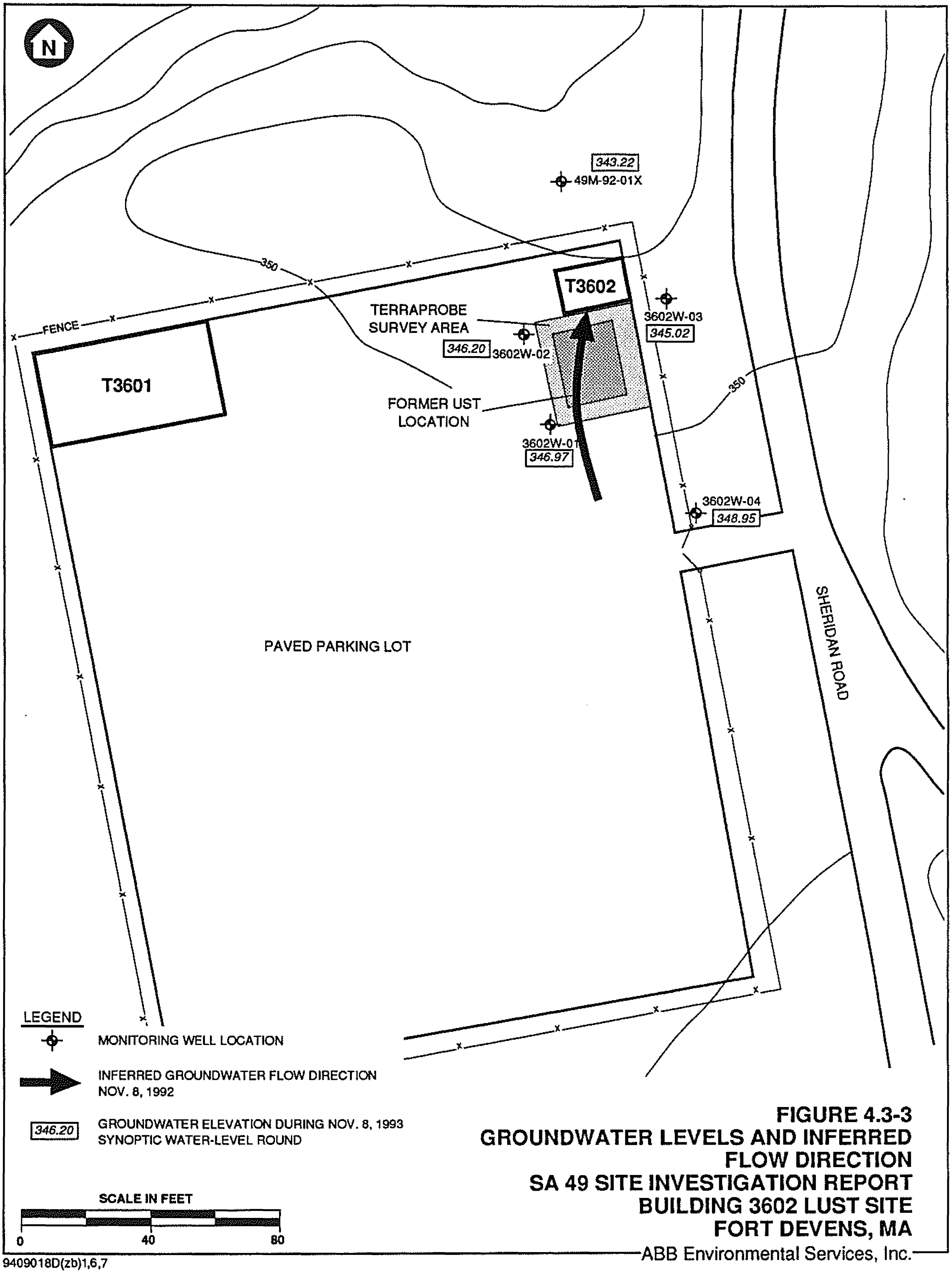


FIGURE 4.3-3
GROUNDWATER LEVELS AND INFERRED
FLOW DIRECTION
SA 49 SITE INVESTIGATION REPORT
BUILDING 3602 LUST SITE
FORT DEVENS, MA
ABB Environmental Services, Inc.

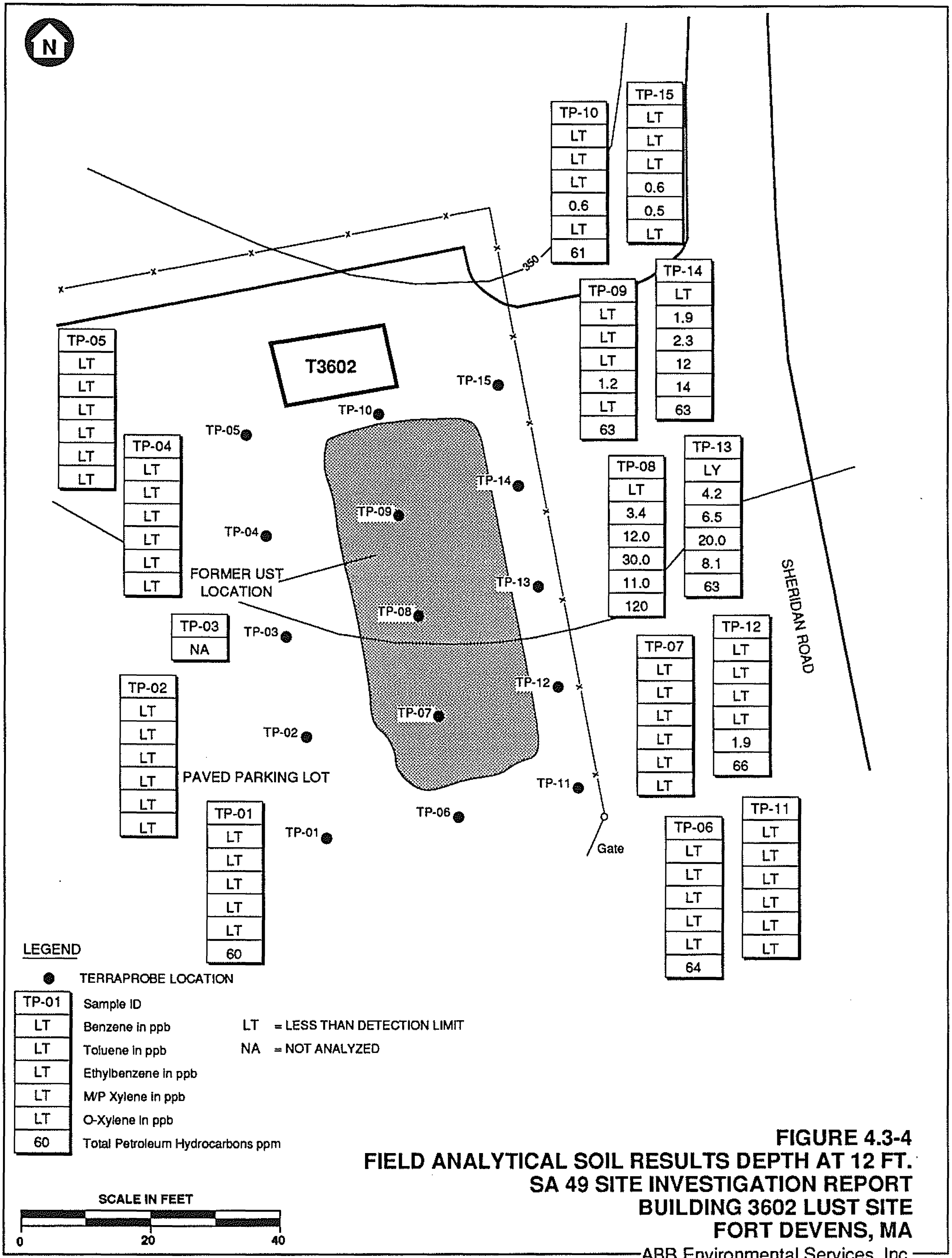
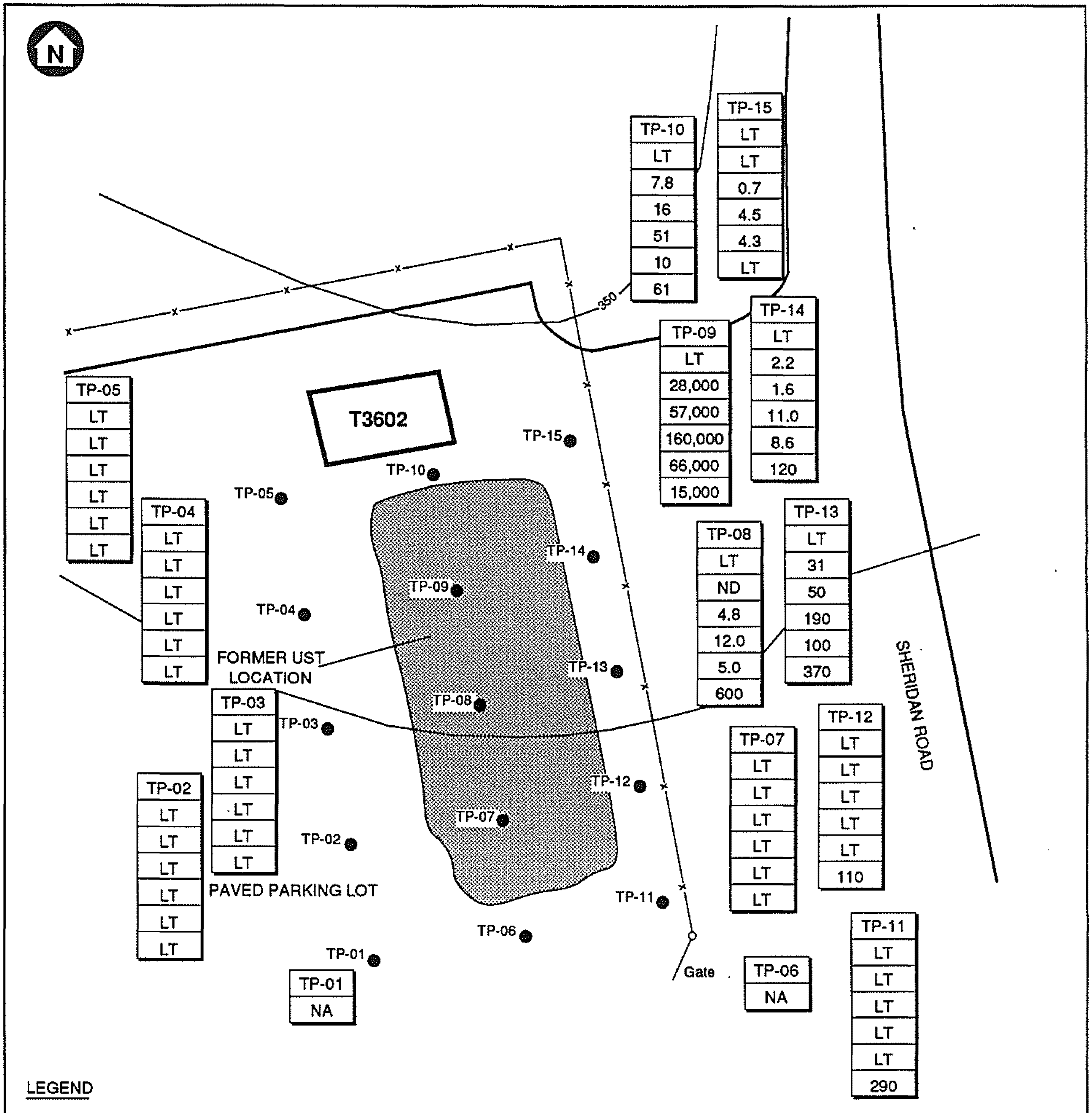


FIGURE 4.3-4
FIELD ANALYTICAL SOIL RESULTS DEPTH AT 12 FT.
SA 49 SITE INVESTIGATION REPORT
BUILDING 3602 LUST SITE
FORT DEVENS, MA

ABB Environmental Services, Inc.



LEGEND

● TERRAPROBE LOCATION

TP-01	Sample ID
LT	Benzene in ppb
LT	Toluene in ppb
LT	Ethylbenzene in ppb
LT	M/P Xylene in ppb
LT	O-Xylene in ppb
60	Total Petroleum Hydrocarbons ppm

LT = LESS THAN DETECTION LIMIT

NA = NOT ANALYZED

SCALE IN FEET

0 20 40

FIGURE 4.3-5
FIELD ANALYTICAL SOIL RESULTS DEPTH AT 13 FT.
SA 49 SITE INVESTIGATION REPORT
BUILDING 3602 LUST SITE
FORT DEVENS, MA

ABB Environmental Services, Inc.

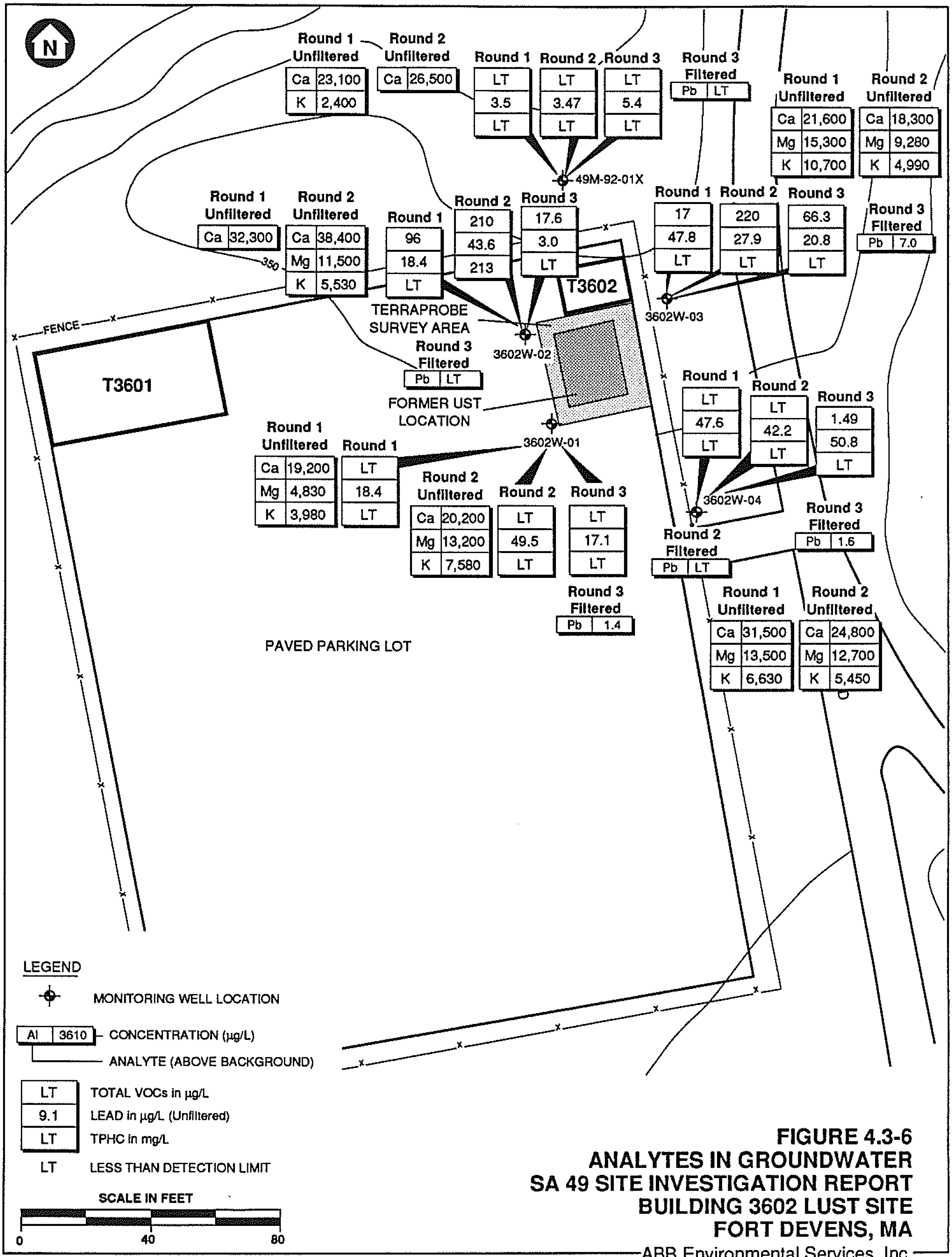


FIGURE 4.3-6
ANALYTES IN GROUNDWATER
SA 49 SITE INVESTIGATION REPORT
BUILDING 3602 LUST SITE
FORT DEVENS, MA

ABB Environmental Services, Inc.

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4.4 SA 56 - BUILDING 2417 LUST SITE

4.4.1 Study Area Background and Conditions

SA 56 is located on an access road west of Givery Road in the central portion of the Main Post (Figure 4.4-1).

In October 1990, a 1,000-gallon UST (used for the storage of No. 2 fuel oil) and approximately 15 cubic yards of contaminated soil were removed by Franklin Environmental Services, Inc. The soil was removed from between the southeast side of Building 2417 and the asphalt access road (Biang, et al., 1992; Kurz Associates, Inc., 1991). Petroleum odors and stained soil were observed in the excavation, and a PID measurement of 60 ppm total VOCs was detected with headspace screening on soil samples from the excavation (Cook and Kurz, 1990). According to Cook and Kurz (1990), no samples were collected for TPHC analysis at that time because soil contamination in the excavation was obvious.

In April 1991, 126 cubic yards of contaminated soil were removed from the previous excavation (Jones, 1991). Soil removal between the road and Building 2417 was terminated because of concern about the stability of Building 2417 when the excavation reached a depth 2 feet below the foundation (Kurz Associates, Inc., 1991). Soil samples from the excavation had TPHC levels of 226 and 234 ppm (Jones, 1991). The excavation was backfilled with clean soil and no further soil removals have been conducted at SA 56.

Building 2417 is presently a warehouse and the area where the heating oil UST was removed is used to park vehicles and/or a garbage dumpster (see Figure 4.4-1).

4.4.2 Study Area Program Summary

The field sampling program conducted at SA 56 consisted of a subsurface soil sampling and field analysis program using ABB-ES' TerraProbe unit to collect the subsurface soil samples, and drilling soil borings and collecting subsurface soil samples for laboratory analysis. A total of 29 subsurface soil samples from 14 TerraProbe points in and around the former UST excavation site were collected (Figure 4.4-2). Up to three soil samples from each TerraProbe point were collected and analyzed on-site with a GC for BTEX and an IR unit for TPHC using a slightly modified form USEPA method 418.1 (Figure 4.4-2). Section 3.2.2 presents the field analytical program conducted at Fort Devens.

The results of the field analyses were used to place two soil borings (56B-92-01X and 56B-92-02X) at the location of highest detected contamination (see Figure 4.4-2). Soil samples were collected continuously with a 2-inch OD split-spoon sampler, to the bedrock surface. Bedrock was encountered at 10.6 feet bgs. Two soil samples from each boring were selected for laboratory analysis based on field analytical results and PID readings. These subsurface soil samples were analyzed for PAL VOCs and TPHC. Bedrock was encountered, prior to reaching the groundwater table, in each of the TerraProbe points and soil borings.

4.4.3 Field Investigation Results and Observations

The area is largely blanketed by unconsolidated surficial deposits of glacial and post-glacial origin. The surficial glacial units consist of till, deltaic deposits of glacial Lake Nashua, and glacial stream deposits (Jahns, 1953).

Bedrock at SA 56 has been mapped as the generally north-south striking Oakdale Formation, consisting of low grade (below biotite isograd) calcareous and ankeritic metasiltstone and phyllite and commonly deformed by kink banding (Zen, 1983; Robinson and Goldsmith, 1991). The rock unit is called Merrimack Formation by Russell and Allmendinger (1975) and G.R. Robinson (1978). The Oakdale (Merrimack) Formation crops out southwest of SA 56, most visibly on Route 2 just east of the Jackson Gate exit. A description of the Main Post geology is presented in Section 2.0.

Borings 56B-92-01X and 56B-92-02X were drilled at the former UST excavation. Clean gravelly sands were penetrated to depths of approximately 6.5 to 7 feet, and from 7 feet to refusal (11 feet) the soil was dense, gravelly sandy-silt and silty-sand. It is likely that the shallow material is artificial fill associated with the former UST and subgrade or backfill for Building 2417, whereas the deeper material has the characteristics of glacial till. Grain size analysis of a sample from depth 9 to 11 feet bgs in 56B-92-01X revealed silty sand with 21.1 percent gravel, and 22.9 percent fines. A sample from depth 10 to 12 feet bgs in 56B-92-02X is a sandy silt with 35.4 percent sand and 10.5 percent gravel. The boring log for each of these borings is provided in Appendix B, and grain size results are provided in Appendix J.

SA 56 is located on the east side of a bedrock high which Engineering Technologies Associates, Inc. (1992, Figures III-22 and III-23) has modeled as a groundwater recharge area. According to the model, groundwater at SA 56 flows generally eastward toward Mirror Lake (which occupies a glacial kettle hole), then southward and eventually westward to the Nashua River (south of Route 2).

Groundwater in the surficial aquifer at the facility has been assigned to Class I under Commonwealth of Massachusetts regulations. Class I consists of groundwaters that are "found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated as a source of potable water supply" (314 CMR 6.03).

4.4.4 Nature and Distribution of Contamination (Field Screening and Laboratory Results)

4.4.4.1 Field Screening Results. The objective of the subsurface soil sampling (via TerraProbe) and field analysis program was to determine the vertical and horizontal distribution of residual fuel contamination around the former UST location. All of the subsurface soil samples were analyzed in the field for BTEX and TPHC.

The results of the field analysis for the subsurface soil samples, indicated that residual fuel-related contamination was present in and around the former UST from 5 feet to 8 feet bgs. The results for soil samples collected below 8 feet indicate that the contaminants detected above have not migrated vertically.

The results of the field analysis from each TerraProbe point are presented in Table 4.4-1. Groundwater was not encountered during the TerraProbe soil sampling program. The distribution of the contamination appears to indicate that the soil below 8 feet, which appears to be a glacial till, has not been contaminated by the residual fuel-related contaminants detected above. This glacial till appears to be hindering the migration of the contaminants from the shallow soil to the bedrock and eventually the groundwater. Figures 4.4-3 through 4.4-5 show the distribution of contaminants detected by field analysis.

4.4.4.2 Laboratory Results. Based on the field analytical results presented above two soil borings were drilled in the presumed "hot spot." Two subsurface soil samples were collected from these soil borings to confirm the field analytical data and further define the geologic conditions at SA 56 (see Figure 4.4-2). The samples collected from these borings were analyzed for PAL VOCs and TPHC. The laboratory results correlated well with the field analytical results, indicating that the soil above 8 feet is contaminated with TPHC, but the glacial till below has not been adversely impacted by the TPHC contamination. Concentrations of TPHC detected in the two soil samples collected from 7 feet to 9 feet bgs, ranged from 56.1 μg/g in 56B-92-01X to 1,440 μg/g in 56B-92-02X. Concentrations of TPHC detected in the samples collected from 9 feet to 13 feet ranged from 34.1 μg/g to 34.4 μg/g (Table 4.4-2; Figure 4.4-6).

Because the till layer appears to be inhibiting the residual fuel-related contaminants from migrating to the bedrock and therefore the groundwater, the four monitoring wells outlined in the Final Groups 2 and 7 Work Plan were not installed.

4.4.5 Source Evaluation and Migration Potential

The objective of sampling program was to investigates the distribution of contamination in the subsurface soils and, if needed, groundwater at SA 56. The potential migration pathway for the fuel contamination is via surface water infiltration and percolation through the contaminated overburden soil and into the groundwater. Subsurface soil samples were collected for field and laboratory analysis to determine the distribution of contamination.

Petroleum-related organic compounds were detected in the field analytical samples and the soil samples submitted for laboratory chemical analysis. The field analytical results identified the area of contamination, both vertically and horizontally, at SA 56. These field analytical results were confirmed by laboratory analysis results for subsurface soil samples collected from the two soil borings made at SA 56 (see Figure 4.4-6). The contaminants appear to be confined to the upper 8 feet of the soil around the location of the former UST. The data indicate that the contaminants have not migrated into or through the glacial till layer. Based upon these results it does not appear that the contamination has migrated into the groundwater, which appears to be in the bedrock at SA 56.

4.4.6 Preliminary Human Health Risk Evaluation

A preliminary human health risk evaluation was prepared for SA 56 to determine if the contaminants detected at this SA pose a risk to human receptors. For this PRE, the future use of SA 56 is assumed to be residential. Table 4.4-3 presents summary statistics and human health standards and guidelines used in the PRE for SA 56.

4.4.6.1 Soils. As discussed in Section 3.5 (Preliminary Risk Evaluation Methodology), all soils collected from 3-15 feet in depth are classified as subsurface and are considered to be accessible under a commercial/industrial future use exposure scenario.

Table 4.4-1 presents field-screening data for Terraprobe soil samples. Based on these screening data, two subsurface soil borings in presumed "hot spots" were collected for analysis. Table 4.4-3 presents summary statistics on the subsurface soil borings at SA 56 and USEPA Region III commercial/industrial soil concentrations for comparison. Subsurface soil at SA 56 was represented by samples 56B-92-01X and 56B-92-02X; samples from two depths were collected at each location.

Eleven TerraProbe soil samples were collected at a depth of 5 feet in the unsaturated zone. Samples collected at TP-03, TP-04 TP-10, TP-11, TP-12, and TP-13 were located in the vicinity of the tank excavation. Toluene, ethylbenzene, and/or xylenes were detected at the 5 foot depths during the field-screening at locations TP-03, TP-10, and TP-13. TPHC was detected above the method detection limit in 8 of the 11 samples. The maximum detected concentration of TPHC was 3,800 ppm at TP-13 (see Table 4.4-1; see Figure 4.4-3).

Seven field-screening TerraProbe soil samples were collected at a depth of 8 to 9 feet in the unsaturated zone. TPHC was detected above the method detection limit in 4 of the 7 samples at a maximum concentration of 1470 ppm at TP-11. Ethylbenzene and xylenes were detected in the 8 to 9 foot interval at TP-11 and TP-12. The maximum detected concentrations of ethylbenzene and xylenes at these locations were 83.936 parts per billion (ppb) and 217.3 ppb (total xylenes), respectively.

Eleven Terraprobe soil samples were also collected at a depth of 10 to 11 feet in the unsaturated zone. No significant concentrations of organics were detected.

The maximum detected concentrations of toluene, ethylbenzene, and xylenes in the Terraprobe soil samples (across all depths) were 29 ppb, 189.2 ppb, and 1030 ppb, respectively. These concentrations are below the USEPA Region III commercial/industrial soil concentrations for toluene, ethylbenzene, and xylenes of 200,000 ppm, 100,000 ppm, and 2,000,000 ppm (mixed xylenes), respectively.

Based on these screening activities, two subsurface soil borings in presumed "hot spots" were collected for analysis. An assessment of the organic compound data for SA 56 soil borings showed that there was limited contamination associated with the soils currently in the location of the former heating oil UST. Acetone was detected at 56B-92-01X at 0.035 μg/g. This concentration of acetone, however, is below the USEPA Region III commercial/industrial soil concentration and is not considered a potential risk to public health.

Soil borings from locations 56B-92-01X and 02X indicated residual TPHC contamination from the former UST up to 1,440 μg/g at a depth of 7 feet. Below 9 feet, subsurface soil samples showed maximal residual TPHC contamination at 34.1 μg/g.

To evaluate the health risk associated with TPHC in soil, ABB-ES developed risk-based concentrations for petroleum products. These concentrations were calculated using the same exposure assumptions as those used by USEPA toxicologists in the USEPA Region III Risk-Based Concentration Table, First Quarter 1993, for commercial/industrial soils. Dose response values for diesel oil used in the calculations are provisional values developed by USEPA, Environmental Criteria and Assessment Office (USEPA, 1992a). USEPA suggests using the reference dose value for diesel oil as a surrogate for No. 2 fuel oil. The risk-based commercial/industrial soil value for No. 2 fuel oil is given in the following table:

Analyte	Residential Soil (μg/g)	Commercial/Industrial Soil (μg/g)
No. 2 Fuel Oil	630	8180

The maximum detected TPHC concentration in soil at SA 56 (3800 μg/g) is below the risk-based commercial/industrial soil concentration of 8180 μg/g and, therefore, is not expected to pose an unacceptable risk to public health. A preliminary ecological risk evaluation was not prepared for SA 56 because the contaminants detected at this SA appear to be confined to subsurface soil, and are not anticipated to impact any ecological receptors.

4.4.7 Conclusions and Recommendations

The field investigation conducted at SA 56 identified TPHC contamination in soil adjacent to the former UST excavation. Based on this finding of the field investigation, and the results of the human health PRE, no unacceptable risk to human health was identified. There is no ecological habitat in the vicinity of SA 56, so an ecological PRE was not necessary. In considering future property value and potential purchase prospects, the Army has proposed that a removal action (focused on TPHC) with engineering considerations (i.e. building demolition, utility removal, etc.) be conducted at this location.

TABLE 4.4-1
FIELD SCREENING RESULTS
SA 56 – BUILDING 2417 LUST SITE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SAMPLE ID	SA	MEDIUM	SITE ID	DEPTH (feet)	TPH ppm	TOTAL BETX ppb	BEN* ppb	TOL* ppb	E-BEN* ppb	M/P XYL** ppb	O-XYL* ppb	COMMENTS
56TSX01XX501XF	56	SOIL	TP-01	5	< 55	0	ND	ND	ND	ND	ND	
56TSX01X1001XF	56	SOIL	TP-01	10	< 56	0	ND	ND	ND	ND	ND	
56TSX02XX901XF	56	SOIL	TP-02	9	< 50	0	ND	ND	ND	ND	ND	
56TSX03XX501XF	56	SOIL	TP-03	5	188	2	ND	2.2	ND	ND	ND	
56TSX03X1001XF	56	SOIL	TP-03	10	< 56	0	ND	0.4	ND	ND	ND	
56TSX04XX501XF	56	SOIL	TP-04	5	93	0	ND	ND	ND	ND	ND	
56TSX04X1001XF	56	SOIL	TP-04	10	< 55	0	ND	ND	ND	ND	ND	
56TSX05XX501XF	56	SOIL	TP-05	5	< 56	0	ND	ND	ND	ND	ND	
56TSX05X1001XF	56	SOIL	TP-05	10	< 56	0	ND	ND	ND	ND	ND	
56TSX06XX501XF	56	SOIL	TP-06	5	< 55	0	ND	ND	ND	ND	ND	
56TSX06X1001XF	56	SOIL	TP-06	10	< 57	0	ND	ND	ND	ND	ND	
56TSX07XX901XF	56	SOIL	TP-07	9	< 55	0	ND	ND	ND	ND	ND	
56TSX08XX901XF	56	SOIL	TP-08	9	< 56	0	ND	ND	ND	ND	ND	
56TSX09XX501XF	56	SOIL	TP-09	5	< 56	0	ND	ND	ND	ND	ND	
56TSX09X1001XF	56	SOIL	TP-09	10	< 52	0	ND	ND	ND	ND	ND	
56TSX10XX501XF	56	SOIL	TP-10	5	2780	1229	ND	29	170	700	330	HEAVY HC
56TSX10X1001XF	56	SOIL	TP-10	10	< 52	0	ND	ND	ND	ND	ND	HEAVY HC
56TSX11XX501XF	56	SOIL	TP-11	5	3480	0	ND	ND	ND	ND	ND	HEAVY HC
56TSX11XX801XF	56	SOIL	TP-11	8	1470/1100	4	ND	ND	0.8	2.2	0.79	HEAVY HC
56TSX11X1001XF	56	SOIL	TP-11	10	< 56	0	ND	ND	ND	ND	ND	
56TSX12XX501XF	56	SOIL	TP-12	5	320	0	ND	ND	ND	ND	ND	
56TSX12XX801XF	56	SOIL	TP-12	8	1390	301	ND	BDL	83.9	155.9	61.4	HEAVY HC

TABLE 4.4–1
FIELD SCREENING RESULTS
SA 56 – BUILDING 2417 LUST SITE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SAMPLE ID	SA	MEDIUM	SITE ID	DEPTH (feet)	TPH ppm	TOTAL BETX ppb	BEN* ppb	TOL* ppb	E–BEN* ppb	M/P XYL** ppb	O–XYL* ppb	COMMENTS
56TSX12X1101XF	56	SOIL	TP–12	11	< 54	0	ND	ND	ND	ND	ND	
56TSX13XX501XF	56	SOIL	TP–13	5	3800	615	ND	BDL	189.2	220.9	205.3	HEAVY HC
56TSX13XX801XF	56	SOIL	TP–13	8	90	0	ND	ND	ND	ND	ND	
56TSX13X1001XF	56	SOIL	TP–13	10	< 55	0	ND	ND	ND	ND	ND	
56TSX14XX501XF	56	SOIL	TP–14	5	90	0	ND	ND	ND	ND	ND	
56TSX14XX801XF	56	SOIL	TP–14	8	< 60	0	ND	ND	ND	ND	ND	
56TSX14X1001XF	56	SOIL	TP–14	10	< 55	0	ND	ND	ND	ND	ND	

Notes:

* = ND denotes a non detect or concentrations below 5 ppb.

** = ND denotes a non detect or concentrations below 10 ppb.

\# = Study area

< Less than detection limit shown

TABLE 4.4–2
ORGANIC COMPOUNDS IN SOIL
SA 56 – BUILDING 2417 LUST SITE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BACK– GROUND	BORING DEPTH	56B–92–01X 7 FT	56B–92–01X 9 FT	56B–92–02X 7 FT	56B–92–02X 9 FT
VOLATILES (ug/g)						
ACETONE			< 0.017	0.035	< 0.017	< 0.017
OTHER (ug/g)						
TOTAL PETROLEUM HYDROCARBON			56.1	34.4	1440.0	34.1

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT ANALYTE LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

TABLE 4.4–3
HUMAN HEALTH PRE EVALUATION OF SUBSURFACE SOIL
SA 56 – BUILDING 2417 LUST SITE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Detected Concentration [a] Average (ug/g)	Detected Concentration [a] Maximum (ug/g)	Frequency of Detection	Region III Commercial/Industrial Concentration (ug/g)	Maximum Exceeds Region III Concentration?
Organics					
Acetone	0.035	0.035	1/4	100,000	NO
Other					
Total Petroleum Hydrocarbons [b]	391.2	1440	4/4	8,180	NO

Notes:

[a] Subsurface soil sample from sampling station 56B–92–01X and 56B–92–02X

[b] The Region III Commercial/Industrial soil equation parameters were used by ABB to calculate a value for Diesel fuel.
This value was used as a surrogate for No. 2 fuel oil that was associated with the SA.
See associated text for additional information.

NA = not available

ug/g = micrograms per gram

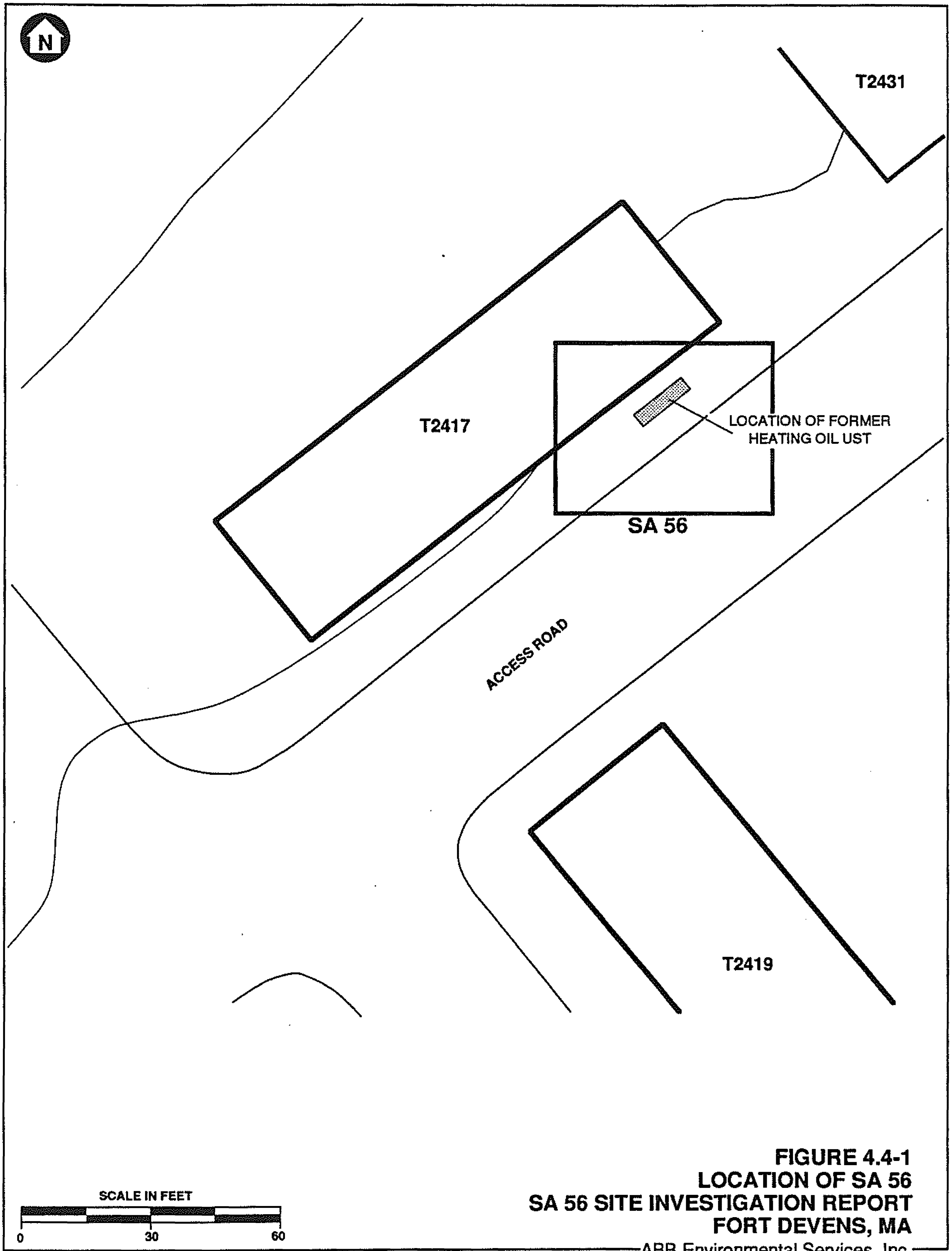

FIGURE 4.4-1
LOCATION OF SA 56
SA 56 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

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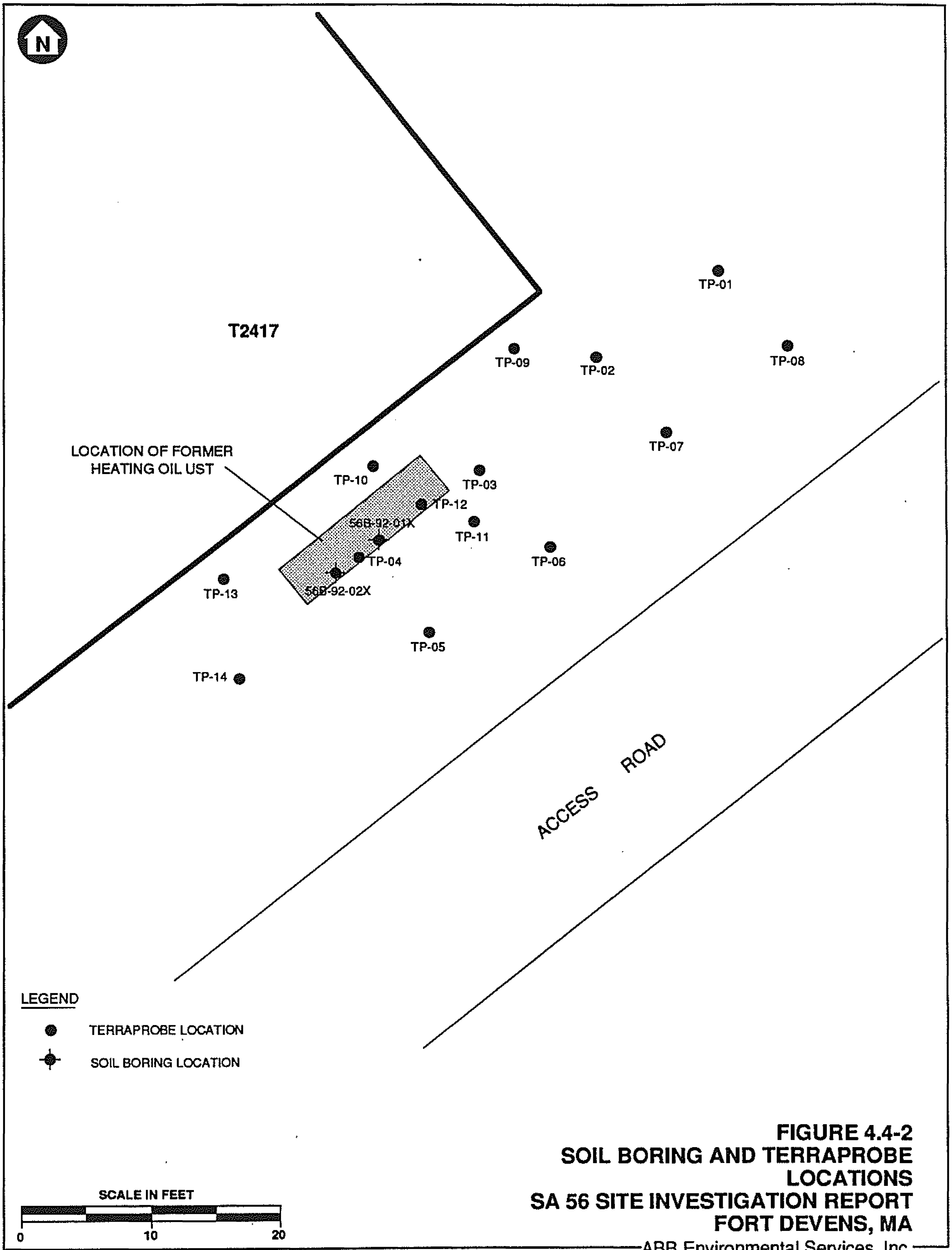

FIGURE 4.4-2
SOIL BORING AND TERRAPROBE LOCATIONS
SA 56 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

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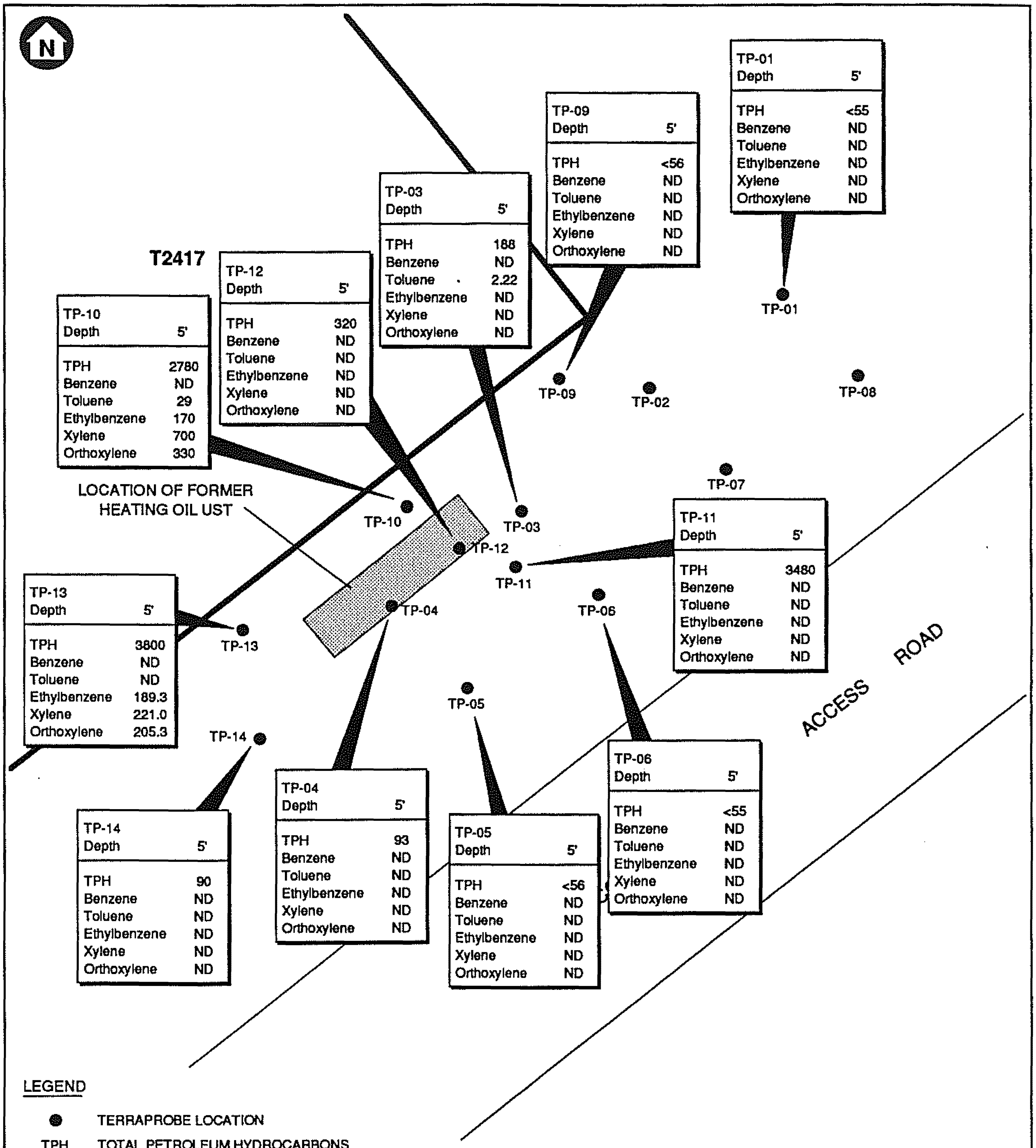


LEGEND

●	TERRAPROBE LOCATION
TPH	TOTAL PETROLEUM HYDROCARBONS
ND	NON DETECT

NOTES

TPH CONCENTRATIONS IN ppm

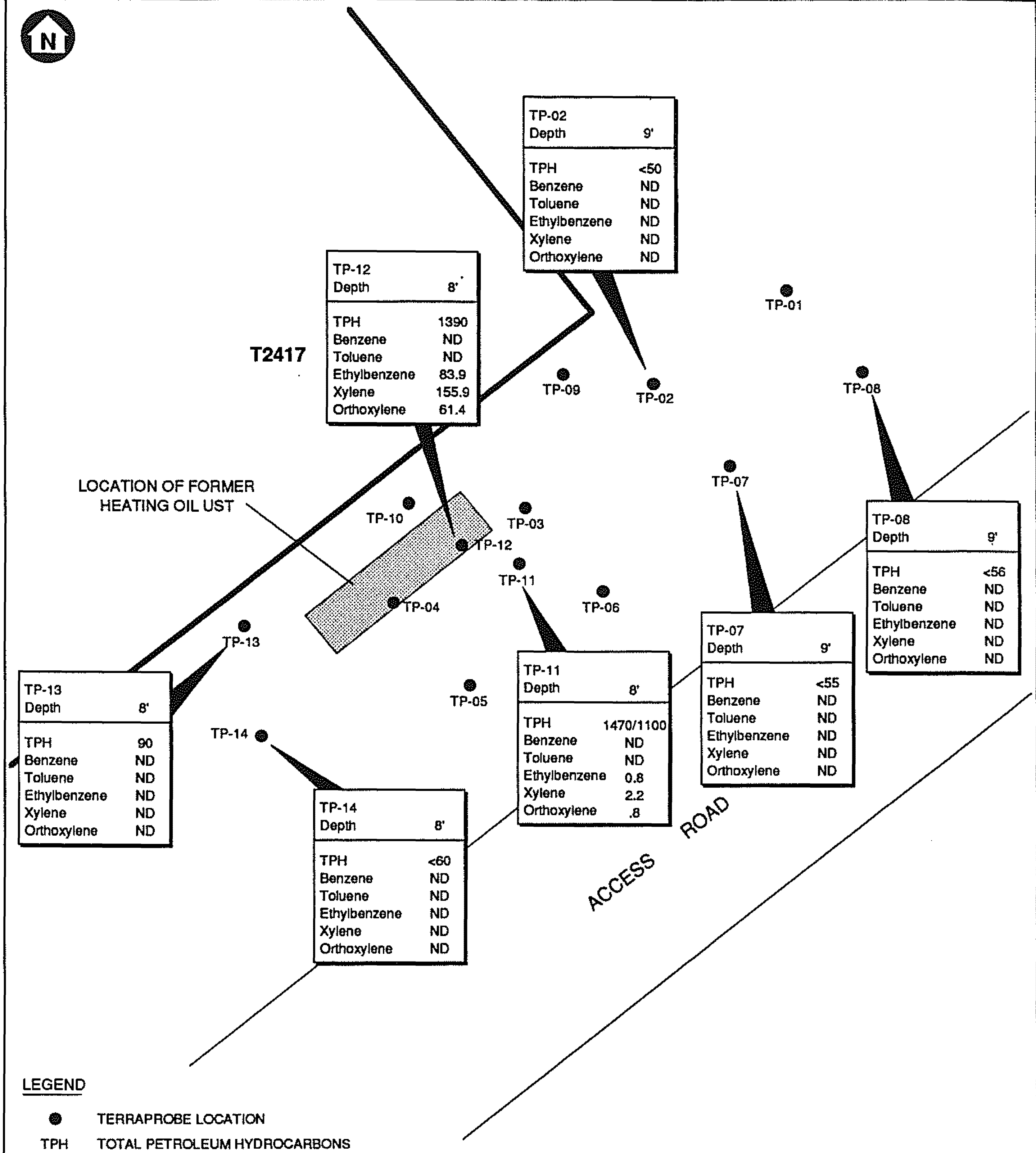
BTEX CONCENTRATIONS IN ppb

SCALE IN FEET

0 10 20

FIGURE 4.4-3
FIELD SCREENING RESULTS
DEPTH AT 5 FT
SA 56 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.



TP-02	
Depth	9'
TPH	<50
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-12	
Depth	8'
TPH	1390
Benzene	ND
Toluene	ND
Ethylbenzene	83.9
Xylene	155.9
Orthoxylene	61.4

TP-08	
Depth	9'
TPH	<56
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-07	
Depth	9'
TPH	<55
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-11	
Depth	8'
TPH	1470/1100
Benzene	ND
Toluene	ND
Ethylbenzene	0.8
Xylene	2.2
Orthoxylene	.8

TP-13	
Depth	8'
TPH	90
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-14	
Depth	8'
TPH	<60
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

LEGEND

●	TERRAPROBE LOCATION
TPH	TOTAL PETROLEUM HYDROCARBONS
ND	NON DETECT

NOTES

TPH CONCENTRATIONS IN ppm

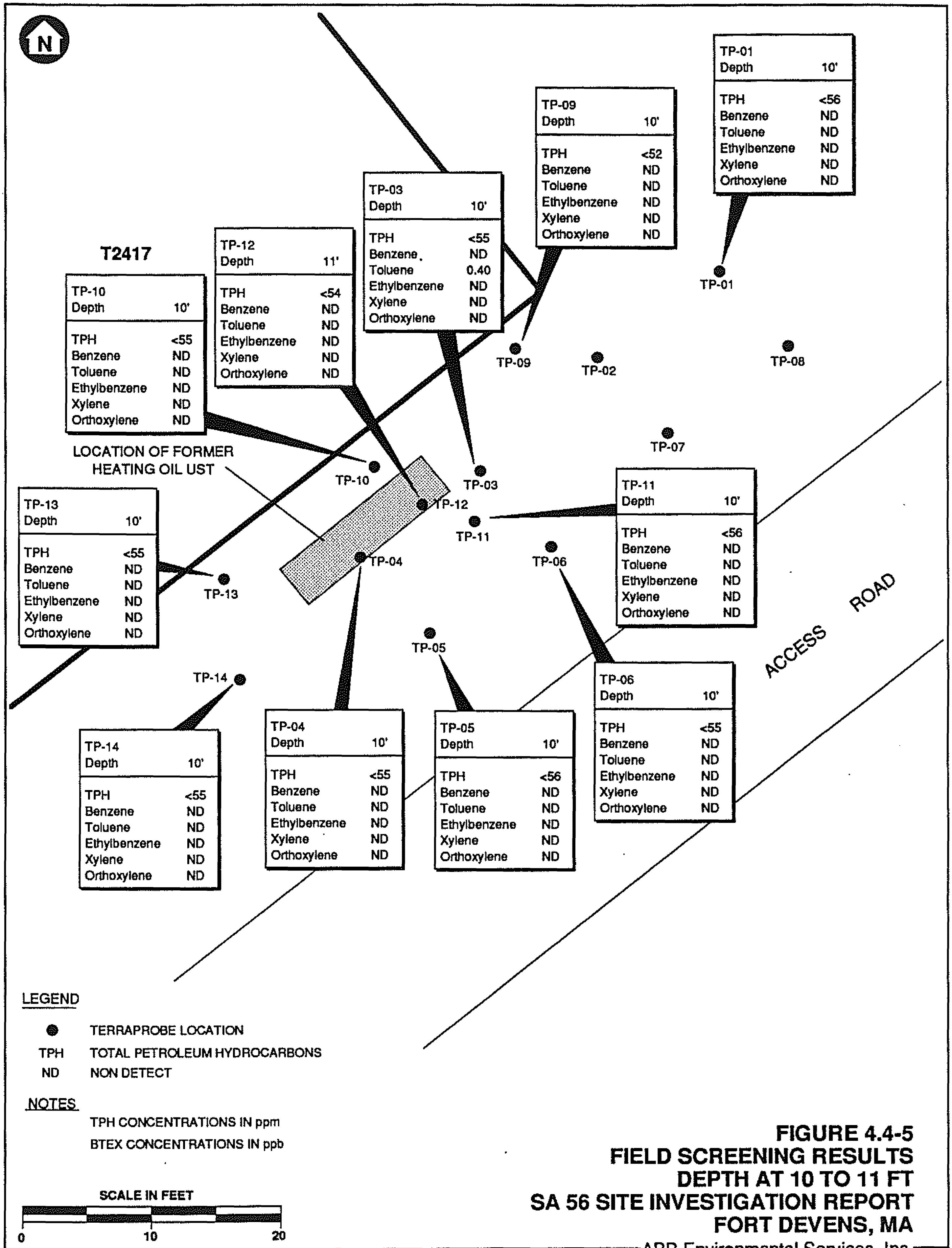
BTEX CONCENTRATIONS IN ppb

SCALE IN FEET

0 10 20

FIGURE 4.4-4
FIELD SCREENING RESULTS
DEPTH AT 8 TO 9 FT
SA 56 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.



TP-01	
Depth	10'
TPH	<56
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-09	
Depth	10'
TPH	<52
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-03	
Depth	10'
TPH	<55
Benzene	ND
Toluene	0.40
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-12	
Depth	11'
TPH	<54
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-10	
Depth	10'
TPH	<55
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-13	
Depth	10'
TPH	<55
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-11	
Depth	10'
TPH	<56
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-06	
Depth	10'
TPH	<55
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-14	
Depth	10'
TPH	<55
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-04	
Depth	10'
TPH	<55
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

TP-05	
Depth	10'
TPH	<56
Benzene	ND
Toluene	ND
Ethylbenzene	ND
Xylene	ND
Orthoxylene	ND

LEGEND

●	TERRAPROBE LOCATION
TPH	TOTAL PETROLEUM HYDROCARBONS
ND	NON DETECT

NOTES

TPH CONCENTRATIONS IN ppm

BTEX CONCENTRATIONS IN ppb

FIGURE 4.4-5
FIELD SCREENING RESULTS
DEPTH AT 10 TO 11 FT
SA 56 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

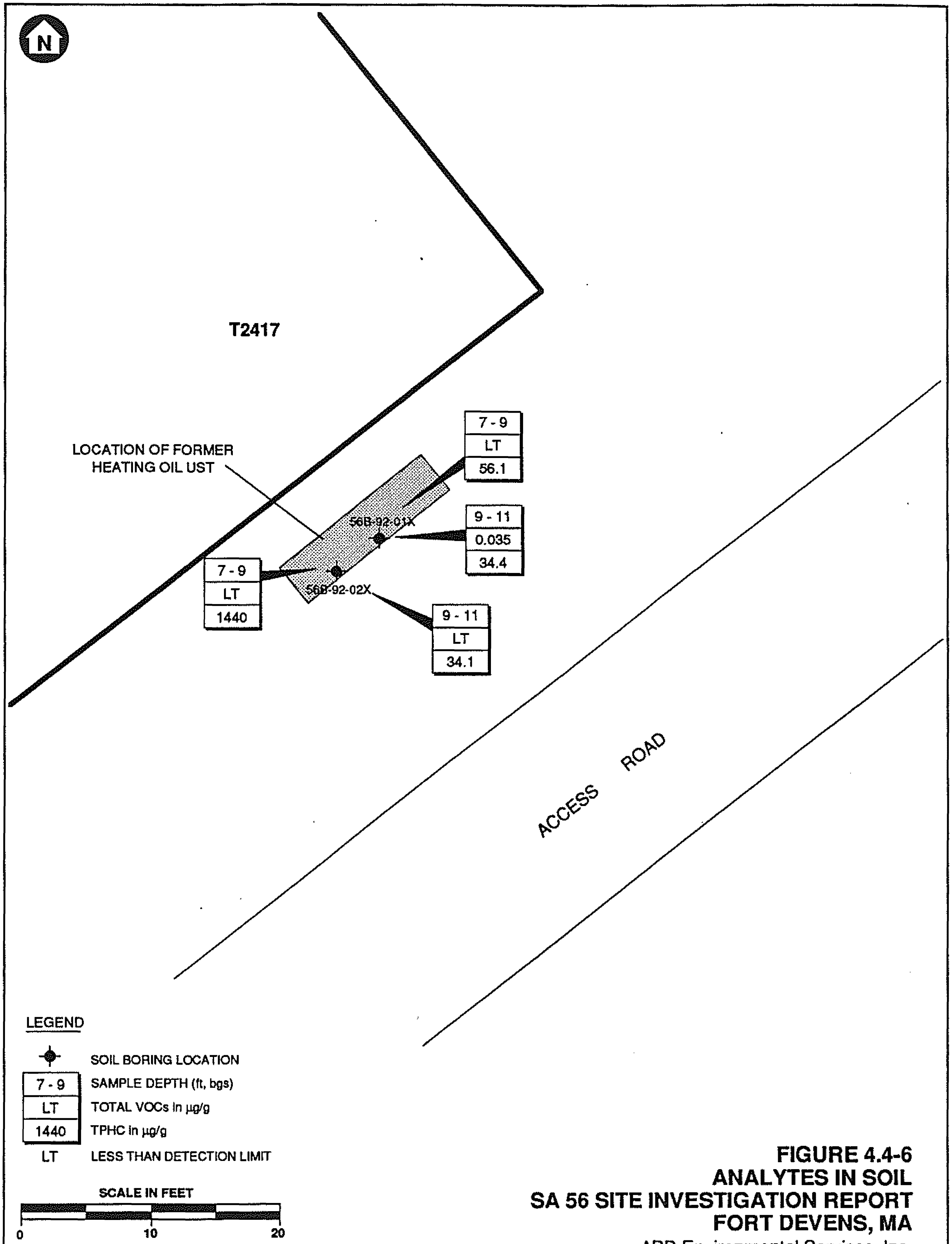


FIGURE 4.4-6
ANALYTES IN SOIL
SA 56 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

4.5 SA 57 - BUILDING 3713 FUEL OIL SPILL

4.5.1 Study Area Background and Conditions

SA 57 is located on the right side of Barnum Road south of Building 3713 on the eastern side of the Main Post. SA 57 is comprised of two areas. Area 1 is the storm drain outfall which collects rainfall from the paved areas around Building 3713. The runoff from the storm drains is collected and runs to the outfall at Area 1 and eventually flows to Cold Spring Brook. Area 2 is located 800 feet north of Area 1 and adjacent to a vehicle storage yard associated with Buildings 3757 and 3758. This area consists of an eroded drainage ditch created by periodic rain runoff. The runoff flows into the ditch and flows east and outfalls into Cold Spring Brook (Figure 4.5-1). On February 13, 1977 Fort Devens personnel at Building 3713 noticed No. 4 fuel oil flowing from an accidentally overfilled 30,000-gallon UST and entering a nearby storm drain (Biang et al., 1992; DFAE, 1977). Leakage was stopped and the storm drain was blocked. There was no evidence on February 13 and 14 of more than about 50 to 100 gallons of oil in the potentially affected water courses. Nevertheless, containment dikes and absorbent booms were set up across Cold Spring Brook, and approximately 3,000 gallons of oil and water were recovered from the swamp (DFAE, 1977).

Reportedly, a portion of the spill flowed across Barnum Road to Area 2. However, the slope of the pavement in the spill area is such that the oil could not have flowed overland to Cold Spring Brook, and the spill report made no mention of overland flow. The spilled oil appears to have flowed into the storm drain system around Building 3713 and exited at the outfall in Area 1. Area 2 appears to be unrelated to this spill (Figure 4.5-2).

4.5.2 Study Area Investigation Program Summary

The field sampling program conducted at SA 57 consisted of collecting six surface soil samples (three from Area 1 and three from Area 2) and two surface water and a sediment sample from Cold Spring Brook. One surface water and sediment sample was collected upstream and one was collected downstream, to assess if contaminants from SA 57 were impacting the surface water and sediment quality in Cold Spring Brook. To aid in this assessment, the results of three surface water and sediment samples collected from Cold Spring Brook during the

Group 3 investigation were used (see Figure 4.5-1). Three surface soil samples (57S-92-01X through 57S-92-03X) were collected from the drainage ditch area below the outfall at Area 1 (Figure 4.5-3). A single surface water and sediment sample (57D-92-01X) was collected upstream of the confluence of Cold Spring Brook and the storm water drainage channel (see Figure 4.5-1).

Three surface soil samples (57S-92-06X through 57S-92-08X) were also obtained from the Area 2 drainage ditch to assess the distribution of contaminants along the ditch (Figure 4.5-4). An additional surface water and sediment sample (57D-92-02X) was collected downstream of the confluence of Cold Spring Brook and the northern-most storm drainage channel (see Figure 4.5-1). A second surface water and sediment sample was collected from 57D-92-01X and a second surface water sample, only, was collected from 57D-92-02X during the second round of the Group 2 and 7 groundwater sampling in January. The samples were collected to further define the distribution of contaminants in Cold Spring Brook. A sediment sample was not collected from 57D-92-02X due to unsafe winter field conditions.

The surface soil samples were submitted for laboratory analysis of PAL SVOCs, TPHC, TOC, oil fingerprinting, and grain size. Surface water samples were analyzed for PAL SVOCs, TPHC, and PAL water quality parameters. Sediment samples were analyzed for PAL SVOCs, TPHC, TOC, and grain size. The second set of surface water samples were analyzed for PAL VOCs, PAL SVOCs, inorganics, and TPHC. The additional sediment sample was analyzed for PAL VOCs, PAL SVOCs, inorganics, TPHC, and TOC.

4.5.3 Field Investigation Results and Observations

Although no subsurface explorations were completed at SA 57, the following are believed to be the geologic conditions at SA 57. Bedrock is not exposed at or near SA 57.

Bedrock in this portion of the installation has been mapped as the generally northeast-striking Berwick Formation (Silurian), consisting of calcareous and biotitic metasiltstone and fine-grained metasandstone, interbedded with small amounts of quartz-muscovite-garnet schist and feldspathic quartzite. West of Building 3713 the mapped bedrock unit is the Long Pond-Fort Devens facies of the Ayer Granite, which is a gneissic granite with both equigranular and porphyroblastic varieties (Zen, 1983; Robinson and Goldsmith, 1991). The "granite" may not be intrusive.

The area is blanketed by unconsolidated surficial deposits of glacial and post-glacial origin. The mapped surficial units in the Barnum Road area consist of sands and pebble- to boulder-gravels of glacial streams, and muck and peat swamp deposits (postglacial) near Cold Spring Brook (Jahns, 1953). Till is known to discontinuously underlie some of the water-laid deposits. The till locally ranges from unstratified gravel to silt, its consistency varies from loose to compact, and it is characteristically bouldery (Jahns, 1953). A complete description of the Main Post geology is presented in Section 2.0.

Grain size analyses were run on surface soil samples (57S-92-01X through -03X and 57S-92-06X through -08X) from near the edge of the Cold Spring Brook swamp. The soils may be fill or reworked glacial outwash. Soil types range from well graded sand to silty sand, with fines ranging from 1.6 to 20.2 percent and gravel from 0.7 to 37.9. Water contents varied from 6.7 to 33.7 percent.

Grain size analyses were run on sediment samples (57D-92-01X and -02X), which respectively were a sandy silt and a silty sand (Table 4.5-1). Grain size results are provided in Appendix J.

An installation-wide water-level survey of 139 monitoring wells and 15 surface-water stations was conducted on December 22, 1992. Included in the survey were monitoring wells from Group 3 which is located across Barnum Road from SA 57. The monitoring wells included G3M-92-01X through G3M-92-07X and surface-water/sediment sampling location 57D-92-01X. The results show that groundwater flows directly southeastward from the Building 3713 area to Cold Spring Brook. The water in Cold Spring Brook flows into Grove Pond, Plow Shop Pond, Nonacoicus Brook, and the Nashua River. The data for this water-level round, and previous rounds is provided in Appendix I.

Groundwater in the surficial aquifer at the facility has been assigned to Class I under Commonwealth of Massachusetts regulations. Class I consists of groundwaters that are "found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated as a source of potable water supply" (314 CMR 6.03).

4.5.4 Nature and Distribution of Contamination (Laboratory Results)

The objective of sampling program was to investigates the distribution of contamination in the surface soils at Area 1 and Area 2 and surface water and sediment in Cold Spring Brook upstream and downstream of SA 57. The primary concern at SA 57 is fuel contamination from two sources: (1) the outfall of a storm drain at Area 1; and (2) the residual surface soil contamination left behind from past releases, unrelated to the 1977 fuel oil spill, at Area 2. The sampling program was designed to assess if contaminants were migrating to Cold Spring Brook and adversely impacting the surface water and sediment quality. The potential migration pathway for the fuel contamination is through mechanical transport of contaminated sediments in surface water runoff from Areas 1 and 2 into Cold Spring Brook.

4.5.4.1 Surface Soil. Three surface soil samples (57S-92-01X, 57S-92-02X and 57S-92-03X) were collected from Area 1 and three surface soil samples (57S-92-06X, 57S-92-07X and 57S-92-08X and its duplicate) were collected from Area 2 (see Figures 4.5-3 and 4.5-4). Samples planned for locations 57S-92-04X and 57S-92-05X were used at sediment sampling locations 57D-92-01X and 57D-92-02X. Surface water samples 57D-92-01X and 57D-92-02X were added to the sampling program at SA 57.

Several PAHs were detected in surface soil samples collected from 57S-92-02X and 57S-92-03X in Area 1. The total PAH detected ranged from 35.5 μg/g in 57S-92-02X to 36.0 μg/g in 57S-92-03X. TPHC was detected in all three surface soil samples collected. TPHC concentrations ranged from 1,410 μg/g in 57S-92-02X to 2,210 μg/g in 57S-92-03X (Table 4.5-2; Figure 4.5-5).

Naphthalene (0.3 μg/g) was the only SVOC detected in the surface soil samples collected from Area 2. TPHC was detected in all three samples ranging from 606 μg/g in 57S-92-08X to 4,910 μg/g in the duplicate soil sample at 57S-92-07X. Petroleum fingerprinting analysis on the six samples resulted in detection of higher molecular weight hydrocarbons suggesting machine and/or lubricating oil sources (see Table 4.5-2; Figure 4.5-6).

4.5.4.2 Surface Water and Sediment. Four surface water samples were collected from Cold Spring Brook as part of the field investigation at SA 57. Two surface water samples were collected from 57D-92-01X, upstream of Area 1, and two from 57D-92-02X, downstream of Area 2 (see Figure 4.5-1). Three additional surface water samples were collected from Cold Spring Brook during the Group 3 investigations. Chloroform was detected at 1.1 μg/L in the second surface water sample collected from 57D-92-01X. No other organic compounds were detected in the surface water samples collected. Cation/anion concentrations appear to remain relatively constant in each sample collected from Cold Spring Brook. Inorganic analytes detected in the second samples collected from 57D-92-01X compared well with the inorganic detected in G3D-92-01X. Inorganic analytes detected in the second sample collected from 57D-92-02X were lower than the analytes detected in G3D-92-03X (Table 4.5-3; Figure 4.5-7).

Three sediment samples (two from 57D-92-01X and one from 57D-92-02X) were collected from Cold Spring Brook in the SA 57 study and three sediment samples were collected from Cold Spring Brook under the Group 3 investigation. PAHs and TPHC were detected in the first two sediment samples collected from Cold Spring Brook. PAHs increased in number and in concentration downstream, with the highest concentrations detected in G3D-92-03X. No PAHs were detected in the second sediment sample collected from 57D-92-01X. TPHC concentrations are relatively constant along Cold Spring Brook except for the most downstream sample (57D-92-02X) which exhibited the lowest concentration. Several inorganic analyte concentrations appeared to be consistent in each of the sediment samples collected from Cold Spring Brook (Table 4.5-4; Figure 4.5-8).

4.5.5 Source Evaluation and Migration Potential

Petroleum-related organic compounds were detected in the surface soil and sediment samples submitted for laboratory chemical analysis from Area 1. Fingerprinting data, however, indicate that the source of the petroleum contaminants detected is likely motor oil. Based on surface water and sediment sampling conducted as part of the Group 3 field investigation and the SA 57 sampling, it appears that the storm drain outfall has likely contributed petroleum contaminants to the sediment contamination detected in Cold Spring Brook. However, based on results from the surface water and sediment samples collected from 57D-92-01X, additional contamination is entering Cold Spring Brook from a source south (upstream) of SA 57.

The contaminants detected in the drainage swale at Area 2 appear to have migrated down the drainage swale towards Cold Spring Brook, and may be adversely impacting the sediment quality in Cold Spring Brook. It appears that the petroleum-related contamination at Area 2 is related to past maintenance of military equipment stored in the yard adjacent to Area 2, and not the 1977 fuel oil spill at Building 3713.

4.5.6 Preliminary Human Health Risk Evaluation

A preliminary human health risk evaluation was prepared for SA 57 to determine if the contaminants detected at this SA pose a risk to human receptors.

For this PRE, the future use of SA 57 is assumed to remain commercial/ industrial. Tables 4.5-5 and 4.5-6 present summary statistics and human health standards and guidelines used in the PRE for SA 57.

4.5.6.1 Soils. Soil at SA 57 is considered to be accessible under a commercial/ industrial future use exposure scenario.

Area 1. The spilled oil flowed through the storm drain pipe of Area 1 and discharged at the outfall where surface soil samples 57S-92-01X through 57S-92-03X were collected to represent surface soil at Area 1. Table 4.5-5 presents summary statistics on surface soil at Area 1 of SA 57 and USEPA Region III commercial/industrial soil concentrations for comparison.

An assessment of the organic compound data for Area 1 surface soil shows that there is some surface contamination from PAHs and TPHC measured from visually contaminated samples. The maximum detected concentrations of the organic compounds are, however, below the USEPA Region III commercial/ industrial soil concentrations.

To evaluate the health risk associated with TPHC in soil, ABB-ES developed risk-based concentrations for petroleum products. These concentrations were calculated using the same exposure assumptions as those used by the USEPA toxicologists in the USEPA Region III Risk-Based Concentration Table, First Quarter, 1993 for commercial/industrial soil. The reference dose value for diesel oil was used as a surrogate for No. 4 fuel oil. The dose response value for diesel oil (a middle distillate) used in the calculation is a provisional value developed by USEPA, Environmental Criteria and Assessment Office (USEPA, 1992a). No. 4 fuel oil is a residual fuel oil that contains higher molecular weight compounds than diesel oil. The use of diesel oil (by itself) as a surrogate in this case could underestimate the true risk associated with exposure to No. 4 fuel oil, primarily because No. 4 fuel oil may contain PAHs not present in diesel oil. However, because soil at SA 57 was analyzed for individual PAHs in addition to TPHC, the use of diesel oil as a surrogate for No. 4 fuel oil is reasonable. (A dose-response value for fuel closer in composition to No. 4 fuel oil is not available.) By considering the risks associated with both TPHC and individual PAHs, the screening evaluation is considered to be health-protective. The risk-based soil concentration for No. 4 fuel oil is as follows:

Analyte	Commercial/Industrial Soil (μg/g)
No. 4 Fuel Oil (Diesel)	8180

The maximum detected TPHC concentration in surface soil (2210 μg/g) is below the commercial/industrial soil concentration of 8180 μg/g.

Area 2. Area 2 where surface soil samples 57S-92-06X through 57S-92-08X were collected is unrelated to the 1977 fuel spill. Table 4.5-6 presents summary statistics on surface soil at Area 2 and USEPA Region III commercial/industrial soil concentrations for comparison.

An assessment of the organic compound data for Area 2 shows that, although there is significant TPHC contamination, there is very limited surface contamination from PAHs in visually contaminated samples. Naphthalene was detected at location 57S-92-07X, however, the maximum detected concentrations was below the USEPA Region III commercial/industrial soil concentration. The contaminated soils in Area 2 are most likely derived from the release of vehicle crank-case oil, not fuel oil as in Area 1. The human health risk associated with exposure to crank-case oil is best represented by the individual compounds in the oil; these compounds are analyzed for by the laboratory. The use of a surrogate for TPHC (based on a dose-response value for fuel oil) is, therefore, not appropriate.

4.5.7 Preliminary Ecological Risk Evaluation

The purpose of the PRE at SA 57 is to provide a screening-level evaluation of actual and potential risks that environmental contaminants may pose to the resident and migratory ecological receptors at the site.

The SA 57 storm drainage conveyance pipe discharges through a concrete spillway into the floodplain of Cold Spring Brook. Three surface soil samples were collected from floodplain soils downgradient of the Area 1 drainage outfall. The Army intends to further evaluate the Area 1 surface soils in conjunction with the proposed installation-wide storm water study (AREE 70). Therefore, this SA 57 PRE does not include an evaluation of ecological risk associated with the Area 1 surface soils in the Cold Spring Brook floodplain. In addition, surface water and sediment samples collected in Cold Spring Brook in the vicinity of SA 57 will also be evaluated in the AREE 70 study.

Area 2, located to the northwest of Area 1, consists of a gradually sloping hillside and a portion of the Cold Spring Brook floodplain. To the north of Area 2 is an un-paved vehicle storage yard. Much of the gradually sloping upland at Area 2 consists of the un-vegetated gravel and sand region between this vehicle storage yard and the Cold Spring Brook floodplain. Three surface soil samples were collected from SA 57 Area 2. These three samples are considered in this PRE.

The Cold Spring Brook floodplain downgradient of Area 2 is a palustrine forested wetland dominated by red maples (*Acer rubrum*). Other hydrophytic species noted in this region include speckled alder (*Alnus rugosa*), highbush blueberry (*Vaccinium corymbosum*), sheep laurel (*Kalmia angustifolium*), swamp azalea (*Rhododendron viscosum*), and red-osier dogwood (*Cornus stolonifera*).

The un-vegetated upland regions in the vicinity of Area 2 are generally covered with eroding sand and gravel and likely provide minimal wildlife habitat. However, the forested wetland in the Cold Spring Brook Floodplain may provide wildlife habitat for a variety of ecological receptors. Organisms expected to occur in this region include various invertebrates, fish, amphibians, reptiles, mammals, and birds. No records exist documenting the current or historical presence of rare and endangered species in the region of SA 57.

Naphthalene was the sole organic compound detected in the three surface soil samples collected at SA 57 Area 2. The concentrations of these two analytes were well below their respective ecological benchmark values (Table 4.5-7). However, no analyses for VOAs, pesticides/PCBs, or inorganics were conducted in Area 2 surface soils, and it is unknown whether or not concentrations of analytes other than SVOCs may be contributing to ecological risk at the site.

4.5.8 Recommendations and Conclusions

Historical information indicates that No.4 fuel oil and/or parking lot runoff was released to the environment at SA 57, Area 1. During the field investigation of this area, PAHs and TPHC were detected in surface soil samples. The human health PRE conducted to evaluate potential exposure to the detected PAH compounds and for TPHC (fuel oil), indicated that there was no unacceptable health risk for commercial/industrial site use. Because Area 1 of SA 57 is part of the storm water drainage network which discharges into Cold Spring Brook, the Army has recommended that this area be further investigated as part of the installation-wide AREE-70 storm water study.

In SA 57, Area 2, overtly contaminated soils are most likely derived from the release of vehicle crank-case oil. During the field investigation, naphthalene and TPHC were detected in surface soils collected from Area 2. Although the results of the human health and ecological PREs indicate that the chemical hazards are not significant, in considering future property value and potential purchase prospects, the Army has proposed that a removal action (focused on TPHC) be conducted at this location.

The proposed action should consist of the excavation of contaminated soils followed by backfilling with clean fill as required for grading. The contaminated soils should be handled, treated, and/or disposed of in an approved manner. TPHC is an adequate indicator of the petroleum-derived contamination in the area. Field screening for TPHC should be used to direct the excavation activities. However, considering that the material may be derived from crank-case oil, selective inorganic analysis should be a part of the analytical protocol. Soil excavation should not be initiated until an interim stockpile location and the final disposal method are established. Excavation activities should consider dust suppression methods and worker safety monitoring. Backfilling with clean fill should commence after satisfactory confirmatory sampling and laboratory analysis for TPHC and inorganic target analytes as required.

TABLE 4.5-1
SOIL CLASSIFICATION OF SEDIMENT SAMPLES
SA 57 - BUILDING 3713 FUEL OIL SPILL

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SAMPLE ID	USCS SYMBOL	WATER CONTENT	GRAVEL (2) DRY WT %	SAND (2) DRY WT %	FINES (2) DRY WT %	COMMENTS
57S-92-01X	SP-SM	1.1	1.6	88.2	10.2	
57S-92-02X	SW-SM	< 0.5	22.6	68.4	9.0	
57S-92-03X	SM	< 0.5	0.7	85.9	13.4	
57S-92-06X	SP	< 0.5	37.9	59.8	2.3	
57S-92-07X	SM	1.3	0.9	78.9	20.2	
57S-92-08X	SP	1.3	9.1	89.3	1.6	
57D-92-01X	ML	81.6	0.5	35.8	63.7	
57D-92-02X	SM	0.6	0.0	62.7	37.3	

Notes:

USCS = Unified soil classification system

DRY WT % = Dry weight percentage

(1) Water content = 100 x weight of water / dry weight of soil

(2) Weight percentage of soil fraction = 100 x dry weight of soil fraction / total dry weight of soil

TABLE 4.5–2
ORGANIC COMPOUNDS IN SOIL
SA 57 – BUILDING 3713 FUEL OIL SPILL

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		AREA 1				AREA 2		
	BORING	57S–92–01X	57S–92–02X	57S–92–03X	57S–92–06X	57S–92–07X	57S–92–07X	57S–92–08X
ANALYTE	**DEPTH**	**0 FT**	**0 FT**	**0 FT**	**0 FT**	**0 FT**	**DUP**	**0 FT**
SEMIVOLATILES (ug/g)								
BENZO(K)FLUORANTHENE		< 1.0	4.0	4.0	< 2.0	< 2.0	NA	< 0.3
CHRYSENE		< 2.0	6.5	5.0	< 3.0	< 3.0	NA	< 0.6
FLUORANTHENE		< 1.0	10.0	12.0	< 2.0	< 9.0	NA	< 0.3
NAPHTHALENE		< 0.7	< 1.0	< 1.0	< 0.9	0.3	NA	< 0.2
PHENANTHRENE		< 0.7	6.0	6.0	< 0.8	< 0.7	NA	< 0.6
PYRENE		< 0.7	9.0	10.0	< 0.8	< 0.7	NA	< 0.2
OTHER (ug/g)								
TOTAL ORGANIC CARBON		24500.0	24700.0	18400.0	5600.0	32600.0	34900.0	2210.0
TOTAL PETROLEUM HYDROCARBON		1860.0	1410.0	2210.0	1030.0	4430.0	4910.0	606.0

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY –
SEE PROJECT ANALYTE LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

NA = NOT ANALYZED

TABLE 4.5–3
ANALYTES IN SURFACE WATER
SA 57 – BUILDING 3713 FUEL OIL SPILL

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	ROUND 1	ROUND 2	ROUND 1	ROUND 2
ANALYTE	57D–92–01X	57D–92–01X	57D–92–02X	57D–92–02X
INORGANICS (ug/L)				
BARIUM	NA	8.76	NA	5.27
CALCIUM	NA	19600.0	NA	8260.0
IRON	NA	682.0	NA	88.2
POTASSIUM	NA	2040.0	NA	1930.0
MAGNESIUM	NA	2990.0	NA	1810.0
MANGANESE	NA	112.0	NA	7.8
SODIUM	NA	19000.0	NA	15600
LEAD	NA	1.7	NA	< 0.5
ORGANICS (ug/L)				
CHLOROFORM	< 0.5	1.1	< 0.5	< 0.5
ANIONS/CATIONS (ug/L)				
KJELDAHL NITROGEN	419.0	< 183.0	533.0	233.0
NITRATE/NITRITE	250.0	464.0	21.9	256.0
CHLORIDE	37000.0	40400.0	28500.0	31300.0
SULFATE	10200.0	11400.0	< 10000.0	< 10000.0
ALKALINITY	< 5000.0	44.0	5000.0	17.0
OTHER (ug/L)				
HARDNESS	60600.0	60000.0	29400.0	27600.0
PHOSPHATE	36.6	< 13.3	277.0	< 13.3
TOTAL SUSPENDED SOLIDS	14000.0	16.0	8000.0	< 4.0

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY –
SEE PROJECT ANALYTE LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN
NA= NOT ANALYZED

TABLE 4.5–4
ANALYTES IN SEDIMENT
SA 57 – BUILDING 3713 FUEL OIL SPILL

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	ROUND 1	ROUND 1	ROUND 2
ANALYTES	57D–92–01X	57D–92–02X	57D–92–01X
INORGANICS (ug/g)			
ALUMINUM	NA	NA	11700.0
ARSENIC	NA	NA	55.3
BARIUM	NA	NA	94.2
CALCIUM	NA	NA	9090
CHROMIUM	NA	NA	33.3
COBALT	NA	NA	21.3
COPPER	NA	NA	27.7
IRON	NA	NA	25600.0
LEAD	NA	NA	99.5
MAGNESIUM	NA	NA	3160.0
MANGANESE	NA	NA	1400
NICKEL	NA	NA	32.2
POTASSIUM	NA	NA	800.0
SODIUM	NA	NA	100.0
VANADIUM	NA	NA	32.4
ZINC	NA	NA	239.0
ORGANICS (ug/g)			
ACENAPHTHYLENE	< 0.2	0.075	< 0.2
ANTHRACENE	< 0.2	0.10	< 0.2
BENZO[A]ANTHRACENE	< 0.8	0.35	< 0.8
BENZO[A]PYRENE	< 1.0	0.51	< 1.0
BENZO[B]FLUORANTHENE	< 1.0	0.67	< 1.0
BENZO[G,H,I]PERYLENE	< 1.0	0.34	< 1.0
BENZO[K]FLUORANTHENE	< 0.3	0.47	< 0.3
CHRYSENE	< 0.6	0.8	< 0.6
FLUORANTHENE	2.0	1.4	< 0.3
FLUORENE	< 0.2	0.086	< 0.2
INDENO[1,2,3–C,D]PYRENE	< 1.0	0.33	< 1.0
PHENANTHRENE	1.0	0.78	< 0.1
PYRENE	2.0	1.3	< 0.1
OTHER (ug/g)			
TOTAL ORGANIC CARBON	189000.0	24500.0	NA
TOTAL PETROLEUM HYDROCARBONS	497.0	92.6	466.0

NOTES:
TABLE LISTS DETECTED ANALYTES ONLY –
SEE PROJECT LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN
NA= NOT ANALYZED

TABLE 4.5–5
HUMAN HEALTH PRE EVALUATION OF SURFACE SOIL
SA 57 – BUILDING 3713 FUEL OIL SPILL (AREA 1)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Detected Concentration [a] Average (ug/g)	Detected Concentration [a] Maximum (ug/g)	Frequency of Detection	Region III Commercial/Industrial Soil Concentration (ug/g)	Maximum Exceeds Region III Concentration?
Organics					
benzo[k]fluoranthene	4.0	4.0	2/3	7.4	NO
chrysene	5	5	2/3	NA	NA
fluoranthene	9.5	10	2/3	41000	NO
phenanthrene	4	4	2/3	30000	NO
pyrene	10	10	2/3	31000	NO
Other					
total petroleum hydrocarbons	1826.7	2210	3/3	NA	NA

Notes:

[a] Surface soil samples from sampling stations 57S–92–01X to 57S–92–03X

NA = not available, not applicable

ug/g = micrograms per gram

TABLE 4.5–6
HUMAN HEALTH PRE EVALUATION OF SURFACE SOIL
SA 57 – BUILDING 3713 FUEL OIL SPILL (AREA 2)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Detected Concentration [b]		Frequency of Detection	Region III Commercial/Industrial Soil Concentration (ug/g)	Maximum Exceeds Region III Concentration?
	Average (ug/g)	Maximum (ug/g)			
Organics					
naphthalene	0.3	0.3	1/3	41000	NO
Other					
total petroleum hydrocarbons	2744.0	4910	4/4	NA	NA

Notes:

[a] Surface soil samples from sampling stations 57S–92–06X, 57S–92–07X, and 57S–92–08X (including one duplicate)

NA = not available

ug/g = micrograms per gram

TABLE 4.5–7
ECOLOGICAL PRE EVALUATION OF SURFACE SOIL
SA 57 – BUILDING 3713 FUEL OIL SPILL (AREA 2)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Soil Background Concentration (ug/g)	Concentration [b] Average (ug/g)	Concentration [b] Maximum (ug/g)	Frequency of Detection	Maximum Exceeds Background?	Ecological Benchmark (ug/g)	Maximum Exceeds Benchmark?
Organics							
naphthalene	NA	0.3	0.3	1/3	NA	170	NO
tetrachloroethylene	NA	2	2	1/1[c]	NA	280	NO

Notes:

[a] Base–wide background soil inorganics database

[b] Surface soil samples from sampling stations 57S–92–06X, 57S–92–07X, and 57S–92–08X

[c] This ratio represents a positively identified TIC found only in 57S–92–06X

NA = not available

ug/g = micrograms per gram

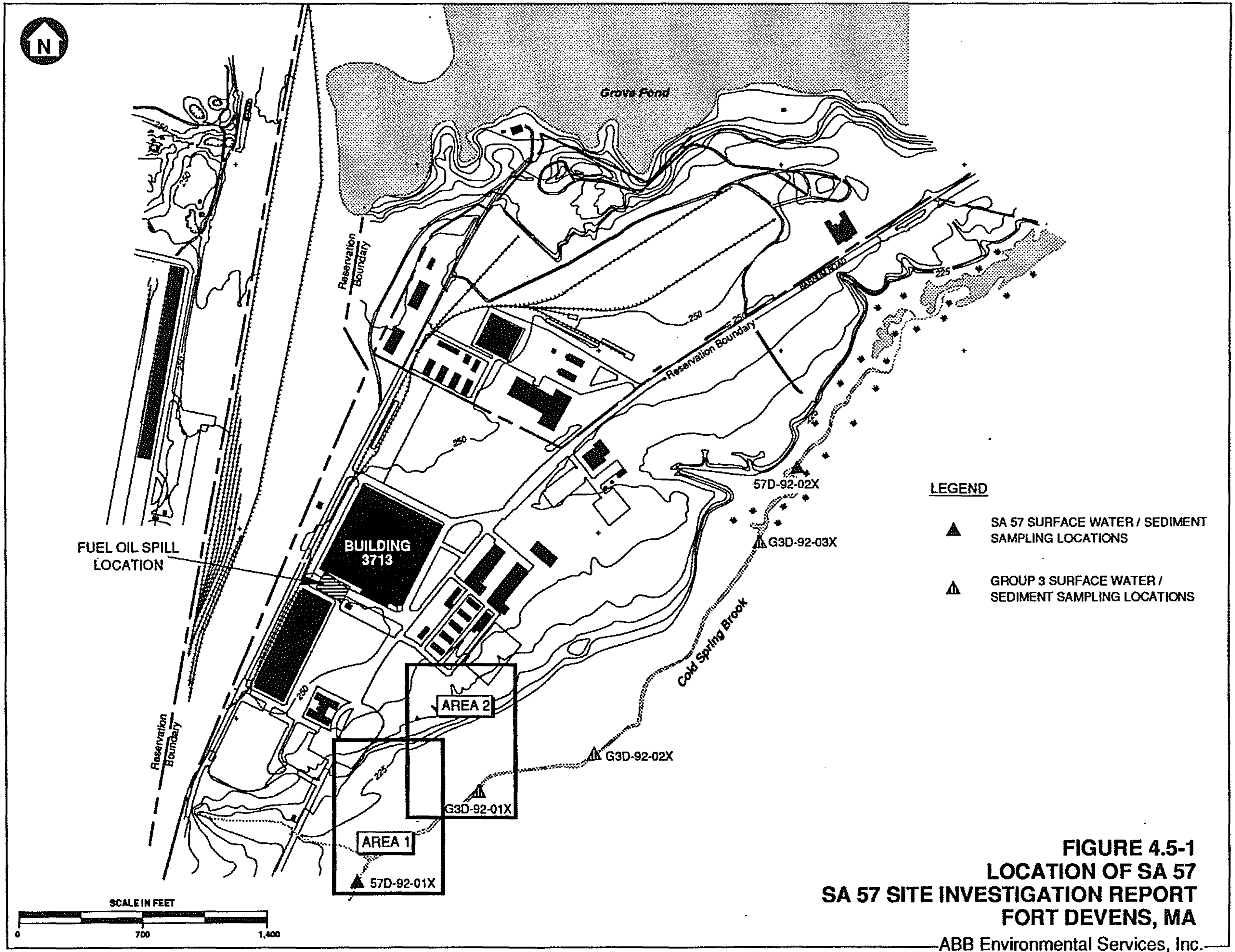


FIGURE 4.5-1
LOCATION OF SA 57
SA 57 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9304049D(zc) 2 5 8

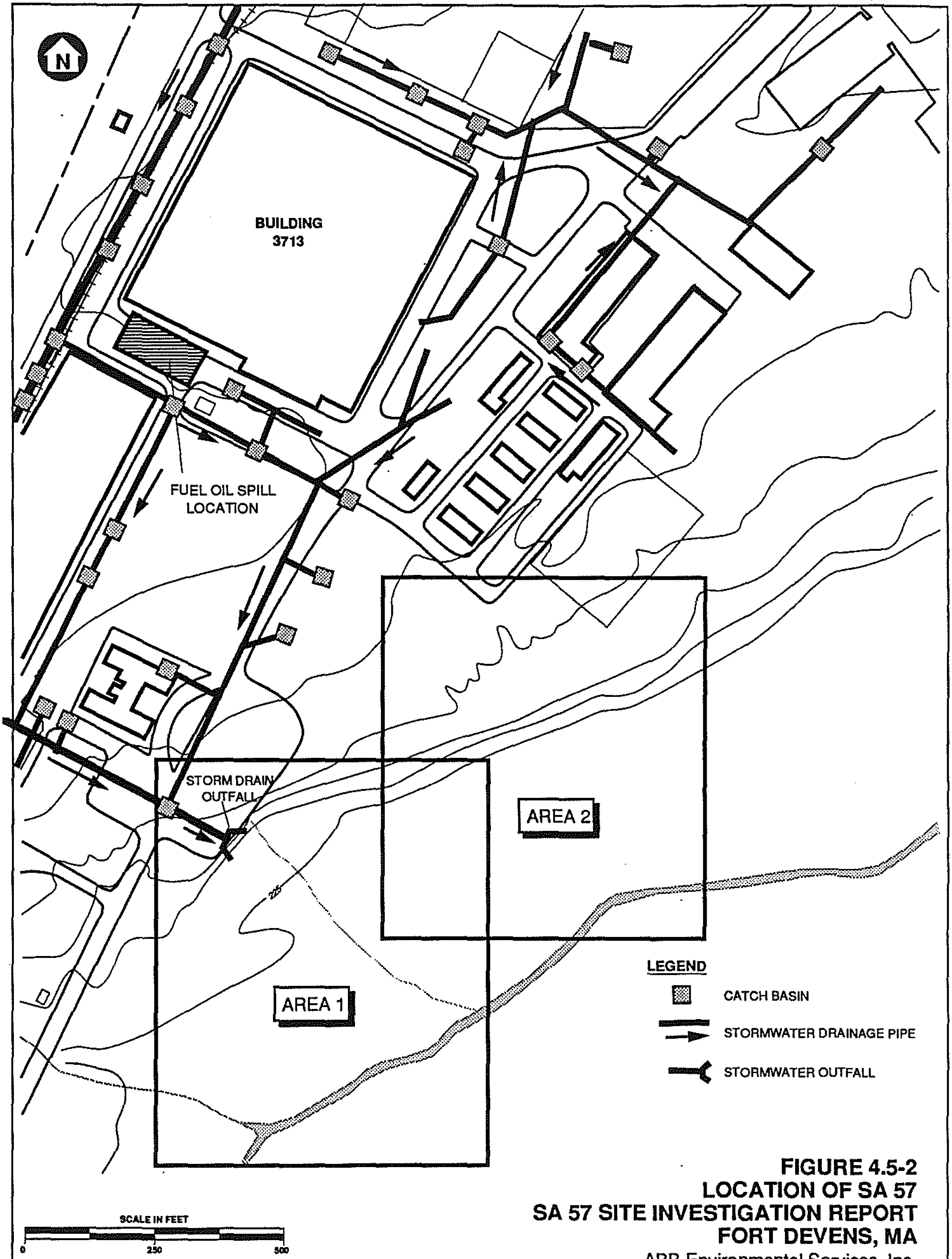


FIGURE 4.5-2
LOCATION OF SA 57
SA 57 SITE INVESTIGATION REPORT
FORT DEVENS, MA

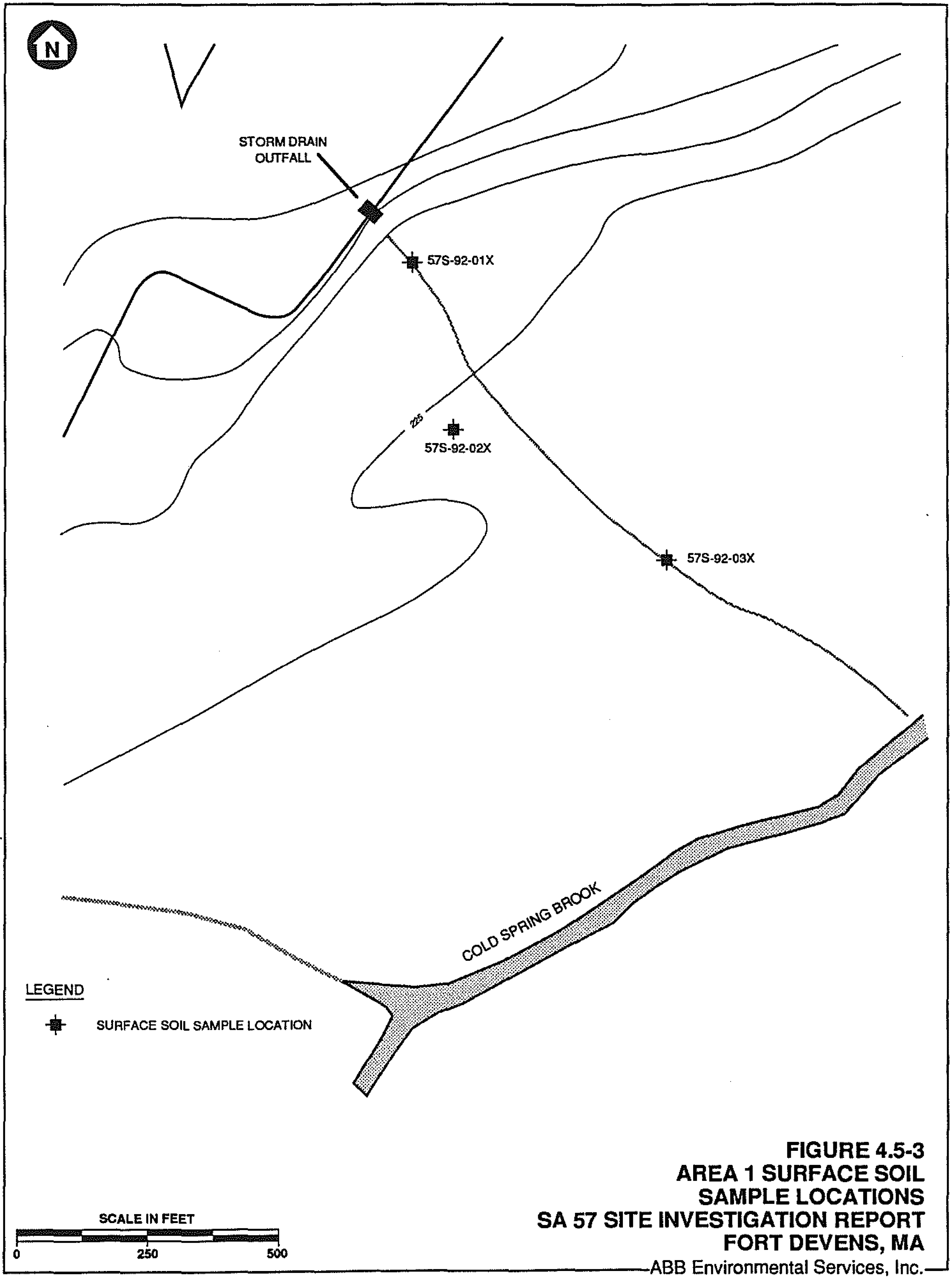


FIGURE 4.5-3
AREA 1 SURFACE SOIL SAMPLE LOCATIONS
SA 57 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9304049D(zc2)1

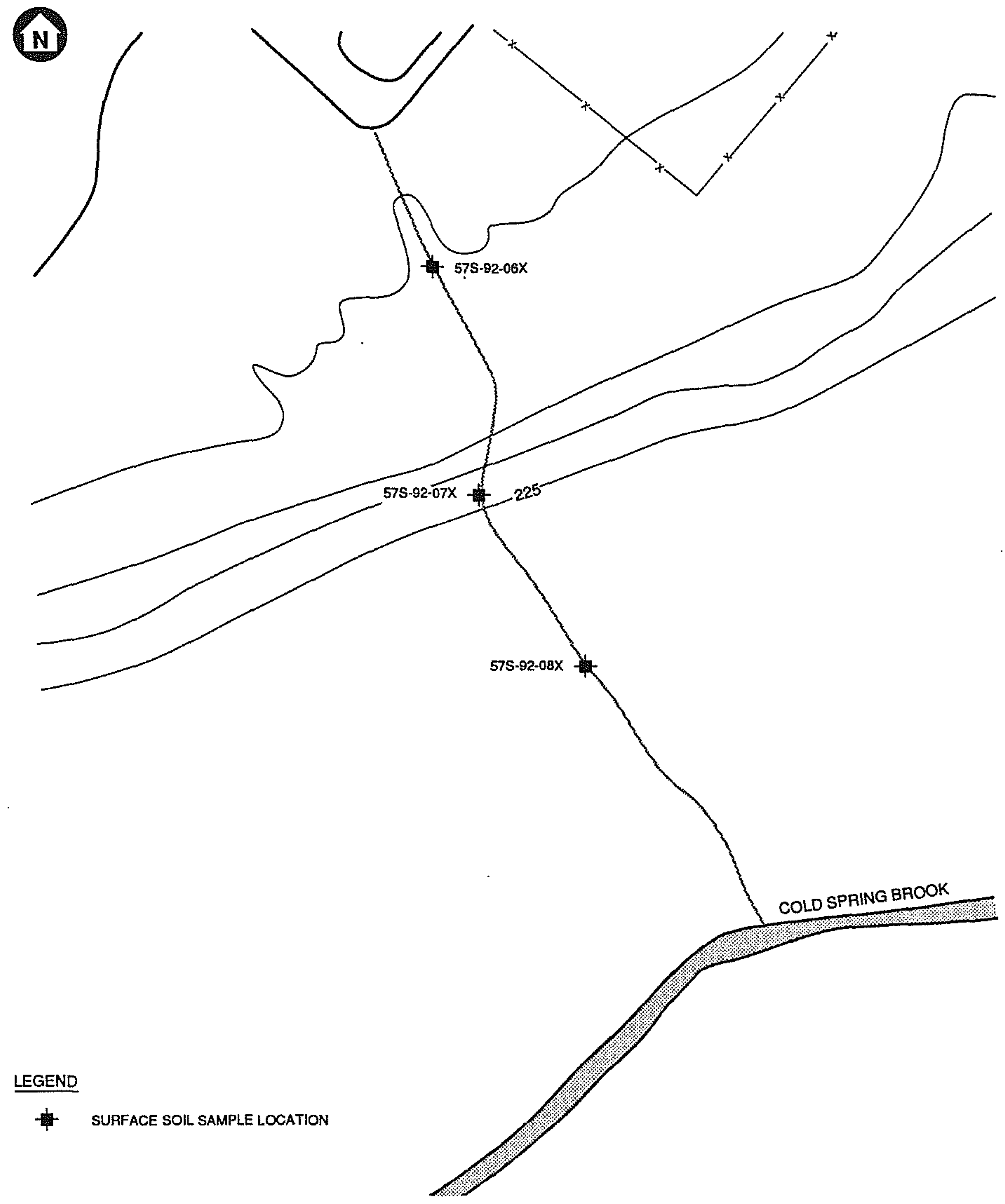


FIGURE 4.5-4
AREA 2 SURFACE SOIL SAMPLE LOCATIONS
SA 57 SITE INVESTIGATION REPORT
FORT DEVENS, MA
ABB Environmental Services, Inc.

9304049D(zc3) 2

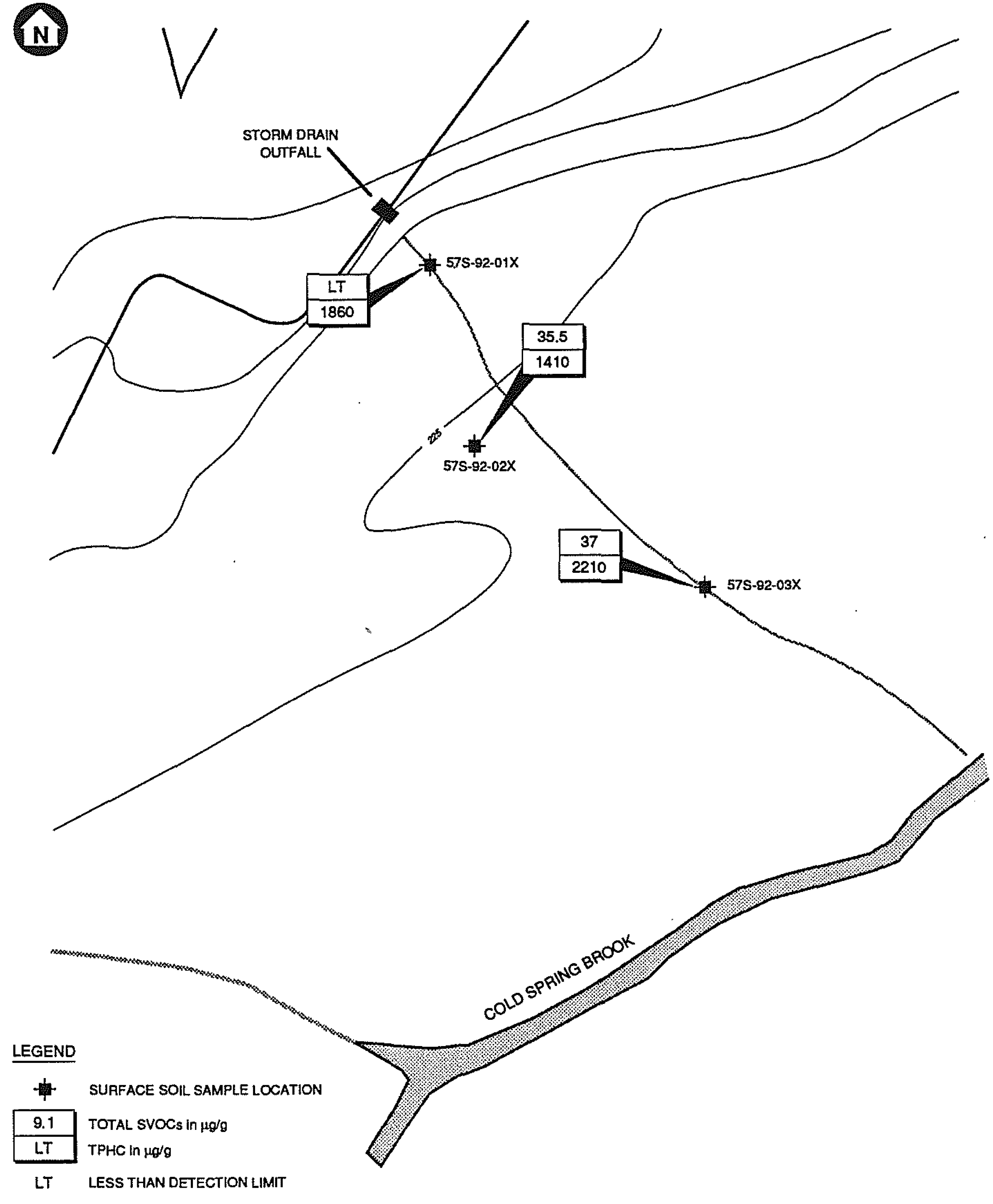


FIGURE 4.5-5
AREA 1 ORGANIC COMPOUNDS IN SURFACE SOIL
SA 57 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

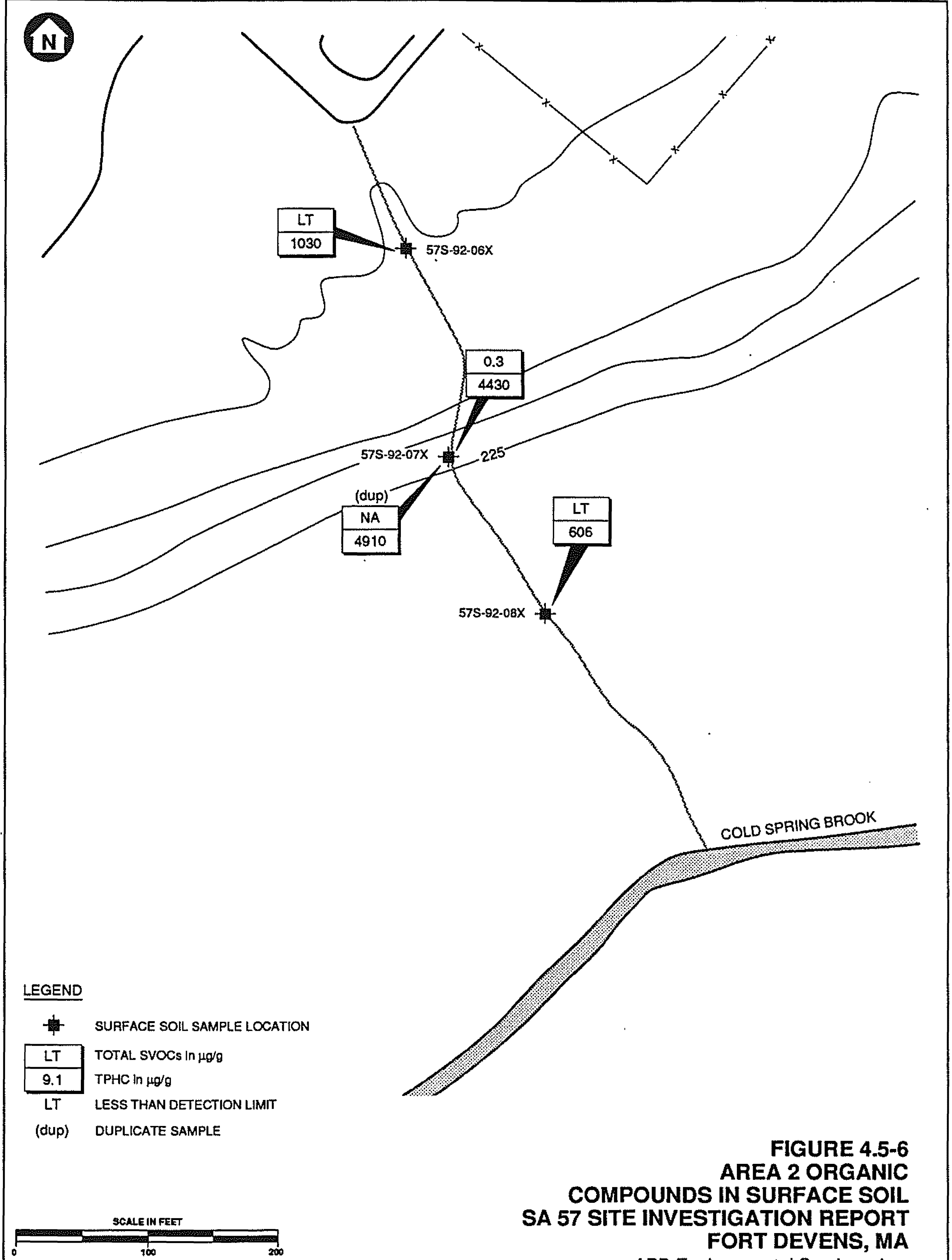


FIGURE 4.5-6
AREA 2 ORGANIC
COMPOUNDS IN SURFACE SOIL
SA 57 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

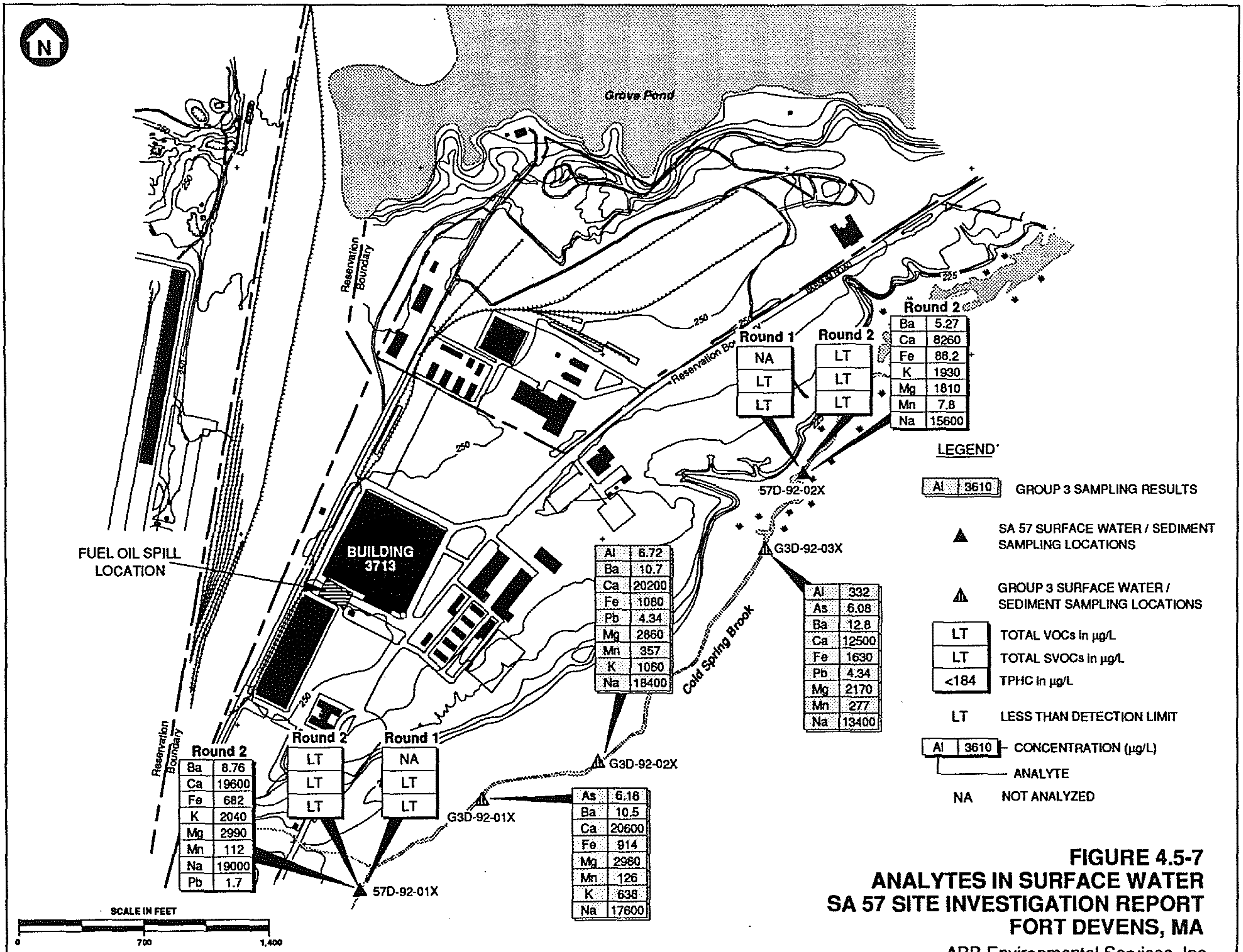
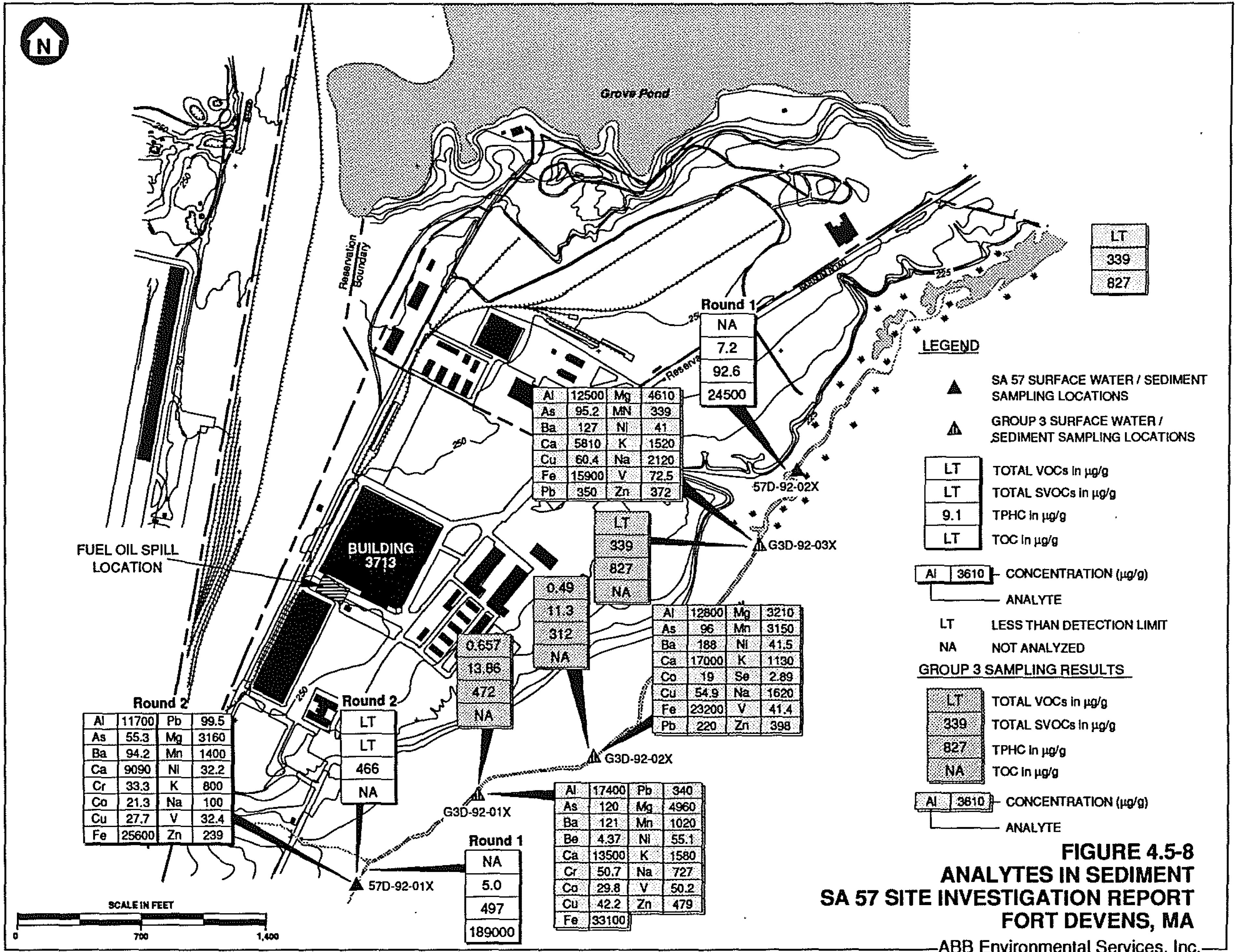


FIGURE 4.5-7
ANALYTES IN SURFACE WATER
SA 57 SITE INVESTIGATION REPORT
FORT DEVENS, MA



57D-92-02X

Round 1

NA
7.2
92.6
24500

Al	12500	Mg	4610
As	95.2	MN	339
Ba	127	Ni	41
Ca	5810	K	1520
Cu	60.4	Na	2120
Fe	15900	V	72.5
Pb	350	Zn	372

G3D-92-03X

LT
339
827
NA

G3D-92-02X

0.49
11.3
312
NA

Al	12800	Mg	3210
As	96	Mn	3150
Ba	188	Ni	41.5
Ca	17000	K	1130
Co	19	Se	2.89
Cu	54.9	Na	1620
Fe	23200	V	41.4
Pb	220	Zn	398

G3D-92-01X

0.657
13.86
472
NA

Al	17400	Pb	340
As	120	Mg	4960
Ba	121	Mn	1020
Be	4.37	Ni	55.1
Ca	13500	K	1580
Cr	50.7	Na	727
Co	29.8	V	50.2
Cu	42.2	Zn	479
Fe	33100		

57D-92-01X

Round 2

Al	11700	Pb	99.5
As	55.3	Mg	3160
Ba	94.2	Mn	1400
Ca	9090	Ni	32.2
Cr	33.3	K	800
Co	21.3	Na	100
Cu	27.7	V	32.4
Fe	25600	Zn	239

Round 2

LT
LT
466
NA

Round 1

NA
5.0
497
189000

FIGURE 4.5-8
ANALYTES IN SEDIMENT
SA 57 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

4.6 SA 58 - BUILDINGS 2648 AND 2650 FUEL OIL SPILL (LUST SITE)

4.6.1 Study Area Background and Conditions

SA 58 is located between former Building T-2647 and former Building T-2649 which were located between Jackson Road and Lake George Street on the Main Post. Two USTs formerly used for heating oil were removed in August 1990 in conjunction with the partial demolition of Buildings T-2648 and T-2650 (Biang et al., 1992). An unreported volume of contaminated soil was removed from these UST sites at the time of tank excavations, and total VOCs in soil headspace were determined by PID to be 60 ppm in the excavation at Building 2648 and >40 ppm in the excavation at Building 2650 ppm (McHugh et al., 1990). The presence of Buildings 2648 and 2650 (which were not completely demolished until October 1990) prevented further soil excavation at the time of tank removal.

In April 1991 more contaminated soil was removed from Building 2650's UST excavation. Total VOCs in soil headspace in this excavation were 54 ppm and 70 ppm, and TPHC levels in soil in the excavation were 76 and 268 ppm (Jones, 1991; Alpha Analytical Laboratories, 1991). The total volume of contaminated soil removed from the Building 2650 excavation was approximately 250 cubic yards (Pierce, 1991). No field investigation was done at this site during the 1992 SI field program.

In April 1991 clay in the bottom of the west corner of the Building 2648 UST excavation was visibly contaminated and had total VOCs in soil headspace of 0.4 to 46 ppm. No samples were collected for TPHC analysis. The observed contaminated soil was not excavated, because of the presence of already stockpiled soil (Kurz Associates, Inc., 1991). In September 1992, the open excavation at Building 2648 was backfilled with clean soil. In March 1993, all of the buildings in the 2600 series around SA 58 were demolished (Figure 4.6-1).

4.6.2 Site Investigation Program Summary

The SI at SA 58 was completed in accordance with the Final SI Task Order Work Plan (ABB-ES, 1992b) and in conformance with the provisions of the Project Operations Plan (ABB-ES, 1992d). The field sampling program for SA 58 was concentrated around the UST excavation for the former Building 2648. The program consisted of field analysis of soil samples collected from TerraProbe points to characterize the vertical and horizontal distribution of potential localized contaminants, the collection of subsurface soil samples for laboratory analysis and geologic classification, the installation of groundwater monitoring wells, and the collection of groundwater samples (Figure 4.6-2).

Twenty-five subsurface soil samples were collected from ten TerraProbe points located around the UST excavation at Building 2648. One soil sample was collected from between 5 feet and 7 feet bgs from each TerraProbe point. Another soil sample was collected from nine of the 10 TerraProbe points at a depth of 9 feet and/or refusal (approximately 11 feet bgs). These samples were analyzed on-site for BTEX and TPHC. The TerraProbe points were situated both upgradient and downgradient of the tank location based on the inferred groundwater flow which was west to east.

Based on the results of the TerraProbe program, four soil borings (58M-92-01X through 58M-92-04X) were drilled (one upgradient and three downgradient) and four monitoring wells were installed (see Figure 4.6-2). Three soil samples were collected from each boring and analyzed for PAL VOCs, TPHC, TOC, and grain size.

Two rounds of groundwater samples were collected from each of the four monitoring wells. The first round was collected in September 1992 and the second round was collected in January 1993. All of the groundwater samples were submitted for laboratory analysis of PAL VOCs, TPHC, and PAL anions and cations. Round Two groundwater samples were also analyzed for TSS.

4.6.3 Additional Site Investigation Program Summary

Based on the concerns raised by MADEP regarding the lack of off-site laboratory documentation on the excavated soils derived from the SA 58 UST removals, which was used to backfill the UST excavations, USAEC collected additional soil samples from the backfilled UST excavations in March 1995. In addition, MADEP requested that USAEC collect an additional groundwater sample from monitoring well 58M-92-01X to further assess the presence or absence of VOC contamination detected in the Round One groundwater sample collected during the SI.

Three soil samples were collected from various depths within the two backfilled excavations for the purpose of determining the residual TPHC concentrations in the backfilled soil (see Figure 4.6-2). These soil samples were submitted to ESE for TPHC analysis, only.

One groundwater sample was also collected in March from 58M-92-01X and submitted to ESE for PAL VOC analysis, only (see Figure 4.6-2).

4.6.4 Field Investigation Results and Observations

SA 58 is located on a physiographic upland, where the land surface slopes gently westward toward the valley of the Nashua River. Local bedrock has been mapped as the generally north-south striking Merrimack Formation, consisting of low grade (below biotite isograd) calcareous and ankeritic metasiltstone and phyllite and commonly deformed by kink banding (Russell and Allmendinger, 1975; G.R. Robinson, 1978). The rock unit is called Oakdale Formation by Zen (1983) and Robinson and Goldsmith (1991). The Merrimack (Oakdale) Formation crops out along strike south of SA 58, most visibly on Route 2 just east of the Jackson Gate exit.

The surficial geology of the Shirley map quadrangle, in which SA 58 is located, has not been mapped. The area is blanketed by unconsolidated surficial deposits of glacial and post-glacial origin. Bedrock is not exposed at SA 58, although it was reportedly encountered in the Building 2648 tank excavation. Russell and Allmendinger (1975) mapped thin (less than 10 feet) surficial cover south and west of SA 58, and Jahns (1953) mapped ground moraine (till) approximately 1,000 feet to the east. A complete description of the Main Post geology is presented in Section 2.0.

The four soil borings at SA 58, encountered strongly weathered bedrock, characterized as incompetent gray shale, at depths ranging from 12.0 feet bgs (in boring 58M-92-01X) to 15.7 bgs (in boring 58M-92-04X). The bedrock was so weathered in boring 58M-92-01X that the augers were advanced 8 feet into the bedrock. This is probably the "blue clay" observed at the bottom of the UST excavation (McHugh et al., 1990). Grain size analyses of samples from these borings indicated that the sand fraction ranges from 43.1 to 51.0 percent, gravel from 12.3 to 29.5 percent, and fines from 27.4 to 38.8 percent. These soils are likely glacial tills. Boring logs for these monitoring wells are provided in Appendix B, and grain size analyses results are provided in Appendix J.

Monitoring well 58M-92-01X was installed as part of this investigation at a location presumed to be upgradient of the UST excavation, and wells 58M-92-02X through 58M-92-04X were installed at downgradient locations (see Figure 4.6-2). Wells 58M-92-01X and 58M-92-02X were screened across the till/bedrock interface, and wells 58M-92-03X and 58M-92-04X were screened in till. Monitoring well completion details are provided in Appendix C.

An installation-wide water-level survey of 139 monitoring wells and 15 surface-water stations was conducted on December 22, 1992. Included in the survey were the four SA 58 monitoring wells. Based on those water levels the groundwater flow direction at the site has been determined to be northwestward toward the Nashua River (Figure 4.6-3). The data from this round, and previous rounds, are presented in Appendix I.

In-situ aquifer tests were performed in the four SA 58 monitoring wells. Aquifer hydraulic conductivities of the soil and/or bedrock at the water table were measured at 9×10^{-6} cm/sec to 2×10^{-4} cm/sec, with a geometric average of 2.4×10^{-5}. These low conductivities reflect the compactness and high percentage of fines in the till. Hydraulic conductivity test results are presented in Appendix A.

One likely groundwater flow path across the site is approximately from monitoring well 58M-92-01X to 58M-92-03X. The average hydraulic gradient between those two points on December 22, 1992 was 0.018 ft/ft, and the geometric average of the hydraulic conductivities is 4×10^{-5} cm/sec. Assuming that conductivity is representative of average conditions along the flow path, and assuming an average soil porosity of 50 percent, the average groundwater flow velocity is less than 2 ft/yr.

Groundwater in the surficial aquifer at the facility has been assigned to Class I under Commonwealth of Massachusetts regulations. Class I consists of groundwaters that are "found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated as a source of potable water supply" (314 CMR 6.03).

4.6.5 Nature and Distribution of Contaminants (Field Screening and Laboratory Results)

4.6.5.1 Field Screening Results. The objective of the TerraProbe subsurface soil sampling and field screening program was to determine the vertical and horizontal distribution of residual fuel contamination outside of the former UST excavation of Building 2648.

A total of 23 subsurface soil samples from 10 TerraProbe locations were collected and analyzed (Figure 4.6-4). Toluene, ethylbenzene, xylenes, and TPHC were detected in several samples indicating that some residual fuel contamination may be present outside of the former UST excavation. The field screening results are presented in Table 4.6-1. Figures 4.6-5 and 4.6-6 show the distribution of contaminants detected.

4.6.5.2 Off-Site Laboratory Results. The objective of the sampling program was to investigate the presence or absence of petroleum contamination in the upgradient and downgradient soils and groundwater at SA 58. The primary concern at SA 58 was that residual fuel-related contaminants detected in the soil around the excavation for Building 2648, during the TerraProbe program, were adversely impacting the groundwater quality downgradient of SA 58. Groundwater and soil samples were collected from the monitoring wells and soil borings installed upgradient and downgradient of Building 2648 and the former UST location (see Figure 4.6-2).

A total of four soil samples were collected, one sample from each of the four monitoring well borings, in the saturated zone to evaluate contaminant migration at the water table. Each boring was completed as a monitoring well. No VOCs or TPHC were detected in any of the subsurface soil samples collected from SA 58 except for trace concentrations of acetone in soil boring 58M-92-01X and 04X, respectively (Table 4.6-2; Figure 4.6-7). Acetone is considered a common laboratory contaminant and does not appear to be a site contaminant. Section 3.2.2 of this SI Report discusses the detection of this compound.

The results of the additional SI soil sampling completed in March 1995, indicated that residual TPHC concentration ranged from below the detection limit to 91.2 μg/g in the 10-foot soil sample associated with Building 2648 (see Table 4.6-2 and Figure 4.6-7).

Four groundwater monitoring wells were installed and two rounds of groundwater samples were collected to evaluate the groundwater quality at SA 58. VOCs were detected in the Round One groundwater sample collected from 58M-92-01X, only. No VOCs were detected in the other three groundwater samples collected. Round Two groundwater sampling results indicate that VOCs were not detected in any of the samples collected. TPHC was not detected in any of the groundwater samples collected from SA 58 during either round. Inorganic (calcium, magnesium, and potassium) concentrations were above the calculated Fort Devens groundwater background concentrations in all wells. Each groundwater sample collected during Round Two was analyzed for TSS. TSS concentrations ranged from 132 mg/L in 58M-92-04X to 1,080 mg/L in 58M-92-02X. These levels of TSS appear to be the reason for the elevated anion and cation results (Table 4.6-3; Figure 4.6-8).

The results for the groundwater sample collected from 58M-92-01X, as part of the additional SI sampling, showed that no VOCs were present in this sample (see Table 4.6-3 and Figure 4.6-8).

4.6.6 Source Evaluation and Migration Potential

The lack of contaminants detected in soil samples collected from the saturated zone up and downgradient of the former UST locations suggests that any contaminant migration at the water table has not significantly impacted soil quality at SA 58. The two VOCs detected the soil samples at trace concentrations are likely laboratory contaminants.

Based on the inferred groundwater flow direction, the VOCs detected in the Round One groundwater sample from 58M-92-01X may be originating from an upgradient source. Because no VOCs were detected downgradient, the contaminants are likely to be localized and of limited lateral extent. In addition, VOCs were not detected in Round Two groundwater sampling results. The inorganic analyte detected in each of the wells are likely due to elevated TSS found in each Round Two sample.

4.6.7 Preliminary Human Health Risk Evaluation

A preliminary human health risk evaluation was prepared for SA 58 to determine if the contaminants detected at this SA pose a risk to human receptors. For this PRE, the future use of SA 58 is assumed to be commercial/industrial. This classification was determined based upon the fact that the site-related contaminants detected at the site were found greater then 2 feet bgs and would only be accessible under a commercial/industrial scenario. Tables 4.6-4 and 4.6-5 present summary statistics and human health standards and guidelines used in the PRE for SA 58.

4.6.7.1 Soils. As discussed in Section 3.5 (Preliminary Risk Evaluation Methodology), all soils collected from 3-15 feet in depth are classified as subsurface and are considered to be accessible under a commercial/industrial future use exposure scenario.

Table 4.6-4 presents summary statistics on subsurface soil boring data at SA 58 and USEPA Region III commercial/industrial soil concentrations for comparison. At SA 58, ABB-ES drilled four soil borings and collected subsurface soil samples from each boring for laboratory chemical analysis. Subsurface soil at SA 58 is represented by samples 58M-92-01X through 58M-92-04X. The soil samples were collected in the saturated zone to evaluate contaminant migration at the water table. No VOCs or TPHC were detected in any of the subsurface soil samples collected from SA 58 except for trace concentrations of acetone at 58M-92-01X. Acetone is considered a common laboratory contaminant and does not appear to be an SA contaminant.

Table 4.6-1 presents the field analytical results for subsurface soil samples collected and screened at the ten Terraprobe locations (19 samples). VOCs and TPHC were used as the primary organic compound indicators for the study area soils. The aromatic VOCs toluene (2.5 ppm maximum), ethylbenzene (4.0 ppm maximum), and xylenes (13 ppm maximum) were detected in four subsurface soil samples from the TerraProbe program, probably derived from fuel oil releases. The maximum concentrations of BTEX compounds detected in the Terraprobe samples are below the USEPA Region III commercial/industrial soil concentrations.

TPHC concentrations by field analysis in the 19 TerraProbe soil samples ranged. The maximum TPHC concentration was 328 ppm. To evaluate the health risk associated with TPHC in soil, ABB-ES developed risk-based concentrations for petroleum products. These concentrations were calculated using the same exposure assumptions as those used by USEPA toxicologists in the USEPA Region III Risk-Based Concentration Table, First Quarter, 1993 for commercial/industrial soils and residential soils. A dose response value for marine diesel used in the calculation is a provisional value developed by USEPA, Environmental Criteria and Assessment Office (USEPA, 1992a). USEPA suggests using the reference dose value for diesel oil as a surrogate for No. 2 fuel oil, the type of oil stored in the former USTs. The table below presents the risk-based concentration for No. 2 fuel oil:

Analyte	Residential Soil (µg/g)	Commercial/Industrial Soil (µg/g)
No. 2 Fuel Oil	630	8,180

The maximum detected TPHC concentration in soil at SA 58 (328 µg/g) is well below the risk-based commercial/industrial and residential soil concentrations. The TPHC levels indicate that contamination from fuel spillage has been adequately removed during tank excavation and is not migrating in the unsaturated soil.

4.6.7.2 Groundwater. Table 4.6-5 presents summary statistics on groundwater associated with SA 58 and drinking water standards or guidelines for comparison. Four groundwater monitoring wells were installed at SA 58 to evaluate the groundwater quality (58M-92-01X through 58M-92-04X). The data reported in Table 4.6-5 are based on unfiltered samples. Four organic compounds were detected in the groundwater associated with SA 58; benzene, toluene, trichloroethene, and trichlorofluoromethane. The maximum detected concentrations of the organic compounds were below their respective drinking water standard/guideline.

An assessment of the inorganic data for SA 58 groundwater shows that there is some inorganic analyte contamination directly surrounding the SA. When comparing groundwater concentrations to the statistical background, the inorganic data for SA 58 groundwater shows that there are several compound exceedances: calcium, magnesium, and potassium. No drinking water standards or guidelines exist for these analytes; they are all essential nutrients.

A preliminary ecological risk evaluation was not prepared for SA 56 because the contaminants detected at this SA appear to be confined to subsurface soil, and are not anticipated to impact any ecological receptors.

4.6.8 Conclusions and Recommendations

The field investigation at SA 58 identified VOCs and TPHC (possibly indicative of residual petroleum contamination) in TerraProbe soil samples collected from the vadose zone and backfill soil in and around the former UST excavations. Soil samples collected in the saturated zone up and downgradient of SA 58, however, did not contain VOCs and TPHC. The Round One groundwater sample collected upgradient of SA 58 contained VOCs. However, the results of the Round Two and additional SI samples, collected from the upgradient monitoring well, indicated that no VOCs were present in the groundwater at this location. Three inorganics (calcium, magnesium and potassium) were detected above their Fort Devens background concentrations in groundwater from all well locations. Since the investigation focused on the subsurface soils and groundwater, no ecological PRE was conducted. The human health PRE indicated that there was no unacceptable risk associated with exposure to contaminants identified in soil and groundwater at the study area. Based on the results of the PRE, no further action (NFA) is recommended for SA 58.

TABLE 4.6–1
FIELD SCREENING RESULTS
SA 58 – BUILDING 2648/2650 FUEL OIL SPILLS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SAMPLE ID	SA	MEDIUM	SITE ID	DEPTH (feet)	TPH ppm	TOTAL BETX ppb	BEN* ppb	TOL* ppb	E–BEN* ppb	M/P XYL** ppb	O–XYL* ppb	COMMENTS
58TSX01XX601XF	58	SOIL	TP–01	6	229	0	ND	ND	ND	ND	ND	
58TSX01X1101XF	58	SOIL	TP–01	11	<55	0	ND	ND	ND	ND	ND	
58TSX02XX701XF	58	SOIL	TP–02	7	< 54	0	ND	ND	ND	ND	ND	
58TSX02XX901XF	58	SOIL	TP–02	9	328	10	ND	ND	4.05	13.20	6.28	
58TSX03XX501XF	58	SOIL	TP–03	5	< 55	2	ND	2.45	ND	ND	ND	
58TSX03X1101XF	58	SOIL	TP–03	11	< 55	0	ND	ND	ND	ND	ND	
58TSX04XX501XF	58	SOIL	TP–04	5	56	0	ND	ND	ND	ND	ND	
58TSX05XX501XF	58	SOIL	TP–05	5	< 54	0	ND	ND	ND	ND	ND	
58TSX05X1101XF	58	SOIL	TP–05	11	< 57	0	ND	ND	ND	ND	ND	
58TSX06XX501XF	58	SOIL	TP–06	5	< 54	0	ND	ND	ND	ND	ND	
58TSX06X1101XF	58	SOIL	TP–06	11	124	0	ND	ND	ND	ND	ND	
58TSX07XX501XF	58	SOIL	TP–07	5	102	0	ND	0.39	ND	ND	ND	
58TSX07X1101XF	58	SOIL	TP–07	11	< 63	0	ND	ND	ND	ND	ND	
58TSX08XX501XF	58	SOIL	TP–08	5	<55	0	ND	ND	ND	0.306	ND	
58TSX08X1001XF	58	SOIL	TP–08	10	95	0	ND	ND	ND	ND	ND	
58TSX09XX501XF	58	SOIL	TP–09	5	<55	0	ND	ND	ND	ND	ND	
58TSX09X1101XF	58	SOIL	TP–09	11	<55	0	ND	ND	ND	ND	ND	
58TSX10XX501XF	58	SOIL	TP–10	5	<55	0	ND	ND	ND	ND	ND	
58TSX10X1101XF	58	SOIL	TP–10	11	<55	0	ND	ND	ND	ND	ND	

NOTES:

* = ND DENOTES A NON DETECT OR CONCENTRATIONS BELOW 5 PPB

** = ND DENOTES A NON DETECT OR CONTRACTIONS BELOW 10 PPB

\# = STUDY AREA

TABLE 4.6-2
ORGANIC COMPOUNDS IN SOIL
SA 58 – BUILDING 2648/2650 FUEL OIL SPILLS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BORING DEPTH	58M-92-01X 12 FT	58M-92-02X 9 FT	58M-92-03X 8 FT	58M-92-04X 9 FT
VOLATILES (µg/g)					
ACETONE		0.054	< 0.017	< 0.017	< 0.017
OTHER (µg/g)					
TOTAL ORGANIC CARBON		420.0	3780.0	334.0	3520.0

ANALYTE	BORING DEPTH	58B-95-01X 0 FT	58B-95-01X 5 FT	58B-95-01X 10 FT
OTHER (µg/g)				
TOTAL PETROLUEM HYDROCARBONS		<20.8	36.4	91.2

ANALYTE	BORING DEPTH	58B-95-02X 0 FT	58B-95-02X 5 FT	58B-95-02X 10 FT
OTHER (µg/g)				
TOTAL PETROLUEM HYDROCARBONS		24.7	35.0	<27.9

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT ANALYTE LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

TABLE 4.6-3
ANALYTES IN GROUNDWATER
SA 58 - BUILDING 2648/2650 FUEL OIL SPILLS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		ROUND 1	ROUND 2	ROUND 3	ROUND 1	ROUND 2
ANALYTE	**BACK-GROUND**	**58M-92-01X**	**58M-92-01X**	**58M-92-01X**	**58M-92-02X**	**58M-92-02X**
ORGANICS (Ág/L)						
BENZENE		0.69	< 0.50	< 0.50	< 0.50	< 0.50
TOLUENE		0.84	< 0.50	< 0.50	< 0.50	< 0.50
TRICHLOROETHYLENE/TRICHLOROETHENE		0.83	< 0.50	< 0.50	< 0.50	< 0.50
TRICHLOROFLUOROMETHANE		3.3	< 0.50	< 0.50	< 0.50	< 0.50
INORGANICS (Ág/L)						
CALCIUM	14700.0	29500.0	24700.0	NA	47000.0	57300.0
MAGNESIUM	3480.0	4710.0	7990.0	NA	8230.0	5830.0
POTASSIUM	2370.0	6460.0	6400.0	NA	2830.0	4970.0
ANIONS/CATIONS (Ág/L)						
SULFATE		16100.0	12900.0	NA	19800.0	75400.0
ALKALINITY		63000.0	61000.0	NA	108000.0	117000.0
BICARBONATE		76900.0	74400.0	NA	179000.0	143000.0
NITRATE/NITRITE		7500.0	3300.0	NA	1100.0	970.0
CHLORIDE		19900.0	6340.0	NA	32300.0	5490.0
OTHER (Ág/L)						
TOTAL SUSPENDED SOLIDS		NA	540.0	NA	NA	1080.0

NOTES:
NA = NOT ANALYZED
TABLE LISTS DETECTED ANALYTES ONLY - SEE PROJECT LIST FOR SUMMARY
▨ = VALUE ABOVE BACKGROUND LEVEL

TABLE 4.6-3
ANALYTES IN GROUNDWATER
SA 58 - BUILDING 2648/2650 FUEL OIL SPILLS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		ROUND 1	ROUND 2	ROUND 1	ROUND 2
ANALYTE	**BACK-GROUND**	**58M-92-03X**	**58M-92-03X**	**58M-92-04X**	**58M-92-04X**
ORGANICS (Ág/L)					
BENZENE		< 0.05	< 0.50	< 0.05	< 0.50
TOLUENE		< 0.05	< 0.50	< 0.05	< 0.50
TRICHLOROETHYLENE/TRICHLOROETHENE		< 0.05	< 0.50	< 0.05	< 0.50
TRICHLOROFLUOROMETHANE		< 0.05	< 0.50	< 0.05	< 0.50
INORGANICS (Ág/L)					
CALCIUM	14700.0	45700.0	49100.0	66300.0	10200.0
MAGNESIUM	3480.0	11600.0	18100.0	13000.0	1980.0
POTASSIUM	2370.0	15900.0	12700.0	3940.0	1620.0
ANIONS/CATIONS (Ág/L)					
SULFATE		34900.0	26500.0	36300.0	13600.0
ALKALINITY		160000.0	165000.0	105000.0	17000.0
BICARBONATE		195000.0	201000.0	128000.0	20700.0
NITRATE/NITRITE		340.0	5200.0	550.0	33.8
CHLORIDE		29300.0	23900.0	19300.0	3450.0
OTHER (Ág/L)					
TOTAL SUSPENDED SOLIDS		NA	439.0	NA	132.0

TABLE 4.6-4
HUMAN HEALTH PRE EVALUATION OF SUBSURFACE SOIL
SA 58 - BUILDING 2648 AND 2650 FUEL OIL SPILLS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Detected Concentration [b]		Frequency of Detections	Region III Commercial/Industrial Concentration (ug/g)	Maximum Exceeds Region III Concentration?
	Average (ug/g)	(ug/g)			
Organics					
Acetone	0.054	0.054	1/4	100,000	NO

Notes:

[a] Base-wide background soil inorganics database

[b] Subsurface soil samples from sampling stations 58M-92-01X to 58M-92-04X

NA = not available

ug/g = micrograms per gram

TABLE 4.6–5
HUMAN HEALTH PRE EVALUATION OF GROUNDWATER
SA 58 – BUILDING 2648 AND 2650 FUEL OIL SPILLS

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Groundwater Background Concentration (ug/L)	Detected Concentration [a] Average (ug/L)	Detected Concentration [a] Maximum (ug/L)	Frequency of Detection	Maximum Exceeds Background?	Drinking Water Standard/Guideline [b] (ug/L)	Maximum Exceeds Standard/Guideline?
Organics							
benzene		0.69	0.69	1/8		5	NO
toluene		0.84	0.84	1/8		1000	NO
trichloroethene		0.83	0.83	1/8		5	NO
trichlorofluoromethane		3.3	3.3	1/8		1300	NO
Inorganics							
calcium	14700	41225	66300	8/8	YES	NA	NA
magnesium	3480	8930	18100	8/8	YES	NA	NA
potassium	2370	6852.5	15900	8/8	YES	NA	NA
Anions/Cations							
nitrite/nitrate	NA	2374.2	7500	8/8	NA	10000	NO
Other							
total suspended solids	NA	547750	1080000	4/4	NA	NA	NA

Notes:

[a] Based on unfiltered samples from Round 1 and Round 2

[b] Includes the lowest of either the EPA or MA drinking water standards, or if no federal standard or guideline is available, the Region III tap water concentration

SA 58 is represented by the following monitoring wells: 58M–92–01X through 58M–92–04X.

NA = Not available

ug/L = micrograms per liter

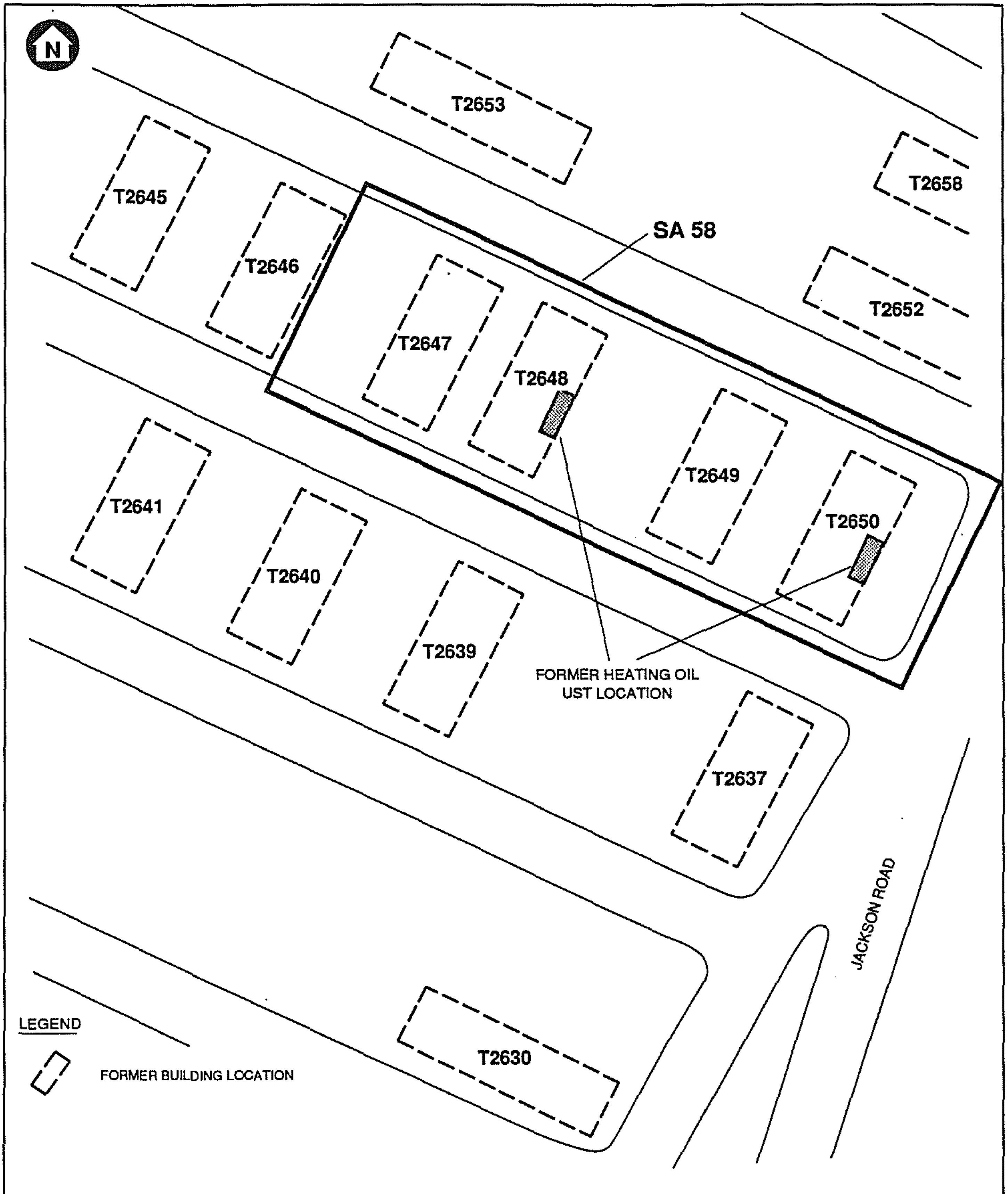


FIGURE 4.6-1
LOCATION OF SA 58
SA 58 SITE INVESTIGATION REPORT
FORT DEVENS, MA
ABB Environmental Services, Inc.

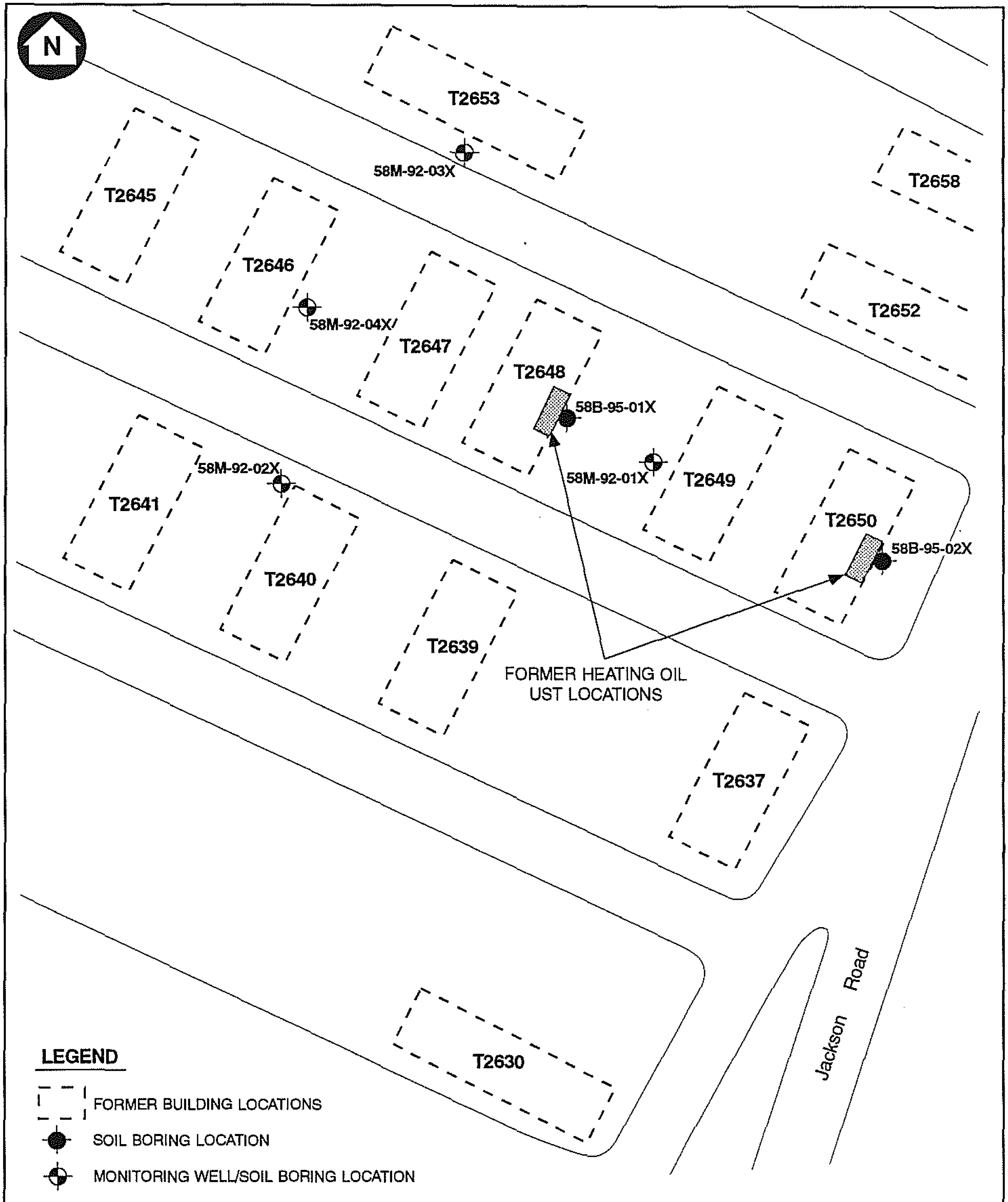


FIGURE 4.6-2
MONITORING WELL/SOIL BORING LOCATIONS
SA 58 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

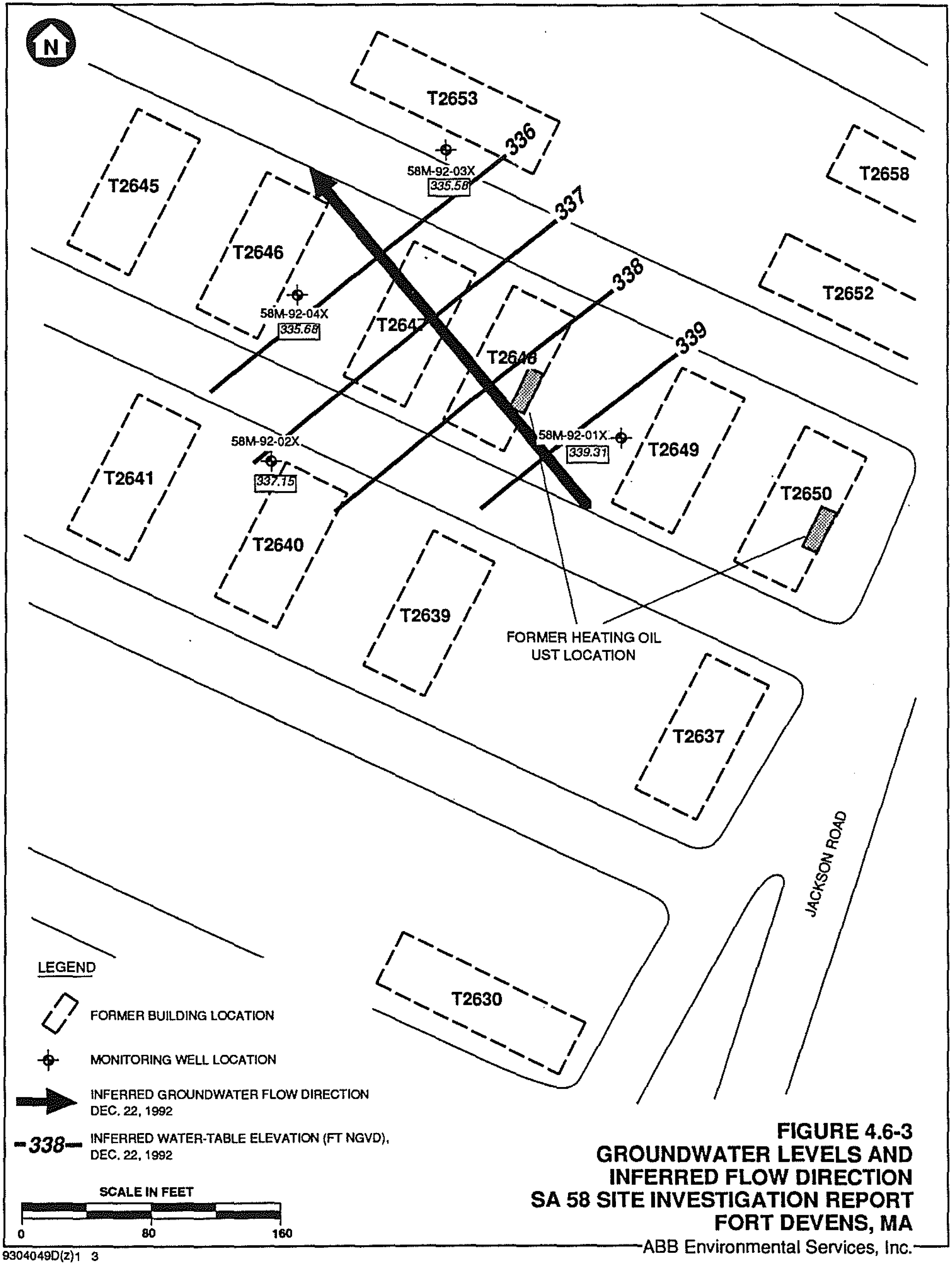


FIGURE 4.6-3
GROUNDWATER LEVELS AND INFERRED FLOW DIRECTION
SA 58 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

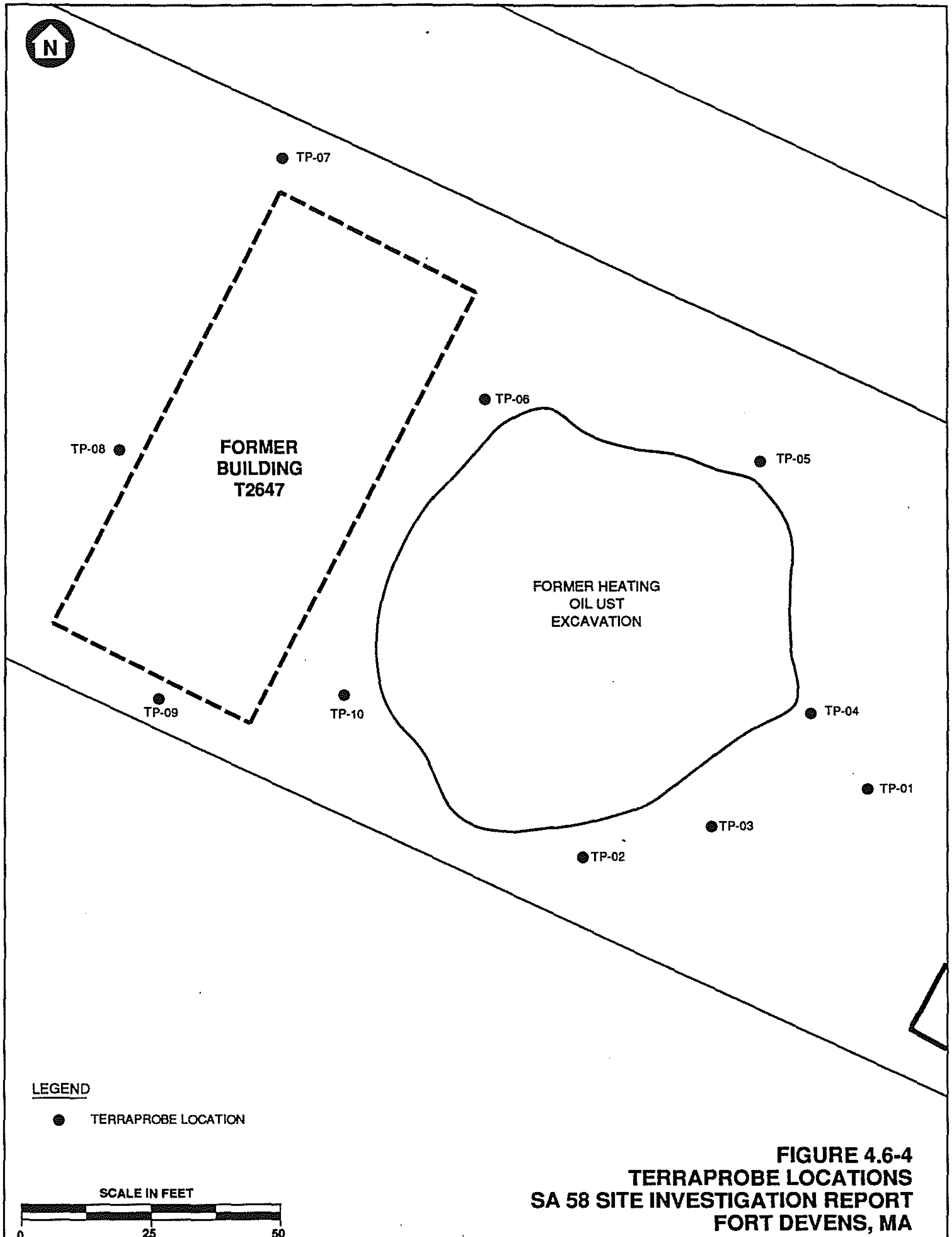


FIGURE 4.6-4
TERRAPROBE LOCATIONS
SA 58 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9304049D(z1)1

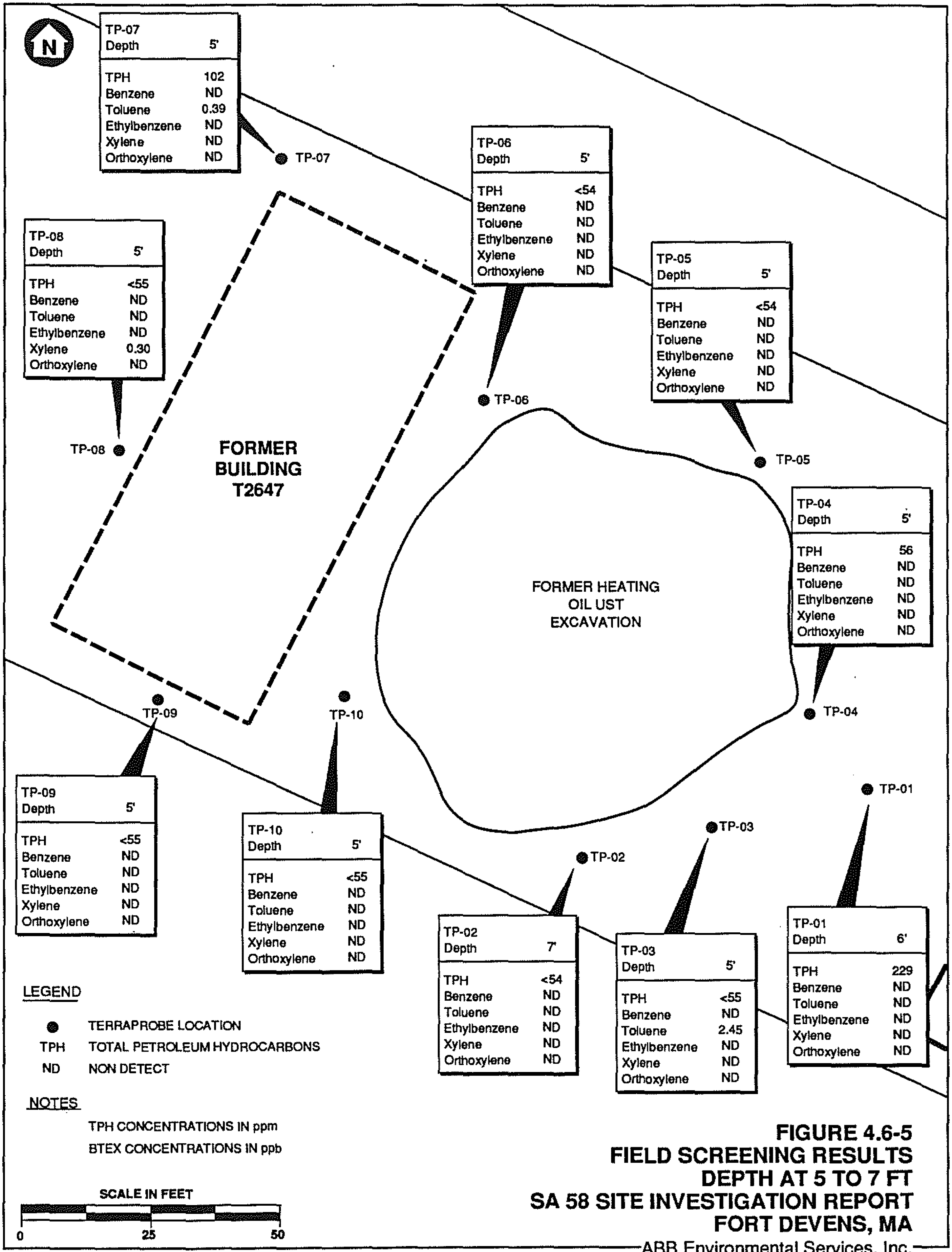


FIGURE 4.6-5
FIELD SCREENING RESULTS
DEPTH AT 5 TO 7 FT
SA 58 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9304049D(z1)1 2

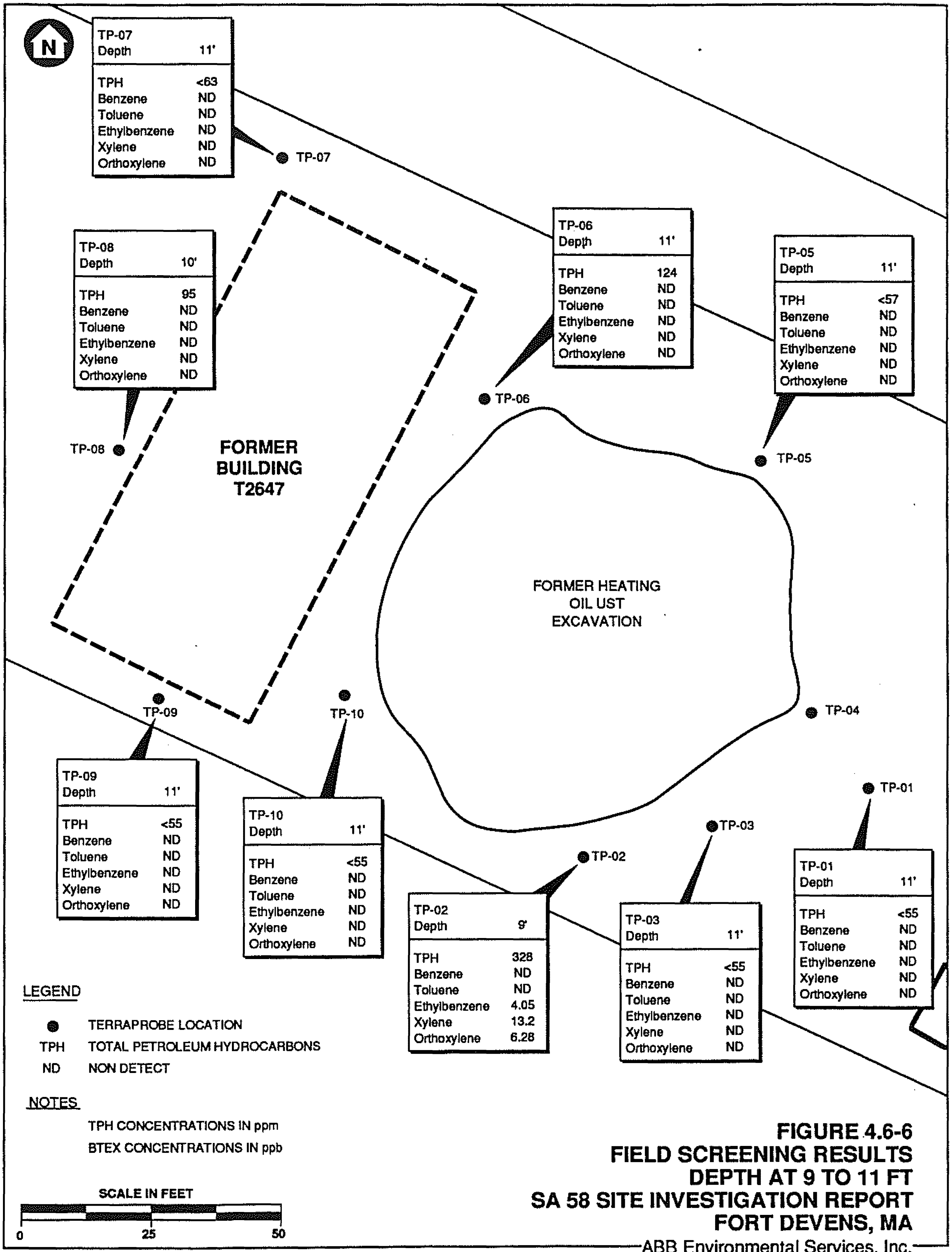


FIGURE 4.6-6
FIELD SCREENING RESULTS
DEPTH AT 9 TO 11 FT
SA 58 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

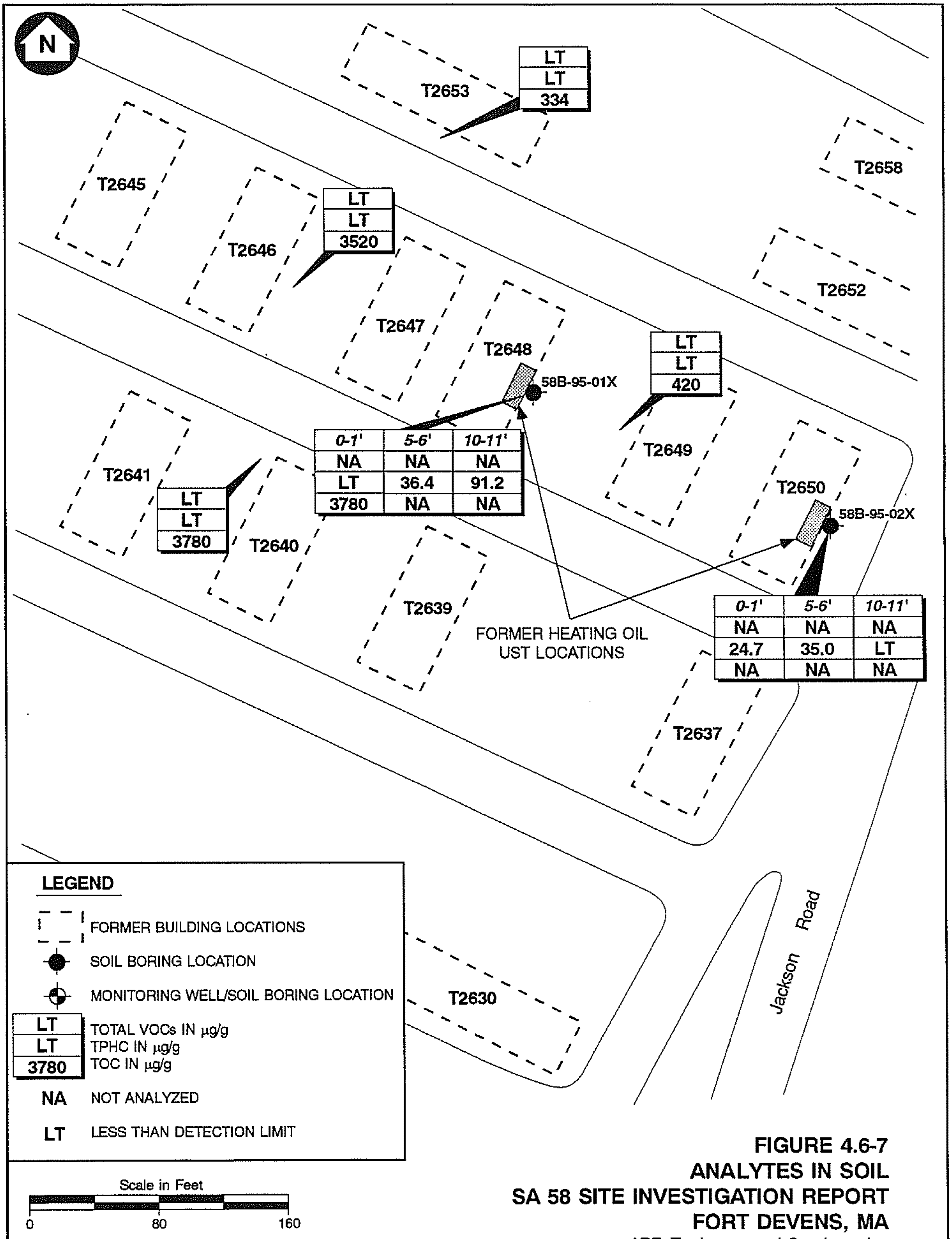


FIGURE 4.6-7
ANALYTES IN SOIL
SA 58 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

W9509018D 12 5

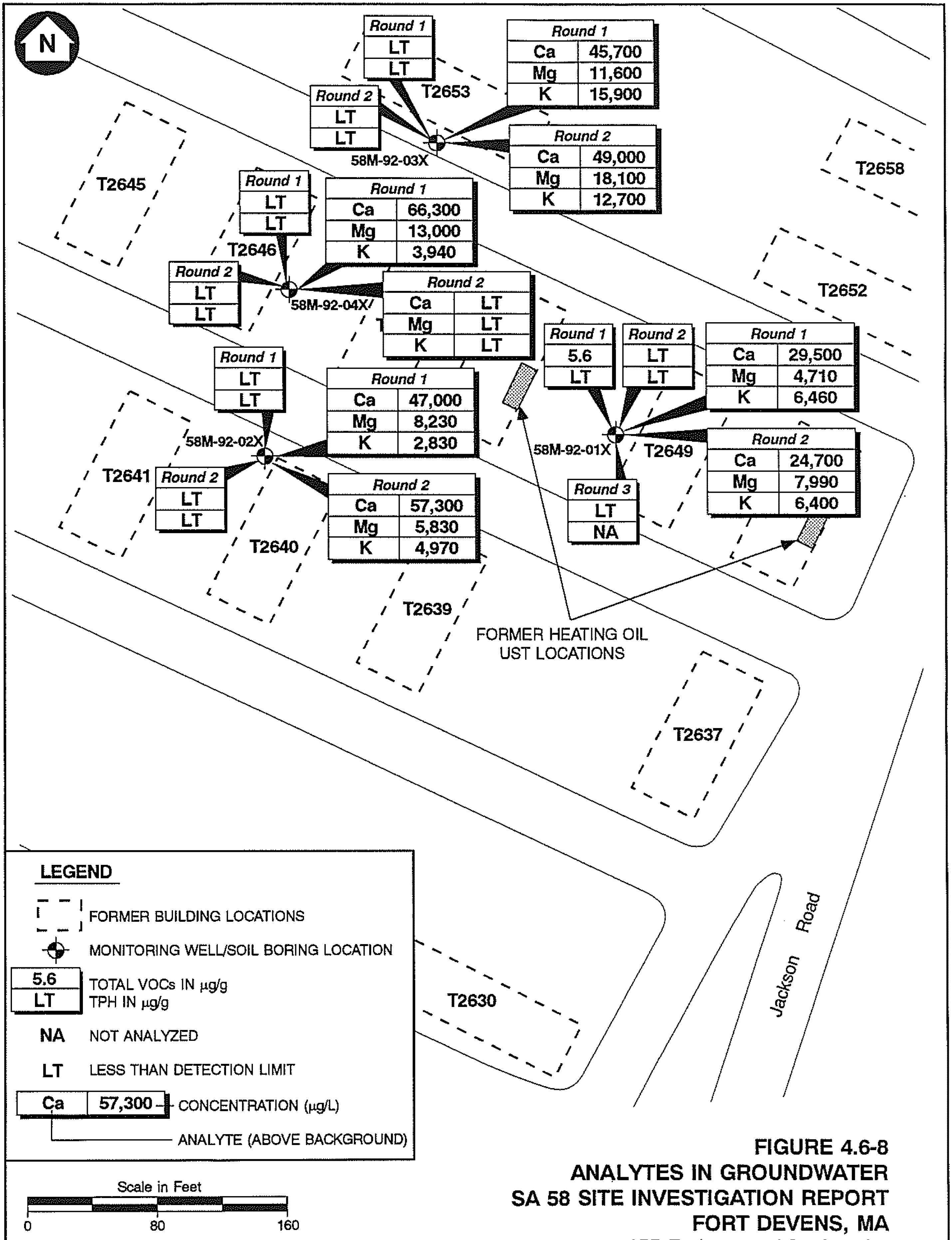


FIGURE 4.6-8
ANALYTES IN GROUNDWATER
SA 58 SITE INVESTIGATION REPORT
FORT DEVENS, MA

5.0 GROUP 7 STUDY AREA INVESTIGATIONS

The Group 7 SAs, all of which are located on the South Post (Figure 5.1-1), include:

- SA 12 - Landfill No. 8
- SA 14 - Landfill No. 10
- SA 27 - Waste Explosives Detonation Range [Hotel]
- SA 28 - Waste Explosives Detonation Range [Training Area 14]
- SA 41 - Unauthorized Dumping Area [Site A]
- SA 42 - Popping Furnace

The following subsections present the findings of the SI and the SSI field investigations conducted at Group 7 SAs during the 1992 and 1993 field programs.

5.1 SA 12 - LANDFILL NO. 8

5.1.1 Background and Conditions

Landfill No. 8 is located across from the combat pistol range B and P in the South Post between Dixie Road and the Nashua River (Figure 5.1-2).

The landfill consists of debris randomly dumped over the edge of a 30-foot hill. The debris covers the entire slope from approximately 40 feet east of the road to the wetland area at the base of the hill. Construction debris (bricks and metal) was also observed southeast of SA 12. The unsupervised dumping began in 1960 and a wide variety of scrap metal and wooden debris has been disposed of at this SA (McMaster et al., 1982). The base of the hill abuts the wetland area that merges into the Nashua River north of the SA. The Oxbow National Wildlife Refuge is approximately 250 feet east of SA 12. No records are available concerning the quantities or nature of the material disposed of at SA 12. Presently, the site is overgrown with shrubs and small trees. A thin layer (approximately 0.5 feet) of soil is covering 50 percent of the waste material.

5.1.2 Site Investigation Summary Program

The SI at SA 12 was completed in accordance with the Final SI Task Order Work Plan (ABB-ES, 1992b) and in conformance with the Project Operations Plan (ABB-ES, 1992a). The field investigation program conducted at SA 12 consisted of delineating the extent of the landfill by visible observation and surveying, surface soil sampling from the soil cover on the waste material, surface water and sediment sampling, and the installation of one monitoring well. These activities were conducted to assess whether the historic use of the study area had generated conditions that posed a risk to human health or the environment. Table 5.1-1 summarizes the scope of the SI.

Once the extent of the landfill was determined, eight surface soil samples (12S-92-01X through 12S-92-04X and 12D-92-01X through 12D-92-04X) were collected. The surface soil samples from locations 12S-92-01X through 12S-92-04X were collected from the landfill material in visibly stained areas to evaluate localized impact from the landfill materials (see Figure 5.1-2). The samples collected from 12D-92-01X through 12D-92-04X were originally collected as sediment samples. However, these samples were collected at 2 feet bgs from the side walls of sumps, dug for the collection of a water sample. Because these samples were obtained from between 0 feet and 3 feet bgs (which is the established risk evaluation depth for surface soil at Fort Devens) these samples were used to supplement surface soil data. The samples were analyzed at an off-site laboratory for PAL VOCs, SVOCs, pesticides/PCBs, inorganics, TPHC, and explosives (see Figure 5.1-2).

Four surface water and sediment samples were collected from the area between the landfill and the Nashua River. Two surface water and sediment pairs (12D-92-05X and 12D-92-06X) were collected from the wetland between the landfill material and the Nashua River. The final two sample pairs (12D-92-07X and 12D-92-08X) were collected from the Nashua River (see Figure 5.1-2). All four surface water samples were analyzed at an off-site laboratory for PAL VOCs, SVOCs, pesticides/PCBs, inorganics, TPHC, explosives, and water quality parameters. All four sediment samples were analyzed for PAL VOCs, SVOCs, pesticides/PCBs, inorganics, TPHC, explosives, TOC, and grain size. All of the sediment samples were obtained from areas of deposition.

A single soil boring (12M-92-01X) was advanced upgradient of the landfill material to characterize upgradient groundwater quality and determine the geologic conditions at this SA. Soil samples were collected continuously (2-foot intervals) with a 2-inch OD split-spoon sampler. Bedrock was encountered at 40 feet bgs and the water table was encountered in the bedrock at 44 feet bgs. Three subsurface soil samples were collected for grain size analysis. Subsurface soil samples were not submitted for laboratory analysis (see Figure 5.1-2).

One monitoring well was installed in the soil boring mentioned above. The well was screened across the water table and across the bedrock and soil interface. The boring was drilled with a 6¼-inch ID HSA to allow for the installation of the 4-inch ID PVC monitoring well. This monitoring well was developed between two and seven days after installation.

Two rounds of groundwater samples (Round One and Round Two) were collected from 12M-92-01X. Round One was collected in September 1992 and Round Two was collected in January 1993. The inorganic groundwater sample collected from 12M-92-01X during the Round One was unfiltered, while during the Round Two sampling both an unfiltered and filtered inorganic samples was collected. The samples for both rounds were submitted for off-site laboratory analysis of PAL VOC, SVOCs, inorganics, TPHC, pesticides/PCBs, anions and cations, and explosives.

Aquifer hydraulic conductivity was determined by performing two slug tests in 12M-92-01X. The tests were conducted between Rounds One and Two of groundwater sampling. The results of the hydraulic conductivity tests are presented in Appendix A.

5.1.3 Supplemental Site Investigation Summary Program

The SSI at SA 12 was completed in accordance with the Final SSI Task Order Work Plan (ABB-ES, 1993b) and in conformance with the Project Operations Plan (ABB-ES, 1992a). The SSI was conducted to further define the distribution of contaminants detected in the surface water and sediments in backwater area at the base of the waste material, and attempt to identify the relative contribution of the SA 12 landfill vs. the Nashua River to the contamination detected in the SA 12 backwater. Table 5.1-1 summarizes the scope of the SSI.

An upstream backwater sampling area was selected on the east side of the Nashua River, approximately 0.8 miles from SA 12 (see Figure 5.1-1). It is partially separated from the river by a natural levee. It is immediately surrounded by forested land, but it is downslope of extensive agricultural land in the Still River area of Harvard, MA. There are no other known land uses nearby, and there is no apparent evidence of past non-agricultural land uses. At the time of sampling (August 1993), water levels were low and surface water covered less then half of the area of the backwater. Surface water and sediment samples were collected on August 16, 1993 (Figure 5.1-3).

A downstream backwater sampling area was selected on the east side of the Nashua River near Jackson Gate, approximately 1.3 miles from SA 12 (see Figure 5.1-1). The lagoon occupies a cutoff meander of the river. This backwater is hydraulically connected to the Nashua River at the channel's downstream end, but the flow of water is restricted by a shallow sand bar. In periods of very low water the backwater may be entirely cut off from the river. The backwater is located on the north side of the Route 2 cloverleaf, but drainage from the highway does not appear to flow directly into the lagoon (Figure 5.1-4).

To better evaluate the surface water and sediment results obtained from the backwater at SA 12, the samples were grouped into two areas. Area 1 comprises the sample collected closest to the SA 12 landfill waste material (12D-93-09X through 12D-93-14X). Area 2 is comprised of the samples collected from the portion of the backwater area occupied by the lagoon (12D-93-15X through 12D-93-28X). Figure 5.1-2 shows the locations of these areas.

A total of 20 surface water and sediment sampling locations were established in the backwater area at SA 12 (see Figure 5.1-2). Because sufficient volumes of surface water were not available at all of the sampling locations, only nine, out of the potential 20, surface water samples were collected. No surface water samples were collected from Area 1. Two additional surface water samples were collected at the upriver backwater location and five were collected from the downriver backwater location (see Figures 5.1-3 and 5.1-4). The surface water samples were analyzed for PAL VOCs, SVOCs, inorganics, pesticides/PCBs, explosives, and water quality parameters.

Sediment samples were collected at all 20 locations in the backwater area at SA 12 (see Figure 5.1-2). Five sediment samples were collected from both the upriver and downriver backwater areas (see Figures 5.1-3 and 5.1-4). The sediment samples collected from each area were analyzed for PAL VOCs, SVOCs, inorganics, pesticides/PCBs, explosives, TPHC, TOC, and grain size. The soil classification for each sediment sample is presented in Table 5.1-2. Each surface water and sediment sampling location was surveyed.

The water of the Nashua River has been assigned to Class B. Class B surface water is "designated for the uses of protection and propagation of fish, other aquatic life and wildlife, and for primary and secondary contact recreation" (MADEP, 1990).

5.1.4 Field Investigation Results and Observations

The South Post is blanketed by unconsolidated surficial deposits of glacial and post-glacial origin. There are few bedrock exposures. Based on regional trends and infrequent local outcrops, bedrock in the vicinity of SA 12 has been mapped as a unit of the Merrimack Formation, of Silurian-Devonian age. Most of the surficial glacial units in the Nashua Valley are associated with deposition in glacial Lake Nashua, which formed against the terminus of the Wisconsinan ice sheet as it retreated northward along the valley. Successively lower outlets were uncovered by the retreating glacier, and the lake level was correspondingly lowered. The geologic conditions in the South Post are presented in Section 2.2. The soils encountered at SA 12 consisted of well graded sands from the ground surface to 16 feet. This material is underlain by silty clay/clayey silt from 16 feet to 22 feet bgs. Below 22 feet the soil is a poorly graded silty fine sand to the top of bedrock at 40 feet bgs. Groundwater was not encountered in the overburden soils. The bedrock was cored from 40 feet to 74 feet bgs for the placement of the groundwater monitoring well. The bedrock cores collected were classified as a gray metapellitic siltstone with calcite intrusions. Table 5.1-2 summarizes the soils encountered in the monitoring well boring for 12M-92-01X. Soil boring logs and rock core logs are provided in Appendix B.

Monitoring well 12M-92-01X was installed as part of this investigation at a location presumed to be upgradient of the landfill material at SA 12. The monitoring well is screened in bedrock, across the water table (Table 5.1-3). Well completion details are provided in Appendix C.

Installation-wide water-level surveys of monitoring wells and surface water stations have been conducted quarterly since May 1992. Included in each of the surveys was monitoring well 12M-92-01X and a surface water station (SWEL-11). The results of this round of water-levels, and the previous rounds, is provided in Appendix I.

The one groundwater measuring point at SA 12 is insufficient to construct a map of water table contours or flow directions. However, the major surface water body in the region is the Nashua River, located approximately 500 feet east of the landfill. Higher ground is located to the west of the landfill. Under these conditions, groundwater would be expected to flow generally eastward from the landfill toward the river. This interpretation is consistent with the installation-wide model of Engineering Technologies Associates, Inc. (1992, Figure III-20).

Based on *in-situ* aquifer testing, hydraulic conductivities of 2 x 10^{-3} cm/sec and 6 x 10^{-4} cm/sec were determined in the fractured bedrock at the water table in monitoring well 12M-92-01X (Table 5.1-4). The results of the hydraulic conductivity tests are provided in Appendix A.

Sediment samples collected from the wetland located at the base of the waste material and the Nashua River, were submitted for grain size analysis. The results indicated that the sediment consisted of silty sand with organics (vegetation) and water contents ranging from 9.4 to 87.2 percent. Table 5.1-5 summarizes the results and the grain size results are presented in Appendix J.

5.1.5 Nature and Distribution of Contamination (Laboratory Results)

The objective of sampling at SA 12 was to investigate for the presence of environmental contamination generated by the historical use of the landfill and, if found, assess the vertical and horizontal distribution of contaminants. Samples of soil, groundwater, surface water, and sediment were collected to characterize local impacts from the landfill material.

5.1.5.1 Surface Soil. Four surface soil samples were collected from within the limits of the landfill from areas exhibiting surficial staining apparently caused by landfilling operations. No VOCs, except for a single acetone detection in 12S-92-04X, were detected. Acetone is a common laboratory contaminant.

Several PAHs were detected in the samples collected from 12S-92-03X and 12S-92-04X. The highest concentrations and greatest number of PAHs were found in 12S-92-04X. 4,4'-DDT and 4,4'-DDE were detected in the samples collected at 12S-92-01X, 12S-92-03X and 12S-92-04X. No pesticides were detected in 12S-92-02X. Aroclor-1254 was detected at 6.9 $\mu g/g$ in the surface soil sample collected from 12S-92-03X. TPHC was detected in 12S-92-03X, 12S-92-04X, and 12D-92-02X, and its duplicate (Table 5.1-6; see Figure 5.1-5).

Inorganic analytes were detected at concentrations above the established Fort Devens background concentrations in all but the soil sample collected from 12D-92-01X. Copper, sodium, and zinc were the most common analytes; barium, beryllium, lead, and nickel were also detected above background (Table 5.1-7; Figure 5.1-6).

5.1.5.2 Groundwater. One groundwater monitoring well was installed in an apparent upgradient location, for the purpose of characterizing upgradient groundwater quality. Two rounds of groundwater samples were collected from this well. The inorganic sample from Round One was unfiltered, but the inorganic sample collected during Round Two was both filtered and unfiltered. The Round Two groundwater sample was also analyzed for TSS. Organic contaminants were not detected above the analytical method detection limits in groundwater samples from either round. Calcium, manganese, and zinc were detected above the established Fort Devens groundwater background concentrations in both rounds of groundwater samples. The results of the filtered inorganic sample from Round Two showed that only calcium and zinc were detected above the established Fort Devens background (Table 5.1-8; Figure 5.1-7).

For the purposes of evaluating the landfill's impact on downgradient groundwater due to the historical use of the landfill, four sumps were dug (12D-92-01X through 12D-92-04X) for the collection of soil and water samples (see Figure 5.1-2). The samples of the water from these sumps were collected, prior to the Round One groundwater sampling, and submitted for laboratory analysis as surface water samples from 12D-92-01X through 12D-92-04X, but more accurately these samples reflect downgradient groundwater conditions. The results from these samples were used to supplement the results from 12M-92-01X. Only this one round of sampling was performed on these sumps. A trace concentration of bis (2-ethylhexyl) phthalate (presumed laboratory contaminant) was detected in

12D-92-03X only. No other organic compounds were detected in these sump water samples. TSS concentrations were high in these sump samples apparently due to the sampling method. The resulting inorganic analyte concentrations in these sump water samples were also high when compared to the established Fort Devens background groundwater concentrations. It appears that these inorganics concentrations are not representative of true groundwater conditions. No PCB/ pesticide or explosive compounds were detected in these four water samples (see Table 5.1-8; Figure 5.1-7).

5.1.5.3 Surface Water. During the SI a total of four locations (12D-92-05X through 12D-92-08X) were selected in the backwater at the base of the landfill material for collection of representative samples of surface water and sediment (see Figure 5.1-2).

SA 12 Backwater. Two of the sample pairs (12D-92-05X and 12D-92-06X) were collected from the wetlands area between the Nashua River and the landfill material. The remaining two sample pairs (12D-92-07X and 12D-92-08X) were collected from the Nashua River in the presumed groundwater discharge zone along the western side of the river, downgradient of the landfill (see Figure 5.1-2). A low concentration of bis (2-ethylhexyl) phthalate (a common laboratory contaminant) was detected in the surface water sample collected from 12D-92-06X. No other organic compounds were detected in this sample or the other three surface water samples. Inorganic analytes (aluminum, arsenic, barium, calcium, chromium, copper, iron, potassium, magnesium, manganese, sodium, lead, vanadium, and zinc) were detected at elevated concentrations in 12D-92-05X and 12D-92-06X. No significant concentrations of organic or inorganic analytes were detected in 12D-92-07X and 12D-92-08X (Table 5.1-9; Figures 5.1-8 and 5.1-9).

Analyte concentrations in SSI surface water samples collected from Area 2 at SA 12 are also listed in Table 5.1-9. Concentrations of organic and inorganic analytes are shown, respectively, in Figures 5.1-8 and 5.1-9.

1,2-Dichloroethane (DCA) was the only VOC detected in surface water at SA 12. DCA was detected in eight out of 10 surface water samples and the concentrations ranged from below the detection limit (0.5 μg/L) to 2 μg/L. DCA was not detected above the certified reporting limit (CRL) in any of the laboratories or field blanks. DCA was reported on one sampler blank

(SBK-93-686) at concentration similar to those found in these surface water samples. The contract laboratory used a deuterated form of DCA as a surrogate for VOC analysis. Therefore, laboratory contamination of the samples may be the cause of the DCA.

No SVOCs, pesticides, PCBs, or explosives were detected in any of the SSI surface water samples. Inorganic analytes present at notable concentrations included aluminum, iron, and manganese.

Chloride was detected at concentrations ranging from 3,450 to 8,730 μg/L; sulfate from less than the detection limit to 129,000 μg/L; total kjeldahl nitrogen (TKN) from 629 to 3,520 μg/L; nitrite, nitrate from less then the detection limit to 190 μg/L (NO_2 + NO_3; and phosphate from 95.8 to 790 μg/L. The range of hardness values was from 22,000 to 146,000 μg/L. Field pH measurements were between 5.9 and 6.7.

Upriver Backwater. Analyte concentrations in surface water from the upriver backwater sample location (12D-93-29X and 12D-93-30X) are listed in Table 5.1-10. Concentrations of organic and inorganic analytes are shown, respectively, in Figure 5.1-10.

Chloroform (a common laboratory contaminant) was detected in one sample, and it was the only VOC detected in surface water from the upriver backwater.

No SVOCs, pesticides, PCBs, or explosives were detected in any of the samples. Inorganic analytes present at elevated concentrations included aluminum, iron, and manganese.

Chloride was detected at concentrations of 43,000 μg/L and 41,000 μg/L, respectively in 12D-93-29X and 12D-93-30X. Sulfate was detected at concentrations of 12,200 and 13,500 μg/L; TKN 476 and 914 μg/L; nitrogen (NO_2 + NO_3) from 820 and 1,100 μg/L; and phosphorous 43.9 and 155 μg/L. Hardness values were 81,600 and 94,400 μg/L, respectively. Field pH measurements were 7.1 and 7.7, respectively.

Downriver Backwater. Analyte concentrations in surface water from the downriver backwater sample locations (12D-93-34X through 12D-93-38X) are listed in Table 5.1-11. Concentrations of organic and inorganic analytes are shown, respectively, in Figure 5.1-11.

VOCs at the downriver backwater included chloroform and methylene chloride, both of which are common laboratory contaminants. DCA was the only other VOC detected, at 1 μg/L at 12D-93-35X. The presence of this VOC in this sample appears to be the result of laboratory contamination (see Section 2.2.1.1).

No SVOCs, pesticides/PCBs, or explosives were detected in any of the samples. Inorganic analytes present at notable concentrations included aluminum, iron, and manganese.

Chloride was detected in each sample at concentrations of 66,000 to 66,500 μg/L; sulfate consistently at 16,500 μg/L; TKN from 924 to 1,810 μg/L; nitrogen (NO_2 + NO_3) from 18 to 41.8 μg/L; and total phosphorous from 68 to 147 μg/L. The range of hardness values was from 45,400 to 61,000 μg/L.

5.1.5.4 Sediment. The following subsections summarize the off-site laboratory results of the sediment samples collected during the SI and the SSI. Sediments were sampled using a hand auger or dredge sampler. The sediment samples were submitted for off-site laboratory analysis and tested for grain-size distribution.

SA 12 Backwater. The sediment samples collected during the SI from the backwater area (Area 2) between the landfill material and the Nashua River (12D-92-05X and 12D-92-06X) contained detectable concentrations of organic compounds including acetone (likely laboratory contaminant), and several PAHs. PAH concentrations ranged from 4.9 μg/g at 12D-92-06X to 41.9 μg/g at 12D-92-05X. Significant concentrations of TPHC were also detected in 12D-92-05X (2,250.0 μg/g) and 12D-92-06X (1,940 μg/g). Inorganic analytes were also detected in these two samples, along with 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE. Aroclor-1260 was detected in 12S-92-05X at 0.921 μg/g. Inorganic analytes detected at notable concentrations included arsenic, barium, cadmium, chromium, cobalt, copper, lead, magnesium, manganese, mercury, nickel, silver, vanadium, and zinc (Table 5.1-12; Figures 5.1-12, 5.1-13, and 5.1-14).

The two sediment samples were collected from the Nashua River during the SI (12D-92-07X and 12D-92-08X) contained several PAHs. Total PAH concentrations ranged from 0.5 μg/g in 12D-92-05X to 2.7 μg/g in 12D-92-07X.

No VOCs were detected. Low concentrations of TPHC were detected in both samples ranging from 100 μg/g in 12D-92-08X to 12.4 μg/g in 12D-92-07X. Several inorganic analyte concentrations were detected at notable concentrations in both samples including arsenic and lead. 4,4'-DDD, 4,4'-DDT, and 4,4'-DDE, and Aroclor-1260 were detected in the downstream sediment sample collected at 12D-92-07X. The inorganic analytes detected at notable concentrations were similar to those detected in Area 2 (see Table 5.1-12; Figure 5.1-12).

Total VOC concentrations in the sediment samples collected from Area 1 during the SSI ranged from less than the detection limit to 0.14 μg/g. Acetone (a common laboratory contaminant) was found in three of the six samples. Toluene (0.003 μg/g) was found in one sample (12D-93-14X) (Table 5.1-13; Figure 5.1-15).

Total SVOCs in Area 1 ranged in concentration from 0.4 to 4.1 μg/g and included bis(2-ethylhexyl)phthalate (a common laboratory contaminant) and several PAHs. TPHC concentrations ranged from 56.2 to 223 μg/g. Pesticides were detected in four of the sediment samples. Pesticides included 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and heptachlor. No explosives or PCBs were detected (see Table 5.1-13; Figure 5.1-15).

Inorganic analytes detected at notable concentrations in sediment from Area 1 included barium, cadmium, chromium, copper, lead, mercury, and zinc (see Table 5.1-13; Figure 5.1-16).

Total VOC concentrations in the sediment samples collected during the SSI from Area 2 ranged from less than the detection limit to 0.59 μg/g. Acetone (a common laboratory contaminant) was found in eight of the 14 samples collected. Carbon disulfide was found in 12D-93-16X at 0.09 μg/g and in 12D-93-20X at 0.02 μg/g. Toluene (0.004 μg/g) was detected in 12D-93-25X, and trichlorofluoromethane (frcon) was detected in four samples (0.011 to 0.051 μg/g). Freon is also believed to be a laboratory contaminant (see Table 5.1-12; Figure 5.1-12).

Total SVOCs ranged from 9.05 to 144.0 μg/g and included bis(2-ethylhexyl) phthalate, a common laboratory contaminant, and several PAHs. TPHC concentrations ranged from 977 to 5,810 μg/g. Pesticides were detected in all of the sediment samples collected from Area 2. The pesticides included beta-benzenehexachloride, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, heptachlor, isodrin, and alpha- and gamma-chlordane. PCB-1260 was detected in ten of the 14 samples ranging from less than the detection limit to 0.92 μg/g. Explosives were not detected (see Figures 5.1-12 and 5.1-12).

Inorganic analytes detected at notable concentrations in sediment from Area 2 included antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, silver, and zinc (see Table 5.1-12; Figures 5.1-13 and 5.1-14).

In general, higher concentrations of organic and inorganic analytes and TOC were detected in Area 2, with lower concentrations near the landfill and southeast of the landfill in Area 1. Seasonal influxes from the Nashua River are the principal source of sediments in Area 2; the comparatively quiet waters of the lagoon allow the deposition and accumulation of fine particulates which would remain suspended in the flowing waters of the river itself. The general pattern of analyte distribution in sediment at SA 12 is consistent with this type of depositional environment.

Upriver Backwater. The common laboratory contaminant acetone was the only VOC detected in sediment at this area. Total SVOCs ranged from below the detection limit to 58 μg/g and included bis(2-ethylhexyl)phthalate (a common laboratory contaminant) and several PAHs. TPHC concentrations ranged from 64 to 2,260 μg/g. Pesticides were detected in three of the samples, including 4,4'-DDD, 4,4'-DDE, and heptachlor. PCB-1260 (0.237 μg/g) was detected in 12D-93-33X. Explosives were not detected (see Table 5.1-14; Figure 5.1-17).

Inorganic analytes detected at elevated concentrations in sediment from the upriver backwater included arsenic, cadmium, chromium, copper, lead, mercury, and zinc (see Table 5.1-14; Figure 5.1-7).

Downriver Backwater. VOCs in sediment included only acetone (a common laboratory contaminant) and carbon disulfide (0.044 μg/g at 12D-93-36X). Total SVOCs ranged from 8.0 to 108.5 μg/g and included bis(2-ethylhexyl)phthalate (a common laboratory contaminant) and several PAHs. TPHC concentrations ranged from 2190 to 12,800 μg/g. Nitroglycerine was detected in three samples with concentrations ranging from 5.08 to 11.3 μg/g. Pesticides were detected in all five samples, including 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. PCB-1260 was detected in three of the samples ranging from 0.72 to 1.83 μg/g (Table 5.1-15; Figure 5.1-18).

Inorganic analytes detected at notable concentrations in sediment from the downriver backwater included antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc (see Table 5.1-15; Figure 5.1-18).

5.1.6 Source Evaluation and Migration Potential

The SVOCs, inorganic analytes, and pesticide compounds detected in surface soil samples (12S-92-03X and 12S-92-04X and 12D-92-01X through 12D-92-04X) are likely derived from the landfilled materials. This is particularly true for lead and zinc. Contaminant migration has most likely occurred via surface water runoff. However, a specific source within the debris was not discovered. The acetone detected in these samples appears to be attributed to off-site laboratory contamination.

Concentrations of similar SVOCs, inorganic analytes, TPHC, and pesticide compounds were found in surface water and sediment samples located between the landfill material and the Nashua River (12D-92-05X and 12D-92-06X) suggesting a contribution of additional contamination to this depositional area from upriver sources in the Nashua River.

The suite of SVOCs (PAHs), inorganic analytes, pesticide compounds, and TPHC were detected in SSI sediment samples collected from the backwater at SA 12. No surface water samples were collected from Area 1 during the SSI. These same compounds and inorganic analytes were also found in the upriver and downriver backwater sampling locations. To compare each sampling area, nine indicator analytes (aluminum, arsenic, barium, cadmium, copper, lead, nickel, and vanadium) were chosen and the average of detects for sediment samples from each area were calculated (see Tables 5.1-12 through 5.1-15). These inorganic analytes were chosen because they are identified as exceeding their benchmark values in the human health and ecological PREs for Area 1 sediments surface water was not compared due to the fact that the human health and ecological PREs did not assess the risks in surface water at Area 1. The results of the comparison are presented in Figures 5.1-19.

The comparison of the sediment sample results showed that the concentration of target analytes were consistently lower in Area 1 compared to the other three areas (see Figure 5.1-19). If these comparisons are used as the model for both inorganic and organic contaminant profiles at SA 12, then these comparisons indicate that the Nashua River is the source of the contaminants detected in Area 2, and to a lesser degree (because of seasonal flooding) Area 1, not the landfill material at SA 12. Because PAHs and elevated inorganics were detected in the surface soil samples collected from the cover soils on the waste material during the SI, it is also anticipated that contaminant migration may occur from the cover soils to the sediments in Area 1, via colloidal transport in surface water runoff.

Upgradient groundwater contained only calcium, manganese, and zinc above the established Fort Devens background concentration for these analytes. No organic compounds were detected. Inorganic analytes detected in downgradient/ downslope sump groundwater (12D-92-01X through 12D-92-04X) may be the result of excessive TSS concentrations. The TSS concentrations are likely the result of the sampling methodology and not representative of the groundwater conditions in the wetlands. No organic compounds were detected in these samples, suggesting non-observable impacts from the landfill materials.

5.1.7 Preliminary Human Health Risk Evaluation

A preliminary human health risk evaluation was prepared for SA 12 to determine if the contaminants detected at the site pose a risk to human receptors. For this PRE, the future use of SA 12 is assumed to be residential. Tables 5.1-7 through 5.1-10 present summary statistics and human health standards and guidelines used in the PRE for SA 12.

5.1.7.1 Soils. As discussed in Section 3.5 (Preliminary Risk Evaluation Methodology), all soils to a depth of 3 feet are classified as surface soil and considered to be accessible under a residential future use exposure scenario.

Table 5.1-16 presents summary statistics on surface soil at SA 12 and USEPA Region III residential soil concentrations for comparison. Surface soil at SA 12 is represented by samples 12S-92-01X through 12S-92-04X collected from stained surficial soils, and 12D-92-01X through 12D-92-04X collected from shallow soil depths. An assessment of the organic compound data for SA 12 surface soils showed that there was some contamination from TPHC, pesticide residues, PAHs, and PCBs, specifically, Aroclor 1254. The levels of the detected organic analytes in the surface soils were below the USEPA Region III residential soil concentrations, with the exception of Aroclor 1254. The maximum detected concentration of Aroclor 1254 (6.9 μg/g) exceeded the USEPA Region III residential soil concentration of 0.22 μg/g; however, Aroclor 1254 was detected in only one of the nine samples (eight samples and one duplicate) collected.

An assessment of the inorganic data for SA 12 surface soils showed that there was elevated inorganic analyte surface contamination particularly in the visually contaminated soils directly on top of the landfill (12S-92-02X to 12S-92-04X) but less contamination laterally (12D-92-01X to 12D-92-04X).

When comparing concentrations of the surface soils at SA 12 to the statistical soil background, there were a number of compound exceedances, most notably lead and zinc. This was not unexpected since the soil samples were collected from visually stained areas (12S-92-02X to 12S-92-04X). There were few exceedances in the soil samples collected from the shallow soil samples (locations 12D-92-01X through 12D-92-04X).

Of the eight inorganic analytes detected above the established Fort Devens background levels, only two analytes were detected at concentrations above their respective health-based soil guideline. Although beryllium was detected at 0.74 μg/g, above the USEPA Region III residential soil concentration of 0.4 μg/g, it was detected in only three of nine samples. The USEPA Superfund lead cleanup level of 500 μg/g was exceeded at only one sampling location (12S-92-03X). One additional inorganic analyte, arsenic, was detected at concentrations above the USEPA Region III residential soil concentrations. Arsenic was detected at concentrations above the residential soil concentration, but the maximum detected concentration did not exceed the established background concentration for arsenic (21 μg/g). Based on this screening-level analysis, it appears that beryllium and lead at the reported sampling locations may pose a potential risk to human health.

5.1.7.2 Groundwater. Table 5.1-17 presents summary statistics on groundwater associated with SA 12 and drinking water standards/guidelines for comparison. Monitoring well location 12M-92-01X has been used to define the upgradient groundwater quality in the vicinity of the landfill. Water samples from four downgradient sump locations in close proximity to the fill area have been used to assess the impact on groundwater from the landfill. All four locations (12D-92-01X through 12D-92-04X) were dug sumps. All of the data reported in Table 5.1-8 is based on unfiltered samples.

Two organic compounds were detected in the groundwater associated with SA 12; bis (2-ethylhexyl) phthalate and chloroform. The maximum detected concentration of chloroform was below the Massachusetts drinking water standard for non-chlorinated water supplies. Bis (2-ethylhexyl) phthalate was detected in one of six samples at concentration (9.1 μg/L) above the USEPA Region III tap water concentration (6.1 μg/L).

An assessment of the inorganic data for SA 12 groundwater showed that there was some inorganic analyte contamination directly surrounding the SA. When comparing groundwater concentrations to the established background, the inorganic data for SA 12 groundwater shows that there were significant compound exceedances, including: aluminum, arsenic, chromium, copper, iron, lead, manganese, mercury, and zinc.

A drinking water standard or guideline is available for fifteen of the seventeen inorganic analytes detected above the established background concentrations. Seven analytes were detected at concentrations above their drinking water standard/guideline. Aluminum, iron, and manganese were detected in six of six samples collected and each average concentration exceeded its respective USEPA secondary MCL. (Secondary MCLs are set for aesthetic or economic reasons, not health reasons.) Beryllium, antimony, and cadmium were detected in one of six samples and the detected concentration of each contaminant exceeded its respective drinking water standard/guideline. The maximum concentration of lead (500 μg/L) and the average (125.8 μg/L) exceeded the USEPA lead action level of 15 μg/L. Based on this screening-level analysis, it appeared that lead and, possibly beryllium, antimony, and cadmium, at the reported sampling locations may pose a potential risk to human health.

A filtered sample was collected in Round Two at 12M-92-01X. A comparison of the filtered and unfiltered samples at this monitoring well indicated that high TSS levels may be responsible for the high levels of some inorganic analytes. The concentrations of aluminum, calcium, iron, potassium, magnesium, and manganese in the filtered sample were significantly lower than in the unfiltered sample from this well.

5.1.7.3 Sediment. The focus of this PRE is on the Area 1 sediments. This area was chosen because of the fact that the contaminants detected in the soil cover may have impacted this area. Surface water was excluded because no surface water was present at this area during sampling. Tables 5.1-18 present summary statistics on sediment associated with Area 1 at SA 12.

The organic analyses of these samples indicate the presence of pesticide residues, TPHC, and PAHs. Acetone, bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were detected but are not believed to be site-related as they are common laboratory contaminants. The PAHs, pesticides, and TPHC were detected at concentrations below both the MCP S-2/GW-1 soil standards and the USEPA Region III residential soil concentrations. Of the inorganic analytes, only beryllium and manganese exceeded both the USEPA Region III residential soil concentrations and the MCP S-2/GW-1 soil standards. Although the maximum detected concentration of arsenic exceeds the USEPA Region III residential soil concentration, it was below the MCP S-2/GW-1 soil standard. The remaining inorganics did not exceed either screening guideline. Because the magnitude and frequency of exposure to Area 1 sediment would be expected to be less than that upon which the guidelines are based, exposure to the sediment does not appear to pose a significant human health risk.

5.1.8 Preliminary Ecological Risk Evaluation

The purpose of the PRE at SA 12 is to provide a screening-level evaluation of actual and potential risks that environmental contaminants may pose to the resident and migratory ecological receptors at the site.

Between Dixie Road and the landfill is a small dry region containing occasional poplar (*Populus tremuloides*), pitch pine (*Pinus rigida*), sweet fern (*Comptonia peregrina*), brambles (*Rubus* spp.), and grasses.

To the north and south of the landfill is a forested slope descending to the Nashua River floodplain. The steep slope is covered with a secondary-growth deciduous forest dominated by red oak (*Quercus rubra*) and shagbark hickory (*Carya ovata*), with occasional red maple (*Acer rubrum*) and black cherry (*Prunus serotina*). The understory on the slope is open, with occasional wood ferns (*Dryopteris spinulosa*).

The Nashua River floodplain is primarily a palustrine forested wetland. Dominant trees in this region include red and silver maples (*Acer rubrum* and *A. saccharinum*), and white ash (*Fraxinus americana*). The dense, shrubby understory includes speckled alder (*Alnus rugosa*), northern arrowwood (*Viburnum recognitum*), red-osier dogwood (*Cornus stolonifera*), honeysuckle (*Lonicera* sp.), highbush blueberry (*Vaccinium corymbosum*), and swamp azalea (*Rhododendron viscosum*). The floodplain vine and herbaceous layers range from sparse to dense, and include greenbriar (*Smilax* sp.), tussock sedge (*Carex stricta*), skunk cabbage (*Symplocarpus foetidus*), and sensitive fern (*Onoclea sensibilis*).

Floodplain wetlands of the Nashua River provide significant wildlife habitat for a variety of taxa (USFWS, 1992c). A diverse assemblage of invertebrates, amphibians, reptiles, mammals, and birds are expected to seek cover, forage or nest in the river floodplain in the vicinity of SA 12.

The Nashua River floodplain at Fort Devens is known to provide suitable habitat for the Blanding's turtle (*Emydoidea blandingii*), a state-threatened species in Massachusetts. The largest known population of Blanding's turtles in New England is located in the vicinity of Fort Devens (Butler, 1992). The status of this population has been well documented and Blanding's turtles are known to occur in the floodplain in the vicinity of SA 12. Records also exist documenting the occurrence of the blue-spotted salamander (*Ambystoma laterale*) in the vicinity of SA 12. This state-listed Species of Special Concern breeds in vernal pools in wooded, swampy, or moist areas in New England (DeGraaf and Rudis, 1987).

Fifteen organic analytes, including three pesticides and a PCB, were detected in SA 12 surface soils. All were chosen as CPCs for SA 12. Aroclor 1254 was detected in one sample, at a concentration of 6.9 μg/g. Other surface soil CPCs include 4,4-DDT, 4,4-DDE, 4,4-DDD, acenaphthalene, acetone, anthracene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, carbazole, chrysene, fluoranthene, phenanthrene, and pyrene (Table 5.1-19).

Thirteen inorganic analytes were detected in nine surface soil samples (including one duplicate) collected at the SA 12 landfill. The maximum concentrations of barium, beryllium, copper, lead, nickel and zinc were higher than background, and these analytes were therefore chosen as surface soil CPCs. In addition, because no background values were available for cobalt or vanadium, they were also included as CPCs. Barium was detected at all samples, at a maximum concentration of 165 μg/g. Lead was detected in all samples at a maximum concentration of 880 μg/g. Zinc was detected in all samples at a maximum concentration of 736 μg/g, and nickel was detected at all sampling locations at a maximum concentration of 16.5 μg/g (see Table 5.1-11).

Six sediment samples were collected from Area 1. Eighteen inorganic analytes, and 18 organics, were detected and chosen as sediment CPCs. Organic analytes in sediments included four pesticides (4,4-DDT, 4,4-DDE, 4,4-DDD, and heptachlor), acetone and toluene, and 11 SVOCs. Inorganic CPCs in Area 1 included aluminum, arsenic, barium, beryllium, cobalt, copper, lead, magnesium, manganese, mercury, nickel, potassium, sodium, vanadium, and zinc (Table 5.1-17).

Potential contaminant exposure pathways exist at SA 12 for terrestrial receptors via incidental soil ingestion and terrestrial food web exposure. In addition, wetlands and semi-terrestrial receptors in the site's palustrine floodplain wetlands may be exposed to environmental contaminants in surface water and sediment.

5.1.8.1 Surface Soils. A screening-level evaluation of potential effects from surface soil exposure was conducted by comparing the maximum concentrations of all CPCs to their respective surface soil benchmark values (see Table 5.1-19). The maximum concentrations of barium, lead, zinc and Aroclor 1254 exceeded their respective ecological benchmarks. Lead was detected at a maximum concentration of 880 μg/g, approximately 18 times greater than the lead background concentration (48.4 μg/g), which was established as the benchmark value for lead in surface soils. Aroclor 1254, was detected in one sample at a concentration of 6.9 μg/g, which is approximately twice the benchmark value established for this PCB. The maximum barium and zinc concentrations were approximately 4 and 6 times their respective surface soil benchmark values.

5.1.8.2 Sediments. A total of 6 sediment samples were collected from Area 1. The sampling locations are typically not under water; therefore they have been referred to as sediment/surface soil for the purpose of this ecological PRE and have been compared to both surface soil and to sediment protective contaminant levels (PCLs). This was done because the physicochemical nature of these six samples is likely to be closer to surface soil than that of sediment, since they are not submerged continuously.

Eighteen organic compounds were detected in the six surface soil/sediment samples collected in Area 1 and were retained as Contaminants of Potential

Concern (CPCs) (see Table 5.1-20). Bis(2-ethylhexyl)phthalate, phenanthrene, and pyrene were detected in all six samples. 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE were detected at maximum concentrations of 0.028 μg/g, 0.087 μg/g, and 0.041 μg/g, respectively. Nine PAHs were detected at concentrations ranging from 0.069 μg/g (anthracene) to 0.98 μg/g (pyrene). Nineteen inorganics were detected in the six surface soil/sediment samples collected in Area 1 and were retained as CPCs (see Table 5.1-20). With the exception of beryllium and cadmium, all inorganics were detected in all six samples. Maximum detected inorganic concentrations ranged from 0.83 μg/g (mercury) to 37,800 μg/g (iron).

Potential contaminant exposure pathways exist at SA 12 for terrestrial and wetland receptors via incidental surface soil/sediment ingestion and food web exposure.

Risks to ecological receptors from exposure to Area 1 sediment/surface soil were evaluated through comparison of maximum surface soil/sediment CPC concentrations to surface soil benchmark values. Although aquatic receptor exposure to Area 1 sediments is likely only during times of seasonal flooding, the floodplain surface soil/sediment data were also compared to sediment benchmark values to evaluate potential risk to aquatic receptors from exposure to Area 1 sediment.

The maximum detected concentrations of aluminum, barium, lead, and vanadium in Area 1 surface soil/sediment exceeded their respective soil benchmark values, which were established at soil background concentrations for these analytes (see Table 5.1-20). The maximum detected concentrations of beryllium, cadmium, copper, and nickel also slightly exceeded their respective soil benchmark values. With the exception of barium, which was detected at a maximum concentration approximately four times background, maximum detected concentrations of these analytes exceeded their respective soil benchmark values by factors of two or less.

There were no surface soil benchmark exceedances for organic compounds detected in Area 1 surface soil/sediment. However, the maximum detected concentrations of 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE slightly exceeded their respective sediment benchmark values (see Table 5.1-20). In addition, the sediment benchmark value for heptachlor was exceeded by a factor of approximately six. The maximum detected concentrations of arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc in Area 1 surface soil/sediment exceeded their respective sediment benchmark values. Benchmarks for these analytes were exceeded by factors of less than one (manganese and zinc) to factors of greater than seven (mercury).

In summary, the maximum detected concentrations of eight analytes in Area 1 surface soil/sediment exceeded their respective soil benchmark values, and the maximum detected concentrations of fourteen analytes exceeded their respective sediment benchmarks.

5.1.9 Conclusions and Recommendations

Based on the results of the SI, the SSI and the PREs, no further hazardous waste actions are recommended for Landfill No. 8, SA 12. However, it is recommended that the SA be considered for closure under the proposed landfill consolidation FS. This recommendation is based on the information gathered during the SI and the SSI which indicates that the contamination detected in the sediment at the base of the landfill, Area 1 and Area 2, is a result of seasonal flooding by the Nashua River and minor migration of landfill-derived contaminants. Surface soil contamination was found to be a risk to human health and ecological receptors. The landfill closure will remove the surface soil hazard.

An important consideration is possible chipping of the brush and tree stumps and consolidation of the remaining waste at a designated on-post location. Although site-specific solid waste actions must be fully designed and engineering, consideration of importance are listed in this section on a preliminary basis.

TABLE 5.1-1
SUMMARY OF TECHNICAL APPROACH
SA 12 - LANDFILL NO.8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ACTIVITY	PURPOSE	SITE IDENTIFICATION	RATIONALE FOR SELECTED LOCATIONS
SI PROGRAM			
SOIL BORING AND SUBSURFACE SOIL SAMPLING	* INSTALL MONITORING WELL * CHARACTERIZE SOIL	12M-92-01X	* APPARENT UPGRADIENT LOCATION * OUTSIDE OF LANDFILL WASTE
MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING	* MONITOR GROUNDWATER LEVELS * MONITOR GROUNDWATER QUALITY * DETERMINE AQUIFER CONDUCTIVITIES	12M-92-01X	* APPARENT UPGRADIENT LOCATION
SURFACE WATER AND SEDIMENT SAMPLING	* COLLECT SAMPLES FOR OFF-SITE LABORATORY ANALYSIS * DETERMINE PHYSICAL CHARACTERISTICS OF SEDIMENT * DETERMINE WATER QUALITY OF SURFACE WATER	12D-92-01X 12D-92-02X 12D-92-03X 12D-92-04X	* BASE OF LANDFILL MATERIAL
		12D-92-05X 12D-92-06X	* WETLAND BETWEEN LANDFILL MATERIAL AND NASHUA RIVER
		12D-92-07X 12D-92-08X	* WEST SIDE OF NASHUA RIVER TO DETERMINE IF THE LANDFILL WAS EFFECTING THE NASHUA RIVER QUALITY
SURFACE SOIL SAMPLING	* COLLECT SAMPLES FOR OFF-SITE LABORATORY ANALYSIS	12S-92-01X 12S-92-02X 12S-92-03X 12S-92-04X	* AT APPARENTLY STAINED AREAS
SSI PROGRAM			
SURFACE WATER AND SEDIMENT SAMPLING	* COLLECT SAMPLES FOR OFF-SITE LABORATORY ANALYSIS * DETERMINE PHYSICAL CHARACTERISTICS OF SEDIMENT * DETERMINE WATER QUALITY OF SURFACE WATER	12D-93-09X 12D-93-10X 12D-93-11X 12D-93-12X 12D-93-13X 12D-93-14X 12D-93-15X 12D-93-16X	* IN THE BACKWATER AREA BELOW SA 12

TABLE 5.1–1
SUMMARY OF TECHNICAL APPROACH
SA 12 – LANDFILL NO.8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ACTIVITY	PURPOSE	SITE IDENTIFICATION	RATIONALE FOR SELECTED LOCATIONS
SURFACE WATER AND SEDIMENT SAMPLING (cont.)		12D–93–17X 12D–93–18X 12D–93–19X 12D–93–20X 12D–93–21X 12D–93–22X 12D–93–23X 12D–93–24X 12D–93–25X 12D–93–26X 12D–93–27X 12D–93–28X	
		12D–93–29X 12D–93–30X 12D–93–31X 12D–93–32X 12D–93–33X	* IN THE BACKWATER AREA UPSTREAM OF SA 12
		12D–93–34X 12D–93–35X 12D–93–36X 12D–93–37X 12D–93–38X	* IN THE BACKWATER AREA DOWNSTREAM OF SA 12

TABLE 5.1–2
SUMMARY OF SOIL BORINGS
SA 12 – LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

EXPLORATION ID	COMPLETION DEPTH (Feet bgs)	REFERENCE SAMPLE INTERVALS (Feet bgs)	ANALYTICAL SAMPLES COLLECTED	SOIL TYPE (USCS)	TOTAL VOCs BY PID (ppm)	COMMENTS
12M–92–01X	40	0–2		SW	BKG	
		2–4		SW	BKG	
		4–6		SW	BKG	
		6–8		SW	BKG	
		8–10		SW	BKG	
		10–12		SW	BKG	
		12–14		SW	BKG	
		14–16		SW/CL	BKG	
		16–18		CL	BKG	
		18–20		ML	BKG	
		20–22		ML	BKG	
		22–24		SM	––	
		24–26		SM	––	
		26–28		SM	––	
		28–30		SM	––	
		30–32		SM	––	
		32–34		SP	BKG	
		34–36		SP	BKG	
		36–38		SP/SM	BKG	
		38–40		GM	BKG	

Notes:
bgs = below ground surface
VOCs = Volatile organic compounds
USCS = Unified soil classification system
ppm = parts per million

TABLE 5.1-3
MONITORING WELL COMPLETION DETAILS
SA 12 - LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

WELL IDENTIFICATION	SOIL DRILLING METHOD	BEDROCK DRILLING MEHTOD	MEDIA SCREENED	WELL SCREEN DEPTH (Feet bgs)	WELL SCREEN ELEVATION (Feet NGVD)	COMPLETION DEPTH (Feet bgs)	CONSTRUCTION MATERIAL
12M-92-01X	DRIVE AND WASH	HX CORE	BEDROCK	42-52	224.8 - 215.1	52.5	4" ID PVC

Notes: bgs = below ground surface
NGVD = National geodetic vertical datum

TABLE 5.1-4
SUMMARY OF WATER LEVELS AND HYDRAULIC CONDUCTIVITIES
STUDY AREA 12 - LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

WELL IDENTIFICATION	ELEVATION1	DEPTH TO WATER (Feet bgs)	ELEVATION OF WATER (Feet bgs)	HYDRAULIC CONDUCTIVITY	
				HVORSLEV2 (cm/sec)	BOUWER & RICE2 (cm/sec)
12M-92-01X	266.32	47.01	219.31	6E-04	2E-03

Notes: bgs = below ground surface
cm/sec = centimeters per second
1 = elevation of top of pvc
2 = averaged value of two tests

TABLE 5.1–5
SOIL CLASSIFICATION OF SEDIMENTS SAMPLES
SA 12 – LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SAMPLE ID	USCS SYMBOL	WATER CONTENT	GRAVEL (2) DRY WT %	SAND (2) DRY WT %	SILT (2) DRY WT %	CLAY (2) DRY WT %
12D–92–01X*	ML	10.4	0.0	1.0	99.0	0.0
12D–92–02X*	SM	26.3	0.0	65.4	34.6	0.0
12D–92–03X*	SM	34.7	0.0	61.6	38.4	0.0
12D–92–04X*	SM	25.3	0.0	56.9	43.1	0.0
12D–92–05X	ML	74.7	0.0	16.0	84.0	0.0
12D–92–06X	ML	87.2	0.0	16.2	83.8	0.0
12D–92–07X	SM	9.4	0.0	81.1	18.9	0.0
12D–92–08X	SM	18.8	0.0	72.5	27.5	0.0
12D–93–09X	ML	26.6	0.0	12.0	51.4	36.6
12D–93–10X	ML	34.5	0.0	7.0	30.1	62.9
12D–93–11X	ML	41.3	0.0	10.0	34.1	55.9
12D–93–12X	ML	46.1	0.0	27.0	50.7	22.9
12D–93–13X	ML	35.8	0.0	12.7	60.0	26.5
12D–93–14X	ML	50.2	0.0	31.0	60.2	8.8
12D–93–15X	ML	73.9	0.0	25.0	51.7	23.3
12D–93–16X	GP	66.7	65.7	11.4	11.5	11.5
12D–93–17X	ML	61.3	0.0	13.0	56.6	30.4
12D–93–18X	ML	73.8	0.0	10.0	55.3	34.7
12D–93–19X	ML	73.8	0.0	34.5	37.8	27.7
12D–93–20X	ML	72.3	0.0	5.0	66.8	28.2
12D–93–21X	ML	72.0	0.0	49.0	32.2	18.6
12D–93–22X	SM	53.8	0.0	52.0	36.6	11.4
12D–93–23X	ML	66.1	0.0	11.0	55.4	33.6
12D–93–24X	SM	52.7	0.0	52.0	54.2	0.0
12D–93–25X	ML	54.5	0.0	26.0	51.2	22.8
12D–93–26X	ML	52.8	0.0	20.0	50.8	29.2
12D–93–27X	ML	60.5	0.0	37.0	54.2	8.8
12D–93–28X	ML	62.3	0.0	16.0	56.9	27.1
12D–93–29X	ML	54.9	0.0	28.0	43.6	28.4
12D–93–30X	ML	43.4	0.0	48.0	40.8	11.2
12D–93–31X	ML	69.8	0.0	18.0	57.5	24.5
12D–93–32X	ML	72.8	0.0	6.8	71.3	21.9
12D–93–33X	ML	62.5	0.0	8.0	61.8	30.2
12D–93–34X	ML	75.7	0.0	32.0	53.2	14.0
12D–93–35X	ML	68.7	0.0	42.0	36.5	21.5
12D–93–36X	ML	80.7	0.0	38.8	32.0	29.2
12D–93–37X	ML	82.2	0.0	33.0	52.8	14.2
12D–93–38X	ML	71.1	0.0	20.0	60.0	20.0

Notes:

USCS = Unified soil classification system

DRY WT % = Dry weight percentage

(1) Water content = 100 x weight of water / dry weight of soil

(2) Weight percentage of soil fraction = 100 x dry weight of soil fraction / total dry weight of soil

* = Sediment sample was considered as a surface soil sample

TABLE 5.1–6
ORGANIC COMPOUNDS IN SOIL
SA 12 – LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	BORING	12S–92–01X	12S–92–02X	12S–92–03X	12S–92–04X
ANALYTE	**DEPTH**	**0 FT**	**0 FT**	**0 FT**	**0 FT**
VOLATILES (µg/g)					
ACETONE		< 0.017	< 0.017	< 0.017	0.019
SEMIVOLATILES (µg/g)					
ACENAPHTHYLENE		< 0.03	< 0.03	0.1	0.1
ANTHRACENE		< 0.03	< 0.03	< 0.03	0.2
BENZO[A]ANTHRACENE		< 0.17	< 0.17	< 0.30	0.4
BENZO[B]FLUORANTHENE		< 0.21	< 0.21	< 0.40	1.0
BENZO[K]FLUORANTHENE		< 0.06	< 0.06	< 0.10	0.4
CHRYSENE		< 0.12	< 0.12	< 0.6	0.8
FLUORANTHENE		< 0.06	< 0.06	< 0.06	0.8
PHENANTHRENE		< 0.03	< 0.03	0.3	0.1
PYRENE		< 0.03	< 0.03	0.3	0.8
PESTICIDE/PCBS (µg/g)					
AROCLOR 1254		< 0.082	< 0.082	6.9 S	< 0.082
4,4'–DDE		0.011	< 0.008	0.21	< 0.008
4,4'–DDT		0.018	< 0.007	1.0	0.02
OTHER (µg/g)					
TOTAL PETROLEUM HYDROCARBONS		< 28.1	< 27.7	1350.0	80.2

NOTES:
TABLE LISTS DETECTED ANALYTES ONLY –
SEE PROJECT ANALYTE LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN
DUP = DUPLICATE SAMPLE

TABLE 5.1–6
ORGANIC COMPOUNDS IN SURFACE SOIL
SA 12 – LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BORING	12D–92–01X	12D–92–02X	12D–92–02X	12D–92–03X	12D–92–04X
				DUP		
VOLATILES ($\mu g/g$)						
ACETONE		0.076	0.14	0.049	< 0.017	0.058
PESTICIDE/PCBS ($\mu g/g$)						
4,4'–DDD		< 0.008	< 0.008	< 0.008	< 0.013	< 0.008
OTHER ($\mu g/g$)						
TOTAL PETROLEUM HYDROCARBONS		< 27.9	45.4	46.5	< 27.9	< 28.1

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY –
SEE PROJECT ANALYTE LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN
DUP = DUPLICATE SAMPLE

TABLE 5.1-7
INORGANIC ANALYTES IN SURFACE SOIL
SA 12 – LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS

ANALYTE		BORING	12D-92-01X	12D-92-02X	12D-92-02X	12D-92-03X	12D-92-04X
ug/g	BACKGROUND				DUP		
ALUMINUM	15000.0		4480.0	6770.0	6430.0	10500.0	8580.0
ARSENIC	21.0		3.59	3.36	3.98	6.29	6.39
BARIUM	42.5		21.4	33.7	33.2	45.1	38.6
BERYLLIUM	0.347		< 0.5	0.6	< 0.5	0.7	0.5
CADMIUM	2.0		< 0.7	< 0.7	< 0.7	0.9	< 0.7
CALCIUM	1400.0		690.0	1150.0	1660.0	1400.0	936.0
CHROMIUM	31.0		9.68	14.9	13.4	22.0	18.3
COBALT	NA		2.38	2.58	2.37	3.62	4.15
COPPER	8.39		3.04	5.0	6.08	5.7	4.5
IRON	15000.0		4660.0	7170.0	6620.0	10500.0	9740.0
LEAD	48.4		3.74	5.42	5.38	12.5	4.62
MAGNESIUM	5600.0		1470.0	2350.0	2090.0	3360.0	2820.0
MANGANESE	300.0		49.7	77.1	69.4	122.0	124.0
NICKEL	14.0		5.62	7.94	7.42	12.7	10.6
POTASSIUM	1700.0		355.0	622.0	463.0	935.0	900.0
SODIUM	131.0		< 100.0	208.0	240.0	280.0	237.0
VANADIUM	28.7		8.35	12.8	12.0	17.3	15.1
ZINC	35.5		17.8	28.2	29.5	43.5	34.7

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY –

SEE PROJECT ANALYTE LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

= VALUE ABOVE BACKGROUND LEVELS

DUP = DUPLICATE SAMPLE

TABLE 5.1–7
INORGANIC ANALYTES IN SOIL
SA 12 – LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE		BORING	12S–92–01X	12S–92–02X	12S–92–03X	12S–92–04X
ug/g	BACKGROUND	DEPTH	0 FT	0 FT	0 FT	0 FT
ALUMINUM	15000.0		3610.0	6010.0	9900.0	5290.0
ARSENIC	21.0		12.0	17.0	21.0	16.0
BARIUM	42.5		24.8	25.5	165.0	22.6
BERYLLIUM	0.347		< 0.50	0.661	0.74	0.573
CADMIUM	2.0		< 0.70	< 0.70	0.968	< 0.70
CALCIUM	1400.0		599.0	854.0	1350.0	598.0
CHROMIUM	31.0		9.13	13.4	22.6	13.7
COBALT	NA		4.2	5.07	3.59	5.66
COPPER	8.39		11.4	12.4	11.2	11.3
IRON	15000.0		6880.0	9190.0	10500.0	10400.0
LEAD	48.4		15.0	60.0	880.0	110.0
MAGNESIUM	5600.0		1360.0	1940.0	1830.0	2270.0
MANGANESE	300.0		229.0	227.0	198.0	259.0
NICKEL	14.0		8.98	13.0	10.6	16.5
POTASSIUM	1700.0		689.0	814.0	623.0	679.0
SODIUM	131.0		155.0	174.0	207.0	196.0
VANADIUM	28.7		7.12	9.57	14.8	8.17
ZINC	35.5		40.6	72.3	736.0	64.6

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY –
SEE PROJECT ANALYTE LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN
= VALUE ABOVE BACKGROUND LEVELS
DUP = DUPLICATE SAMPLE

TABLE 5.1–8
ANALYTES IN GROUNDWATER
SA 12 – LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		ROUND 1	ROUND 2	ROUND 2				
ANALYTE	BACK–GROUND	12M–92–01X	12M–92–01X	12M–92–01X FILTERED	12D–92–01X	12D–92–02X	12D–92–03X	12D–92–04X
ORGANICS (μg/L)								
BIS(2–ETHYLHEXYL)PHTHALATE		< 4.8	< 4.8	NA	< 4.8	< 4.8	9.1	< 4.8
INORGANICS (μg/L)								
ALUMINUM	6870.0	179.0	339.0	< 141.0	24500.0	7930.0	4770.0	25200.0
ANTIMONY	3.03	< 3.0	< 3.03	< 3.03	< 3.0	< 3.0	6.96	< 3.0
ARSENIC	10.5	< 2.5	< 2.5	< 2.5	33.4	19.7	22.6	44.2
BARIUM	39.6	< 5.0	6.38	< 5.0	110.0	47.0	78.3	114.0
BERYLLIUM	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6.63
CADMIUM	4.01	< 4.0	< 4.01	<4.01	< 4.0	< 4.0	12.1	< 4.0
CALCIUM	14700.0	23200.0	24300.0	18700.0	8000.0	17800.0	117000.0	8390.0
CHROMIUM	14.7	< 6.0	< 6.02	< 6.02	55.2	25.4	28.9	40.6
COPPER	8.09	< 8.0	< 8.09	< 8.09	34.6	21.6	122.0	23.1
IRON	9100.0	373.0	885.0	< 38.8	22400.0	8200.0	29000.0	40200.0
LEAD	4.25	4.23	2.6	< 1.26	150.0	58.2	500.0	39.5
MAGNESIUM	3480.0	69.9	3620.0	2810.0	6190.0	3320.0	8480.0	7460.0
fs	291.0	4110.0	55.7	13.5	227.0	76.3	271.0	990.0
MERCURY	0.243	< 0.2	< 0.24	< 0.24	1.65	0.757	0.723	< 0.2
POTASSIUM	2370.0	1500.0	1680.0	1320.0	3370.0	2090.0	4690.0	5040.0
SODIUM	10800.0	4250.0	3890.0	3580.0	3700.0	4580.0	7400.0	6130.0
VANADIUM	11.0	< 11.0	< 11.0	< 11.0	40.6	13.8	19.5	44.9
ZINC	21.1	47.0	32.2	26.3	111.0	53.4	874.0	86.8
ANIONS/CATIONS (μg/L)								
KJELDAHL NITROGEN		NA	NA	NA	3140.0	2480.0	8600.0	2670.0
NITRATE/NITRITE		900.0	1100.0	NA	< 10.0	< 10.0	< 10.0	< 10.0
CHLORIDE		4130.0	4260.0	NA	< 2120.0	13700.0	6960.0	8680.0
SULFATE		NA	< 10000.0	NA	< 10000.0	< 10000.0	40000	< 10000.0
ALKALINITY		100000.0	64000.0	NA	42000.0	33000.0	231000.0	18000.0
BICARBONATE		122000.0	78000.0	NA	NA	NA	NA	NA
OTHER (ug/L)								
HARDNESS		NA	NA	NA	26000.0	50000.0	122000.0	24400.0
PHOSPHATE		NA	NA	NA	990.0	590.0	990.0	990.0
TOTAL SUSPENDED SOLIDS		NA	21000.0	NA	756000.0	551000.0	420000.0	1270000.0

NOTES:
TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN
NA = NOT ANALYZED
▨ = VALUE ABOVE BACKGROUND LEVELS
SITE ID DESIGNATIONS: 12M = MONITORING WELL; 12D = SUMP WATER SAMPLE

TABLE 5.1-9
ANALYTES IN SURFACE WATER AT SA 12 BACKWATER (AREA 2)
SA 12 – LANDFILL NO. 8 (AREA 2)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI					
ANALYTE SITE ID	**12D-93-15X**	**12D-93-18X**	**12D-93-18X**	**12D-93-20X**	**12D-93-21X**	**12D-93-22X**
ORGANICS (µg/L)			**DUP**			
1,2-DICHLOROETHANE	0.67	1.2	2	0.54	1	0.9
BENZYL ALCOHOL	< 0.72	< 0.72	< 0.72	< 0.72	< 0.72	< 0.72
BIS (2-ETHYLHEXYL) PHTHALATE	< 4.8	< 4.8	< 4.8	< 4.8	< 4.8	< 4.8
INORGANICS (µg/L)						
ALUMINUM	2810	322	259	970	< 141	< 141
ANTIMONY	7.86	4.64	< 3.03	3.75	< 3.03	< 3.03
ARSENIC	12.4	< 2.54	3.41	6.82	3.2	4.58
BARIUM	173	78.5	54.8	41.9	28.4	40.3
CADMIUM	56.7	5.02	< 4.01	5.83	< 4.01	4.73
CALCIUM	41400	10900	8470	6910	6410	10600
CHROMIUM	36.2	< 6.02	< 6.02	7.83	< 6.02	< 6.02
COPPER	86.6	9.72	< 8.09	17.7	< 8.09	< 8.09
IRON	8220	1350	816	3290	1520	2580
LEAD	91.3	13.6	7.81	54	3.04	6.18
MAGNESIUM	8480	2330	2030	2000	1770	1970
MANGANESE	524	729	214	188	228	376
MERCURY	0.66	< 0.243	< 0.243	< 0.243	< 0.243	< 0.243
POTASSIUM	654	1380	694	1310	716	1630
SODIUM	5060	2670	2430	4270	3520	3740
VANADIUM	< 11	< 11	< 11	< 11	< 11	< 11
ZINC	1180	71.2	27.2	61.5	< 21.1	148
OTHER (µg/L)						
ALKALINITY	14000	13000	13000	20000	21000	19000
CHLORIDE	3850	3640	3450	5410	4030	3750
NITRITE, NITRATE-NON SPECIFIC	174	< 10	45.6	11.6	20	18
NITROGEN BY KJELDAHL METHOD	3520	629	733	2480	1050	1240
PHOSPHATE	790	95.8	118	750	159	266
SULFATE	129000	28900	26600	< 10000	< 10000	21400
TOTAL HARDNESS	146000	32400	30400	27200	23200	36800
TOTAL SUSPENDED SOLIDS	212000	15000	11000	124000	16000	20000

Notes:
< = Less than detection limit

TABLE 5.1–9
ANALYTES IN SURFACE WATER AT SA 12 BACKWATER (AREA 2)
SA 12 – LANDFILL NO. 8 (AREA 2)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI				SI	
ANALYTE SITE ID	**12D–93–23X**	**12D–93–24X**	**12D–93–27X**	**12D–93–28X**	**12D–92–05X**	**12D–92–06X**
ORGANICS (µg/L)						
1,2–DICHLOROETHANE	< 0.5	1.2	1.2	< 0.5	< 0.5	< 0.5
BENZYL ALCOHOL	< 0.72	< 0.72	< 0.72	< 0.72	< 0.72	8.6
BIS (2–ETHYLHEXYL) PHTHALATE	< 4.8	< 4.8	< 4.8	< 4.8	< 4.8	4.6
INORGANICS (µg/L)						
ALUMINUM	498	< 141	< 141	326	227	1110
ANTIMONY	4.91	2.86	< 3.03	< 3.03	< 3.03	3.39
ARSENIC	3.94	6.08	5.54	6.29	3.2	72.4
BARIUM	35.2	24.3	21.8	31.9	35.2	129
CADMIUM	6.08	< 4.01	< 4.01	10.8	< 4.01	< 4.01
CALCIUM	7250	7270	7050	8170	10900	76500
CHROMIUM	< 6.02	< 6.02	< 6.02	< 6.02	< 6.02	12.5
COPPER	13.8	< 8.09	< 8.09	11.3	< 8.09	15.7
IRON	2810	1890	1980	2490	1380	74200
LEAD	21.4	3.69	2.93	11	8.68	49.7
MAGNESIUM	1850	1920	1960	2000	1770	5180
MANGANESE	216	138	131	151	116	271
MERCURY	< 0.243	< 0.243	< 0.243	< 0.243	< 0.243	< 0.243
POTASSIUM	1060	1290	< 375	1500	1360	2340
SODIUM	4070	4840	4830	4950	5620	6040
VANADIUM	< 11	< 11	< 11	< 11	< 11	17.2
ZINC	47.2	25.6	< 21.1	146	33.4	259
OTHER (µg/L)						
ALKALINITY	24000	22000	22000	23000	45000	28000
CHLORIDE	5230	5390	5590	5770	8730	6360
NITRITE, NITRATE–NON SPECIFIC	12.9	34.3	31.3	190	< 10	< 10
NITROGEN BY KJELDAHL METHOD	2380	1050	1050	1330	781	2000
PHOSPHATE	590	162	142	500	140	2500
SULFATE	< 10000	< 10000	< 10000	< 10000	< 10000	< 10000
TOTAL HARDNESS	24800	24000	22000	27800	36400	27600
TOTAL SUSPENDED SOLIDS	52000	12000	9000	26000	21000	176000

Notes:
< = Less than detection limit

TABLE 5.1–10
ANALYTES IN SURFACE WATER
SA 12 – UPRIVER BACKWATER

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI	
ANALYTE SITE ID	**12D–93–29X**	**12D–93–30X**
ORGANICS (µg/L)		
CHLOROFORM	< 0.5	0.82
INORGANICS (µg/L)		
ALUMINUM	403	153
ARSENIC	3.84	3.41
BARIUM	28.9	15.7
CALCIUM	23200	25100
CHROMIUM	5.97	< 6.02
COPPER	21.5	< 8.09
IRON	1440	432
LEAD	10.1	< 1.26
MAGNESIUM	6670	7550
MANGANESE	105	123
POTASSIUM	2610	2330
SODIUM	17100	14400
ZINC	26.8	< 21.1
OTHER (µg/L)		
ALKALINITY	50000	55000
CHLORIDE	43000	41000
NITRITE, NITRATE–NON SPECIFIC	820	1100
NITROGEN BY KJELDAHL METHOD	914	476
PHOSPHATE	155	43.9
SULFATE	13500	12200
TOTAL HARDNESS	81600	94400
TOTAL SUSPENDED SOLIDS	15000	5000

Notes:
< = Less than detection limit

TABLE 5.1-11
ANALYTES IN SURFACE WATER
SA 12 - DOWNRIVER BACKWATER

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI				
ANALYTE SITE ID	**12D-93-34X**	**12D-93-35X**	**12D-93-36X**	**12D-93-37X**	**12D-93-38X**
ORGANICS (µg/L)					
1,2-DICHLOROETHANE	< 0.5	1	< 0.5	< 0.5	< 0.5
CHLOROFORM	< 0.5	2.4	< 0.5	< 0.5	0.7
METHYLENE CHLORIDE	2.5	3	3.1	< 2.3	< 2.3
INORGANICS (µg/L)					
ARSENIC	6.29	6.72	6.82	5.33	6.72
BARIUM	27.1	27.2	26.9	26.5	30.8
CALCIUM	15700	15800	15900	15200	17500
IRON	643	646	583	559	618
LEAD	3.25	9.98	2.6	2.39	2.6
MAGNESIUM	2030	2030	2090	1940	2240
MANGANESE	130	127	114	108	124
POTASSIUM	4460	4530	4640	3870	4720
SODIUM	39700	40000	41000	40100	46100
OTHER (µg/L)					
ALKALINITY	46000	51000	53000	44000	38000
CHLORIDE	66000	66000	66000	66000	66000
NITRITE, NITRATE-NON SPECIFIC	40.7	41.8	18	34.2	25.6
NITROGEN BY KJELDAHL METHOD	1810	943	1050	924	1330
PHOSPHATE	147	81.2	73.8	68.2	95.8
SULFATE	16500	16500	16500	16500	16500
TOTAL HARDNESS	47600	45400	45600	61000	48000
TOTAL SUSPENDED SOLIDS	12	7	10	9	10

Notes:
< = Less than detection limit

TABLE 5.1-12
ANALYTES IN SEDIMENT
SA 12 – LANDFILL NO. 8 (AREA 2)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI			
ANALYTE SITE ID	**12D-93-15X**	**12D-93-16X**	**12D-93-17X**	**12D-93-18X**
ORGANICS (ug/g)				
ACETONE	< 0.017	0.5	< 0.017	< 0.08
CARBON DISULFIDE	< 0.004	0.09	< 0.004	< 0.02
TOLUENE	< 0.001	< 0.004	< 0.001	< 0.004
TRICHLOROFLUOROMETHANE	< 0.006	< 0.03	0.051	< 0.03
2-METHYLNAPHTHALENE	< 0.1	< 0.5	< 0.2	< 0.5
ACENAPHTHENE	< 0.07	< 0.4	< 0.2	< 0.4
ACENAPHTHYLENE	0.3	< 0.3	< 0.2	< 0.3
ANTHRACENE	< 0.07	< 0.3	< 0.2	2
BENZO [A] ANTHRACENE	< 0.3	< 2	< 0.8	< 2
BENZO [A] PYRENE	< 0.5	< 2	< 1	< 2
BENZO [B] FLUORANTHENE	< 0.4	< 2	< 1	< 2
BENZO [K] FLUORANTHENE	0.6	3	< 0.3	8
BIS (2-ETHYLHEXYL) PHTHALATE	< 1	< 6	< 3	< 6
CHRYSENE	2	7	< 0.6	9
DI-N-BUTYL PHTHALATE	2	3	3	2
FLUORANTHENE	2	7	3	10
FLUORENE	< 0.07	< 0.3	< 0.2	< 0.3
NAPHTHALENE	< 0.07	< 0.4	< 0.2	< 0.4
PHENANTHRENE	2	3	1	8
PYRENE	2	10	2	10
4,4'-DDT	0.15	0.12	< 0.007	0.048
4,4'-DDD	0.28	0.26	0.15	0.14
4,4'-DDE	0.2	0.24	0.127	0.086
BETA-BENZENEHEXACHLORIDE	< 0.003	< 0.003	< 0.003	< 0.003
HEPTACHLOR	0.054	0.039	< 0.006	0.035
ISODRIN	< 0.005	< 0.005	< 0.005	< 0.005
PCB 1260	0.427	0.303	< 0.08	< 0.08
INORGANICS (ug/g)				
ALUMINUM	14900	13100	12200	15800
ANTIMONY	15.7	17.8	17.3	9.35
ARSENIC	22.7	21	20.7	35.4
BARIUM	142	203	184	279
BERYLLIUM	2.04	< 0.5	< 0.5	< 0.5
CADMIUM	43.7	84.9	130	60.6
CALCIUM	3260	2410	2520	1730
CHROMIUM	203	212	261	319
COBALT	13.9	5.6	< 1.42	14.3
COPPER	262	417	359	402
IRON	12300	12200	11000	15800
LEAD	530	490	580	1100
MAGNESIUM	2810	2260	1890	2270
MANGANESE	108	105	64.9	162
MERCURY	4	4.6	3.16	5.2
NICKEL	45.8	25.9	72.1	40.7
POTASSIUM	772	686	620	1160
SELENIUM	4.93	3.73	5.01	1.88
SILVER	2.59	6.79	8.03	4.74
SODIUM	1470	1090	1260	1180
VANADIUM	27	37.5	40.7	27.8
ZINC	1220	1270	1600	1310
OTHER (ug/g)				
TOTAL ORGANIC CARBON	204000	148000	194000	103000
TOTAL PETROLEUM HYDROCARBONS	1030	2350	4060	3050

Notes:
< = Less than the detection limit

TABLE 5.1–12
ANALYTES IN SEDIMENT
SA 12 – LANDFILL NO. 8 (AREA 2)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI			
ANALYTE SITE ID	12D–93–19X	12D–93–20X	12D–93–21X	12D–93–22X
ORGANICS (ug/g)				
ACETONE	0.09	0.27	0.4	0.18
CARBON DISULFIDE	< 0.004	0.022	< 0.02	< 0.004
TOLUENE	< 0.001	< 0.001	< 0.004	< 0.001
TRICHLOROFLUOROMETHANE	< 0.006	< 0.006	< 0.03	0.011
2–METHYLNAPHTHALENE	< 0.5	< 0.2	< 0.5	< 0.2
ACENAPHTHENE	< 0.4	< 0.2	< 0.4	< 0.2
ACENAPHTHYLENE	< 0.3	1	< 0.3	< 0.2
ANTHRACENE	< 0.3	0.8	1	< 0.2
BENZO [A] ANTHRACENE	< 2	< 0.8	< 2	< 0.8
BENZO [A] PYRENE	< 2	< 1	< 2	< 1
BENZO [B] FLUORANTHENE	< 2	7	< 2	< 1
BENZO [K] FLUORANTHENE	6	2	4	0.8
BIS (2–ETHYLHEXYL) PHTHALATE	30	< 3	30	10
CHRYSENE	8	4	9	1
DI–N–BUTYL PHTHALATE	2	4	3	0.8
FLUORANTHENE	7	8	8	2
FLUORENE	< 0.3	0.8	< 0.3	< 0.2
NAPHTHALENE	< 0.4	0.8	2	< 0.2
PHENANTHRENE	6	4	7	2
PYRENE	10	6	10	3
4,4'–DDT	0.084	0.37	0.11	0.049
4,4'–DDD	0.27	0.86	0.39	0.086
4,4'–DDE	0.15	0.42	0.4	0.049
BETA–BENZENEHEXACHLORIDE	< 0.003	< 0.003	0.011	< 0.003
HEPTACHLOR	0.054	< 0.006	0.078	0.034
ISODRIN	< 0.005	< 0.005	< 0.005	0.018
PCB 1260	0.335	0.31	0.421	0.249
INORGANICS (ug/g)				
ALUMINUM	14800	17400	17900	10900
ANTIMONY	14.3	13.9	39.7	43.6
ARSENIC	17.4	14.7	16.1	11.1
BARIUM	276	311	566	233
BERYLLIUM	< 0.5	2.79	1.95	< 0.5
CADMIUM	161	136	378	84.5
CALCIUM	1130	1840	2280	2170
CHROMIUM	333	278	352	166
COBALT	8.87	6.09	< 1.42	5.61
COPPER	442	804	563	235
IRON	10700	10900	11200	12200
LEAD	1000	670	980	390
MAGNESIUM	2010	2470	2260	2490
MANGANESE	75.5	102	142	236
MERCURY	4.5	6.6	0.176	1.75
NICKEL	37.6	40.9	50.1	28.6
POTASSIUM	991	1160	1310	1140
SELENIUM	6.26	3.57	8.54	2.09
SILVER	10.1	9.24	17.5	7.44
SODIUM	923	941	1150	759
VANADIUM	37.9	47.6	62.7	27.1
ZINC	1030	2960	1310	536
OTHER (ug/g)				
TOTAL ORGANIC CARBON	128000	107000	136000	54800
TOTAL PETROLEUM HYDROCARBONS	3610	2580	5710	1100

Notes:
< = Less than the detection limit

TABLE 5.1–12
ANALYTES IN SEDIMENT
SA 12 – LANDFILL NO. 8 (AREA 2)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI			
ANALYTE SITE ID	**12D–93–23X**	**12D–93–24X**	**12D–93–25X**	**12D–93–26X**
ORGANICS (ug/g)				
ACETONE	0.33	< 0.08	< 0.017	< 0.017
CARBON DISULFIDE	< 0.004	< 0.02	< 0.004	< 0.004
TOLUENE	< 0.001	< 0.004	0.004	< 0.001
TRICHLOROFLUOROMETHANE	< 0.006	< 0.03	0.03	0.025
2–METHYLNAPHTHALENE	1	< 0.5	< 0.5	< 0.5
ACENAPHTHENE	< 0.2	< 0.4	< 0.4	< 0.4
ACENAPHTHYLENE	0.7	< 0.3	< 0.3	1
ANTHRACENE	0.8	< 0.3	< 0.3	2
BENZO [A] ANTHRACENE	< 0.8	< 2	< 2	6
BENZO [A] PYRENE	< 1	< 2	< 2	8
BENZO [B] FLUORANTHENE	6	< 2	< 2	5
BENZO [K] FLUORANTHENE	2	2	2	7
BIS (2–ETHYLHEXYL) PHTHALATE	< 3	40	70	< 6
CHRYSENE	4	< 1	5	10
DI–N–BUTYL PHTHALATE	2	< 0.6	2	9
FLUORANTHENE	7	< 0.7	3	10
FLUORENE	1	< 0.3	< 0.3	< 0.3
NAPHTHALENE	1	< 0.4	< 0.4	2
PHENANTHRENE	6	2	5	9
PYRENE	7	8	8	30
4,4'–DDT	0.13	0.026	0.083	0.14
4,4'–DDD	0.32	0.065	0.32	0.31
4,4'–DDE	0.25	0.029	0.083	0.24
BETA–BENZENEHEXACHLORIDE	< 0.003	< 0.003	< 0.003	< 0.003
HEPTACHLOR	0.069	< 0.006	0.034	0.05
ISODRIN	< 0.005	< 0.005	< 0.005	< 0.005
PCB 1260	0.526	< 0.08	0.303	0.378
INORGANICS (ug/g)				
ALUMINUM	17000	9440	18000	15500
ANTIMONY	8.58	41.3	100	< 1.09
ARSENIC	14.4	10.8	7.44	14.1
BARIUM	424	190	485	219
BERYLLIUM	< 0.5	< 0.5	< 0.5	< 0.5
CADMIUM	176	66	456	43.8
CALCIUM	2050	1770	1540	1880
CHROMIUM	269	122	336	206
COBALT	6.28	5.55	4.61	7.74
COPPER	591	176	518	385
IRON	11600	11400	9610	12400
LEAD	710	360	750	510
MAGNESIUM	2430	2290	2380	2910
MANGANESE	154	218	125	152
MERCURY	2.9	1.5	7.2	4.8
NICKEL	43.1	25.3	42.4	32.1
POTASSIUM	1260	1010	1310	1330
SELENIUM	5.42	1.65	9.23	1.01
SILVER	10.6	5.54	17.6	5.35
SODIUM	1010	663	780	671
VANADIUM	46.1	23.2	62.5	32.2
ZINC	1970	417	750	1790
OTHER (ug/g)				
TOTAL ORGANIC CARBON	111000	60500	115000	60600
TOTAL PETROLEUM HYDROCARBONS	4280	977	2730	4130

Notes:
< = Less than the detection limit

TABLE 5.1-12
ANALYTES IN SEDIMENT
SA 12 - LANDFILL NO. 8 (AREA 2)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI		SI	
ANALYTE SITE ID	**12D-93-27X**	**12D-93-28X**	**12D-92-05X**	**12D-92-06X**
ORGANICS (ug/g)				
ACETONE	< 0.08	0.5	0.1	2
CARBON DISULFIDE	< 0.02	< 0.02	< 0.004	< 0.02
TOLUENE	< 0.004	< 0.004	< 0.001	< 0.004
TRICHLOROFLUOROMETHANE	< 0.03	< 0.03	< 0.006	< 0.03
2-METHYLNAPHTHALENE	< 0.5	2	< 0.2	< 0.049
ACENAPHTHENE	< 0.4	2	< 0.2	< 0.036
ACENAPHTHYLENE	< 0.3	2	< 0.2	< 0.033
ANTHRACENE	< 0.3	3	< 0.2	< 0.033
BENZO [A] ANTHRACENE	< 2	10	< 0.8	< 0.17
BENZO [A] PYRENE	< 2	9	< 1	< 0.25
BENZO [B] FLUORANTHENE	< 2	10	< 1	< 0.21
BENZO [K] FLUORANTHENE	2	10	2	< 0.066
BIS (2-ETHYLHEXYL) PHTHALATE	100	< 6	20	< 0.62
CHRYSENE	< 1	20	< 0.6	< 0.12
DI-N-BUTYL PHTHALATE	< 0.6	< 0.6	< 0.3	< 0.061
FLUORANTHENE	3	20	5	1.1
FLUORENE	< 0.3	3	< 0.2	< 0.033
NAPHTHALENE	< 0.4	3	< 0.2	< 0.037
PHENANTHRENE	2	20	2	0.56
PYRENE	6	30	7	1.1
4,4'-DDT	< 0.007	< 0.007	0.088	< 0.007
4,4'-DDD	0.12	0.24	0.18	0.159
4,4'-DDE	0.049	0.025	0.21	0.077
BETA-BENZENEHEXACHLORIDE	< 0.003	< 0.003	< 0.003	< 0.003
HEPTACHLOR	0.019	< 0.006	< 0.006	< 0.006
ISODRIN	< 0.005	< 0.005	< 0.005	< 0.005
PCB 1260	< 0.08	0.333	0.921	< 0.08
INORGANICS (ug/g)				
ALUMINUM	12000	18300	15800	11400
ANTIMONY	200	7.09	70.8	62.8
ARSENIC	14	18.6	19.8	77.6
BARIUM	321	406	417	196
BERYLLIUM	< 0.5	< 0.5	< 0.5	< 0.5
CADMIUM	163	47.9	217	71.8
CALCIUM	2140	2610	1880	13600
CHROMIUM	258	357	344	139
COBALT	5.42	11	9.6	< 1.42
COPPER	263	443	512	241
IRON	12000	13200	15000	30800
LEAD	740	1600	760	580
MAGNESIUM	2430	2660	2260	2160
MANGANESE	193	176	128	122
MERCURY	2.1	2.2	3.31	2.44
NICKEL	41.9	27.1	61.8	19.8
POTASSIUM	1190	1070	547	1330
SELENIUM	2.84	1.04	10.3	4.94
SILVER	10.6	5.23	10.3	5.95
SODIUM	693	958	781	1360
VANADIUM	32.7	25.4	48.1	47.3
ZINC	659	836	1620	1720
OTHER (ug/g)				
TOTAL ORGANIC CARBON	87800	106000	37800	34600
TOTAL PETROLEUM HYDROCARBONS	2760	5810	2250	1940

Notes:
< = Less than the detection limit

TABLE 5.1-13
ANALYTES IN SEDIMENT
SA 12 - LANDFILL NO. 8 (AREA 1)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI					
ANALYTES **SITE ID**	12D-93-09X	12D-93-10X	12D-93-11X	12D-93-12X	12D-93-13X	12D-93-14X
ORGANICS (ug/g)						
ACETONE	< 0.017	0.05	0.14	0.096	< 0.017	< 0.017
TOLUENE	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003
ACENAPHTHYLENE	0.094	< 0.033	< 0.033	< 0.033	< 0.033	< 0.07
ANTHRACENE	0.069	< 0.033	< 0.033	< 0.033	< 0.033	< 0.07
BENZO [A] ANTHRACENE	0.26	< 0.17	< 0.17	< 0.17	< 0.17	< 0.3
BENZO [B] FLUORANTHENE	0.52	< 0.21	< 0.21	< 0.21	< 0.21	< 0.4
BENZO [K] FLUORANTHENE	0.18	< 0.066	< 0.066	0.16	< 0.066	< 0.1
BIS (2-ETHYLHEXYL) PHTHALATE	< 0.62	1.4	< 0.62	< 0.62	< 0.62	< 1
CHRYSENE	0.52	< 0.12	< 0.12	0.36	< 0.12	< 0.2
DI-N-BUTYL PHTHALATE	0.2	0.26	0.26	0.15	0.32	0.9
FLUORANTHENE	0.65	0.18	< 0.068	0.43	0.13	0.9
NAPHTHALENE	0.1	< 0.037	< 0.037	< 0.037	< 0.037	< 0.07
PHENANTHRENE	0.49	0.15	0.062	0.21	0.088	0.4
PYRENE	0.98	0.29	0.13	0.57	0.22	0.5
4,4'-DDT	0.015	< 0.007	< 0.007	< 0.007	< 0.007	0.028
4,4'-DDD	0.011	0.033	< 0.008	0.024	< 0.008	0.087
4,4'-DDE	0.041	< 0.008	< 0.008	< 0.008	< 0.008	0.022
HEPTACHLOR	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	0.02
INORGANICS (ug/g)						
ALUMINUM	13800	22500	26300	10400	12500	11500
ARSENIC	16	17	12.8	22	15.4	11.8
BARIUM	101	125	158	50.5	64	60.9
BERYLLIUM	0.939	1.58	< 0.5	< 0.5	1.16	< 0.5
CADMIUM	2.43	1.99	< 0.7	2	< 0.7	2.79
CALCIUM	1670	1500	1460	1670	1760	2410
CHROMIUM	48.2	47.4	62.6	31.1	51.6	45.2
COBALT	14.6	12.7	13.9	4.53	5.54	3.77
COPPER	39	33.8	38.1	23.2	27.6	28.3
IRON	23000	33200	37800	10900	12800	11100
LEAD	96	33	36	55	96	72
MAGNESIUM	5320	8200	10300	3180	3380	3250
MANGANESE	553	386	424	111	140	116
MERCURY	0.446	0.226	0.249	0.582	0.111	0.829
NICKEL	28.3	37.7	43.9	13.8	15.6	14.7
POTASSIUM	2720	5770	7230	983	853	745
SODIUM	563	647	715	597	465	692
VANADIUM	30.5	48.4	60.2	19.6	21.8	21.9
ZINC	107	113	135	128	60.5	76.7
OTHER (ug/g)						
TOTAL ORGANIC CARBON	6990	17600	11800	39000	18400	60600
TOTAL PETROLEUM HYDROCARBONS	48.8	55.1	61	223	56.2	64.7

Notes:
< = Less than detection limit

TABLE 5.1–14
ANALYTES IN SEDIMENT
SA 12 – UPRIVER BACKWATER

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI				
ANALYTE SITE ID	**12D–93–29X**	**12D–93–30X**	**12D–93–31X**	**12D–93–32X**	**12D–93–33X**
ORGANICS (ug/g)					
ACETONE	0.16	0.4	0.085	< 0.017	< 0.017
ACENAPHTHYLENE	< 0.3	< 0.033	0.41	< 0.033	2
ANTHRACENE	1	< 0.033	0.35	< 0.033	2
BENZO [A] ANTHRACENE	< 2	< 0.17	1	< 0.17	< 2
BENZO [A] PYRENE	< 2	< 0.25	1.5	< 0.25	10
BENZO [B] FLUORANTHENE	< 2	< 0.21	1.7	< 0.21	< 2
BENZO [G,H,I] PERYLENE	< 2	< 0.25	0.88	< 0.25	< 2
BENZO [K] FLUORANTHENE	5	< 0.066	1	< 0.066	8
CHRYSENE	5	< 0.12	2.1	< 0.12	10
DI–N–BUTYL PHTHALATE	< 0.6	< 0.061	0.33	< 0.061	2
FLUORANTHENE	5	< 0.068	2.8	0.31	6
FLUORENE	< 0.3	< 0.033	0.22	< 0.033	< 0.3
NAPHTHALENE	1	< 0.037	0.29	< 0.037	2
PHENANTHRENE	5	< 0.033	1.6	0.16	6
PYRENE	10	< 0.033	3.9	0.48	20
4,4'–DDD	0.072	< 0.008	0.089	< 0.008	0.17
4,4'–DDE	< 0.008	< 0.008	0.031	< 0.008	0.05
HEPTACHLOR	< 0.006	< 0.006	< 0.006	< 0.006	0.026
PCB 1260	< 0.08	< 0.08	< 0.08	< 0.08	0.237
INORGANICS (ug/g)					
ALUMINUM	12200	8400	18900	13200	17700
ANTIMONY	5.64	< 1.09	< 1.09	< 1.09	4.77
ARSENIC	38	4.89	30.3	110	19.4
BARIUM	223	39.6	194	104	220
CADMIUM	5.01	< 0.7	31.6	14.3	32.8
CALCIUM	1160	1140	3130	3340	1870
CHROMIUM	194	16.1	183	139	320
COBALT	6.8	5.38	10.5	8.44	8.42
COPPER	177	7.67	242	155	445
IRON	11500	6100	15600	10700	11000
LEAD	560	12.5	600	540	840
MAGNESIUM	2500	1940	4050	2670	2660
MANGANESE	131	106	215	165	121
MERCURY	2.7	< 0.14	3.2	3.2	4.3
NICKEL	17.5	12.7	35.1	26.5	35.2
POTASSIUM	877	358	797	668	981
SELENIUM	0.846	< 0.25	1.34	1.3	1.57
SILVER	< 0.589	< 0.589	4.31	< 0.589	6.63
SODIUM	673	498	930	1170	837
VANADIUM	17.9	11	34.6	22	33.3
ZINC	489	34.2	679	584	1150
OTHER (ug/g)					
TOTAL ORGANIC CARBON	55700	34800	119000	146000	109000
TOTAL PETROLEUM HYDROCARBONS	1880	64.1	1730	438	2260

Notes:
< = Less than detection limit

TABLE 5.1-15
ANALYTES IN SEDIMENT
SA 12 - DOWNRIVER BACKWATER

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE SITE ID	12D-93-34X	12D-93-35X	12D-93-36X	12D-93-37X	12D-93-38X
ORGANICS (ug/g)					
ACETONE	4	0.7	0.38	0.49	0.4
CARBON DISULFIDE	< 0.02	< 0.02	0.044	< 0.004	< 0.02
2-METHYLNAPHTHALENE	1	2	< 0.2	< 0.1	< 0.1
ACENAPHTHENE	< 0.2	0.8	< 0.2	< 0.07	< 0.07
ACENAPHTHYLENE	< 0.2	6	< 0.2	0.5	0.3
ANTHRACENE	0.9	4	< 0.2	< 0.07	0.3
BENZO [A] ANTHRACENE	< 0.8	6	< 0.8	< 0.3	< 0.3
BENZO [A] PYRENE	< 1	8	< 1	< 0.5	< 0.5
BENZO [B] FLUORANTHENE	< 1	8	< 1	< 0.4	< 0.4
BENZO [G,H,I] PERYLENE	< 1	4	< 1	< 0.5	< 0.5
BENZO [K] FLUORANTHENE	< 0.3	3	< 0.3	< 0.1	< 0.1
BIS (2-ETHYLHEXYL) PHTHALATE	20	< 1	< 3	8	4
CHRYSENE	5	8	< 0.6	1	2
DI-N-BUTYL PHTHALATE	< 0.3	0.7	< 0.3	1	< 0.1
FLUORANTHENE	5	20	3	3	2
FLUORENE	1	3	< 0.2	< 0.07	0.4
INDENO [1,2,3-C,D] PYRENE	< 1	4	< 1	< 0.6	< 0.6
NAPHTHALENE	1	1	< 0.2	< 0.07	< 0.07
PHENANTHRENE	4	10	2	1	0.7
PYRENE	7	20	3	3	2
4,4'-DDT	0.11	0.066	0.106	1.4	0.082
4,4'-DDD	0.52	0.37	0.65	0.66	0.19
4,4'-DDE	0.31	0.14	0.34	0.17	0.087
PCB 1260	0.72	< 0.24	1.83	0.996	< 0.08
NITROGLYCERINE	< 4	5.08	9.08	11.3	< 4
INORGANICS (ug/g)					
ALUMINUM	19800	19700	25400	19400	14800
ANTIMONY	65	< 1.09	38.8	43.3	18.5
ARSENIC	21.7	22.4	53.7	40.3	24.7
BARIUM	787	261	733	395	354
BERYLLIUM	< 0.5	< 0.5	< 0.5	5.02	< 0.5
CADMIUM	383	75	295	200	77.9
CALCIUM	2850	2690	4120	4040	4200
CHROMIUM	464	430	522	367	205
COBALT	6.9	10.8	13	17.1	11.8
COPPER	666	644	795	476	305
IRON	15000	10500	24500	19700	20100
LEAD	1200	1400	1200	850	400
MAGNESIUM	2510	2580	3370	3680	2970
MANGANESE	179	170	128	151	328
MERCURY	4.1	2.8	7.7	4.32	2.18
NICKEL	60.5	41.9	87.5	70.4	57.3
POTASSIUM	1330	1160	1780	1820	1290
SELENIUM	9.02	1.49	6.23	7.07	3.94
SILVER	21.4	12	22.3	17.1	5.61
SODIUM	1310	1110	1990	2290	1300
VANADIUM	65.6	35.1	68.7	55.1	40.3
ZINC	1880	1310	2430	1380	736
OTHER (ug/g)					
TOTAL ORGANIC CARBON	151000	99000	255000	190000	94800
TOTAL PETROLEUM HYDROCARBONS	9880	12800	5490	3540	2190

Notes:
< = Less than detection limit

TABLE 5.1-16
HUMAN HEALTH PRE EVALUATION OF SURFACE SOIL
SA 12 - LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a] AVERAGE (ug/g)	DETECTED CONCENTRATION [a] MAXIMUM (ug/g)	SOIL BACKGROUND CONCENTRATION [b] (ug/g)	MAXIMUM EXCEEDS BACKGROUND?	REGION III RESIDENTIAL SOIL CONCENTRATION (ug/g)	MCP S-1 (ug/g)	MAXIMUM EXCEEDS GUIDELINE CONCENTRATION?
ORGANICS								
4,4'-DDT	3/9	0.3	1	NA	-	1.9	2	NO
4,4'-DDD	1/9	0.013	0.013	NA	-	2.7	2	NO
4,4'-DDE	2/9	0.1	0.21	NA	-	1.9	2	NO
ACENAPHTHYLENE	2/9	0.1	0.1	NA	-	NA	100	NO
ACETONE	5/9	0.07	0.14	NA	-	7800	3	NO
ANTHRACENE	1/9	0.2	0.2	NA	-	23000	1000	NO
AROCLOR 1254	1/9	6.9	6.9	NA	-	.0083	2	YES
BENZO [a] ANTHRACENE	1/9	0.4	0.4	NA	-	.87	0.7	NO
BENZO [b] FLUORANTHENE	1/9	1	1	NA	-	.87	0.7	YES
BENZO [k] FLUORANTHENE	1/9	0.4	0.4	NA	-	8.8	0.7	NO
CARBAZOLE	1/9	0.1	0.1	NA	-	32	NA	NO
CHRYSENE	1/9	0.8	0.8	NA	-	87	0.7	MCP
FLUORANTHENE	2/9	0.7	0.8	NA	-	3100	600	NO
PHENANTHRENE	2/9	0.2	0.3	NA	-	NA	100	NO
PYRENE	2/9	0.6	0.8	NA	-	2300	500	NO
INORGANICS								
ALUMINUM	9/9	6841.1	10500	15000	NO	230000	NA	NO
ARSENIC	9/9	10	21	21	NO	0.36	30	REGION III
BARIUM	9/9	45.5	165	42.5	YES	5500	NA	NO
BERYLLIUM	3/9	0.7	0.74	0.347	YES	0.15	0.4	YES
CADMIUM	1/9	0.968	0.968	2.0	NO	39	30	NO
CALCIUM	9/9	1026.3	1660	1400	YES	NA	NA	-
CHROMIUM	9/9	15.2	22.6	31	NO	390	200	NO
COBALT	9/9	3.7	5.66	NA	-	NA	NA	-
COPPER	9/9	7.9	12.4	8.39	YES	2900	NA	NO
IRON	9/9	8406.7	10500	15000	NO	NA	NA	-
LEAD	9/9	121.9	880	48.4	YES	500	300	YES
MAGNESIUM	9/9	2165.6	3360	5600	NO	NA	NA	-
MANGANESE	9/9	150.6	259	300	NO	390	NA	NO
NICKEL	9/9	10.4	16.5	14.0	YES	1600	300	NO
POTASSIUM	9/9	675.6	935	1700	NO	NA	NA	-
SODIUM	8/9	212.1	207	131	YES	NA	NA	-
VANADIUM	9/9	11.7	17.3	28.7	NO	550	NA	NO
ZINC	9/9	118.6	736	35.5	YES	23000	2500	NO
OTHER								
TOTAL PETROLEUM HYDROCAR	4/9	380.5	10400	NA	NO	NA	500	MCP

Notes:

[a] Surface soil samples from sampling stations 12S-92-01X to 12S-92-04X and 12D-92-01X to 12D-92-04X (including one duplicate)

[b] Base-wide background soil inorganics database

NA = not available

ug/g = micrograms per gram

- = not applicable

MCP = Massachusetts Contingency Plan

Shaded compounds exceed standard or guideline.

TABLE 5.1-17
HUMAN HEALTH PRE EVALUATION OF GROUNDWATER
SA 12 – LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a]		GROUNDWATER BACKGROUND CONCENTRATION (ug/L)	MAXIMUM EXCEEDS BACKGROUND ?	DRINKING WATER STANDARD/ GUIDELINE [b] (ug/L)	MAXIMUM EXCEEDS STANDARD/ GUIDELINE ?
		AVERAGE (ug/L)	MAXIMUM (ug/L)				
ORGANICS							
BIS (2-ETHYLHEXYL) PHTHALATE	1/6	9.1	9.1	NA	–	6.1	YES
CHLOROFORM	1/6	13	13	NA	–	5	NO
INORGANICS							
ALUMINUM	6/6	10486.3	25200	6870	YES	50-200	YES
ANTIMONY	1/6	6.96	6.96	3.03	YES	2	YES
ARSENIC	4/6	30	44.2	10.5	YES	50	NO
BARIUM	5/6	71.1	114	39.6	YES	2000	NO
BERYLLIUM	1/6	6.63	6.63	5	YES	4	YES
CADMIUM	1/6	12.1	12.1	4.01	YES	5	YES
CALCIUM	6/6	33115	117000	14700	YES	NA	–
CHROMIUM	4/6	37.5	55.2	14.7	YES	100	NO
COPPER	4/6	50.3	122	8.09	YES	1300	NO
IRON	6/6	16843	40200	9100	YES	300	YES
LEAD	6/6	125.8	500	4.25	YES	15	YES
MAGNESIUM	6/6	5530	8480	3480	YES	NA	–
MANGANESE	6/6	281.7	990	291	YES	50	YES
MERCURY	3/6	1	1.65	0.243	YES	2	NO
POTASSIUM	6/6	3061.7	5040	2370	YES	NA	–
SODIUM	6/6	4991.7	7400	10800	NO	28000	NO
VANADIUM	4/6	29.7	44.9	11	YES	260	NO
ZINC	6/6	200.7	874	21.1	YES	5000	NO
ANIONS/CATIONS							
NITRITE/NITRATE	2/6	1000	1100	NA	–	10000	NO
OTHER							
TOTAL SUSPENDED SOLIDS	5/5	603600	1270000	NA	–	NA	–

Notes:

[a] Based on unfiltered samples from Round 1 and Round 2

[b] Includes the lowest of either the EPA or MA drinking water standards, or if no federal standard or guideline is available, the Region III tap water concentration.

SA 12 is represented by monitoring well 12M-92-01X and sump samples 12D-92-01X through 12D-92-04X (including one duplicate)

NA = not available

ug/L = micrograms per liter

– = not applicable

Shaded compounds exceed standard or guideline.

TABLE 5.1-18
HUMAN HEALTH PRE EVALUATION OF SEDIMENT
SA 12- LANDFILL NO. 8 AREA 1

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a]		REGION III RESIDENTIAL SOIL CONCENTRATION (µg/g)	MCP S-2 STANDARD (µg/g)	MAXIMUM EXCEEDS GUIDELINE CONCENTRATION ?
		AVERAGE (µg/g)	MAXIMUM (µg/g)			
ORGANICS						
4,4'-DDT	2/6	0.022	0.028	1.9	2	NO
4,4'-DDD	4/6	0.039	0.087	2.7	3	NO
4,4'-DDE	2/6	0.032	0.041	1.9	2	NO
ACENAPHTHYLENE	1/6	0.094	0.094	NA	100	NO
ACETONE	3/6	0.095	0.14	7800	3	NO
ANTHRACENE	1/6	0.069	0.069	2300	1000	NO
BENZO [A] ANTHRACENE	1/6	0.26	0.26	0.87	0.7	NO
BENZO [B] FLUORANTHENE	1/6	0.52	0.52	0.87	0.7	NO
BENZO [K] FLUORANTHENE	2/6	0.17	0.18	8.8	0.7	NO
BIS (2-ETHYLHEXYL) PHTHALATE	1/6	1.4	1.4	46	100	NO
CHRYSENE	2/6	0.44	0.52	87	0.7	NO
DI-N-BUTYL PHTHALATE	6/6	0.348	0.9	7800	NA	–
FLUORANTHENE	5/6	0.458	0.9	3100	600	NO
HEPTACHLOR	1/6	0.02	0.02	0.14	0.2	NO
NAPHTHALENE	1/6	0.1	0.1	3100	4	NO
PHENANTHRENE	6/6	0.233	0.49	NA	700	NO
PYRENE	6/6	0.448	0.98	2300	500	NO
TOLUENE	1/6	0.003	0.003	16000	90	NO
INORGANICS						
ALUMINUM	6/6	16166.667	26300	230000	NA	–
ARSENIC	6/6	15.833	22	0.36	30	(Region III)
BARIUM	6/6	93.233	158	5500	NA	–
BERYLLIUM	3/6	1.226	1.58	0.15	0.8	YES
CADMIUM	4/6	2.303	2.79	39	80	NO
CALCIUM	6/6	1745	2410	NA	NA	–
CHROMIUM	6/6	47.683	62.6	390	600	NO
COBALT	6/6	9.173	14.6	NA	NA	–
COPPER	6/6	31.667	39	2900	NA	NO
IRON	6/6	21466.667	37800	NA	NA	–
LEAD	6/6	64.667	96	500	600	NO
MAGNESIUM	6/6	5605	10300	NA	NA	–
MANGANESE	6/6	288.333	553	390	NA	YES
MERCURY	6/6	0.407	0.829	23	60	NO
NICKEL	6/6	25.667	43.9	1600	700	NO
POTASSIUM	6/6	3050.167	7230	NA	NA	–

TABLE 5.1-18
HUMAN HEALTH PRE EVALUATION OF SEDIMENT
SA 12- LANDFILL NO. 8 AREA 1

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a]		REGION III RESIDENTIAL SOIL CONCENTRATION (µg/g)	MCP S-2 STANDARD (µg/g)	MAXIMUM EXCEEDS GUIDELINE CONCENTRATION ?
		AVERAGE (µg/g)	MAXIMUM (µg/g)			
SODIUM	6/6	613.167	715	NA	NA	-
VANADIUM	6/6	33.733	60.2	550	NA	-
ZINC	6/6	103.367	135	23000	2500	NO
OTHER						
TOTAL PETROLEUM HYDROCARBONS	6/6	84.8	223	NA	2500	NO

Notes:
[a] Sediment from sampling locations 12D-93-09X to 12D-93-14X.
NA = Not available
- = Not applicable
Shaded compounds exceed standard or guideline.
µg/g = micrograms per gram

TABLE 5.1-19
ECOLOGICAL PRE EVALUATION OF SURFACE SOIL
SA 12 - LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Soil Background Concentration [a] (ug/g)	Concentration [b]		Frequency of Detection	Maximum Exceeds Background?	Ecological Benchmark (ug/g)	Maximum Exceeds Banchmark?
		Average (ug/g)	Maximum (ug/g)				
Organics							
4,4'-DDT	NA	0.3	1	3/9	NA	1.07	NO
4,4'-DDD	NA	0.013	0.013	1/9	NA	1.07	NO
4,4'-DDE	NA	0.1	0.21	2/9	NA	1.07	NO
acenaphthylene	NA	0.1	0.1	2/9	NA	2600	NO
acetone	NA	0.07	0.14	5/9	NA	2000	NO
anthracene	NA	0.2	0.2	1/9	NA	14000	NO
aroclor 1254	NA	6.9	6.9	1/9	NA	3.1	YES
benzo [a] anthracene	NA	0.4	0.4	1/9	NA	8.9	NO
benzo [b] fluoranthene	NA	1	1	1/9	NA	180	NO
benzo [k] fluoranthene	NA	0.4	0.4	1/9	NA	320	NO
carbazole	NA	0.1	0.1	1/9	NA	43	NO
chrysene	NA	0.8	0.8	1/9	NA	440	NO
fluoranthene	NA	0.7	0.8	2/9	NA	1100	NO
phenanthrene	NA	0.2	0.3	2/9	NA	510	NO
pyrene	NA	0.6	0.8	2/9	NA	550	NO
Inorganics							
aluminum	15000	6841.1	10500	9/9	NO		
arsenic	21	10	21	9/9	NO		
barium	42.5	45.5	165	9/9	YES	42.5	YES
beryllium	0.347	0.7	0.74	3/9	YES	0.88	NO
cadmium	2.00	0.968	0.968	1/9	NO		
chromium	31	15.2	22.6	9/9	NO		
cobalt	NA	3.7	5.66	9/9	NA	50	NO
copper	8.39	7.9	12.4	9/9	YES	34	NO
lead	48.4	121.9	880	9/9	YES	48.4	YES
manganese	300	150.6	259	9/9	NO		
nickel	14.0	10.4	16.5	9/9	YES	100	NO
vanadium	28.7	11.7	17.3	9/9	NO		
zinc	35.5	118.6	736	9/9	YES	640	YES

Notes:
[a] Base-wide background soil inorganics database
[b] Surface soil samples from sampling stations 12S-92-01X to 12S-92-04X, 12D-92-01X to 12D-92-04X, and one duplicate
NA = not available
ug/g = micrograms per gram

TABLE 5.1-20
ECOLOGICAL PRE EVALUATION OF SEDIMENT - AREA 1
SA 12 - LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	CONCENTRATION [a] AVERAGE (ug/g)	CONCENTRATION [a] MAXIMUM (ug/g)	FREQUENCY OF DETECTION	ECOLOGICAL SOIL BENCHMARK (ug/g)	MAXIMUM EXCEEDS SOIL BENCHMARK?	ECOLOGICAL SEDIMENT BENCHMARK (ug/g)	MAXIMUM EXCEEDS SEDIMENT BENCHMARK?
ORGANICS							
TOLUENE	0.003	0.003	1/6	1,800	NO	NA	NA
ACENAPHTHYLENE	0.094	0.094	1/6	2,600	NO	19 [b]	NO
ACETONE	0.095	0.14	3/6	2,000	NO	NA	NA
ANTHRACENE	0.069	0.069	1/6	14,000	NO	0.085	NO
BENZO(A)ANTHRACENE	0.26	0.26	1/6	8.9	NO	34.2 [b]	NO
BENZO(B)FLUORANTHENE	0.52	0.52	1/6	180	NO	NA	NA
BENZO(K)FLUORANTHENE	0.17	0.18	2/6	320	NO	NA	NA
BIS(2-ETHYLHEXYL)PHTHALATE	1.4	1.4	1/6	84	NO	120	NO
CHRYSENE	0.44	0.52	2/6	440	NO	NA	NA
DI-N-BUTYLPHTHALATE	0.348	0.9	6/6	2,650	NO	NA	NA
FLUORANTHENE	0.458	0.9	5/6	1,100	NO	49 [b]	NO
NAPHTHALENE	0.1	0.1	1/6	170	NO	0.34	NO
PHENANTHRENE	0.233	0.49	6/6	530	NO	3.61 [b]	NO
PYRENE	0.448	0.98	6/6	550	NO	34.1 [b]	NO
HEPTACHLOR	0.02	0.02	1/6	0.64	NO	0.003 [b]	YES
4,4'-DDT	0.022	0.028	2/6	1.07	NO	0.022 [b]	YES
4,4'-DDD	0.039	0.087	4/6	1.07	NO	0.022 [b]	YES
4,4'-DDE	0.032	0.041	2/6	1.07	NO	0.022 [b]	YES
INORGANICS							
ALUMINUM	16,167	26,300	6/6	15,000	YES	NA	NA
ARSENIC	15.8	22	6/6	33	NO	5	YES
BARIUM	93.2	158	6/6	42.5	YES	NA	NA
BERYLLIUM	1.23	1.58	3/6	0.88	YES	NA	NA
CADMIUM	2.30	2.79	4/6	2	YES	0.8	YES
CALCIUM	1,745	2,410	6/6	NA	NA	NA	NA
CHROMIUM	47.7	62.6	6/6	180	NO	26	YES
COBALT	9.17	14.6	6/6	50	NO	NA	NA
COPPER	31.7	39	6/6	28	YES	19	YES

TABLE 5.1-20
ECOLOGICAL PRE EVALUATION OF SEDIMENT - AREA 1
SA 12 - LANDFILL NO. 8

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	CONCENTRATION [a] AVERAGE (ug/g)	CONCENTRATION [a] MAXIMUM (ug/g)	FREQUENCY OF DETECTION	ECOLOGICAL SOIL BENCHMARK (ug/g)	MAXIMUM EXCEEDS SOIL BENCHMARK?	ECOLOGICAL SEDIMENT BENCHMARK (ug/g)	MAXIMUM EXCEEDS SEDIMENT BENCHMARK?
IRON	21,467	37,800	6/6	NA	NA	24,000	YES
LEAD	64.7	96	6/6	48.4	YES	27	YES
MAGNESIUM	5,605	10,300	6/6	NA	NA	NA	NA
MANGANESE	288	553	6/6	1,500	NO	428	YES
MERCURY	0.407	0.829	6/6	3.6	NO	0.11	YES
NICKEL	25.7	43.9	6/6	35	YES	22	YES
POTASSIUM	3,050	7,230	6/6	NA	NA	NA	NA
SODIUM	613	715	6/6	NA	NA	NA	NA
VANADIUM	33.7	60.2	6/6	28.7	YES	NA	NA
ZINC	103	135	6/6	640	NO	85	YES
OTHER							
TOTAL ORGANIC CARBON	25,732	60,600	6/6	—	—	—	—

Notes:

[a] Sediment samples from sampling stations 12D-93-09X through 12D-93-14X.

[b] Benchmark is carbon-normalized using site-specific total organic carbon data (see Section 3.6.2 of ABB-ES, 1993).

NA = not available

ug/g = micrograms per gram

— = Analyte not a CPC for this medium

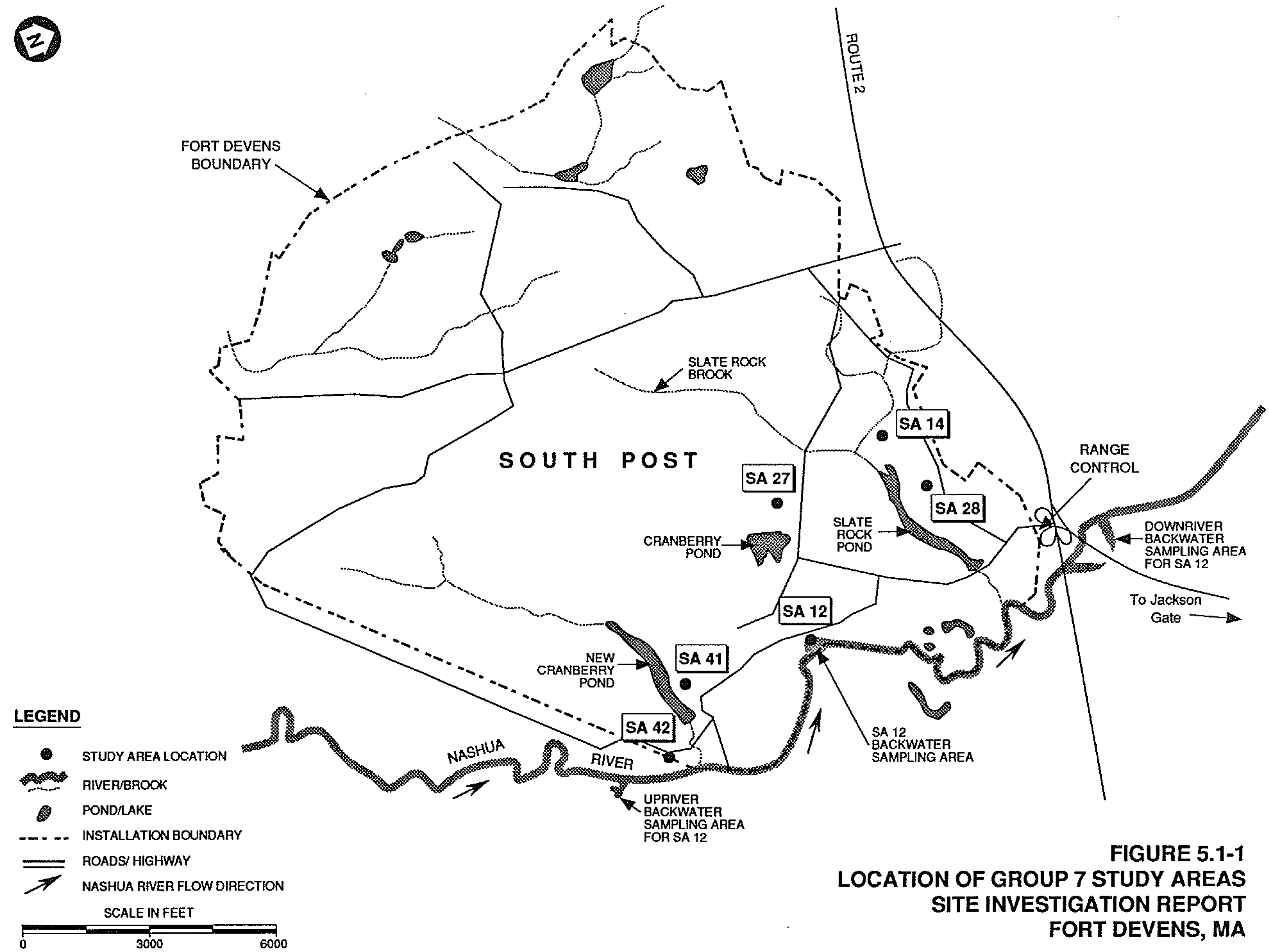


FIGURE 5.1-1
LOCATION OF GROUP 7 STUDY AREAS
SITE INVESTIGATION REPORT
FORT DEVENS, MA

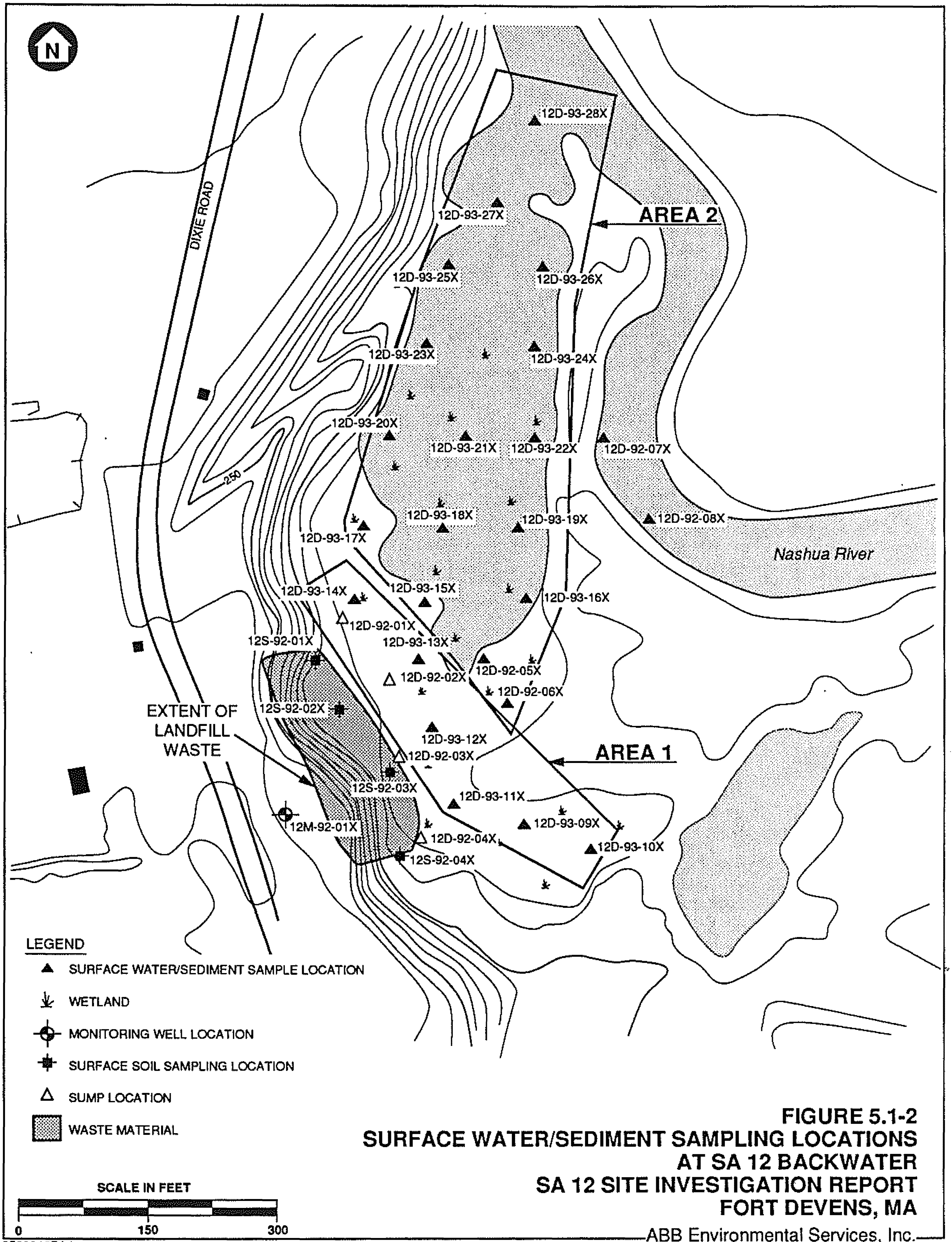


FIGURE 5.1-2
SURFACE WATER/SEDIMENT SAMPLING LOCATIONS
AT SA 12 BACKWATER
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

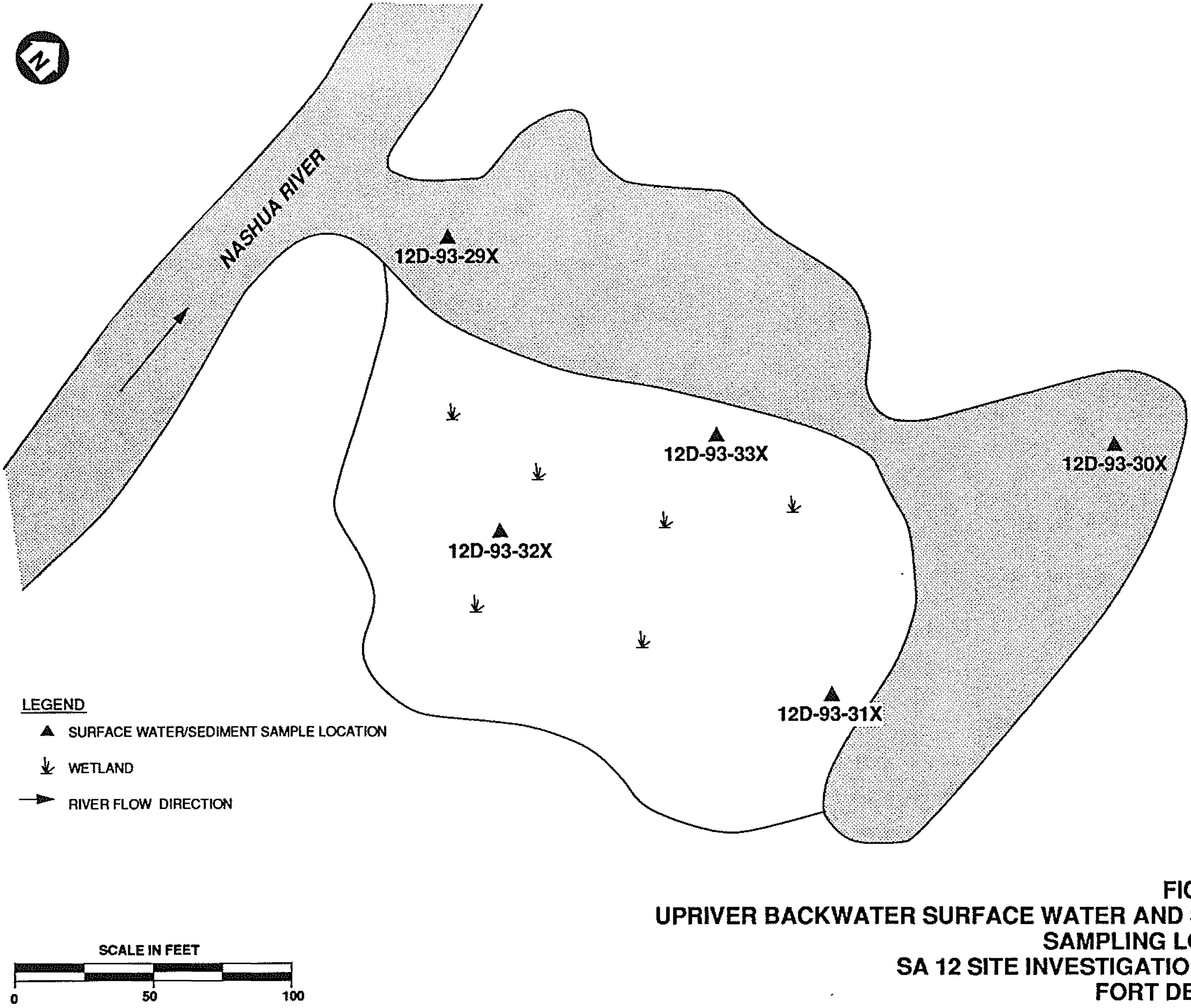


FIGURE 5.1-3
UPRIVER BACKWATER SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D 1

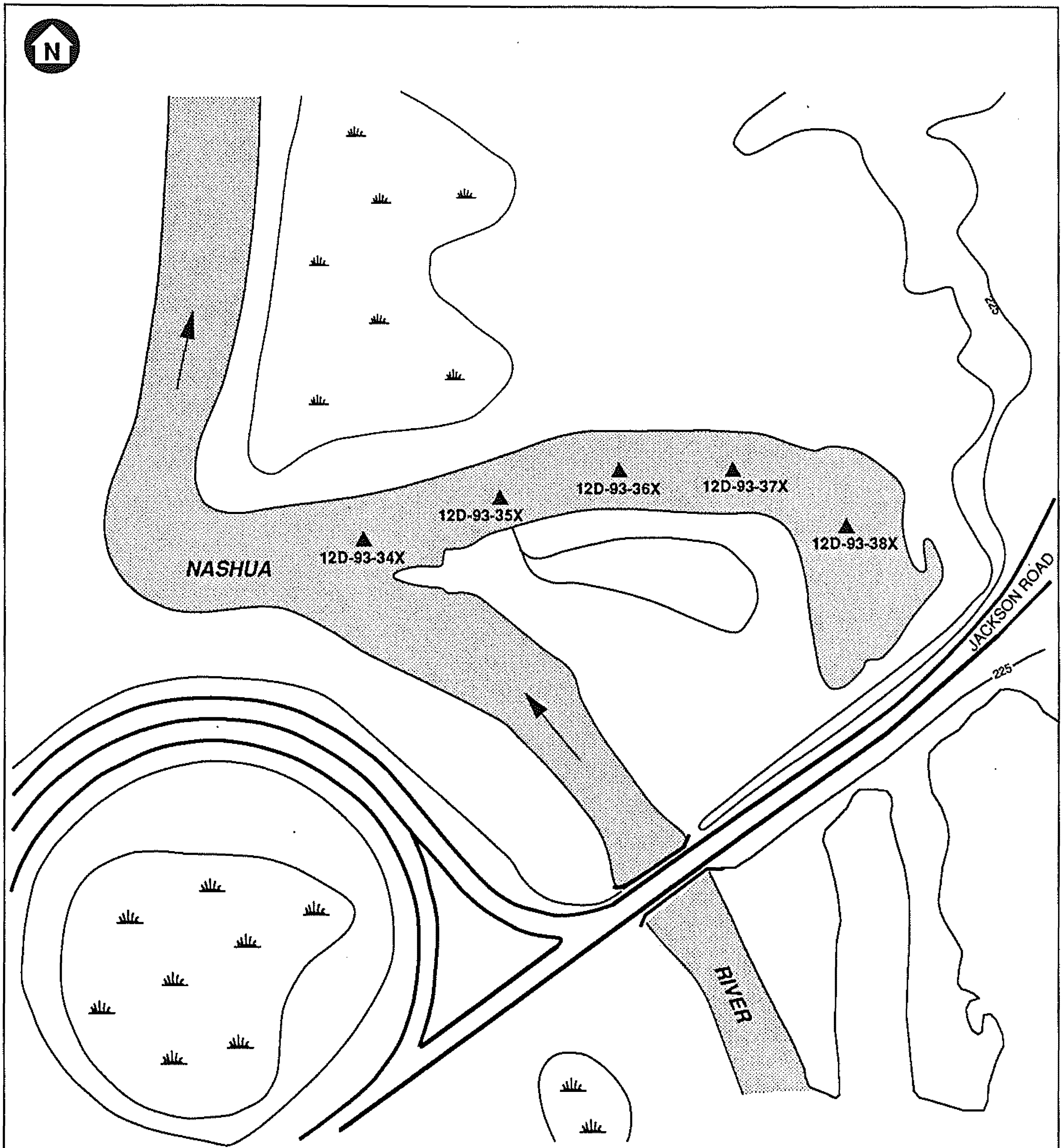


FIGURE 5.1-4
DOWNRIVER BACKWATER SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

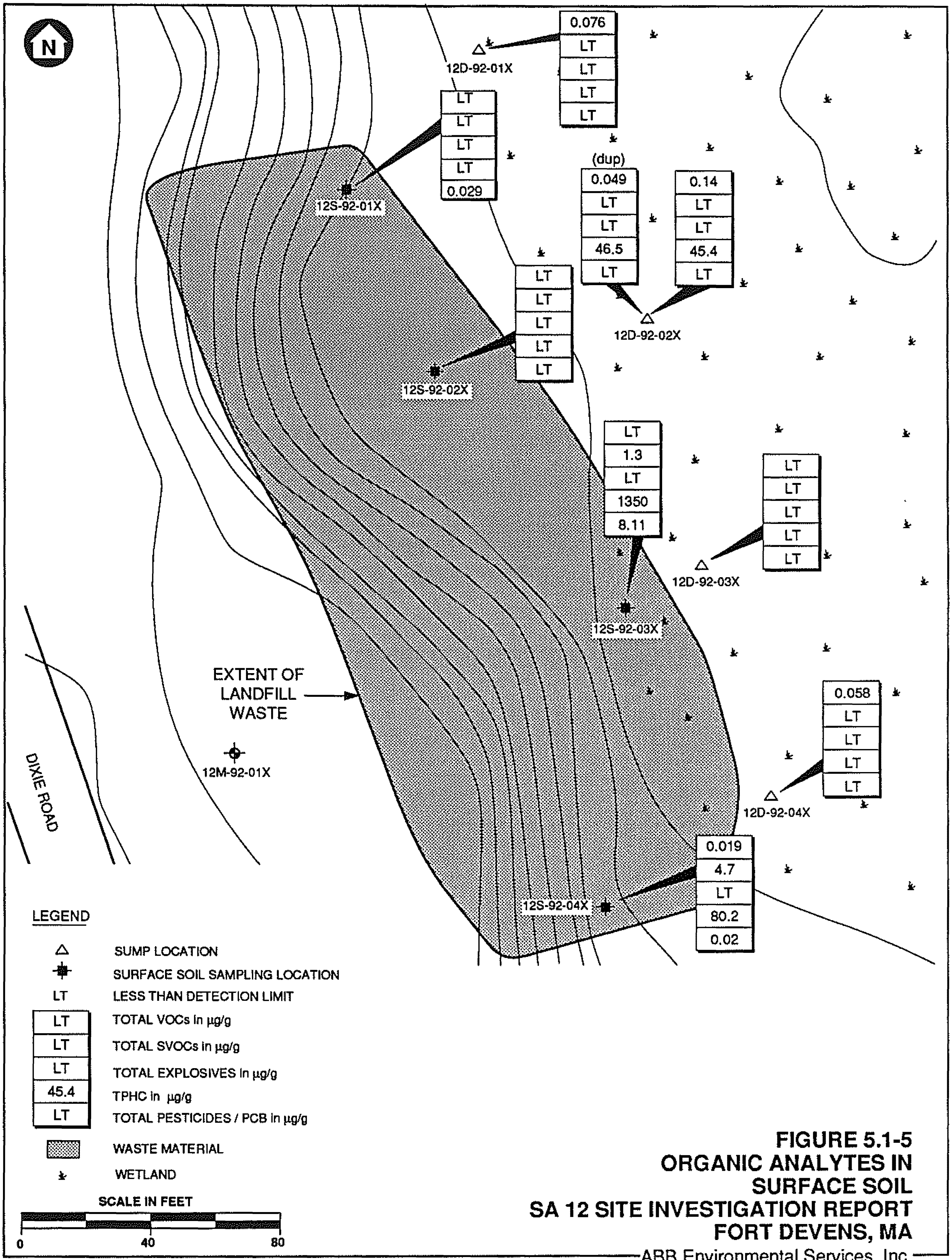


FIGURE 5.1-5
ORGANIC ANALYTES IN SURFACE SOIL
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(v2)123 5 8

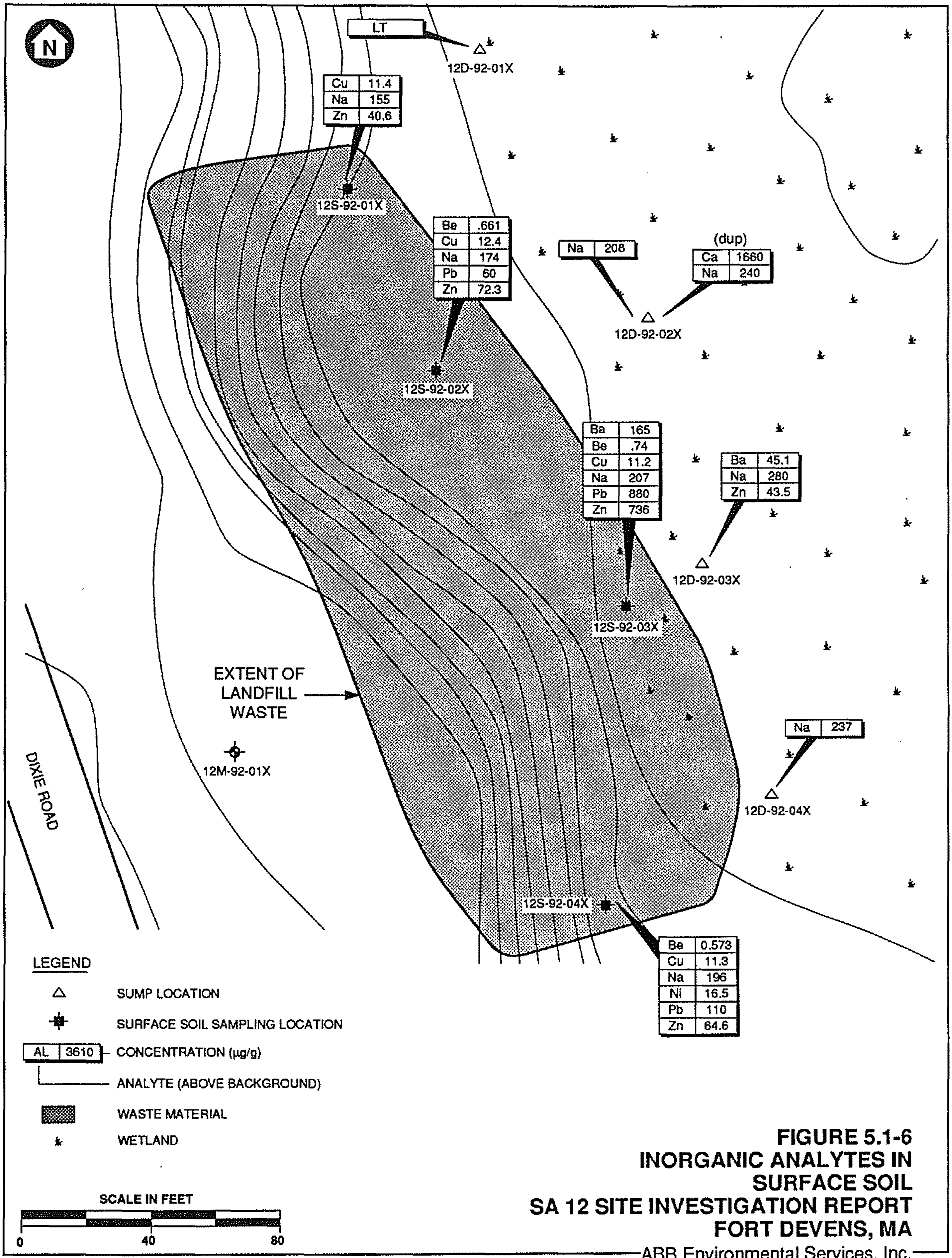


FIGURE 5.1-6
INORGANIC ANALYTES IN SURFACE SOIL
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

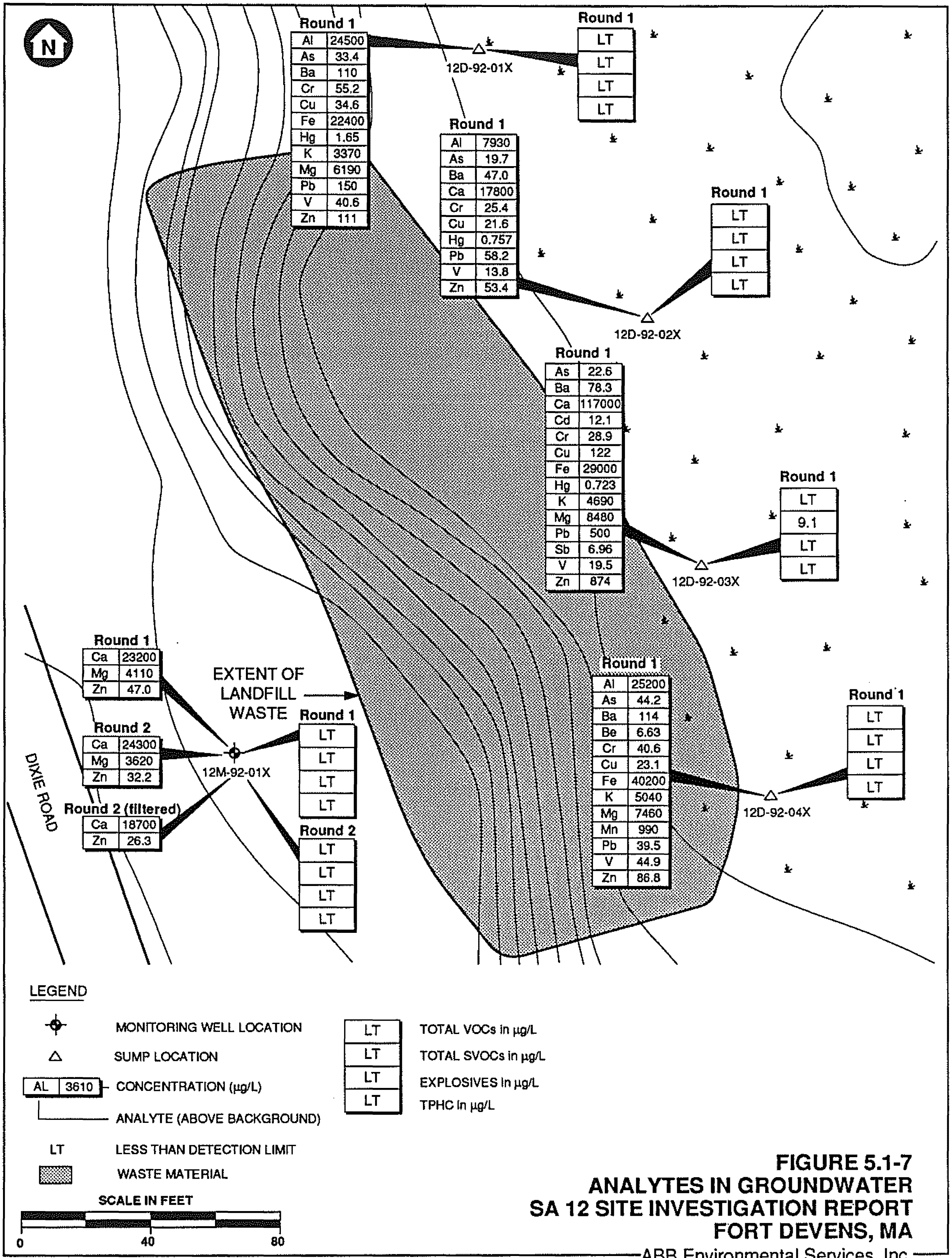
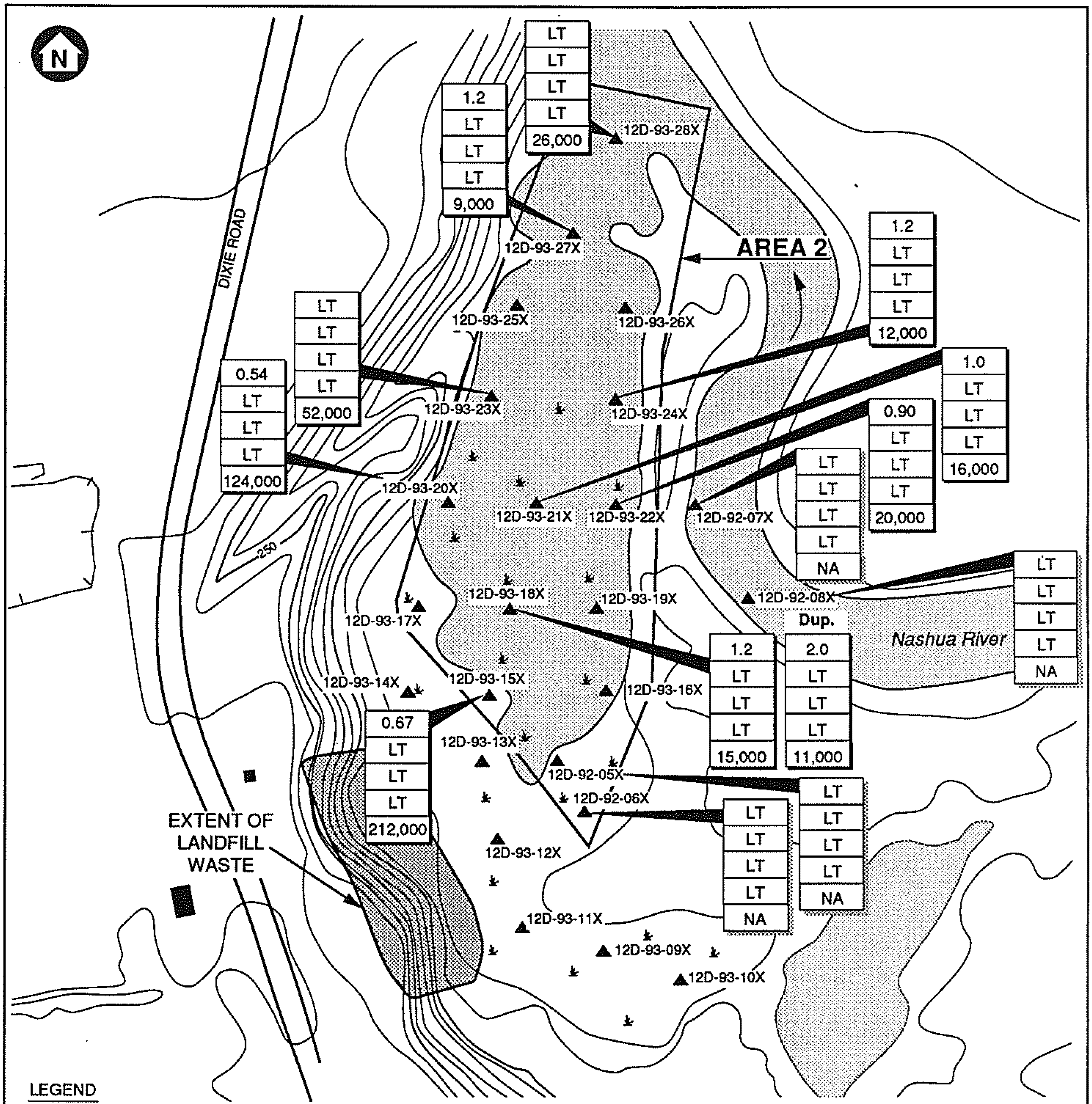


FIGURE 5.1-7
ANALYTES IN GROUNDWATER
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.



LEGEND

▲ SURFACE WATER/SEDIMENT SAMPLE LOCATION

⫫ WETLAND

LT	TOTAL VOCs in µg/L
LT	TOTAL SVOCs in µg/L
LT	TOTAL PESTICIDES/PCBs in µg/L
LT	TOTAL EXPLOSIVES in µg/L
LT	TSS in µg/L

LT	TOTAL VOCs in µg/L
LT	TOTAL SVOCs in µg/L
LT	TOTAL EXPLOSIVES in µg/L
LT	TPHC in µg/L
LT	TOTAL

LT LESS THAN DETECTION LIMIT
NA NOT ANALYZED

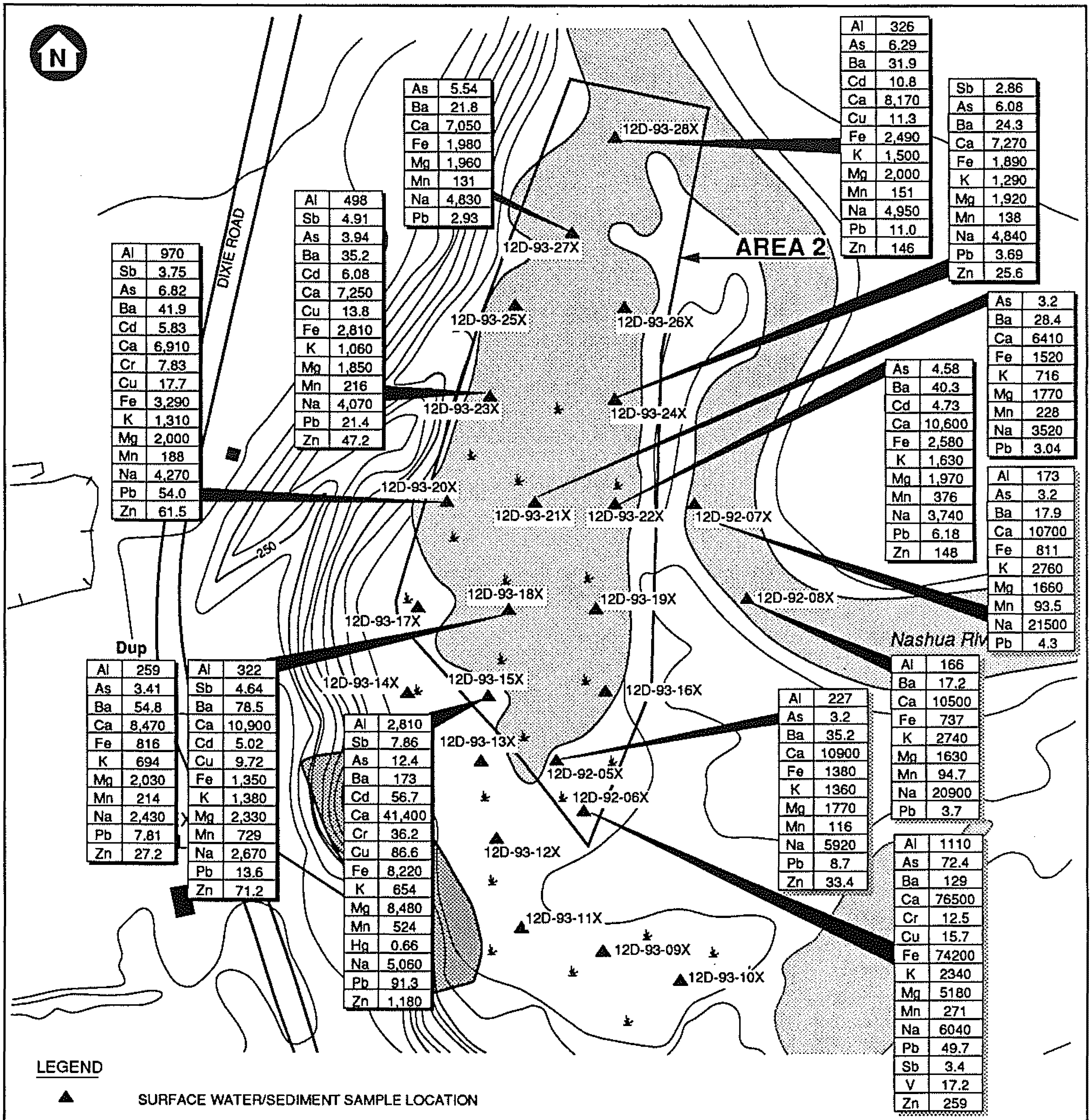
SCALE IN FEET

0 150 300

FIGURE 5.1-8
ORGANIC COMPOUNDS IN SURFACE WATER AT AREA 2
SA 12 SITE INVESTIGATION REPORTS
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(v) 1,A,E,G



As	5.54
Ba	21.8
Ca	7,050
Fe	1,980
Mg	1,960
Mn	131
Na	4,830
Pb	2.93

Al	326
As	6.29
Ba	31.9
Cd	10.8
Ca	8,170
Cu	11.3
Fe	2,490
K	1,500
Mg	2,000
Mn	151
Na	4,950
Pb	11.0
Zn	146

Sb	2.86
As	6.08
Ba	24.3
Ca	7,270
Fe	1,890
K	1,290
Mg	1,920
Mn	138
Na	4,840
Pb	3.69
Zn	25.6

Al	498
Sb	4.91
As	3.94
Ba	35.2
Cd	6.08
Ca	7,250
Cu	13.8
Fe	2,810
K	1,060
Mg	1,850
Mn	216
Na	4,070
Pb	21.4
Zn	47.2

Al	970
Sb	3.75
As	6.82
Ba	41.9
Cd	5.83
Ca	6,910
Cr	7.83
Cu	17.7
Fe	3,290
K	1,310
Mg	2,000
Mn	188
Na	4,270
Pb	54.0
Zn	61.5

As	3.2
Ba	28.4
Ca	6410
Fe	1520
K	716
Mg	1770
Mn	228
Na	3520
Pb	3.04

As	4.58
Ba	40.3
Cd	4.73
Ca	10,600
Fe	2,580
K	1,630
Mg	1,970
Mn	376
Na	3,740
Pb	6.18
Zn	148

Al	173
As	3.2
Ba	17.9
Ca	10700
Fe	811
K	2760
Mg	1660
Mn	93.5
Na	21500
Pb	4.3

Dup

Al	259
As	3.41
Ba	54.8
Ca	8,470
Fe	816
K	694
Mg	2,030
Mn	214
Na	2,430
Pb	7.81
Zn	27.2

Al	322
Sb	4.64
Ba	78.5
Ca	10,900
Cd	5.02
Cu	9.72
Fe	1,350
K	1,380
Mg	2,330
Mn	729
Na	2,670
Pb	13.6
Zn	71.2

Al	2,810
Sb	7.86
As	12.4
Ba	173
Cd	56.7
Ca	41,400
Cr	36.2
Cu	86.6
Fe	8,220
K	654
Mg	8,480
Mn	524
Hg	0.66
Na	5,060
Pb	91.3
Zn	1,180

Al	227
As	3.2
Ba	35.2
Ca	10900
Fe	1380
K	1360
Mg	1770
Mn	116
Na	5920
Pb	8.7
Zn	33.4

Al	166
Ba	17.2
Ca	10500
Fe	737
K	2740
Mg	1630
Mn	94.7
Na	20900
Pb	3.7

Al	1110
As	72.4
Ba	129
Ca	76500
Cr	12.5
Cu	15.7
Fe	74200
K	2340
Mg	5180
Mn	271
Na	6040
Pb	49.7
Sb	3.4
V	17.2
Zn	259

LEGEND

▲ SURFACE WATER/SEDIMENT SAMPLE LOCATION

⚘ WETLAND

Al 3610 – CONCENTRATION (µg/L) – ANALYTE

Al 3610 – CONCENTRATION (µg/L) – ANALYTE

LT LESS THAN DETECTION LIMIT

NOTE TOPOGRAPHIC CONTOURS DO NOT ACCURATELY REFLECT LANDFILL TOPOGRAPHY.

SCALE IN FEET

0 150 300

FIGURE 5.1-9
INORGANIC ANALYTES IN BACKWATER SURFACE WATER AT AREA 2
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

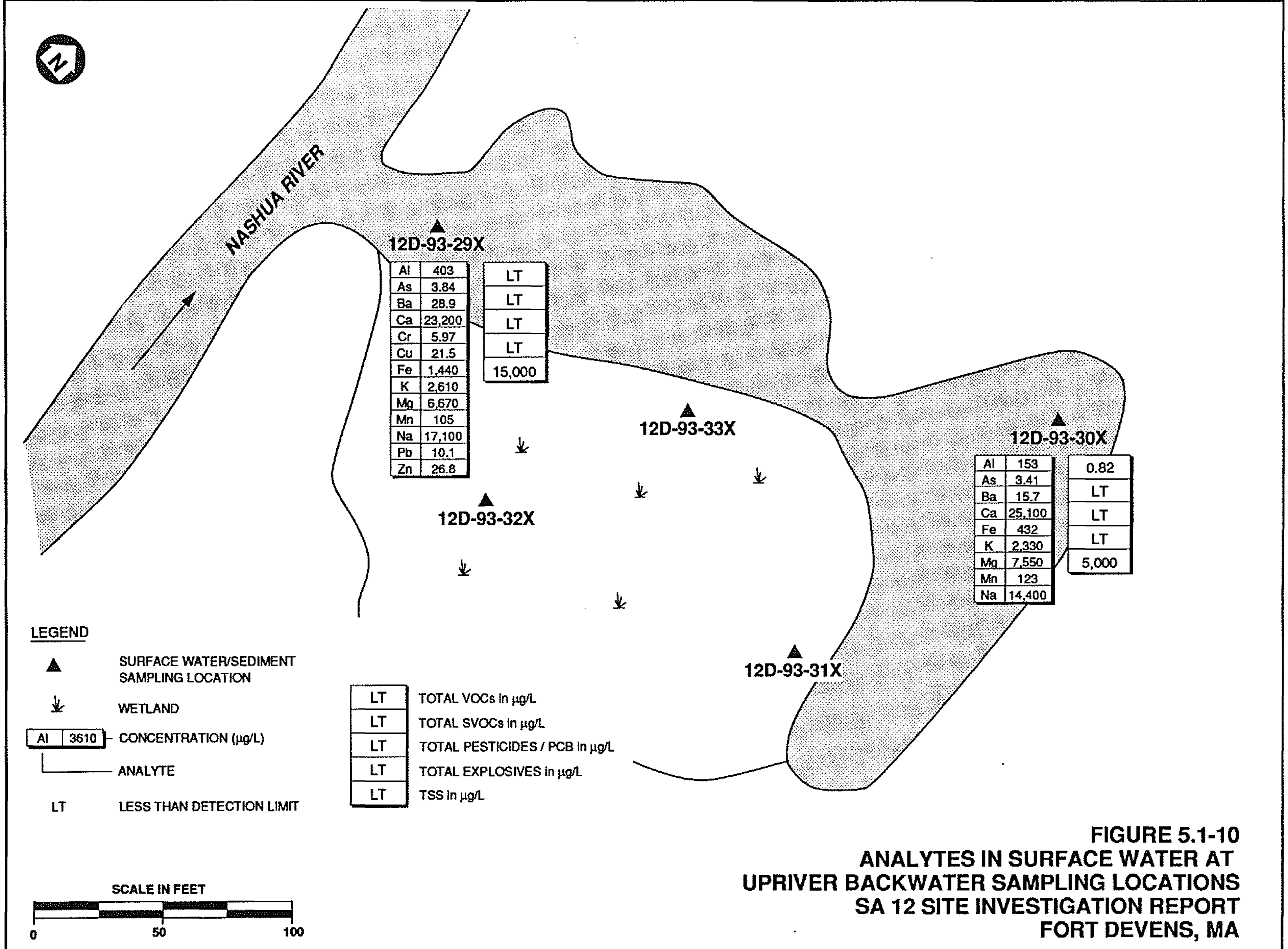


FIGURE 5.1-10
ANALYTES IN SURFACE WATER AT
UPRIVER BACKWATER SAMPLING LOCATIONS
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D 1,2

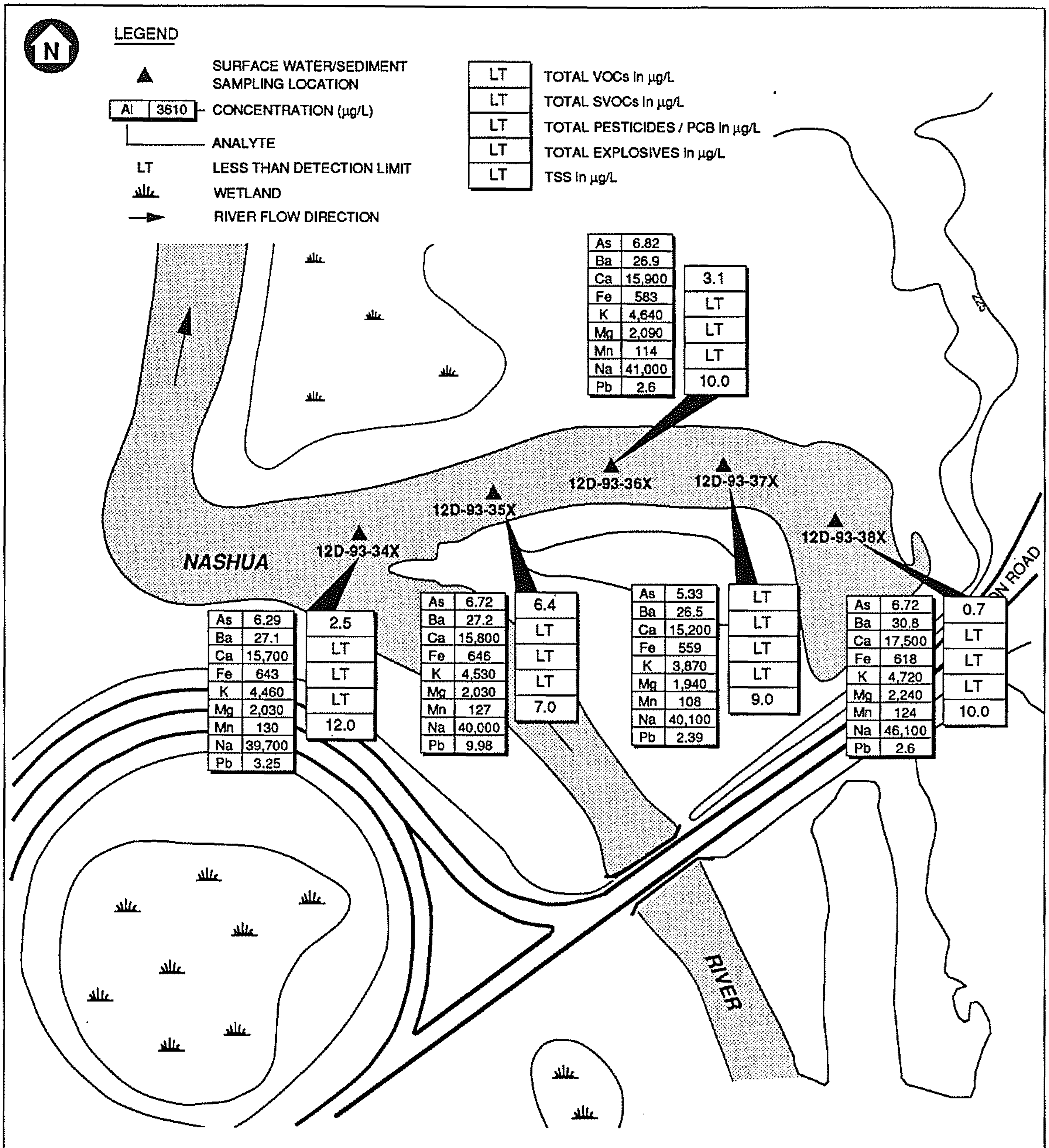


FIGURE 5.1-11
ANALYTES IN SURFACE WATER AT DOWNRIVER BACKWATER SAMPLING LOCATIONS
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

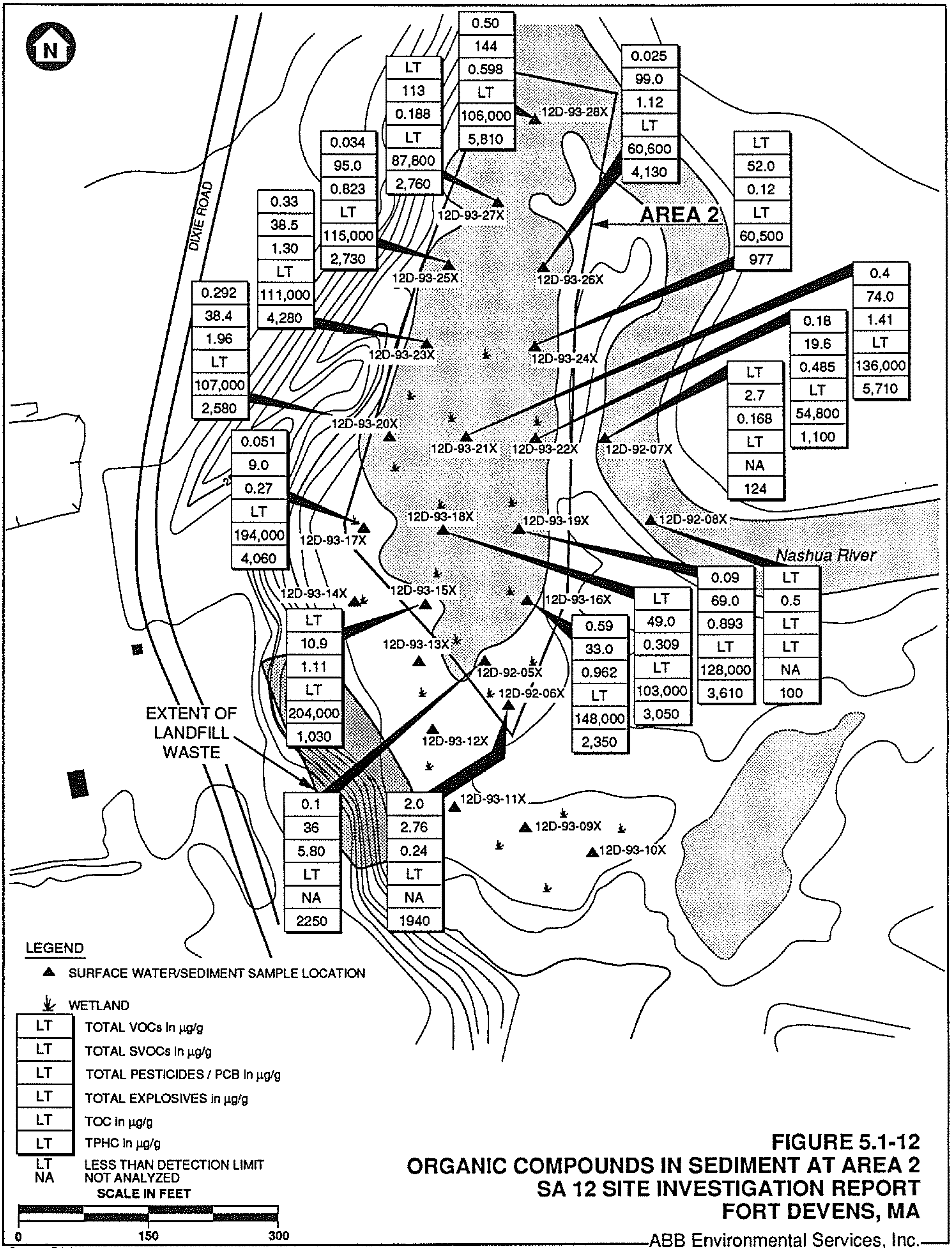
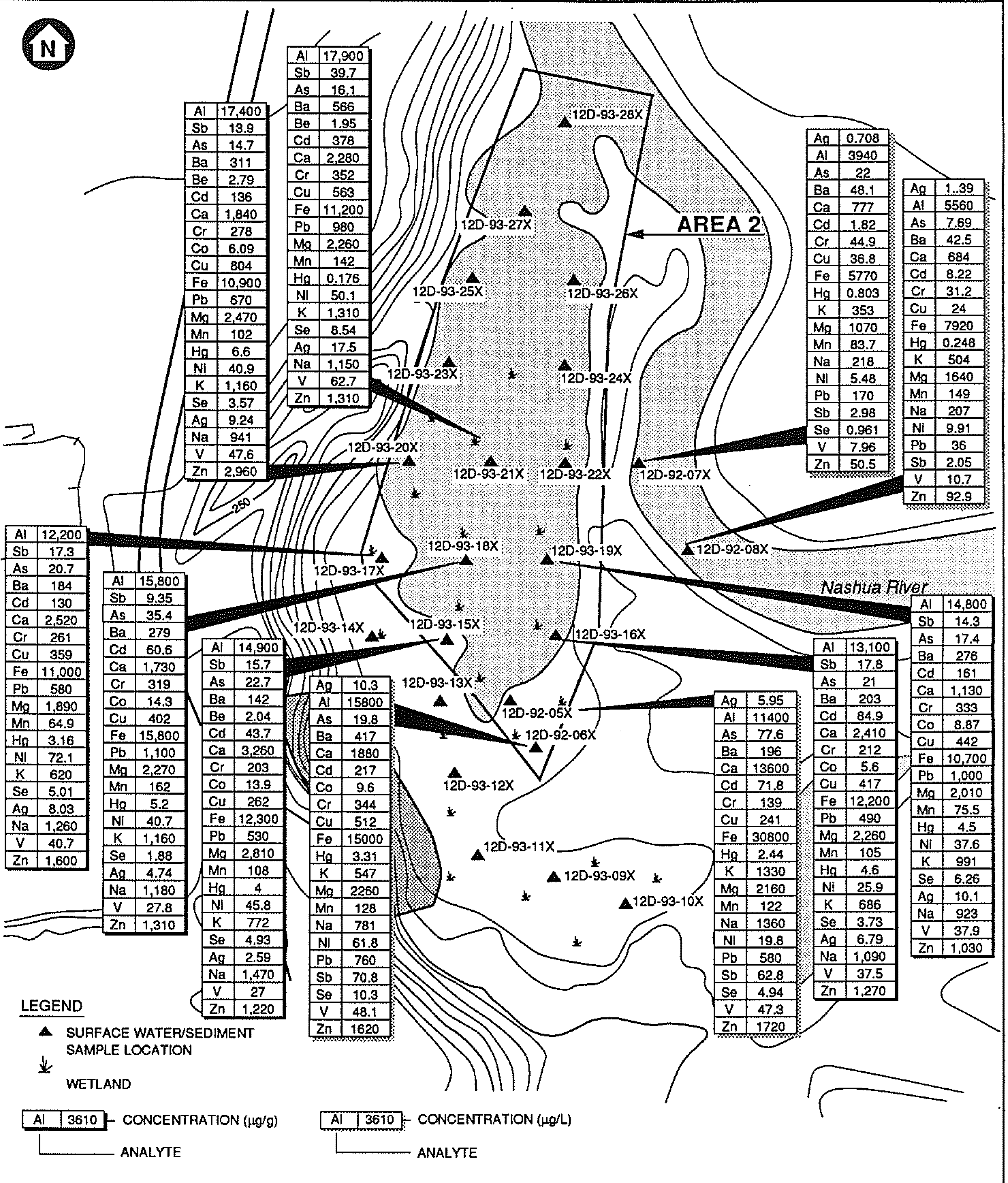


FIGURE 5.1-12
ORGANIC COMPOUNDS IN SEDIMENT AT AREA 2
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(v) 1,7,E,F



Al	17,900
Sb	39.7
As	16.1
Ba	566
Be	1.95
Cd	378
Ca	2,280
Cr	352
Cu	563
Fe	11,200
Pb	980
Mg	2,260
Mn	142
Hg	0.176
Ni	50.1
K	1,310
Se	8.54
Ag	17.5
Na	1,150
V	62.7
Zn	1,310

Al	17,400
Sb	13.9
As	14.7
Ba	311
Be	2.79
Cd	136
Ca	1,840
Cr	278
Co	6.09
Cu	804
Fe	10,900
Pb	670
Mg	2,470
Mn	102
Hg	6.6
Ni	40.9
K	1,160
Se	3.57
Ag	9.24
Na	941
V	47.6
Zn	2,960

Ag	0.708
Al	3940
As	22
Ba	48.1
Ca	777
Cd	1.82
Cr	44.9
Cu	36.8
Fe	5770
Hg	0.803
K	353
Mg	1070
Mn	83.7
Na	218
Ni	5.48
Pb	170
Sb	2.98
Se	0.961
V	7.96
Zn	50.5

Ag	1..39
Al	5560
As	7.69
Ba	42.5
Ca	684
Cd	8.22
Cr	31.2
Cu	24
Fe	7920
Hg	0.248
K	504
Mg	1640
Mn	149
Na	207
Ni	9.91
Pb	36
Sb	2.05
V	10.7
Zn	92.9

Al	12,200
Sb	17.3
As	20.7
Ba	184
Cd	130
Ca	2,520
Cr	261
Cu	359
Fe	11,000
Pb	580
Mg	1,890
Mn	64.9
Hg	3.16
Ni	72.1
K	620
Se	5.01
Ag	8.03
Na	1,260
V	40.7
Zn	1,600

Al	15,800
Sb	9.35
As	35.4
Ba	279
Cd	60.6
Ca	1,730
Cr	319
Co	14.3
Cu	402
Fe	15,800
Pb	1,100
Mg	2,270
Mn	162
Hg	5.2
Ni	40.7
K	1,160
Se	1.88
Ag	4.74
Na	1,180
V	27.8
Zn	1,310

Al	14,900
Sb	15.7
As	22.7
Ba	142
Be	2.04
Cd	43.7
Ca	3,260
Cr	203
Co	13.9
Cu	262
Fe	12,300
Pb	530
Mg	2,810
Mn	108
Hg	4
Ni	45.8
K	772
Se	4.93
Ag	2.59
Na	1,470
V	27
Zn	1,220

Ag	10.3
Al	15800
As	19.8
Ba	417
Ca	1880
Cd	217
Co	9.6
Cr	344
Cu	512
Fe	15000
Hg	3.31
K	547
Mg	2260
Mn	128
Na	781
Ni	61.8
Pb	760
Sb	70.8
Se	10.3
V	48.1
Zn	1620

Ag	5.95
Al	11400
As	77.6
Ba	196
Ca	13600
Cd	71.8
Cr	139
Cu	241
Fe	30800
Hg	2.44
K	1330
Mg	2160
Mn	122
Na	1360
Ni	19.8
Pb	580
Sb	62.8
Se	4.94
V	47.3
Zn	1720

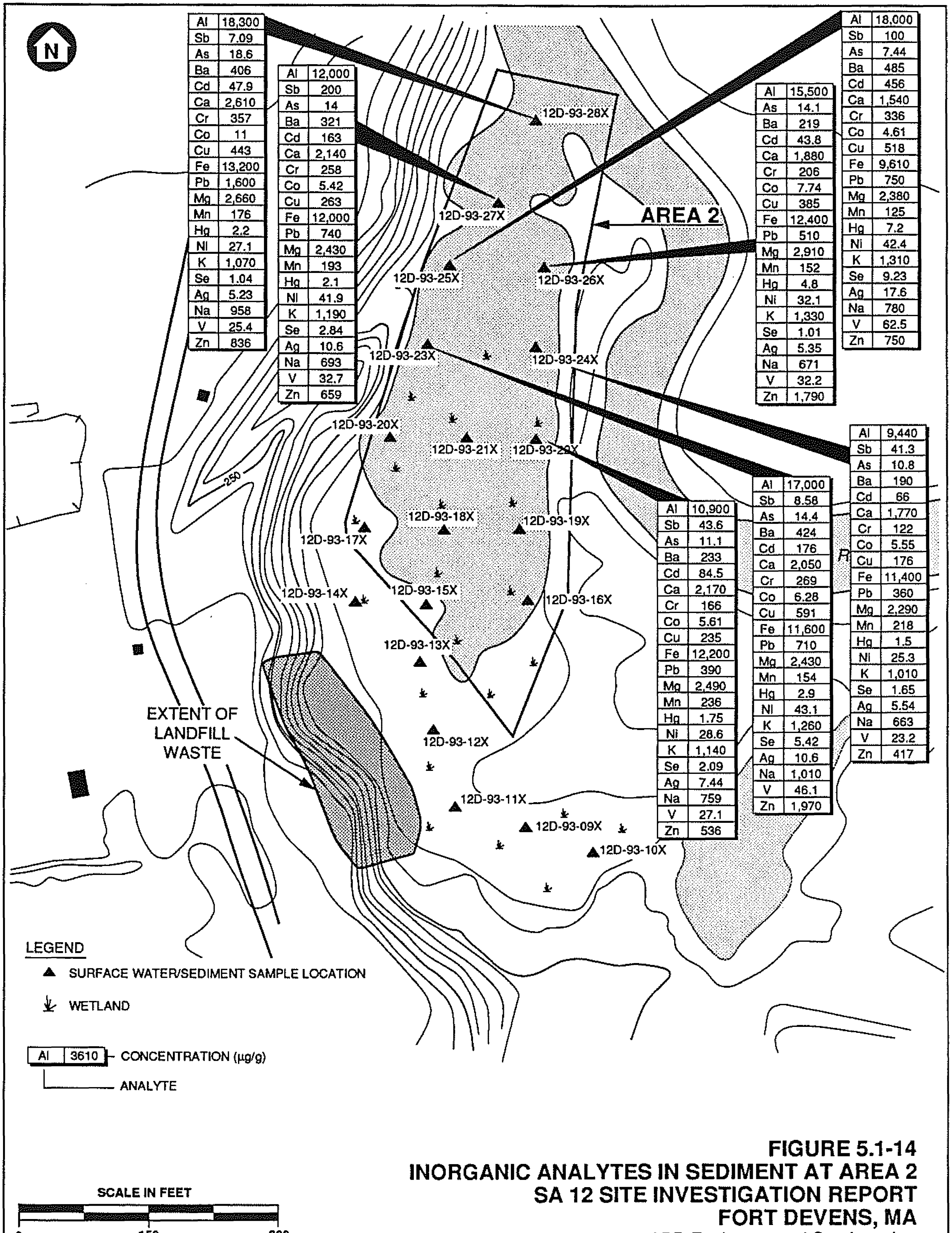
Al	13,100
Sb	17.8
As	21
Ba	203
Cd	84.9
Ca	2,410
Cr	212
Co	5.6
Cu	417
Fe	12,200
Pb	490
Mg	2,260
Mn	105
Hg	4.6
Ni	25.9
K	686
Se	3.73
Ag	6.79
Na	1,090
V	37.5
Zn	1,270

Al	14,800
Sb	14.3
As	17.4
Ba	276
Cd	161
Ca	1,130
Cr	333
Co	8.87
Cu	442
Fe	10,700
Pb	1,000
Mg	2,010
Mn	75.5
Hg	4.5
Ni	37.6
K	991
Se	6.26
Ag	10.1
Na	923
V	37.9
Zn	1,030

FIGURE 5.1-13
INORGANIC ANALYTES IN SEDIMENT AT AREA 2
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(v) 1,B ,E,I



Al	18,300
Sb	7.09
As	18.6
Ba	406
Cd	47.9
Ca	2,610
Cr	357
Co	11
Cu	443
Fe	13,200
Pb	1,600
Mg	2,660
Mn	176
Hg	2.2
Ni	27.1
K	1,070
Se	1.04
Ag	5.23
Na	958
V	25.4
Zn	836

Al	12,000
Sb	200
As	14
Ba	321
Cd	163
Ca	2,140
Cr	258
Co	5.42
Cu	263
Fe	12,000
Pb	740
Mg	2,430
Mn	193
Hg	2.1
Ni	41.9
K	1,190
Se	2.84
Ag	10.6
Na	693
V	32.7
Zn	659

Al	18,000
Sb	100
As	7.44
Ba	485
Cd	456
Ca	1,540
Cr	336
Co	4.61
Cu	518
Fe	9,610
Pb	750
Mg	2,380
Mn	125
Hg	7.2
Ni	42.4
K	1,310
Se	9.23
Ag	17.6
Na	780
V	62.5
Zn	750

Al	15,500
As	14.1
Ba	219
Cd	43.8
Ca	1,880
Cr	206
Co	7.74
Cu	385
Fe	12,400
Pb	510
Mg	2,910
Mn	152
Hg	4.8
Ni	32.1
K	1,330
Se	1.01
Ag	5.35
Na	671
V	32.2
Zn	1,790

Al	9,440
Sb	41.3
As	10.8
Ba	190
Cd	66
Ca	1,770
Cr	122
Co	5.55
Cu	176
Fe	11,400
Pb	360
Mg	2,290
Mn	218
Hg	1.5
Ni	25.3
K	1,010
Se	1.65
Ag	5.54
Na	663
V	23.2
Zn	417

Al	17,000
Sb	8.58
As	14.4
Ba	424
Cd	176
Ca	2,050
Cr	269
Co	6.28
Cu	591
Fe	11,600
Pb	710
Mg	2,430
Mn	154
Hg	2.9
Ni	43.1
K	1,260
Se	5.42
Ag	10.6
Na	1,010
V	46.1
Zn	1,970

Al	10,900
Sb	43.6
As	11.1
Ba	233
Cd	84.5
Ca	2,170
Cr	166
Co	5.61
Cu	235
Fe	12,200
Pb	390
Mg	2,490
Mn	236
Hg	1.75
Ni	28.6
K	1,140
Se	2.09
Ag	7.44
Na	759
V	27.1
Zn	536

FIGURE 5.1-14
INORGANIC ANALYTES IN SEDIMENT AT AREA 2
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA
ABB Environmental Services, Inc.

9509018D(v) 1,C

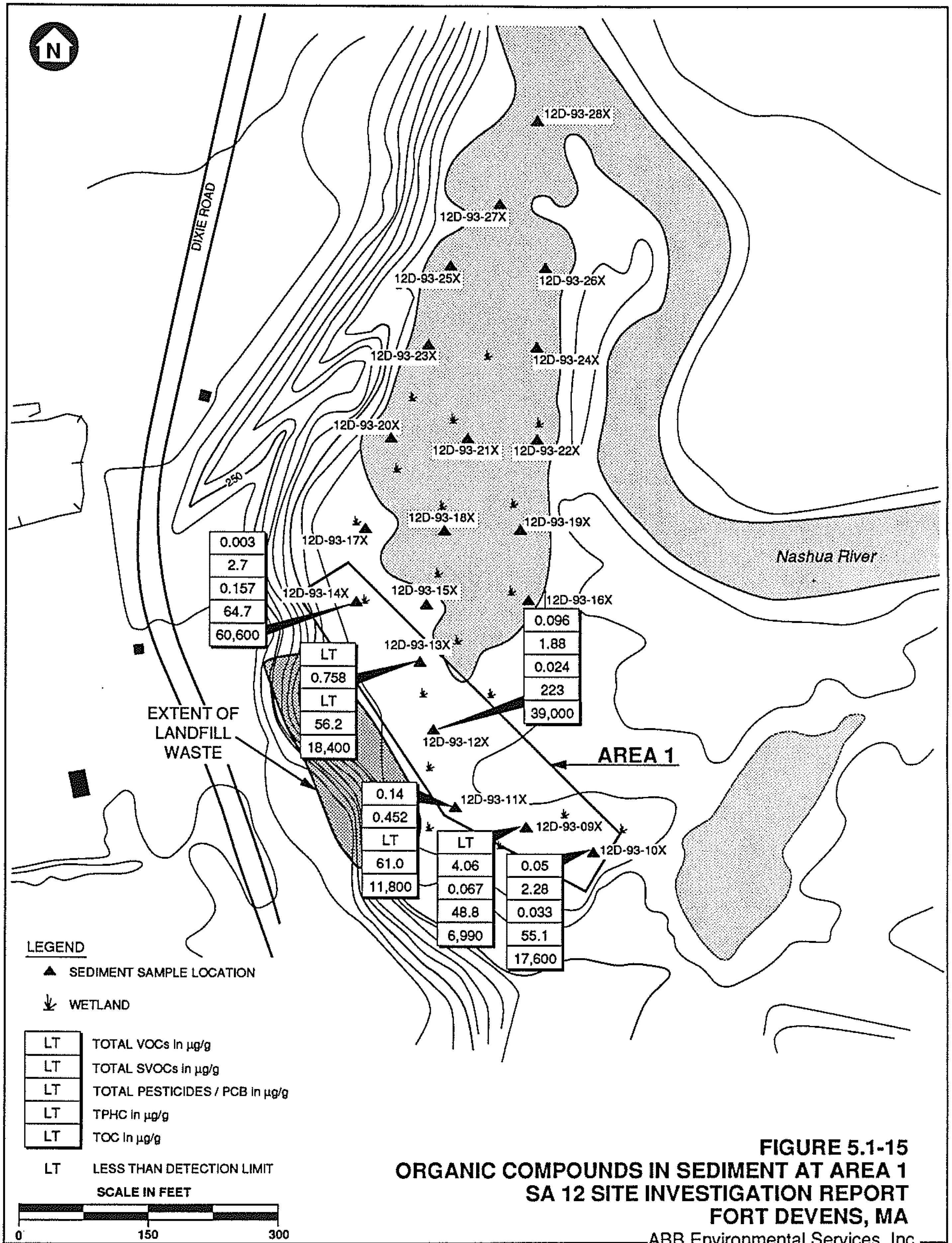
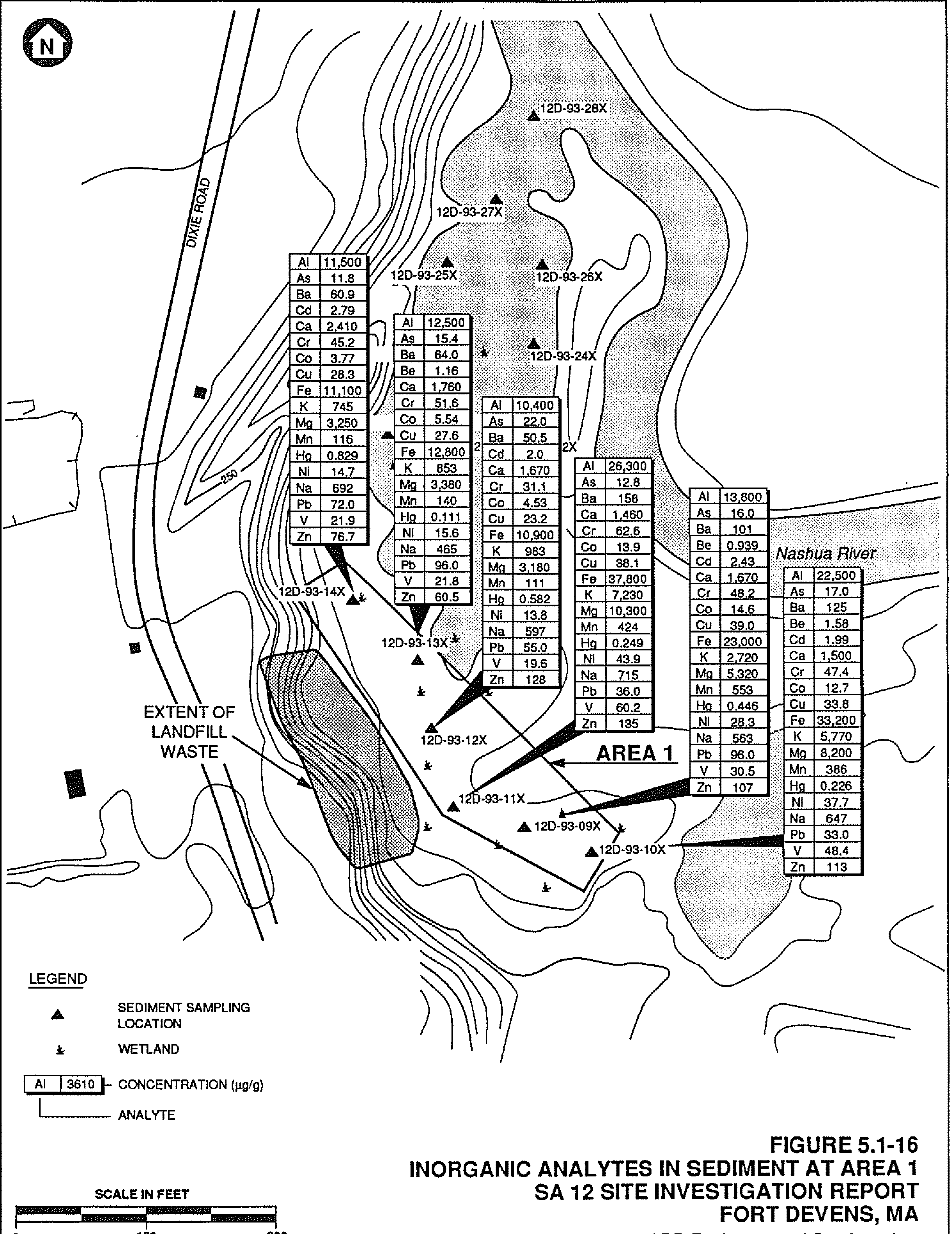


FIGURE 5.1-15
ORGANIC COMPOUNDS IN SEDIMENT AT AREA 1
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(v) 1,0



Al	11,500
As	11.8
Ba	60.9
Cd	2.79
Ca	2,410
Cr	45.2
Co	3.77
Cu	28.3
Fe	11,100
K	745
Mg	3,250
Mn	116
Hg	0.829
Ni	14.7
Na	692
Pb	72.0
V	21.9
Zn	76.7

Al	12,500
As	15.4
Ba	64.0
Be	1.16
Ca	1,760
Cr	51.6
Co	5.54
Cu	27.6
Fe	12,800
K	853
Mg	3,380
Mn	140
Hg	0.111
Ni	15.6
Na	465
Pb	96.0
V	21.8
Zn	60.5

Al	10,400
As	22.0
Ba	50.5
Cd	2.0
Ca	1,670
Cr	31.1
Co	4.53
Cu	23.2
Fe	10,900
K	983
Mg	3,180
Mn	111
Hg	0.582
Ni	13.8
Na	597
Pb	55.0
V	19.6
Zn	128

Al	26,300
As	12.8
Ba	158
Ca	1,460
Cr	62.6
Co	13.9
Cu	38.1
Fe	37,800
K	7,230
Mg	10,300
Mn	424
Hg	0.249
Ni	43.9
Na	715
Pb	36.0
V	60.2
Zn	135

Al	13,800
As	16.0
Ba	101
Be	0.939
Cd	2.43
Ca	1,670
Cr	48.2
Co	14.6
Cu	39.0
Fe	23,000
K	2,720
Mg	5,320
Mn	553
Hg	0.446
Ni	28.3
Na	563
Pb	96.0
V	30.5
Zn	107

Al	22,500
As	17.0
Ba	125
Be	1.58
Cd	1.99
Ca	1,500
Cr	47.4
Co	12.7
Cu	33.8
Fe	33,200
K	5,770
Mg	8,200
Mn	386
Hg	0.226
Ni	37.7
Na	647
Pb	33.0
V	48.4
Zn	113

FIGURE 5.1-16
INORGANIC ANALYTES IN SEDIMENT AT AREA 1
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

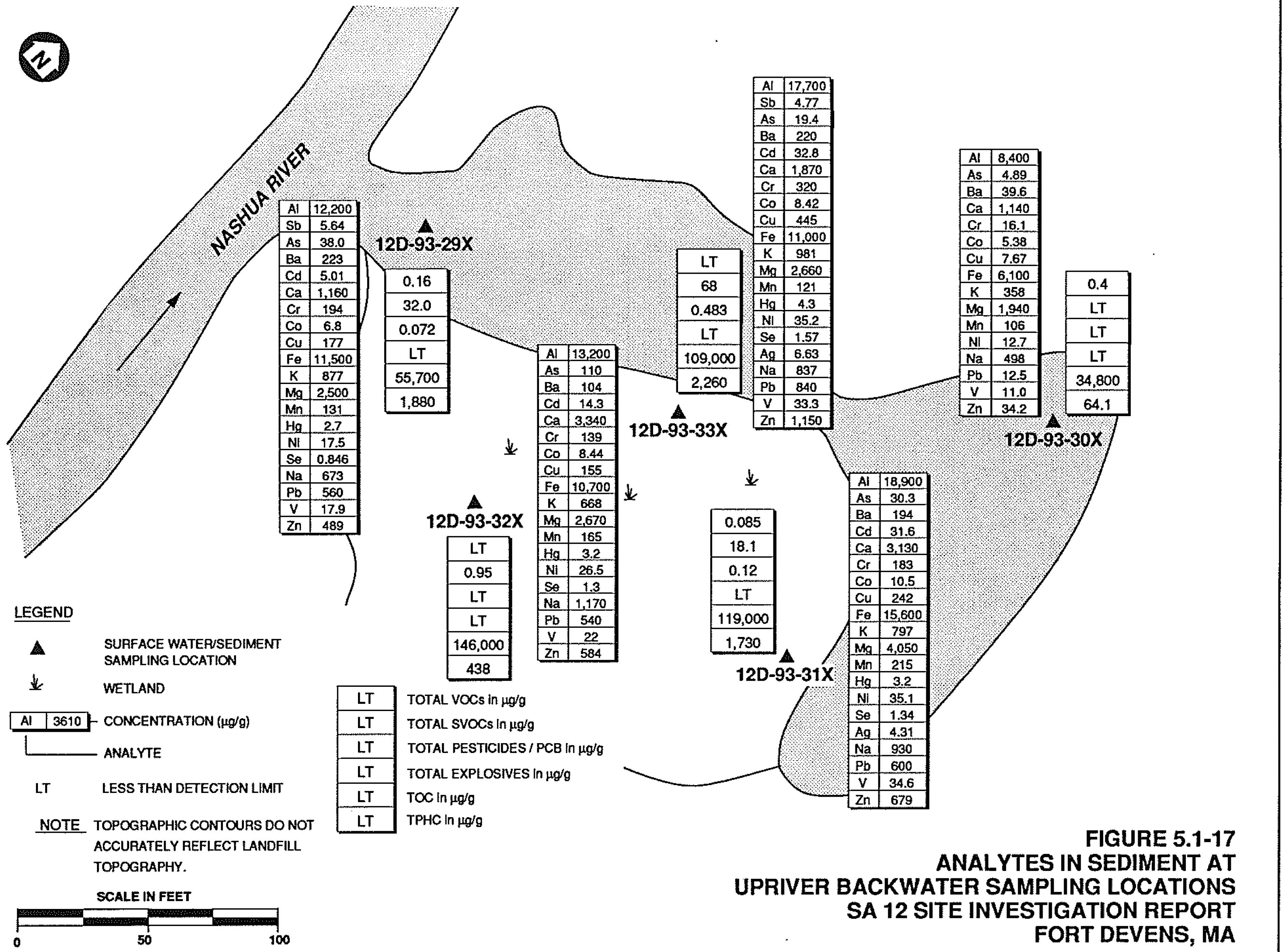
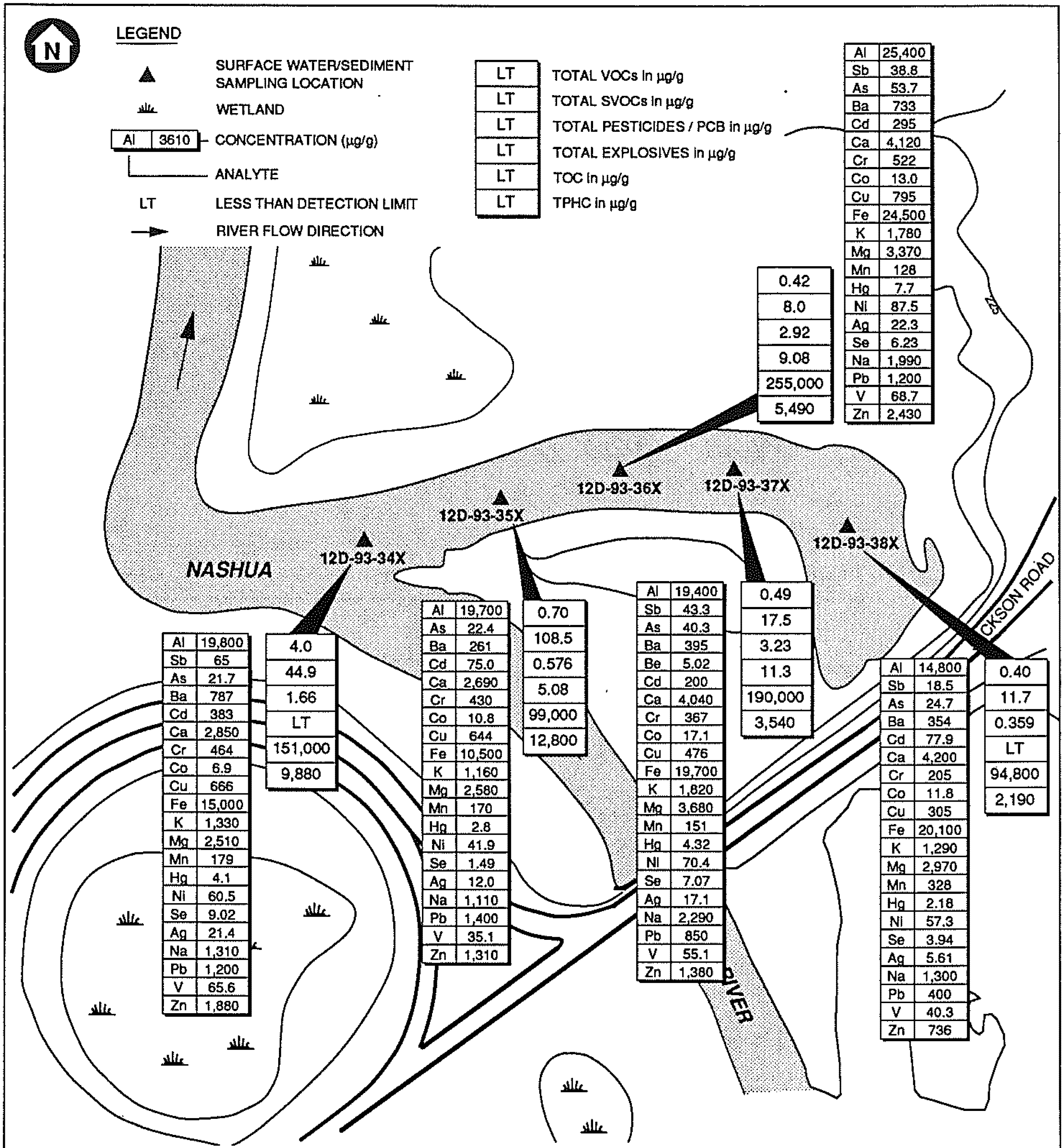


FIGURE 5.1-17
ANALYTES IN SEDIMENT AT
UPRIVER BACKWATER SAMPLING LOCATIONS
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D 1,3



12D-93-34X

Al	19,800
Sb	65
As	21.7
Ba	787
Cd	383
Ca	2,850
Cr	464
Co	6.9
Cu	666
Fe	15,000
K	1,330
Mg	2,510
Mn	179
Hg	4.1
Ni	60.5
Se	9.02
Ag	21.4
Na	1,310
Pb	1,200
V	65.6
Zn	1,880

4.0
44.9
1.66
LT
151,000
9,880

12D-93-35X

Al	19,700
As	22.4
Ba	261
Cd	75.0
Ca	2,690
Cr	430
Co	10.8
Cu	644
Fe	10,500
K	1,160
Mg	2,580
Mn	170
Hg	2.8
Ni	41.9
Se	1.49
Ag	12.0
Na	1,110
Pb	1,400
V	35.1
Zn	1,310

0.70
108.5
0.576
5.08
99,000
12,800

12D-93-36X

0.42
8.0
2.92
9.08
255,000
5,490

Al	25,400
Sb	38.8
As	53.7
Ba	733
Cd	295
Ca	4,120
Cr	522
Co	13.0
Cu	795
Fe	24,500
K	1,780
Mg	3,370
Mn	128
Hg	7.7
Ni	87.5
Ag	22.3
Se	6.23
Na	1,990
Pb	1,200
V	68.7
Zn	2,430

12D-93-37X

Al	19,400
Sb	43.3
As	40.3
Ba	395
Be	5.02
Cd	200
Ca	4,040
Cr	367
Co	17.1
Cu	476
Fe	19,700
K	1,820
Mg	3,680
Mn	151
Hg	4.32
Ni	70.4
Se	7.07
Ag	17.1
Na	2,290
Pb	850
V	55.1
Zn	1,380

0.49
17.5
3.23
11.3
190,000
3,540

12D-93-38X

Al	14,800
Sb	18.5
As	24.7
Ba	354
Cd	77.9
Ca	4,200
Cr	205
Co	11.8
Cu	305
Fe	20,100
K	1,290
Mg	2,970
Mn	328
Hg	2.18
Ni	57.3
Se	3.94
Ag	5.61
Na	1,300
Pb	400
V	40.3
Zn	736

0.40
11.7
0.359
LT
94,800
2,190

FIGURE 5.1-18
ANALYTES IN SEDIMENT AT DOWNRIVER BACKWATER SEDIMENT SAMPLING LOCATIONS
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D 1,2

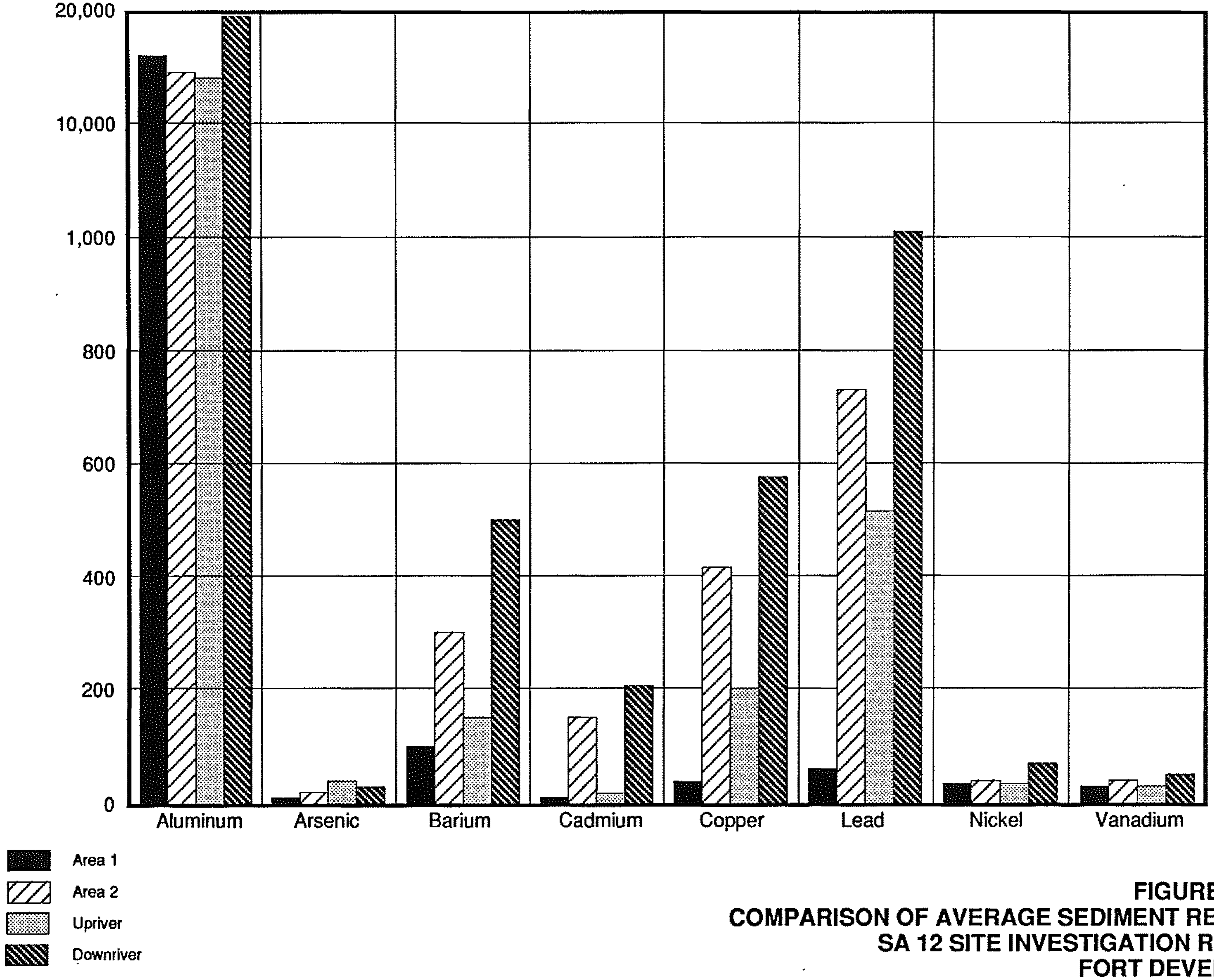


FIGURE 5.1-19
COMPARISON OF AVERAGE SEDIMENT RESULTS
SA 12 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

5.2 SA 14 - LANDFILL NO. 10

5.2.1 Study Area Background and Conditions

SA 14 is not a landfill but an abandoned slate quarry approximately 1-acre in size. The quarry is located on the South Post along an unnamed dirt road south of Attu Road (Figure 5.2-1). The quarry appears to be spring-fed with no inlets or outlets. The quarry had approximately 50 feet to 60 feet of water during the field investigation. This water appears to be an expression of the groundwater in this area. The water appears to remain consistent throughout the year and fluctuate with the regional water table (see Figure 5.2-1).

Automobiles and other debris were illegally dumped in this quarry. Installation personnel stated that, in the past, divers were hired to remove the automobiles and that, during those dives, unexplored ordinance (UXO) was observed on the bottom of the quarry (Poole, 1992). No records are available on the number of automobiles or UXO disposed of at this SA. A rope swing and a diving platform were observed at the quarry, which suggests that people use the quarry for recreational purposes.

5.2.2 Site Investigation Program Summary

The SI at SA 14 was completed in June 1992 and was conducted in accordance with the Final SI Task Order Work Plan (ABB-ES, 1992c), and in conformance with the Project Operations Plan (ABB-ES, 1992d). The field investigation program conducted at SA 14 consisted of the collection of two sediment samples, and a duplicate sample, from the bottom of the quarry and the collection of one surface water sample from just below the surface of the water in the quarry. Table 5.2-1 summarizes the scope of the SI.

The samples were collected to assess whether the historic dumping of automobiles and UXO had generated conditions that may have posed a risk to human or ecological receptors. Before the initiation of any field investigation activities, the bottom of the quarry was cleared by a UXO subcontractor in accordance with the UXO clearance procedures described in the POP, Volume I, Section 4.4.2 Unexploded Ordnance Clearance Survey. The UXO subcontractor first pulled a metal detector over the bottom of the quarry to determine if there were any metallic objects located on the bottom of the quarry. The UXO subcontractor recorded an underwater video of the conditions on the quarry bottom, to aid in mapping the physical features and debris.

Two sediment samples (14D-92-02X and its duplicate, and 14D-92-03X) were collected by a diver employed by the UXO subcontractor after the quarry bottom had been cleared (Figure 5.2-2). The diver used a stainless steel spoon and bucket to collect the sediment samples from the bottom. The sediment sample collected from 14D-92-01X was not submitted for laboratory analysis due to the large percentage of organics (vegetation) and the small percentage of sediment. One surface water sample (14D-92-04X) was collected for laboratory analysis from the northern end of the quarry (see Figure 5.2-2). All sediment samples, to the extent possible, contained at least 30 percent solids. However, due to the thin layer of sediment and large amount of organics, not all samples contained 30 percent solids. The surface water sample (14D-92-04X) was submitted for off-site laboratory analysis of PAL VOCs, SVOCs, inorganics, pesticides/PCBs, TPHC, explosives, and water quality parameters. The sediment samples (14D-92-02X and 14D-92-03X) were submitted for off-site laboratory analysis of PAL VOCs, SVOCs, inorganics, pesticides/PCBs, TPHC, explosives, TOC, and grain size.

5.2.3 Supplemental Site Investigation Program Summary

The SSI at SA 14 was completed in August 1993 and was conducted in accordance with the Final SSI Task Order Work Plan (ABB-ES, 1993b), and in conformance with the Project Operations Plan (ABB-ES, 1992b). The SSI was conducted to assess the water quality at different depths within the quarry pond. Table 5.2-1 summarizes the scope of the SSI.

A bathymetry of the pond was completed prior to sample collection. A temperature and dissolved oxygen profile of the quarry pond water was completed at the same time (Figure 5.2-3).

Three water samples from discrete depths (10, 20, and 45 feet below pond surface) were collected from one sampling location (14D-93-05X) with a Pacs Bomb Sampler (see Figure 5.2-2). The sample collected from 45 feet was chosen because this depth was below the measured thermocline, while the 10- and 20-foot samples were collected above the thermocline. The water samples were analyzed for PAL VOCs, SVOCs, inorganics, pesticides/PCBs, explosives, and water quality parameters.

5.2.4 Field Investigation Results and Observations

The quarry at SA 14 contains water on a year-round basis, and water depths reach approximately 50 feet. The quarry appears to be used as a swimming hole for base personnel. There was no outward evidence of waste disposal on the edges of the quarry.

A diver was sent into the quarry to observe underwater conditions and to collect sediment samples. The sediment cover on the bottom of the quarry was thin and consisted mostly of tree litter (leaves and branches) and bedrock chips. Some wooden timbers (possibly related to quarrying) were observed, and numerous unfired and misfired small caliber rounds were recovered in sediment samples. No car bodies or other significant debris were found.

The South Post is blanketed by unconsolidated surficial deposits of glacial and post-glacial origin. There are few bedrock exposures. SA 14 is an exception in that it is an outcrop area of the Worcester Formation (Silurian-Devonian). The exposed unit of the Worcester Formation generally consists of low grade (below biotite isograd) carbonaceous slate, phyllite, and metagraywacke (Peck, 1975 and 1976; Robinson, 1978). The conditions in the South Post are presented in greater detail in Section 2.0.

The two sediment samples collected from the quarry bottom during the SI, were submitted for grain size analysis. The sand fraction ranged from 59.1 to 75.9 percent, fines ranged from 22.7 to 37.1 percent, and gravel was less than 4 percent. Water contents were 87.9 and 193.0 percent. The grain size results are presented in Appendix J.

The quarry is near the upstream end of Slate Rock Brook, which drains eastward into Slate Rock Pond and eventually to the Nashua River. The quarry itself has no surface inlets or outlets. The diver reported a thermocline at a depth of approximately 30 feet, below which the water temperature was significantly colder than the water above the thermocline. This suggests that there is little circulation or exchange of deep water in the quarry.

The SSI at SA 14 was conducted on August 11, 1993. Temperature and dissolved oxygen measurements were made *in-situ* in the pond at 2-foot depth intervals. The results indicate a distinct thermal layering (Table 5.2-2; Figure 5.2-4). An upper layer warmed by the summer air extended to a depth of 6 feet, with temperatures ranging from 31°C to 18.5°C. From there to a depth of 24 feet the water temperature declined steadily, to 6°C. From 24 feet to the bottom of the pond (at 48 feet deep) the temperature remained between 5° and 6°C. These thermal layers are referred to, respectively, as the epilimnion, thermocline, and hypolimnion.

Dissolved oxygen, measured during the SSI, declined in the upper 10 feet of the water column from 7.9 mg/L to 2.55 mg/L. It continued to decline to the base of the thermocline, to a concentration of 1.1 mg/L. Below the thermocline in the hypolimnion, the concentration of dissolved oxygen in the water remained less than 1 mg/L (see Table 5.2-2).

5.2.5 Nature and Distribution of Contamination (Laboratory Results)

The objective of sampling at SA 14 was to investigate the presence and potential distribution of contamination generated by the illegal dumping of automobiles and UXO in the quarry. The primary concerns in SA 14 were the potential for petroleum hydrocarbon from the automobiles and explosive releases from the UXO, into the surface water and sediment at SA 14.

5.2.5.1 Surface Water. No organic compounds were detected in the one surface water sample collected from the northern end of the quarry during the SI. Mercury (1.07 μg/L) was the only inorganic analyte detected at a notable concentration in the surface water sample collected from SA 14 (Table 5.2-3; Figure 5.2-5).

The SSI surface water samples were collected at depths of 10 feet (near the top of the thermocline), 20 feet (near the bottom of the thermocline), and 45 feet (3 feet above the bottom of the pond, within the hypolimnion). A field duplicate was collected at the 20-foot depth.

No SVOCs, explosives, pesticides, or PCBs were detected in any of the samples.

Total VOC concentrations ranged from 2.8 to 5.55 μg/L in the surface water samples. Methylene chloride was found in all of the samples, ranging from 2.8 to 3.1 μg/L and chloroform was detected in the 45-foot samples at 1.6 μg/L. However, methylene chloride and chloroform are common laboratory contaminants, and they were also detected in the field (sampler) blank and trip blank. They are not considered SA-related (see Table 5.2-3; Figure 5.2-6).

DCA as detected in the 10-foot and 45-foot samples (0.79 μg/L and 0.62 μg/L, respectively), and 1,2-dichloroethene (1,2-DCE) was detected at 0.53 μg/L in the 45-foot sample (see Table 5.2-3). DCA was not detected above the certified reporting limit (CRL) in any of the laboratory blanks. However, DCA was detected at a similar concentration in the sampler blank (SBK-93-686) collected from the Pacs Bomb Sampler used to collect the water samples during the SSI. The detection of DCA in the sampler blank and the fact that a deuterated form of DCA is used as a surrogate in the contract laboratory, indicates that DCA appears to be a laboratory contaminant. The source of the DCE is unknown.

Mercury, detected in the surface water collected during the SI, was not detected in any of the SSI water samples. The only inorganic analytes detected above the calculated Fort Devens groundwater background were manganese at 2,100 μg/L in the 20-foot sample and 2,220 μg/L in the duplicate sample from 20 feet, compared to background of 291 μg/L; and arsenic (22.4 μg/L compared to background of 10.5 μg/L), iron (20,900 μg/L compared to background of 9,100 μg/L), and manganese (1,740 μg/L) in the 45-foot sample (see Table 5.2-3; Figure 5.2-6).

5.2.5.2 Sediment. Two sediment samples were collected from the bottom of the quarry during the SI. Acetone, benzene, chloroform, and xylenes were detected in the sample collected from 14D-92-02X. Acetone and chloroform were detected in the sediment sample collected from 14D-92-03X. Similarly, trace concentrations of di-n-butyl phthalate, n-nitrosodiphenylamine (an explosive by-product), and TPHC were detected in both of the samples (Table 5.2-4; Figure 5.2-7). Acetone, chloroform, and di-n-butylphthalate are considered common laboratory contaminants and should not be considered as site contaminants. Section 3.2.2 discusses these and other suspected laboratory contaminants. 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, heptachlor, alpha-Chlordane, and gamma-Chlordane were all detected in sediments sampled from the quarry bottom. Two explosive compounds, nitroglycerine and 2,4-dinitrotoluene (2,4-DNT), were also detected in both samples (see Table 5.2-4; see Figure 5.2-7).

Both sediment samples contained inorganic analytes including: arsenic, beryllium, cadmium, copper, iron, lead, manganese, nickel, and zinc (see Table 5.2-4; see Figure 5.2-7).

5.2.6 Source Evaluation and Migration Potential

The suite of organic and inorganic analytes detected in sediment samples collected from the bottom of the quarry, during the SI, indicate that these sediments have been impacted by disposal practices.

There is no inlet or outlet to carry sediment in or out of the quarry pond, so the suite of organic and inorganic analytes detected in the sediment is likely from direct dumping of automobiles and other materials into the quarry. Pesticide residues are either from unauthorized dumping or regional spraying.

The absence of explosives and pesticides throughout the water column suggests that there is negligible partitioning of organic contaminants from the sediment into the surface water.

The distribution of DCE in the surface water has no apparent consistency with the physical and chemical conditions observed at SA 14.

Mercury was present at a notable concentration in the surface water sample collected during the SI, but it was undetected in the sediment samples and the below-surface water samples collected during the SSI. This suggests that the single detection represented a local, transient condition, such as leaching from local bedrock. Most of the other inorganic analytes remain at about the same concentrations throughout the water column or increase in concentration with depth.

Hydrologically, this small pond is a surface expression of the local water table. It is likely that water seeps into the pond mostly through bedrock fractures and that it exits the pond, probably southward toward Slate Rock Brook, by the same mechanism. Groundwater from the quarry most likely flows south and discharges into the Slate Rock Brook drainage.

5.2.7 Preliminary Human Health Risk Evaluation

A human health risk evaluation was prepared for SA 14 to determine if the contaminants, detected in surface water and sediment pose a risk to human receptors. Tables 5.2-5 and 5.2-6 present summary statistics and human health standards and guidelines used in the PRE for SA 14.

5.2.7.1 Surface Water and Sediment. No organic contaminants were detected in the one surface water sample collected as part of the Final SI. Inorganic analytes detected were all below the drinking water standards and guidelines used for comparison (Table 5.2-5). Several organic analytes (benzene, xylenes, n-nitrosodiphenylamine, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, heptachlor,alpha-chlordane, gamma-chlordane, nitroglycerine, and 2,4-DNT) were detected in the sediment samples collected from the bottom of the quarry. The concentrations of all detected organic analytes in the sediment were below the USEPA Region III residential soil concentrations. Of the inorganic analytes detected in the sediment, only arsenic and beryllium exceeded the USEPA Region III residential soil concentrations. The USEPA Region III residential soil concentration is designed to be protective for exposures that could occur 350 days per year for a residential lifetime of 30 years. Exposure to sediment in the quarry would be much less than that expected in a residential setting. Furthermore, direct human contact with sediment on the quarry bottom is unlikely. Therefore, the SI Report concluded that the concentrations of arsenic and beryllium detected in sediment associated with SA 14 would not be expected to present a risk to public health (Table 5.2-6).

In 1993, three new SSI surface water samples were collected, one each at 10 feet, 20 feet and 45 feet in depth. Table 5.2-5 presents summary statistics on quarry water and a comparison to drink water standards/guidelines. The organics DCA, chloroform, methylene chloride, and total 1,2-dichloroethylene were detected but no concentrations exceeded drinking water guidelines. Both chloroform and methylene chloride are common laboratory contaminants and are not considered site-related. Concentrations of iron and manganese exceed USEPA secondary MCLs. (Secondary MCLs are set for aesthetic or economic reasons, not health reasons.) The other inorganics detected did not exceed drinking water guidelines. There are no guidelines available for calcium, magnesium, and potassium. The use of drinking water guidelines for comparison to surface water concentrations is a conservative approach and is used due to a lack of available health-based guidelines for exposure to surface water. The magnitude and frequency of exposure to surface water associated with SA 14 would be expected to be much less than that upon which drinking water guidelines are based. Exposure to surface water at the quarry, then, is not likely to pose a threat to public health.

5.2.8 Preliminary Ecological Risk Evaluation

The purpose of the ecological PRE at SA 14 is to provide a screening-level evaluation of actual and potential risks that environmental contaminants may pose to the resident and migratory ecological receptors at the site.

The PRE methodology involves selecting CPCs, and comparing the maximum detected CPC concentrations to media-specific ecological standards and criteria in order to identify contaminants which may contribute risk to ecological receptors inhabiting the SA.

The results for the SI sediment samples reported that the maximum concentrations of the pesticides 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, alpha- and gamma-chlordane, and heptachlor were exceeded by their respective sediment benchmark values. Additionally, the maximum concentrations of the inorganics antimony, cadmium, chromium, copper, iron, manganese, mercury, nickel, zinc, lead and arsenic in the quarry sediments were detected at levels greater than their sediment benchmark values (Table 5.2-7).

The SA 14 slate quarry is situated in a mesic forest dominated by white pine (*Pinus strobus*) and white oak (*Quercus alba*), with a fairly open understory. Plant species observed around the quarry perimeter include speckled alder (*Alnus rugosa*), hemlock (*Tsuga canadensis*), lowbush blueberry (*Vaccinium angustifolium*), partridgeberry (*Mitchella repens*), and various grasses and bryophytes. No aquatic macrophytes or emergent plant species were noted in the quarry, although a greenish hue, perhaps indicative of an algal blume, was observed in the surface water during a December 1993 site inspection.

Because of its depth (approximately 50 feet), and its hard slate bottom, the quarry probably provides little, if any, benthic habitat. Sediments occur as a thin layer, at approximately 50 feet under the water's surface. However, according to Fort Devens personnel (Poole, 1993), portions of the quarry may function as a vernal pool, providing breeding habitat for spotted salamanders (*Ambystoma maculatum*) and wood frogs (*Rana silvatica*). In addition, several fish species are thought to occur in the quarry. Terrestrial and semi-terrestrial wildlife may also periodically visit the quarry to forage and obtain water. The exposed slate around the quarry perimeter may provide cover for snakes, small mammals, and other wildlife. No records exist documenting the current or historical presence of rare and endangered species at or in the vicinity of SA 14.

During the SSI, three water samples were collected from the quarry pond: (1) 14D-93-05X (10-foot depth); (2) 14D-93-05X (20-foot depth), (3) 14D-93-05X (45-foot depth) (see Figure 5.2-2). These were combined with the original surface water sample for a data set consisting of four samples. Four volatile organic compounds (DCA, chloroform, methylene chloride, and 1,2-dichloroethylenes) were detected in SA 14 surface water; 1,2- dichloroethane and methylene chloride are likely laboratory contaminants. Maximum detected concentrations ranged from 0.53 μg/L (1,2-dichloroethylenes) to 3.1 μg/L (methylene chloride). Six inorganics were detected in SA 14 surface water. Iron and manganese were detected in all four samples at maximum concentrations of 20,900 μg/L (iron) and 2,100 μg/L (manganese). Barium was detected in two samples, and arsenic, lead and mercury were each detected in one sample. Maximum detected concentrations ranged from 1.07 μg/L (mercury) to 22.4 μg/L (arsenic). All analytes detected in SA 14 surface water were retained as CPCs (Table 5.2-7).

Risks to aquatic receptors in surface water were evaluated through comparison of maximum surface water CPC concentrations to aquatic benchmark values AWQC.

The concentration of mercury detected in SA 14 surface water (1.07 μg/L) during the SI is well above the chronic AWQC for mercury (0.012 μg/L), but below the acute AWQC (2.4 μg/L) (see Table 5.2-7). This mercury concentration is associated with sample 14D-92-04X; mercury was not detected in any of the samples collected at the three depth intervals. The maximum detected concentration of iron in surface water (20,900 μg/L in sample 14D-93-05X (45-foot depth)) exceeded its benchmark value (1000 μg/L) by a factor of 20. However, iron was detected at concentrations well below its benchmark value in samples collected at the quarry pond surface, 10-feet, and 20-feet below the surface. The maximum detected concentration of lead, which was detected in one sample, exceeded its chronic AWQC by a factor of three. This exceedance was associated with the lead concentration detected in sample 14D-93-05X (10-foot depth).

An uncertainty is associated with use of data from surface water samples analyzed for total, rather than dissolved, analytes. Recent USEPA national guidance recommends that dissolved contaminant data can be used for ecological risk assessments evaluating surface water (USEPA, 1993a). Dissolved contaminant data better represent the bioavailable fraction of analytes present in surface water. Therefore, the use of total contaminant surface water data (rather than the dissolved fraction) may result in an over-estimate of risk associated with surface water exposures by aquatic organisms.

Although the mercury AWQC benchmark was exceeded, there is considerable uncertainty associated with use of this value. The chronic AWQC value (0.012 μg/L) is based on bioconcentration of methylmercury in the fathead minnow, which represents an endpoint designed to limit the concentration of mercury in fish tissue for the protection of humans consuming fish. Furthermore, the AWQC was derived under the assumption that all mercury present is in the methylated (most bioconcentratable) form, and ignores the No Observed Adverse Effects Level (NOAEL) concentration (0.23 μg/L) for toxic effects measured in the same fish species and in other fish species (e.g., brook trout NOAELs reported in the AWQC document ranged from 0.29 to 0.93 μg/L). Additionally, many of the species most sensitive to mercury as reported in the AWQC document are salmonids, which do not exist in SA 14 quarry surface water. Therefore, the mercury AWQC value represents a very conservative screening guideline for the SA 14 quarry surface water.

A DO profile of quarry pond water (measured in August, 1993) indicates that the oxygen content of the water is between 7 and 8 mg/L in the top six feet of water, but drops quickly between surface water depths 6 and 10 feet (Figure 5.2-4). The oxygen content at water depths below 10 feet is between 0.5 mg/L and 2.5 mg/L, which is well below the AWQC for DO of 4 mg/L. Hence, it is unlikely that aquatic organisms inhabit deeper portions of the quarry or would be exposed to analyte concentrations associated with surface water samples collected below a depth of 10 feet. In addition, it is unlikely that ecological receptors would be exposed to the thin sediment layer at the quarry bottom (approximately 50 feet below the water surface) unless the sediment was mixed with the quarry water (e.g., via a seasonal overturn of the quarry water). Because seasonal overturn is largely dependant on wind currents to circulate the water and the quarry water is contained in a deep column with a small (one acre) surface area, it is doubtful that significant wind-driven turnover occurs at the site. Therefore, sediment/surface water mixing with subsequent aquatic receptor exposure appears limited.

Two sediment samples (including one duplicate) were collected from the bottom of the quarry during the SI. Fourteen organic compounds, including six pesticides, were detected and chosen as CPCs. 4,4-DDT was detected in all sediment samples at a maximum concentration of 0.55 μg/g, while 4,4-DDE and 4,4-DDD were detected at maximum concentrations of 0.076 μg/g and 0.21 μg/g, respectively. In addition, seventeen inorganic analytes were detected in quarry sediment samples (all were chosen as CPCs). Arsenic was detected in each sample at a maximum concentration of 100 μg/g. Cadmium was detected at a maximum concentration of 30.3 μg/g, and lead was detected in quarry sediment samples at a maximum concentration of 250 μg/g (Table 5.2-8).

The maximum concentrations of a number of analytes detected in the sediment exceeded the sediment benchmark values. Organic analytes detected at levels in excess of their benchmark values include the following five pesticides: 4,4-DDD, 4,4-DDE, 4,4-DDT, alpha- and gamma-chlordane, heptachlor. The maximum sediment concentration of 4,4-DDT was approximately 11 times its TOC normalized benchmark value, while its metabolites (4,4-DDE and 4,4-DDD) were detected at maximum concentrations approximately 1.5 and 4 times, respectively, greater than their benchmark values. Concentrations of the alpha and gamma chlordane isomers, as well as heptachlor, were at least an order of magnitude greater than TOC-normalized benchmark values (see Table 5.2-8).

The maximum concentrations of the inorganics antimony, cadmium, chromium, copper, iron, manganese, mercury, nickel, zinc, lead and arsenic in the quarry sediments were detected at levels greater than their benchmark values. Antimony was detected at a maximum concentration of 8.1 μg/g, approximately 4 times its benchmark value. Arsenic was detected at a maximum concentration of 100 μg/g, 20 times its benchmark value. Copper was detected at a maximum concentration of 211 μg/g, approximately 11 times its benchmark value, while cadmium concentrations were more than 35 times the sediment quality guidelines. Lead was present in quarry sediments at a maximum concentration of 250 μg/g, approximately nine times greater than its benchmark value, and mercury was detected at 0.55 μg/g which is approximately four to five times its sediment benchmark value.

Based on these data, it appears that adverse effects to ecological receptors from exposure to contaminants in quarry surface water and sediment are unlikely.

5.2.9 Conclusions and Recommendations

Based on the results of the field investigations and the human health and ecological PREs, NFA is recommended for SA 14.

TABLE 5.2-1
SUMMARY OF TECHNICAL APPROACH
SA 14 - LANDFILL NO. 10

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ACTIVITY	PURPOSE	SITE IDENTIFICATION	RATIONALE FOR SELECTED LOCATIONS
SI PROGRAM			
SURFACE WATER AND SEDIMENT SAMPLING	* COLLECT SAMPLES FOR OFF-SITE LABORATORY ANALYSIS * DETERMINE PHYSICAL	14D-92-01X 14D-92-02X 14D-92-03X	* BOTTOM OF QUARRY
		14D-92-04X	* SURFACE WATER
SSI PROGRAM			
SURFACE WATER SAMPLING	* COLLECT SAMPLES FOR OFF-SITE LABORATORY ANALYSIS * DEFINE PHYSICAL CHARACTERISTICS OF WATER IN THE QUARRY	14D-93-05X	* SURFACE WATER QUALITY NEAR TOP OF THE THERMOCLINE (DEPTH 10 FEET)
		14D-93-05X	* SURFACE WATER QUALITY NEAR BOTTOM OF THE THERMOCLINE (DEPTH 20 FEET)
		14D-93-05X	* SURFACE WATER QUALITY NEAR BOTTOM OF THE QUARRY (DEPTH 45 FEET)

TABLE 5.2–2
TEMPERATURE AND DISSOLVED OXYGEN IN QUARRY POND
SA 14 – LANDFILL NO. 10

SITE INVESTIGATION REPORT
FORT DEVENS, MA

DEPTH BELOW POND SURFACE (Feet)	WATER TEMPERATURE (Deg. C)	DISSOLVED OXYGEN IN WATER (mg/L)	THERMAL STRATIFICATION
0	31	7.9	EPILIMNION
2	19	7.9	
4	18.9	7.6	
6	19	7.3	
8	17.5	5	THERMOCLINE
10	15	2.55	
12	13	2.59	
14	11	2	
16	9.5	1.85	
18	8	1.7	
20	7	2.2	
22	6.5	1.1	
24	6	0.85	HYPOLIMNION
26	6	0.75	
28	5.5	0.7	
30	6	0.65	
32	6	0.6	
34	5.5	0.55	
36	5.5	0.55	
38	5	0.6	
40	5	0.7	
42	5.5	0.6	
44	6	0.55	
46	6	0.55	
48	6	0.6	

TABLE 5.2-3
ANALYTES IN SURFACE WATER
SA 14 - LANDFILL NO. 10

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	SSI				SI
	14D-93-05X	14D-93-05X	14D-93-05X	14D-93-05X	14D-92-04X
ORGANICS (ug/L)	**10 FT**	**20 FT**	**DUP 20 FT**	**45 FT**	
1,2-DICHLOROETHANE	0.79	< 0.5	< 0.5	0.62	< 0.5
1,2-DICHLOROETHENES	< 0.5	< 0.5	< 0.5	0.53	< 0.5
CHLOROFORM	< 0.5	< 0.5	< 0.5	1.6	< 0.5
METHYLENE CHLORIDE	3.1	2.9	2.8	2.8	< 2.3
INORGANICS (ug/L)					
ARSENIC	< 2.54	< 2.54	< 2.54	22.4	< 2.54
BARIUM	< 5	7.21	7.71	15.4	< 5
CALCIUM	4230	4470	4660	5770	3150
IRON	96.7	319	331	20900	94.8
LEAD	1.41	< 1.26	< 1.26	< 1.26	< 1.26
MAGNESIUM	654	676	672	813	576
MANGANESE	327	2100	2220	1740	40.4
MERCURY	< 0.243	< 0.243	< 0.243	< 0.243	1.07
POTASSIUM	1180	922	1060	1180	1570
SODIUM	1810	1730	1650	1890	1550
OTHER (ug/L)					
ALKALINITY	18000	19000	25000	26000	13000
NITRITE, NITRATE-NON SPECIFIC	< 10	< 10	< 10	< 10	10.1
NITROGEN BY KJELDAHL METHOD	< 183	381	343	1620	305
TOTAL HARDNESS	14000	16000	17600	18000	9600
TOTAL SUSPENDED SOLIDS	< 4	4	< 4	33	< 4000
PHOSPHATE	< 13.3	28.8	26.9	36.3	< 13.3

Notes:

< = Less than detection limit.

TABLE 5.2-4
ANALYTES IN SEDIMENT
SA 14 - LANDFILL NO. 10

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	14D-92-02X	14D-92-02X DUP	14D-92-03X
INORGANICS (ug/g)			
ALUMINUM	14300.0	16400.0	15000.0
ANTIMONY	< 1.1	< 1.1	8.1
ARSENIC	75.0	100.0	44.0
BARIUM	62.9	75.7	51.2
BERYLLIUM	2.34	2.68	1.75
CADMIUM	30.3	8.29	3.83
CALCIUM	1020.0	969.0	1140.0
CHROMIUM	20.0	28.1	22.1
COBALT	81.5	60.8	49.2
COPPER	204.0	211.0	136.0
IRON	30000.0	33000.0	33300.0
LEAD	200.0	250.0	220.0
MAGNESIUM	2310.0	2880.0	3430.0
MANGANESE	437.0	465.0	522.0
MERCURY	0.55	0.507	0.239
NICKEL	48.1	52.7	43.8
POTASSIUM	450.0	750.0	543.0
SELENIUM	< 0.2	1.12	< 0.2
SODIUM	395.0	506.0	414.0
VANADIUM	18.5	19.6	15.2
ZINC	481.0	475.0	324.0
ORGANICS (ug/g)			
ACETONE	0.16	1.0	0.25
BENZENE	0.011	< 0.008	< 0.002
CHLOROFORM	< 0.004	< 0.004	0.005
XYLENES	0.023	< 0.008	< 0.008
DI-N-BUTYL PHTHALATE	< 0.06	2.0	1.0
N-NITROSODIPHENYLAMINE	< 1.0	< 1.0	5.0
ALPHA-CHLORDANE	0.028 S	0.039 S	< 0.005
GAMMA-CHLORDANE	0.033 S	0.031 S	< 0.005
HEPTACHLOR	0.061	0.064	0.044
4,4'-DDD	0.21	0.13	0.12
4,4'-DDE	0.076	0.063	0.053
4,4'-DDT	< 0.007	0.025	0.55
EXPLOSIVES (ug/g)			
2,4-DINITROTOLUENE	< 0.42	0.894	3.39
NITROGLYCERINE	22.3	26.0	65.5
OTHER ug/g			
TOTAL ORGANIC CARBON	56700.0	59400.0	64000.0
TOTAL PETROLEUM HYDROCARBONS	231.0	248.0	323.0

NOTES:
Table lists detected analyses only - see project analyte list for summary.
< = Less than detection limit shown.
S = Results based on internal standard.
DUP = Duplicate Sample.

TABLE 5.2-5
HUMAN HEALTH PRE EVALUATION OF SURFACE WATER
SA 14 - LANDFILL NO. 10

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a] AVERAGE (ug/L)	DETECTED CONCENTRATION [a] MAXIMUM (ug/L)	DRINKING WATER STANDARD/GUIDELINE [b] (ug/L)	MAXIMUM EXCEEDS DRINKING WATER STANDARD/GUIDELINE ?
ORGANICS					
1,2-DICHLOROETHANE	2/4	0.705	0.79	5	NO
CHLOROFORM	1/4	1.6	1.6	5	NO
METHYLENE CHLORIDE	3/4	2.933	3.1	5	NO
1,2-DICHLOROETHENES (CIS AND TRANS ISOMERS)	1/4	0.53	0.53	70	NO
INORGANICS					
ARSENIC	1/4	22.4	22.4	50	NO
BARIUM	2/4	11.305	15.4	2000	NO
CALCIUM	4/4	4405	5770	NA	-
IRON	4/4	5352.625	20900	300	YES
LEAD	1/4	1.41	1.41	15	NO
MAGNESIUM	4/4	679.75	813	NA	-
MANGANESE	4/4	1051.85	2100	50	YES
MERCURY	1/4	1.07	1.07	2	NO
POTASSIUM	4/4	1213	1570	NA	-
SODIUM	4/4	1745	1890	28000	NO
ANIONS/CATIONS					
NITRITE/NITRATE - NONSPECIFIC	1/4	10.1	10.1	1000	NO

Notes:

[a] Surface water from sampling locations 14D-92-04X and 14D-93-05X (at 3 depths).

[b] Includes the lowest of either the EPA or MA drinking water standards, or if no federal or state standard or guideline is available, the Region III tap water concentration.

NA = not available.

ug/L = micrograms per Liter.

- = not applicable.

MCP = Massachusetts Contingency Plan.

Shaded compounds exceed standard or guideline.

TABLE 5.2-6
HUMAN HEALTH PRE EVALUATION OF SEDIMENT
SA 14 - LANDFILL NO. 10

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a] AVERAGE (ug/g)	DETECTED CONCENTRATION [a] MAXIMUM (ug/g)	REGION III RESIDENTIAL SOIL CONCENTRATION (ug/g)	MCP S-1 (ug/g)	MAXIMUM EXCEEDS GUIDELINES ?
ORGANICS						
2,4-DINITROTOLUENE	2/3	2.1	3.39	160	0.7	NO
4,4'-DDD	3/3	0.2	0.21	2.7	2	NO
4,4'-DDE	3/3	0.1	0.076	1.9	2	NO
4,4'-DDT	2/3	0.3	0.55	1.9	2	NO
ACETONE	3/3	0.5	1	7800	3	NO
ALPHA-CHLORDANE	2/3	0.03	0.039	0.49	1	NO
BENZENE	1/3	0.011	0.011	22	10	NO
CHLOROFORM	1/3	0.005	0.005	100	0.1	NO
DI-N-BUTYL PHTHALATE	2/3	1.5	2	7800	NA	NO
GAMMA-CHLORDANE	2/3	0.03	0.033	0.49	1	NO
HEPTACHLOR	3/3	0.06	0.064	0.14	0.1	NO
NITROGLYCERINE	3/3	37.9	65.5	-	NA	-
N-NITROSODIPHENYLAMINE	1/3	5	5	130	NA	NO
XYLENES	1/3	0.023	0.023	160000	500	NO
INORGANICS						
ALUMINUM	3/3	15233.3	16400	230000	NA	NO
ANTIMONY	1/3	8.1	8.1	31	10	NO
ARSENIC	3/3	73	100	0.36	30	YES
BARIUM	3/3	63.3	75.7	5500	NA	NO
BERYLLIUM	1/3	2.3	2.68	0.15	0.4	YES
CADMIUM	3/3	14.1	30.3	39	30	MCP
CALCIUM	3/3	1043	1140	NA	NA	-
CHROMIUM	3/3	23.4	28.1	390	200	NO
COBALT	3/3	63.8	81.5	NA	NA	-
COPPER	3/3	183.7	211	2900	NA	NO
IRON	3/3	32100	33300	NA	NA	-
LEAD	3/3	223.3	250	500	300	NO

TABLE 5.2-6
HUMAN HEALTH PRE EVALUATION OF SEDIMENT
SA 14 - LANDFILL NO. 10

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a] AVERAGE (ug/g)	DETECTED CONCENTRATION [a] MAXIMUM (ug/g)	REGION III RESIDENTIAL SOIL CONCENTRATION (ug/g)	MCP S-1 (ug/g)	MAXIMUM EXCEEDS GUIDELINES ?
MAGNESIUM	3/3	2873.3	3430	NA	NA	-
MANGANESE	3/3	474.7	522	390	NA	YES
MERCURY	3/3	0.4	0.55	23	10	NO
NICKEL	3/3	48.2	52.7	1600	300	NO
POTASSIUM	3/3	581.0	750	NA	NA	-
SELENIUM	1/3	1.12	1.12	390	300	NO
SODIUM	3/3	438.3	506	NA	NA	-
VANADIUM	3/3	17.8	19.6	550	NA	NO
ZINC	3/3	426.7	481	23000	2500	NO
OTHER						
TOTAL PETROLEUM HYDROCARBON	3/3	267.3	323	NA	500	NO

Notes:

[a] Sediment samples from sampling stations 14D-92-02X and 14D-92-03X (including one duplicate)

NA = not available

ug/g = micrograms per gram

- = not applicable

Shaded compounds exceed standard or guideline.

TABLE 5.2−7
ECOLOGICAL PRE EVALUATION OF SURFACE WATER
SA 14 − LANDFILL NO. 10

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	CONCENTRATION [a] AVERAGE (ug/L)	CONCENTRATION [a] MAXIMUM (ug/L)	FREQUENCY OF DETECTION	ECOLOGICAL BENCHMARK (ug/L)	MAXIMUM EXCEEDS BENCHMARK?
ORGANICS					
1,2−DICHLOROETHANE	0.705	0.79	2/4	20,000	NO
CHLOROFORM	1.6	1.6	1/4	1240	NO
METHYLENE CHLORIDE	2.93	3.1	3/4	NA	NA
1,2−DICHLOROETHENES (CIS AND TRANS)	0.53	0.53	1/4	1160	NO
INORGANICS					
ARSENIC	22.4	22.4	1/4	190	NO
BARIUM	11.3	15.4	2/4	NA	NA
IRON	5353	20900	4/4	1000	YES
LEAD	1.41	1.41	1/4	0.54[b]	YES
MANGANESE	1052	2100	4/4	NA	NA
MERCURY	1.07	1.07	1/4	0.012	YES
OTHER					
TOTAL SUSPENDED SOLIDS	18.5	33	2/4	−−−	−−−
TOTAL HARDNESS	14400	18000	4/4	−−−	−−−

Notes:

[a] Surface water sample from sampling station 14D−92−04X and 14D−93−05X (10, 20, and 45 foot depths).

[b] Hardness−dependent criterion; 25 mg/l $CaCO_3$ used because site−specific hardness value (14.4 mg/l) is below the hardness range (25 to 200 mg/l) for which the hardness function is valid (Federal Register, 1992). See Section 3.6.2 (ABB−ES, 1993) for methodology used to calculate site−specific hardness−dependent benchmark values.

ug/L = micrograms per liter.

−−− = Analyte not a CPC for this medium.

NA = Not available.

TABLE 5.2-8
ECOLOGICAL PRE EVALUATION OF SEDIMENT
SA 14 – LANDFIL NO. 10

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	CONCENTRATION [a]		FREQUENCY OF DETECTION	ECOLOGICAL BENCHMARK (ug/g)	MAXIMUM EXCEEDS BENCHMARK
	AVERAGE (ug/g)	MAXIMUM (ug/g)			
ORGANICS					
2,4-DINITROTOLUENE	2.1	3.39	2/3	NA	NA
4,4'-DDD	0.153	0.21	3/3	0.0497[b]	YES
4,4'-DDE	0.064	0.076	3/3	0.0497[b]	YES
4,4'-DDT	0.288	0.55	2/3	0.0497[b]	YES
ACETONE	0.5	1	3/3	NA	NA
ALPHA-CHLORDANE	0.03	0.039	2/3	0.00036[b]	YES
BENZENE	0.011	0.011	1/3	NA	NA
CHLOROFORM	0.005	0.005	1/3	NA	NA
DI-N-BUTYL PHTHALATE	1.5	2	2/3	NA	NA
GAMMA-CHLORDANE	0.03	0.033	2/3	0.00036[b]	YES
HEPTACHLOR	0.06	0.064	3/3	0.0066[b]	YES
NITROGLYCERINE	37.9	65.5	3/3	NA	NA
N-NITROSODIPHENYLAMINE	5	5	1/3	NA	NA
XYLENES	0.023	0.023	1/3	NA	NA
INORGANICS					
ALUMINUM	15233.3	16400	3/3	NA	NA
ANTIMONY	8.1	8.1	1/3	2	YES
ARSENIC	73	100	3/3	5	YES
BARIUM	63.3	75.7	3/3	NA	NA
BERYLLIUM	2.3	2.68	3/3	NA	NA
CADMIUM	14.1	30.3	3/3	0.8	YES
CHROMIUM	23.4	28.1	3/3	26	YES
COBALT	63.8	81.5	3/3	NA	NA
COPPER	183.7	211	3/3	19	YES
IRON	32100	33300	3/3	24000	YES
LEAD	223.3	250	3/3	27	YES
MANGANESE	474.7	522	3/3	428	YES
MERCURY	0.4	0.55	3/3	0.11	YES
NICKEL	48.2	52.7	3/3	22	YES
SELENIUM	1.12	1.12	1/3	NA	NA
VANADIUM	17.8	19.6	3/3	NA	NA
ZINC	426.7	481	3/3	85	YES
OTHER					
TOTAL ORGANIC CARBON	60033.3	64000	3/3	---	---

Notes:

[a] Sediment samples from sampling stations 14D-92-02X, 14D-92-02X (dup), and 14D-92-03X.
[b] Benchmark is carbon-normalized using site-specific total organic carbon data (see Section 3.6.2).
NA = not available.
ug/g = micrograms per gram.
--- = Analyte not a CPC for this medium.

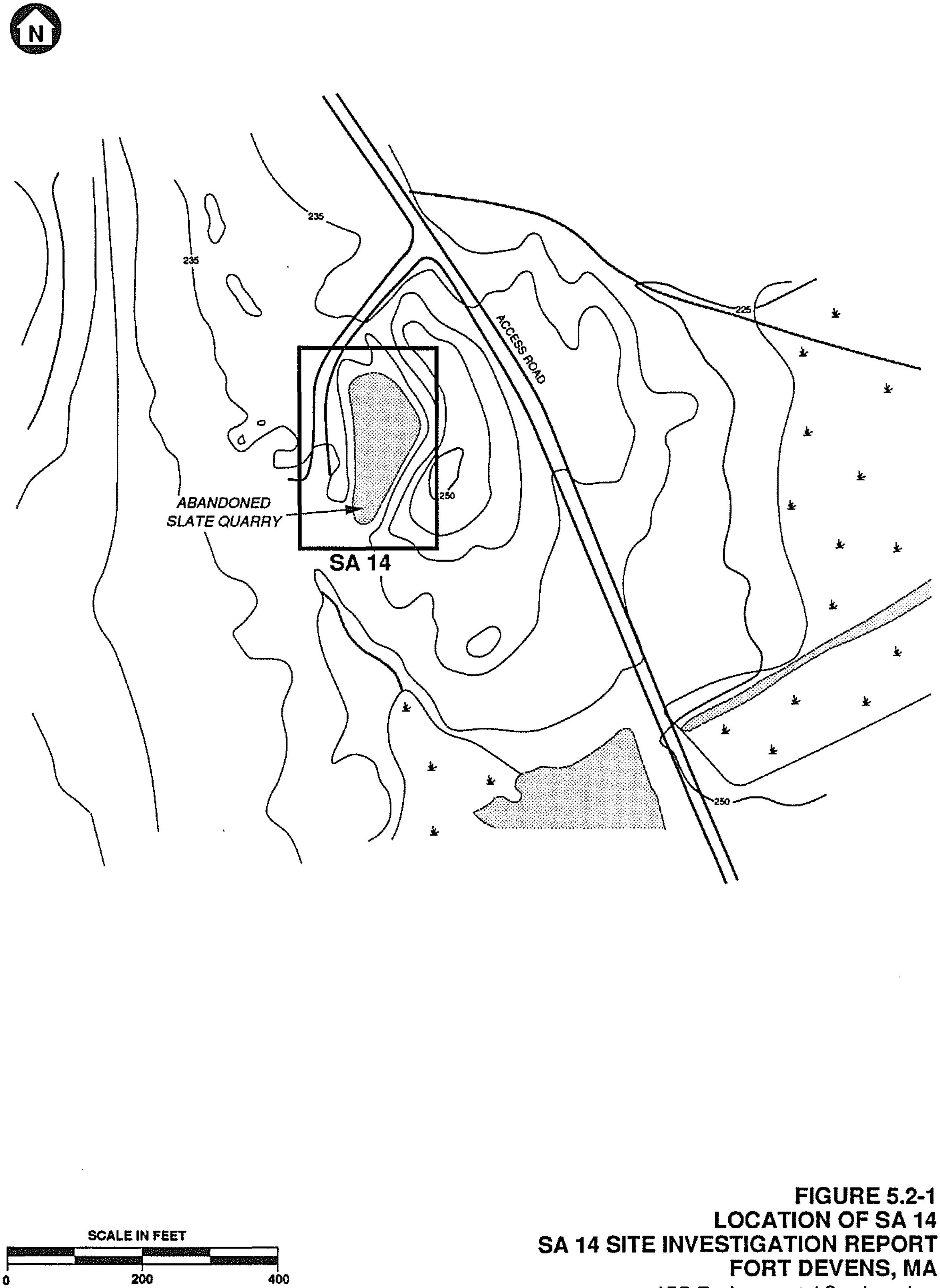


FIGURE 5.2-1
LOCATION OF SA 14
SA 14 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

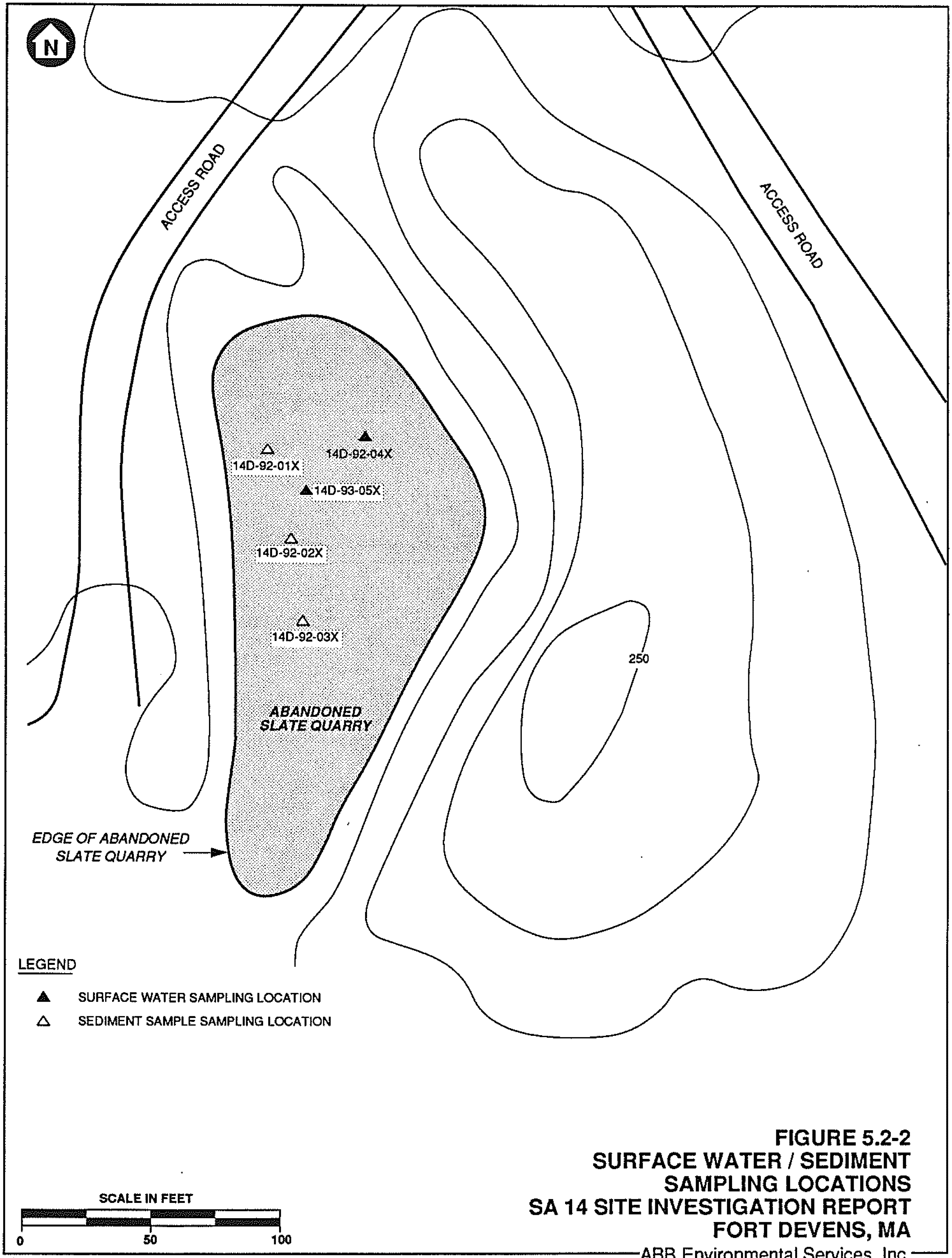
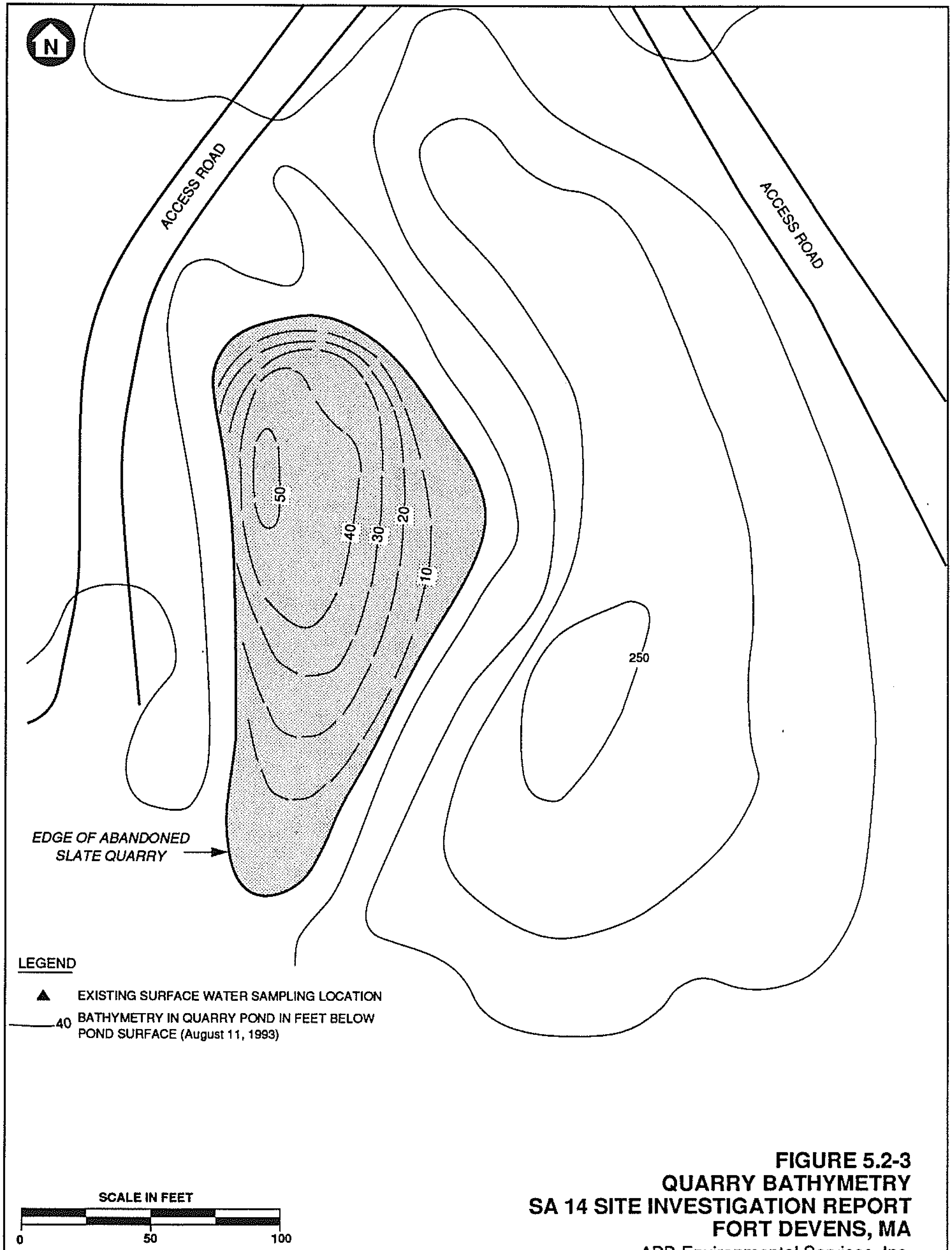


FIGURE 5.2-2
SURFACE WATER / SEDIMENT SAMPLING LOCATIONS
SA 14 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(x1) 1 5 C



LEGEND

▲ EXISTING SURFACE WATER SAMPLING LOCATION

—40 BATHYMETRY IN QUARRY POND IN FEET BELOW POND SURFACE (August 11, 1993)

FIGURE 5.2-3
QUARRY BATHYMETRY
SA 14 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(x1) A

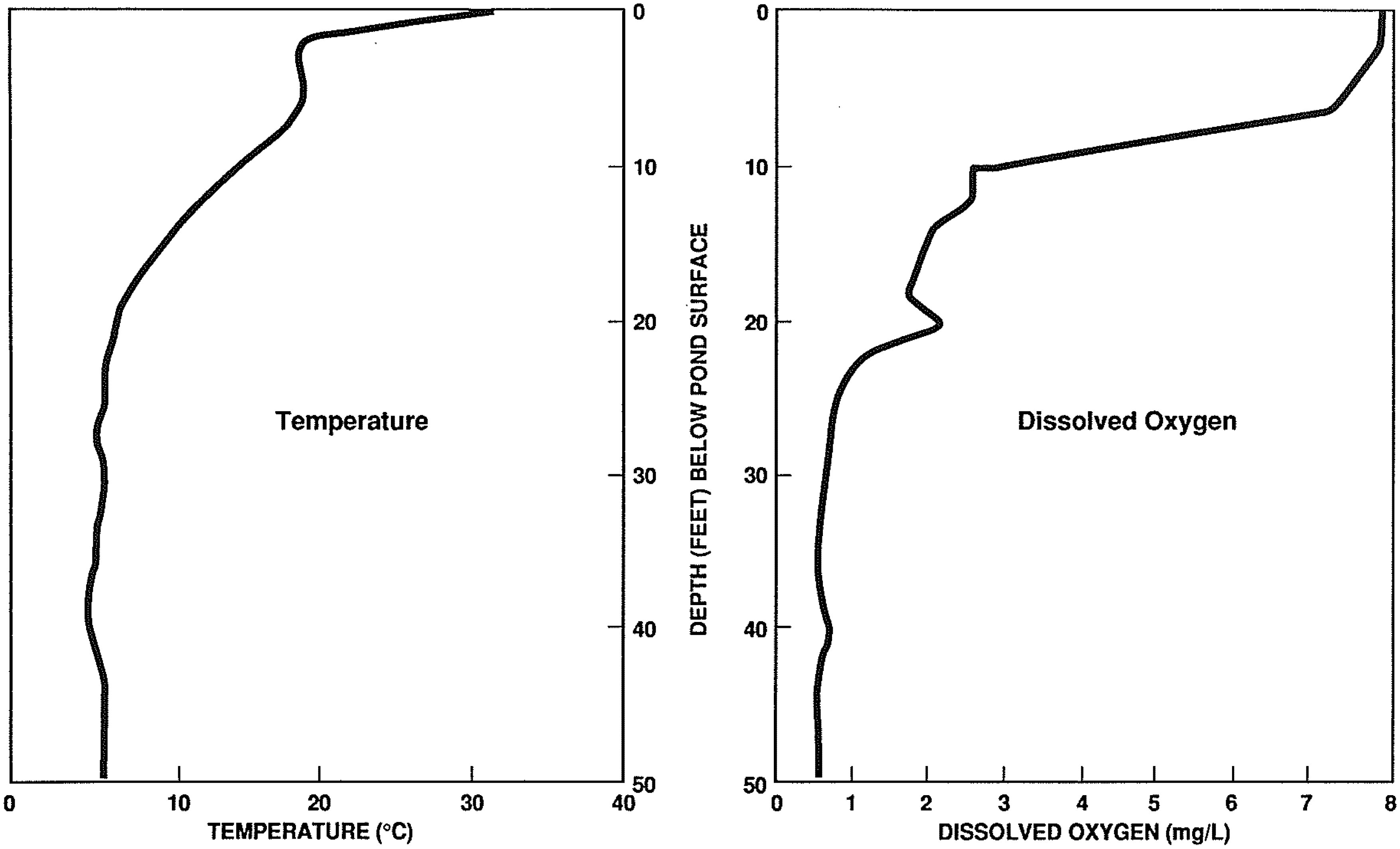


FIGURE 5.2-4
TEMPERATURE AND DISSOLVED OXYGEN IN
QUARRY POND, AUGUST 1993
SA 14 SITE INVESTIGATION REPORT
FORT DEVENS, MA

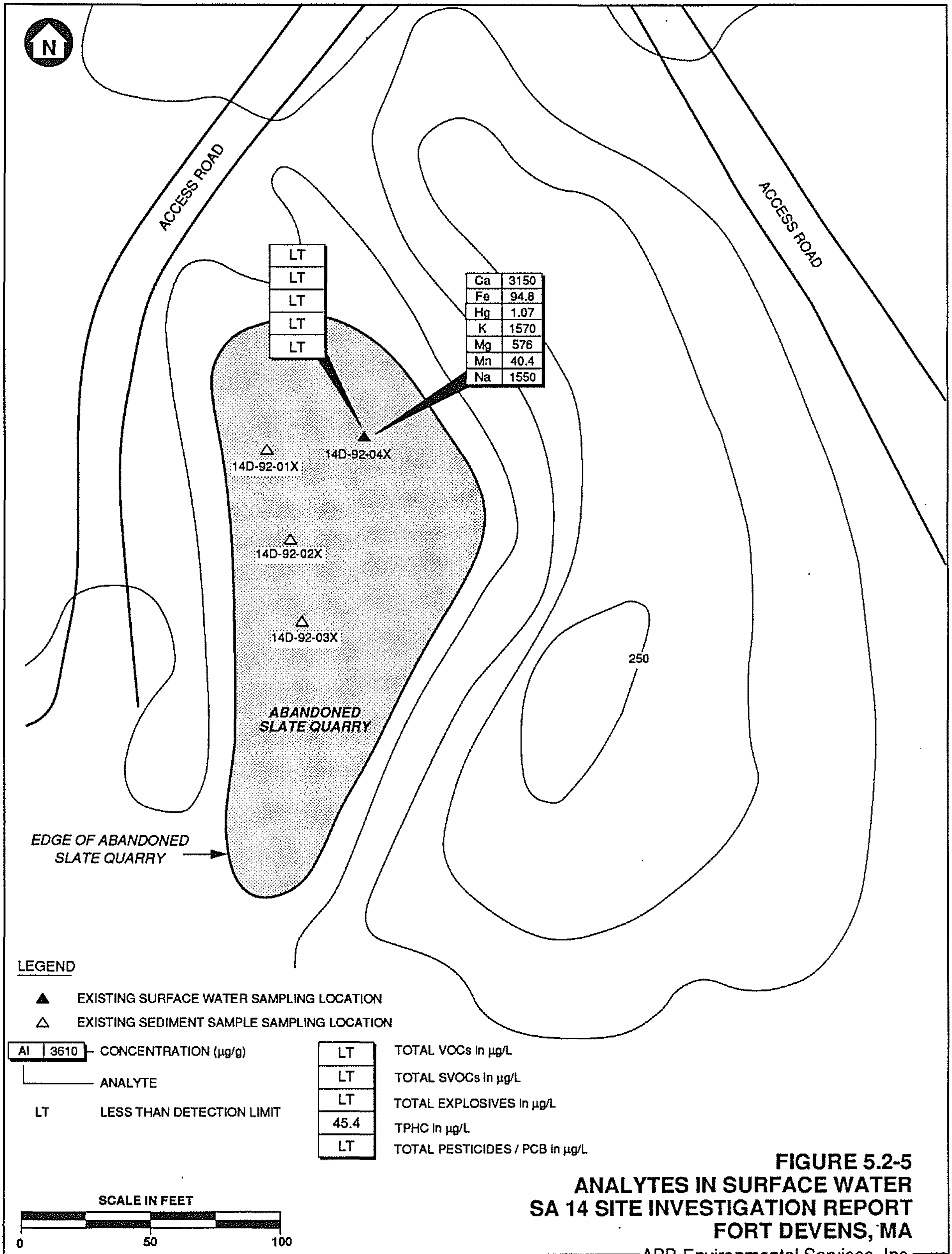
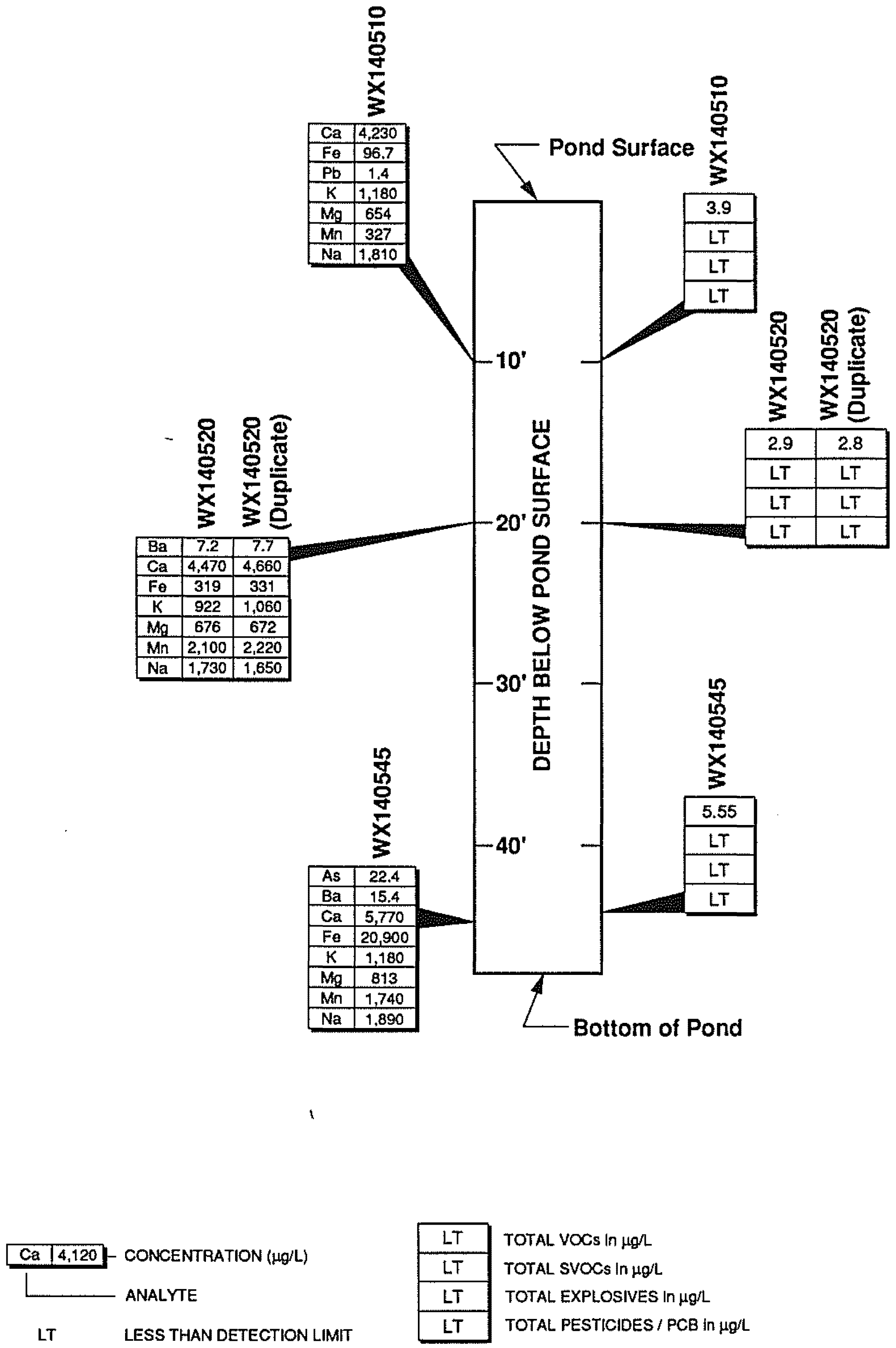


FIGURE 5.2-5
ANALYTES IN SURFACE WATER
SA 14 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(x1) 1 3 5



	WX140510
Ca	4,230
Fe	96.7
Pb	1.4
K	1,180
Mg	654
Mn	327
Na	1,810

WX140510
3.9
LT
LT
LT

	WX140520	WX140520 (Duplicate)
Ba	7.2	7.7
Ca	4,470	4,660
Fe	319	331
K	922	1,060
Mg	676	672
Mn	2,100	2,220
Na	1,730	1,650

WX140520	WX140520 (Duplicate)
2.9	2.8
LT	LT
LT	LT
LT	LT

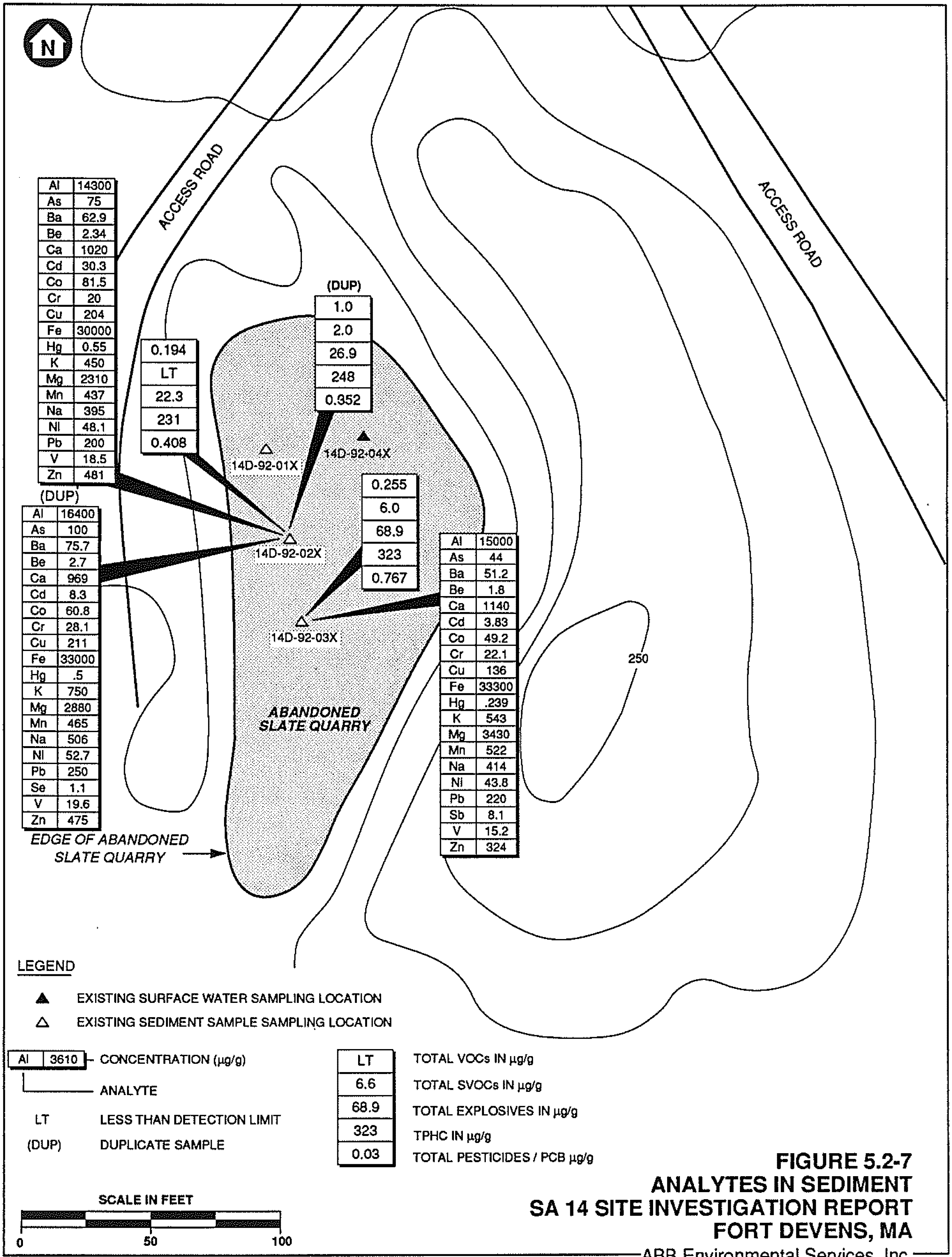
	WX140545
As	22.4
Ba	15.4
Ca	5,770
Fe	20,900
K	1,180
Mg	813
Mn	1,740
Na	1,890

WX140545
5.55
LT
LT
LT

Ca | 4,120 – CONCENTRATION (µg/L)
ANALYTE
LT LESS THAN DETECTION LIMIT

LT	TOTAL VOCs in µg/L
LT	TOTAL SVOCs in µg/L
LT	TOTAL EXPLOSIVES in µg/L
LT	TOTAL PESTICIDES / PCB in µg/L

FIGURE 5.2-6
ANALYTES IN SURFACE WATER
SA 14 SITE INVESTIGATION REPORT
FORT DEVENS, MA



Al	14300
As	75
Ba	62.9
Be	2.34
Ca	1020
Cd	30.3
Co	81.5
Cr	20
Cu	204
Fe	30000
Hg	0.55
K	450
Mg	2310
Mn	437
Na	395
Ni	48.1
Pb	200
V	18.5
Zn	481

(DUP)

Al	16400
As	100
Ba	75.7
Be	2.7
Ca	969
Cd	8.3
Co	60.8
Cr	28.1
Cu	211
Fe	33000
Hg	.5
K	750
Mg	2880
Mn	465
Na	506
Ni	52.7
Pb	250
Se	1.1
V	19.6
Zn	475

0.194
LT
22.3
231
0.408

(DUP)

1.0
2.0
26.9
248
0.352

0.255
6.0
68.9
323
0.767

Al	15000
As	44
Ba	51.2
Be	1.8
Ca	1140
Cd	3.83
Co	49.2
Cr	22.1
Cu	136
Fe	33300
Hg	.239
K	543
Mg	3430
Mn	522
Na	414
Ni	43.8
Pb	220
Sb	8.1
V	15.2
Zn	324

LEGEND

▲ EXISTING SURFACE WATER SAMPLING LOCATION

△ EXISTING SEDIMENT SAMPLE SAMPLING LOCATION

Al	3610	CONCENTRATION (µg/g)

ANALYTE

LT LESS THAN DETECTION LIMIT

(DUP) DUPLICATE SAMPLE

LT	TOTAL VOCs IN µg/g
6.6	TOTAL SVOCs IN µg/g
68.9	TOTAL EXPLOSIVES IN µg/g
323	TPHC IN µg/g
0.03	TOTAL PESTICIDES / PCB µg/g

FIGURE 5.2-7
ANALYTES IN SEDIMENT
SA 14 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(x1) 12 5

5.3 SA 27 - WASTE EXPLOSIVES DETONATION RANGE

5.3.1 Study Area Background and Conditions

SA 27 consists of the Hotel Range which is approximately 7 acres in size and is located south of Old Turnpike Road, on the northwestern edge of the South Post impact area, and west of Cranberry Pond (Figure 5.3-1). The range is currently used as a training range for firing several types of rifle grenades, machine guns, and red phosphorus tracer rounds. Before 1979, this range was used for explosive ordnance disposal of old or defective high-explosive grenades and 3.5-millimeter rocket projectiles. The ordnance were destroyed by burning or detonation. Small arms rounds, smoke grenades, and pyrotechnics were covered, soaked with diesel fuel, and burned in open pits. Larger explosive items were placed in pits, covered with tamped earth, and detonated with C-4 or trinitrotoluene (TNT) (Fox, 1988). Review of aerial photographs of the Hotel Range indicated the presence of four pits that were potentially used to burn UXO (Detrick, 1991). The area has been regraded and the former burn pits are not visible. The range is now used as a small arms firing range with several remote operated targets (see Figure 5.3-1).

5.3.2 Site Investigation Program Summary

The field sampling program at SA 27 consisted of drilling soil borings to collect subsurface soil samples for laboratory analysis, installation of groundwater monitoring wells, groundwater sampling, and the collection of surface water and sediment samples from Cranberry Pond. The results of these samples were used to assess whether the historic use of SA 27 had generated conditions that might pose a risk to human health or the environment. The installation and sampling of groundwater monitoring wells is the most effective means of establishing whether any historical waste releases occurred since the specific locations of the burn pits are unknown. Soil samples were collected from each boring in the event that the overburden has been contaminated by UXO disposal. A surficial UXO clearance survey was conducted to provide access for a drill rig and downhole clearance was performed every 4 feet in each boring to determine the presence or absence of buried UXO. These surveys were performed in accordance with the UXO clearance procedures described in the POP, Volume I, Section 4.4.2 Unexploded Ordnance Clearance Survey.

Four soil borings (27M-92-01X through 27M-92-04X) were drilled to the water table and subsurface soil samples were collected for laboratory analysis. Soil samples were collected using a 2-inch OD split spoon at 5-foot intervals from 27M-92-01X through 27M-92-04X, while soil samples from 27M-92-02X were collected continuously. The four borings were drilled at locations surrounding the SA (see Figure 5.3-1). Each of the soil samples were analyzed for PAL organics and inorganics, PAL explosives, and TPHC. The soil sample collected from below the water table was also analyzed for TOC and grain size.

All of the soil borings were drilled with 6¼-inch ID hollow-stem augers (HSAs) to allow for the installation of a 4-inch ID PVC monitoring well. The monitoring wells were screened across the water table to monitor for floating and dissolved contaminants and allow for seasonal groundwater fluctuation (see Figure 5.3-1). Aquifer hydraulic conductivities were evaluated by performing two rising-head tests per monitoring well after development and the first round of groundwater sampling.

Two rounds of groundwater samples were collected from the four newly installed monitoring wells. The first round was collected in September 1992 and the second round was collected in January 1993. The inorganic samples collected from Round One were unfiltered. During Round Two groundwater sampling, the inorganic samples from 27M-92-03X, was collected as both filtered and unfiltered. The three remaining inorganic groundwater samples were collected as unfiltered samples. The groundwater samples from both rounds were submitted for laboratory analysis of PAL organics and inorganics, TPHC, PAL anions and cations, and PAL explosives. Round Two samples were also analyzed for TSS.

Three surface water and sediment sample pairs (27D-92-01X through 27D-92-03X) were collected from Cranberry Pond to assess whether the pond has been adversely impacted by groundwater discharge from SA 27. This rationale was chosen prior to the installation of the monitoring wells and the subsequent determination of the apparent groundwater flow direction. The surface water and sediment sample pair at 27D-92-01X was collected from the northern end of the western side of Cranberry Pond; the pair at 27D-92-02X was collected at the midpoint of the western bank of the pond; and the pair at 27D-92-03X was collected from the southern end of the western side of the pond (see Figure 5.3-1). The surface water samples were submitted for laboratory analysis of PAL organics and inorganics, TPHC, pesticides/PCBs, PAL explosives, and

PAL water quality parameters. The sediment samples will be submitted for analysis of PAL organics and inorganics, TPHC, pesticides/PCBs, PAL explosives, TOC, and grain size.

5.3.3 Field Investigation Results and Observations

SA 27 is located in the Shirley Quadrangle. Although the surficial geology of the Shirley Quadrangle has not been mapped, conditions reported in the Clinton Quadrangle (Koteff, 1966) can be projected northward to SA 27. Hotel Range occupies an amphitheater-like landform formed by kame-and-kettle deposition during the Ayer Stage of glacial Lake Nashua. Cranberry Pond is in a large kettle located to the east and separated from the range by a high outwash ridge.

The soil encountered in the soil boring for monitoring well 27M-92-01X, consisted of silty clay/clayey silt from the ground surface to approximately 16 feet bgs. Grain size testing of a sample from 14 to 16 feet bgs showed that clay and silt comprise 95.3 percent of the soil. These are characteristics of lake-bottom sediments. Well sorted sand and gravel were encountered beneath the silty clay and to the bottom of the boring at 22 feet bgs.

The soils encountered in the other three soil borings at SA 27 generally consisted of sands and silty sands with gravel and cobbles. Grain size analysis of samples from these borings ranges from 55.5 to 64.0 percent sand, 12.9 to 15.9 percent silts and clays, and 20.1 to 31.6 percent gravel. Water contents ranged from 10.2 to 11.1 percent. Soil boring logs are provided in Appendix B, and grain size results are provided in Appendix J.

Four monitoring wells (27M-92-01X through 27M-92-04X) were installed at SA 27. Well completion details are provided in Appendix C.

An installation-wide water-level survey of 139 monitoring wells and 15 surface water stations was conducted on December 22, 1992. Included in the survey were the four monitoring wells at SA 27 and a nearby surface water measurement at Cranberry Pond (station SWEL-15). These locations are shown in Figure 5.3-1. Appendix A summarizes the synoptic water level data collected during this round and the previous round is provided in Appendix I.

Water levels and inferred flow directions are shown in Figure 5.3-2. Contrary to the interpretation of Biang et al. (1991), groundwater from the range does not appear to flow toward or discharge into Cranberry Pond. Cranberry Pond is more likely a local recharge area. Water levels in the pond are on the order of 4 feet higher than groundwater at the range, and groundwater flow is inferred to be generally northwestward from the pond to the range and eventually to Slate Rock Pond north of the SA. It is likely that this pattern is local and that regional groundwater flow is generally eastward.

The horizontal hydraulic gradient between Cranberry Pond and the near (east) side of the range is approximately 0.01 feet per foot (ft/ft). Within the range, gradients are on the order of 0.003 ft/ft.

Aquifer hydraulic conductivities of the overburden soils at the water table were determined in the four SA 27 water table wells, conductivities range from 1×10^{-4} cm/sec in 27M-92-02X to 7×10^{-3} cm/sec in 27M-92-03X. The results of the hydraulic conductivity tests are provided in Appendix A.

The geometric means of the hydraulic gradients and conductivities are, respectively, 0.0055 ft/ft and 1.20×10^{-3}. Assuming that these are representative of average conditions at the SA 27, and assuming an aquifer effective porosity of 0.30, the average rate of groundwater flow at the water table would be approximately 23 ft/yr. Actual flow rates are controlled by variations in gradients, conductivities, and porosities along specific flow paths.

The major surface water body in the region is Slate Rock Pond, the Nashua River, and Cranberry Pond. It appears that the groundwater is recharged, locally, by the water in Cranberry Pond and the groundwater appears to eventually discharge into Slate Rock Pond and/or the Nashua River.

Groundwater in the surficial aquifer at the facility has been assigned to Class I under Commonwealth of Massachusetts regulations. Class I consists of groundwaters that are "found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated as a source of potable water supply" (314 CMR 6.03).

5.3.4 Nature and Distribution of Contamination (Laboratory Results)

The objective of the sampling program at SA 27 was to investigate for the presence of environmental contamination generated by both historical waste explosives detonation and the current training range. If contamination was found, the objective was to assess the vertical and horizontal distribution of the contamination, assess contaminant migration, and to recommend further actions. A principal concern at SA 27 was that the former waste explosive detonation burn pits may have impacted the soil and groundwater quality at the SA, and effected the surface water and sediment quality in Cranberry Pond.

5.3.4.1 Subsurface Soil. Three soil samples were collected from each of the four soil borings advanced at SA 27 with at least one sample collected at the surface and another collected from below the water table. Trace concentrations of toluene were detected in the soils at 6 feet bgs in 27M-92-02X and at 0 feet and 4 feet in 27M-92-03X. Other organic compounds detected included tetrachloroethylene, trichlorofluoromethane, phthalates, and TPHC. The highest concentrations of these organic compounds were detected in boring 27M-92-03X. Several inorganic analytes were also detected above their established Fort Devens background concentration in the soil samples collected from SA 27. Analytes detected above background concentrations were more numerous in surface samples, with beryllium, copper, nickel, sodium, and zinc detected in nearly all samples. The most numerous and highest concentrations of analytes were detected in boring 27M-92-01X (Tables 5.3-1 and 5.3-2; Figures 5.3-3, 5.3-4, and 5.3-5). No distinct distribution of inorganic concentrations was observed with depth.

5.3.4.2 Groundwater. Two rounds of groundwater samples were collected from the four newly-installed monitoring wells. The only organic compounds detected in either round of groundwater sampling were explosives. Explosive compounds included cyclotetramethylenetetranitramine (HMX) in 27M-92-01X and cyclonite (RDX) in 27M-92-01X, 27M-92-02X, and 27M-92-04X from the Round One groundwater sampling. No explosive compounds were detected in 27M-92-03X during Round One. The results of Round Two sampling indicated that RDX was present in all four wells while HMX was only detected in 27M-92-01X and 27M-92-02X.

Inorganic analyte concentrations were above the established Fort Devens background groundwater concentrations for nearly all analytes in each well based upon Round One results. These samples were unfiltered. High aluminum concentration (typically correlated to TSS) suggested that much of these inorganic concentrations were due to elevated TSS. The results of the Round Two inorganic analysis, of unfiltered samples, indicated that similar concentrations were detected from Round One groundwater samples. As part of the Round Two sampling event, a filtered and unfiltered groundwater sample was collected from 27M-92-03X and each sample was analyzed for TSS. No inorganic analytes were detected above the established groundwater background concentrations in the filtered sample. The results of the inorganic analysis performed on both samples, and the TSS results from Round Two, indicated that the elevated inorganics detected in both rounds were attributed to elevated suspended solids (Table 5.3-3; Figure 5.3-6).

5.3.4.3 Surface Water and Sediment. Three surface water and sediment pairs were collected from the western shore of Cranberry Pond. No organic compounds were detected in any of the surface water samples collected. Lead was detected in surface water samples at notable concentrations in 27D-92-01X and 27M-92-02X (Table 5.3-4; Figure 5.3-7).

Tetrachloroethylene was detected in 27D-92-03X at 0.002 μg/g. No other VOCs or SVOCs were detected in any of the sediment samples collected. TPHC was detected in the sediment samples collected from 27D-92-01X and 27D-92-02X ranging from 46.4 μg/g to 74.7 μg/g, respectively. 4,4'-DDT (0.017 μg/g), 4,4'-DDD (0.011 μg/g), and 4,4'-DDE (0.019 μg/g) were detected in the sediment sample collected at 27D-92-02X (Table 5.3-5; Figure 5.3-8).

5.3.5 Source Evaluation and Migration Potential

The absence of significant concentrations of explosive compounds and related inorganic analytes in all of the soil boring samples suggests that no specific source of contaminants associated with explosive detonation was encountered during the SI field investigation at SA 27. Groundwater samples collected from monitoring wells during both rounds exhibited concentrations of explosive compounds, RDX and HMX. The distribution and similar concentrations of these explosive compounds suggests a common source potentially upgradient of SA 27. Though the contaminants are consistent with the historical and current use of the range, a specific source area was not identified. The concentrations of inorganic analytes detected during the first and second rounds of groundwater sampling, appear to be caused by elevated TSS concentrations. This finding is supported by the concentrations of inorganic analytes detected in the filtered sample collected during the second round of groundwater sampling which showed that no inorganic analytes were above established background concentrations.

Surface water and sediment samples collected from Cranberry Pond exhibited elevated concentrations of lead. No distinct distribution or source of this contamination was identified. Based on the apparent groundwater flow direction at SA 27, there is no evidence that suggests the concentrations of contaminants detected in the surface water and sediment samples are specifically associated with Hotel Range activities.

5.3.6 Preliminary Human Health Risk Evaluation

A preliminary human health risk evaluation was prepared for SA 27 to determine if contaminants detected at this SA pose a risk to human receptors. For this PRE, the future use of SA 27 is assumed to be residential. Tables 5.3-6 through 5.3-10 present summary statistics and human health standards and guidelines used in the PRE for SA 27.

5.3.6.1 Soils. As discussed in Section 3.5 (Preliminary Risk Evaluation Methodology), all soils to a depth of 3 feet are classified as surface soil and considered to be accessible under a residential future use exposure scenario. All soils collected from 3-15 feet in depth are classified as subsurface and are considered to be accessible under a commercial/industrial future use exposure scenario.

Surface Soils. Table 5.3-6 presents summary statistics on surface soil at SA 27 and USEPA Region III residential soil concentrations for comparison. Surface soil at SA 27 is represented by samples 27M-92-01X through 27M-92-04X. An assessment of the organic compound data for SA 27 soils shows that there is some surface contamination from bis (2-ethylhexyl) phthalate, di-n-butylphthalate, toluene, and trichlorofluoromethane. The maximum detected concentrations of the organic compounds are, however, below the USEPA Region III residential soil concentrations.

An assessment of the inorganic data for SA 27 surface soils shows that there is surface contamination. When comparing soil concentrations to the statistical background, the inorganic data for SA 27 surface soils show that there are several compound exceedances.

Of the fourteen inorganic analytes detected above the established Fort Devens background levels, only one analyte was detected at a concentration above its respective health-based soil guideline. Beryllium was detected in two of four samples at concentrations above the USEPA Region III residential soil concentration of 0.4 μg/g. One additional inorganic analyte, arsenic, was detected at concentrations above the USEPA Region III residential soil concentrations. Both the maximum and average concentrations of arsenic are, however, below the established background concentrations.

Subsurface Soils. Table 5.3-7 presents summary statistics on subsurface soil at SA 27 and USEPA Region III commercial/industrial soil concentrations for comparison. Subsurface soil at SA 27 is represented by samples 27M-92-01X through 27M-92-04X. An assessment of the organic compound data for SA 27 subsurface soils shows that there is limited contamination from bis (2-ethylhexyl) phthalate, tetrachloroethylene, toluene, and trichlorofluoromethane. The maximum detected concentrations of these compounds are, however, below the USEPA Region III commercial/industrial soil concentrations.

When comparing against the established Fort Devens background, the inorganic data for SA 27 subsurface soils show that there are nine compound exceedances. Of the nine inorganic analytes detected above the established background concentrations, only beryllium was detected at concentrations above its respective health-based soil guidelines. Although beryllium was detected at 1.13 μg/g, above the USEPA Region III commercial/industrial soil concentration of 0.67 μg/g, the average concentration of beryllium (0.6 μg/g) was below the Region III commercial/industrial soil concentration. One additional analyte, arsenic, was detected at concentrations above the USEPA Region III commercial/industrial soil concentration. The maximum detected concentration of arsenic (15 μg/g) did not, however, exceed the established background concentration for arsenic (21 μg/g).

5.3.6.2 Groundwater. Table 5.3-8 presents summary statistics on groundwater associated with SA 27 and drinking water standards/guidelines for comparison.

Monitoring well locations 27M-92-01 through 27M-92-04X represent the groundwater associated with SA 27. The data reported in Table 5.3-6 are based on unfiltered samples.

Two explosives were detected in the groundwater associated with SA 27: HMX and RDX. RDX was detected in seven of nine samples. The maximum concentration of RDX exceeded its Region III tap water concentration (0.77 μg/L). HMX was detected in three of nine samples. Region III tap water for HMX is 1,800 μg/L. The maximum concentration of HMX did not exceed its Region III guideline.

An assessment of the inorganic data for SA 27 groundwater showed that there was significant inorganic analyte contamination directly surrounding the SA. When comparing groundwater concentrations to the established Fort Devens background, the inorganic data for SA 27 groundwater showed that there were several compound exceedances, most notably, aluminum, arsenic, barium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, and vanadium.

A drinking water standard or guideline is available for fifteen of the eighteen inorganic analytes detected above the base-wide background levels. Of the fifteen inorganic analytes detected above the established background concentrations, eleven analytes were detected at concentrations above their respective drinking water standard/guideline. Antimony and nickel were detected in two of nine samples and six of nine samples, respectively, and each average concentration exceeded its respective USEPA primary MCL. Chromium was detected in nine of nine samples. The maximum concentration of chromium exceeded its USEPA primary MCL; however, the average concentration did not. Aluminum, iron, and manganese were detected in nine of nine samples collected and each average concentration exceeded its respective USEPA secondary MCL. (Secondary MCLs are set for aesthetic or economic reasons, not health reasons.) The maximum concentration of lead (230 μg/L) and the average (53.9 μg/L) exceeds the USEPA lead action level of 15 μg/L. The maximum concentration of cobalt and vanadium exceed their respective USEPA Region III tap water concentrations. The maximum concentration of arsenic and beryllium each exceeded the USEPA primary MCL. Based on this screening-level analysis, it appears that consumption of groundwater at SA 27 may pose a potential risk to human health.

A filtered sample was collected in Round Two at 27M-92-03X. A comparison of the filtered and unfiltered samples at this monitoring well indicates that high TSS concentrations may be responsible for the high concentrations of some inorganic analytes. The concentrations of virtually every analyte in the filtered sample are significantly lower than in the unfiltered sample.

5.3.6.3 Surface Water and Sediment. Tables 5.3-9 and 5.3-10 present summary statistics on surface water and sediment. Three sampling locations were established at the western shore of Cranberry Pond (27D-92-01X through 27D-92-03X). No organic contaminants were detected in the pond.

The concentrations of three inorganic analytes that were detected in the surface water exceed their respective drinking water standard/guideline. The maximum concentration of lead detected at location 27D-92-01X (18.2 μg/L) exceeds the USEPA lead action level of 15 μg/L; however, the average concentration of lead in the three surface water samples (13.8 μg/L) does not exceed the lead action level. Iron was detected in all samples collected and it exceeded its respective USEPA secondary MCL. The detected concentrations of aluminum also exceeded the secondary MCL for aluminum. (Secondary MCLs are set for aesthetic or economic reasons, not health reasons.)

The magnitude and frequency of exposure to surface water in this pond would be expected to be much less than that upon which drinking water guidelines are based. The use of drinking water guidelines for comparison to surface water concentrations in a pond is a conservative approach and is used due to a lack of available health-based guidelines for exposure to surface water. Because exposure to surface waters in Cranberry Pond is anticipated to be restricted to wading in the future, it is not likely that an individual would encounter inorganic analyte concentrations that would pose a threat to public health.

The levels of contaminants detected in sediment are generally below the USEPA Region III residential soil concentrations. The exception is arsenic which was detected above the residential soil concentration of 0.97 μg/g at locations 27D-92-01X through 27D-92-02X. The use of residential soil concentrations for comparison to sediment concentrations in a pond is a conservative approach and is used due to a lack of available health-based guidelines for exposure to sediment. The USEPA Region III residential soil concentration is designed to be protective for exposures that could occur 350 days per year for a residential lifetime of 30 years. Exposure to sediment in this area would be much less than that expected in a residential setting. Therefore, the concentrations of arsenic detected in sediments associated with SA 27 are not expected to present a risk to public health under present or foreseeable future uses of Cranberry Pond.

5.3.7 Preliminary Ecological Risk Evaluation

The purpose of the PRE at SA 27 is to provide a screening-level evaluation of actual and potential risks that environmental contaminants may pose to the resident and migratory ecological receptors at the site.

Much of the Hotel Range consists of un-vegetated sandy cover, although herbaceous plant species cover approximately 50% the open area. Observed plant species include little bluestem grass (*Andropogon scoparius*), sweet fern (*Comptonia peregrina*), an occasional pitch pine (*Pinus rigida*), and bush clover (*Lespedeza capitata*).

The wooded area to the east of the SA is dominated by white oaks (*Quercus alba*) and pitch pines. The grassy area separating this wooded area from Cranberry Pond contains primarily herbaceous species, including goldenrods (*Solidago* spp.), various grass species, and bush clover. Wildlife uses at SA 27 may include occasional forage by whitetail deer (*Odocoileus virginianus*) and cottontail rabbit (*Sylvilagus floridanus*). The grassy regions of this site may also provide suitable habitat for certain sparrows and other grassland avian species.

Cranberry Pond is a characteristic kettle hole pond, with little bordering vegetated wetlands, and relatively steep banks. It is likely that Cranberry Pond provides habitat for a variety of aquatic invertebrates, fish, amphibians, and reptiles. Various semi-terrestrial mammals and birds may also be found in the vicinity of this freshwater wetland resource area.

No records exist documenting the current or historical presence of rare and endangered fauna in the region of SA 27. However, the Commonwealth of Massachusetts has established a "Watch List" of uncommon or rare plants (Massachusetts Natural Heritage Program, 1990). This list includes Massachusetts flora which are believed to be uncommon, but for which insufficient information exists documenting the true status of the plant in the state. One Watch List plant species is known to occur at or in the vicinity of Hotel Range (Hunt and Zaremba, 1992).

Fifteen inorganic analytes were detected in four surface soil samples collected from SA 27. The maximum concentrations of aluminum, barium, beryllium, chromium, copper, manganese, nickel, vanadium and zinc were higher than background and these analytes were therefore chosen as surface soil CPCs. No background data were available for antimony or cobalt, so these two inorganics were also chosen as CPCs. Barium was detected at all sample locations, at a maximum concentration of 106 μg/g. Selenium was detected in two out of four samples, at a maximum concentration of 0.718 μg/g. Vanadium was detected in all samples, at a maximum concentration of 41.1 μg/g. In addition to these fifteen inorganics, four organic analytes bis (2-ethylhexyl) phthalate, di-n-butylphthalate, toluene, and trichlorofluoromethane) were detected in SA 27 surface soils. All four organics were included as CPCs for SA 27 (Table 5.3-11).

Three surface water samples were collected from Cranberry Pond. No organic analytes were detected in these samples. Five inorganic compounds were detected in Cranberry Pond surface water and were chosen as CPCs. Aluminum and barium were detected in two of the three samples analyzed, while iron, manganese, and lead were detected in all three surface water samples. Aluminum was detected at a maximum concentration of 274 μg/L, while lead was detected at a maximum concentration of 18.2 μg/L (Table 5.3-12).

Three sediment samples were collected at SA 27 from identical sampling locations as the surface water samples. Four organic compounds, including three pesticides, and eleven inorganic compounds were chosen as CPCs for sediments at SA 27. Arsenic and copper were detected in all samples, at maximum concentrations of 16.3 μg/g, and 27.1 μg/g, respectively. 4,4-DDT, 4,4-DDD, 4,4-DDE, tetrachloroethylene, aluminum, barium, chromium, iron, manganese, nickel, lead, vanadium, and zinc were also chosen as sediment CPCs (Table 5.3-13).

5.3.7.1 Surface Soils. A screening-level evaluation of potential effects from surface soil exposure was conducted by comparing the maximum concentrations of all CPCs to their respective surface soil benchmark values (see Table 5.3-11). No concentrations of organic analytes at SA 27 surface soils exceeded ecological benchmarks. However, the maximum concentrations of aluminum, barium, beryllium, selenium and vanadium are greater than their respective benchmark values. Aluminum was detected at a maximum concentration of 20,000 μg/g, slightly higher than its benchmark value of 15,000 μg/g. The maximum concentrations of four inorganics: barium, beryllium, selenium, and vanadium were all approximately two times greater than their established surface soil benchmark values. However, the benchmarks for these analytes were developed to be protective of the short-tailed shrew, an animal that is unlikely to inhabit SA 27, due to lack of suitable cover and forage. In general, the protective contaminant levels developed for terrestrial vertebrate receptors other than the shrew are higher than the maximum concentrations of surface soil analytes at Hotel Range (see Appendix H). Most surface soil analytes at SA 27 were detected at concentrations lower than the protective contaminant levels developed for other ecological receptors (i.e., the robin, garter snake, red fox, or red-tailed hawk). Therefore, it is unlikely that CPCs in surface soil at SA 27 are resulting in significant ecological risk.

5.3.7.2 Surface Water and Sediments. Risks to aquatic receptors in Cranberry Pond surface water were evaluated through comparison of maximum CPC concentrations to aquatic benchmark values (USEPA chronic AWQC). Risks to ecological receptors from pond sediments were evaluated through comparison of maximum CPC concentrations to sediment benchmark values. The maximum concentrations of aluminum and lead in SA 27 pond surface water, and the maximum concentrations of 4,4-DDD, 4,4-DDE, 4,4-DDT, arsenic, and copper in pond sediments were detected at levels greater than their benchmark values (see Tables 5.3-12 and 5.3-13).

Aluminum was detected in all three surface water samples at a maximum concentration of 274 μg/L, and an average concentration of 214.5 μg/L. Although the maximum aluminum concentration is above the chronic AWQC (87 μg/L), it is well below the acute AWQC (750 μg/L). Aluminum is naturally present at high levels in background soils and groundwater at Fort Devens, and it is likely that the presence of aluminum at SA 27 surface water is reflective of background conditions, and not of SA impacts. Furthermore, a review of the aluminum AWQC document (USEPA, 1988c) indicates that larval trout are among the most sensitive ecological receptors with regard to aluminum exposure. Because no salmonids (e.g., trout) are likely to occur in Cranberry Pond, it is unlikely that the levels of aluminum in surface water will have an adverse effect on the site's ecological receptors, which are likely to be more tolerant of aluminum than larval trout.

Lead concentrations in the three SA 27 surface water samples averaged 13.8 μg/L. This value is considerably higher than 0.047 μg/L, the hardness-dependent chronic AWQC for lead (assuming site-specific hardness as 3.7 mg/L calcium carbonate [$CaCO_3$]). Because the regression equation used to calculate the hardness-dependent lead AWQC may not be valid at extremely low hardnesses, the lead AWQC for Cranberry Pond hardness was re-evaluated at 50 mg/L as $CaCO_3$, a value more typical of a New England kettle hole pond. At a hardness of 50 mg/L as $CaCO_3$, the chronic AWQC is 1.3 μg/L; this value is still an order of magnitude less than the average lead concentration detected in Cranberry Pond surface waters.

The maximum arsenic concentration in SA 27 sediments was 16.3 μg/g. This concentration is approximately three times greater than the arsenic benchmark, while the maximum copper concentration of 27.1 μg/g was approximately 1.5 times greater than its benchmark of 19 μg/g. The maximum concentrations of 4,4-DDD, 4,4-DDE, and 4,4-DDT were all approximately an order of magnitude in excess of their TOC-normalized benchmarks.

In summary, while it is unlikely that surface soil contamination at Hotel Range is resulting in significant ecological risk, sediments and surface water in Cranberry Pond contain concentrations of analytes in excess of ecological benchmark values.

5.3.8 Conclusions and Recommendations

Inorganics in soil and explosives and inorganics in groundwater pose the greatest potential human health risk at SA 27. In addition, pesticides and inorganics in Cranberry Pond surface water and sediment pose a likely risk to ecological receptors. Based on these results of the preliminary human health and ecological risk evaluation, additional investigation work is required to establish the source, distribution, and environmental effect of the explosives in groundwater at SA 27 and the inorganic concentrations (particularly lead) in Cranberry Pond surface water and sediments. The Army recommended in the Groups 2, 7 and Historic Gas Station Final SI Report, that SA 27 be administratively transferred from Group 7 to Group 1B and an RI/FS is recommended to further assess the contaminants detected.

TABLE 5.3–1
ORGANIC COMPOUNDS IN SOIL
SA 27 – WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	BORING	27M–92–01X	27M–92–01X	27M–92–01X	27M–92–02X	27M–92–02X	27M–92–02X
ANALYTE	DEPTH	0 FT	10 FT	20 FT	0 FT	6 FT	18 FT
VOLATILES (ug/g)							
TOLUENE		< 0.0007	< 0.0007	< 0.0007	< 0.0007	0.001	< 0.0007
OTHER (ug/g)							
TOTAL ORGANIC CARBON		NA	NA	5500.0	NA	NA	12400.0
TOTAL PETROLEUM HYDROCARBONS		34.9	36.2	< 27.7	30.4	40.0	36.5

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT ANALYTE LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

NA = NOT ANALYZED

TABLE 5.3-1
ORGANIC COMPOUNDS IN SOIL
SA 27 - WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BORING	27M-92-03X	27M-92-03X	27M-92-03X	27M-92-04X	27M-92-04X	27M-92-04X
	DEPTH	0 FT	4 FT	22 FT	0 FT	10 FT	20 FT
VOLATILES (ug/g)							
TOLUENE		0.001	0.001	< 0.0007	< 0.0007	< 0.0007	< 0.0007
TETRACHLOROETHYLENE/TETRACHLOROETHENE		< 0.0008	< 0.0008	< 0.0008	< 0.0008	0.001	< 0.0008
SEMIVOLATILES (ug/g)							
BIS(2-ETHYLHEXYL)PHTHALATE		< 0.62	< 1.0	< 0.62	< 0.62	< 0.62	< 0.62
TRICHLOROFLUOROMETHANE		0.01	0.01	0.008	< 0.007	< 0.007	< 0.007
DI-N-BUTYLPHTHALATE		1.4	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06
OTHER (ug/g)							
TOTAL ORGANIC CARBON		NA	NA	6080	NA	NA	12500
TOTAL PETROLEUM HYDROCARBONS		< 27.7	< 28.1	< 27.7	29.6	< 28.1	31.3

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

NA = NOT ANALYZED

TABLE 5.3–2
INORGANIC ANALYTES IN SOIL
SA 27 – WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE (ug/g)	BACK – GROUND	BORING	27M–92–01X	27M–92–01X	27M–92–01X	27M–92–02X	27M–92–02X	27M–92–02X
		DEPTH	0 FT	10 FT	20 FT	0 FT	6 FT	18 FT
ALUMINUM	15000.0		20000.0	13600.0	8540.0	5120.0	6120.0	9200.0
ARSENIC	21.0		18.0	15.0	24.0	13.0	14.0	13.4
BARIUM	42.5		106.0	53.3	46.1	22.0	29.2	40.0
BERYLLIUM	.347		1.78	1.13	0.726	LT	0.6	0.869
CALCIUM	1400.0		1770.0	649.0	914.0	605.0	763.0	911.0
CHROMIUM	31.0		37.3	24.0	25.6	12.3	15.5	38.4
COBALT	NA		13.3	8.12	8.54	3.79	4.87	7.62
COPPER	8.39		20.5	15.7	17.7	13.0	12.0	18.4
IRON	15000.0		29600.0	19100.0	16900.0	8300.0	11400.0	16100.0
LEAD	48.4		20.0	8.63	9.98	18.0	12.0	7.3
MAGNESIUM	5600.0		6930.0	4190.0	4340.0	1870.0	2450.0	3830.0
MANGANESE	300.0		525.0	280.0	420.0	141.0	194.0	272.0
NICKEL	14.0		29.9	20.5	23.5	10.3	13.3	25.1
POTASSIUM	1700.0		5080.0	2010.0	1960.0	705.0	1020.0	1580.0
SELENIUM	NA		0.718	0.956	0.402	< 0.25	< 0.25	0.782
SODIUM	131.0		360.0	214.0	223.0	191.0	211.0	327.0
VANADIUM	28.7		41.1	22.4	17.2	8.89	10.9	15.9
ZINC	35.5		78.2	45.7	41.3	27.9	28.4	62.6

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT ANALYTE LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

NA = NOT AVAILABLE

▨ = VALUE ABOVE BACKGROUND LEVELS

TABLE 5.3–3
ANALYTES IN GROUNDWATER
SA 27 – WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BACK–GROUND	ROUND 1 27M–92–01X	ROUND 2 27M–92–01X	ROUND 1 27M–92–02X	ROUND 1 27M–92–02X DUP	ROUND 2 27M–92–02X
EXPLOSIVES (μ g/L)						
CYCLOTETRAMETHYLENETETRANITRAMINE (HMX)		2.8	3.73	< 1.21	< 1.21	< 1.21
CYCLONITE (RDX)		12.1	12.3	< 1.21	1.6	1.74
INORGANICS (μg/L)						
ALUMINUM	6870.0	27400.0	22900.0	13200.0	15500.0	3200.0
ANTIMONY	3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03
ARSENIC	10.5	25.3	25.9	40.4	46.3	12.7
BARIUM	39.6	121.0	101.0	68.3	84.7	19.0
BERYLLIUM	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
CALCIUM	14700.0	11400.0	9740.0	6500.0	6770.0	5370.0
CHROMIUM	14.7	46.4	35.5	21.7	27.3	7.08
COBALT	25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0
COPPER	8.09	29.4	25.9	29.8	36.8	< 8.09
IRON	9100.0	41500.0	32700.0	20800.0	24700.0	4990
LEAD	4.25	17.4	15.3	16.9	20.3	5.31
MAGNESIUM	3480.0	9610.0	7740.0	4660.0	5370.0	2070.0
MANGANESE	291.0	820.0	585.0	591.0	712.0	204.0
NICKEL	34.3	52.1	< 34.3	41.4	44.9	< 34.3
POTASSIUM	2370.0	8680.0	7950.0	3440.0	3470.0	2530.0
SODIUM	10800.0	4560.0	4690.0	3030.0	3060.0	2600.0
VANADIUM	11.0	44.9	44.9	20.8	21.7	< 11.0
ZINC	21.1	125.0	119.0	72.1	81.0	109.0
ANIONS/CATIONS (μg/L)						
NITRATE/NITRITE		900.0	1500.0	840.0	187.0	240.0
ALKALINITY		25000.0	22000.0	24000.0	30000.0	25000.0
BICARBONATE		30500.0	26800.0	29300.0	36600.0	30500.0
OTHER (μg/L)						
TOTAL SUSPENDED SOLIDS		NA	1180.0	NA	NA	60.0

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN
☐ = VALUE ABOVE BACKGROUND LEVELS
DUP = DUPLICATE SAMPLE

NA = NOT ANALYZED

TABLE 5.3–3
ANALYTES IN GROUNDWATER
SA 27 – WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		ROUND 1	ROUND 2	ROUND 2	ROUND 1	ROUND 2
ANALYTE	BACK– GROUND	27M–92–03X	27M–92–03X	27M–92–03X FILTERED	27M–92–04X	27M–92–04X
EXPLOSIVES (μ g/L)						
CYCLOTETRAMETHYLENETETRANITRAMINE (HMX)		< 1.21	< 1.21	NA	< 1.21	2.06
CYCLONITE (RDX)		< 1.21	2.14	NA	2.9	7.5
INORGANICS (μg/L)						
ALUMINUM	6870.0	75500.0	164000.0	< 141.0	8700.0	27500.0
ANTIMONY	3.03	9.3	12.9	< 3.03	< 3.03	< 3.03
ARSENIC	10.5	73.6	130.0	< 2.54	32.3	88.5
BARIUM	39.6	379.0	806.0	< 5.0	52.0	124.0
BERYLLIUM	5.0	7.3	< 5.0	< 5.0	< 5.0	< 5.0
CALCIUM	14700.0	15200.0	22500.0	6960.0	8820.0	10700.0
CHROMIUM	14.7	133.0	288.0	< 6.02	16.4	46.4
COBALT	25.0	115.0	282.0	< 25.0	< 25.0	29.9
COPPER	8.09	213.0	553.0	< 8.09	19.0	70.7
IRON	9100.0	127000.0	305000.0	< 38.8	11200.0	36400.0
LEAD	4.25	120.0	230.0	< 1.26	12.4	47.6
MAGNESIUM	3480.0	22900.0	48300.0	1530.0	3550.0	8010.0
MANGANESE	291.0	2810.0	6540.0	26.3	1110.0	1300.0
NICKEL	34.3	209.0	522.0	< 34.3	< 34.3	74.0
POTASSIUM	2370.0	14400.0	26300.0	2030.0	2790.0	7230.0
SODIUM	10800.0	5070.0	5870.0	2730.0	3070.0	3700.0
VANADIUM	11.0	102.0	264.0	< 11.0	12.8	44.7
ZINC	21.1	356.0	795.0	< 21.1	41.7	144.0
ANIONS/CATIONS (μg/L)						
NITRATE/NITRITE	NA	380.0	480.0	NA	1400.0	3800.0
ALKALINITY	NA	11000.0	39000.0	NA	24000.0	21000.0
BICARBONATE	NA	13400.0	47600.0	NA	29300.0	25600.0
OTHER (μg/L)						
TOTAL SUSPENDED SOLIDS		NA	4750.0	NA	NA	700.0

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN
☐ = VALUE ABOVE BACKGROUND LEVELS
DUP = DUPLICATE SAMPLE

NA = NOT ANALYZED

TABLE 5.3–4
ANALYTES IN SURFACE WATER
SA 27 – WASTE EXPLOSIVE DENOTATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	27D–92–01X	27D–92–02X	27D–92–03X
INORGANICS (ug/L)			
ALUMINUM	274.0	155.0	< 144.0
BARIUM	4.79	4.63	< 5.0
CALCIUM	931.0	875.0	886.0
IRON	819.0	415.0	385.0
LEAD	18.2	14.9	8.24
MANGANESE	11.5	8.08	7.21
POTASSIUM	579.0	739.0	730.0
SODIUM	1230.0	1220.0	1080.0
ANIONS/CATIONS (ug/L)			
KJELDAHL NITROGEN	438.0	400.0	324.0
ALKALINITY	8000.0	5000.0	< 5000.0
OTHER (ug/L)			
HARDNESS	6200.0	3000.0	1800.0
PHOSPHATE	26.7	22.8	18.8
TOTAL SUSPENDED SOLIDS	26000.0	31000.0	7000.0

NOTES:
TABLE LISTS DETECTED ANALYTES ONLY –
SEE PROJECT ANALYTE LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN

TABLE 5.3-5
ANALYTES IN SEDIMENT
SA 27 – WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	27D-92-01X	27D-92-02X	27D-92-03X
INORGANICS (ug/g)			
ALUMINUM	3560.0	5120.0	2630.0
ARSENIC	4.77	16.3	9.14
BARIUM	10.2	24.1	8.01
CALCIUM	192.0	474.0	< 100.0
CHROMIUM	8.27	11.6	5.67
COPPER	8.19	27.1	7.36
IRON	5880.0	9750.0	5060.0
LEAD	80.0	120.0	27.0
MAGNESIUM	1360.0	1680.0	1100.0
MANGANESE	65.4	91.9	45.7
NICKEL	7.57	10.2	4.7
POTASSIUM	< 100.0	345.0	< 100.0
SODIUM	184.0	308.0	170.0
VANADIUM	5.95	10.6	4.85
ZINC	17.3	29.4	12.6
ORGANICS (ug/g)			
TETRACHLOROETHYLENE	< 0.0008	< 0.0008	0.002
4,4'-DDD	< 0.008	0.017	< 0.008
4,4'-DDE	< 0.008	0.011	< 0.008
4,4'-DDT	< 0.007	0.019	< 0.007
OTHER (ug/g)			
TOTAL ORGANIC CARBON	6220.0	23900.0	2560.0
TOTAL PETROLEUM HYDROCARBON	46.4	74.7	< 27.7

NOTES:
TABLE LISTS DETECTED ANALYTES ONLY –
SEE PROJECT ANALYTE LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN

TABLE 5.3-6
HUMAN HEALTH PRE EVALUATION OF SURFACE SOIL
SA 27 – WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Soil Background Concentration (ug/g)	Detected Concentration [b]		Frequency of Detection	Maximum Exceeds Background ?	Region III Residential Soil Concentration (ug/g)	Maximum Exceeds Region III Concentration ?
		Average (ug/g)	Maximum (ug/g)				
Organics							
bis (2-ethylhexyl) phthalate		1	1	1/4		120	NO
di-n-butyl phthalate		1.4	1.4	1/4		7800	NO
toluene		0.001	0.001	1/4		16000	NO
trichlorofluoromethane		0.01	0.01	1/4		23000	NO
Inorganics							
aluminum	15000	9737.5	20000	4/4	YES	230000	NO
antimony	NA	2.84	2.84	1/4	NA	31	NO
arsenic	21	14.7	19	4/4	NO	0.97	YES
barium	42.5	43.8	106	4/4	YES	5500	NO
beryllium	0.347	1.3	1.78	2/4	YES	0.4	YES
calcium	1400	818	1770	4/4	YES	NA	NA
chromium	31	20.6	37.3	4/4	YES	390	NO
cobalt	NA	6.8	13.3	4/4	NA	NA	NA
copper	8.39	19.9	31.4	4/4	YES	2900	NO
iron	15000	15177.5	29600	4/4	YES	NA	NA
lead	48.4	19.5	24	4/4	NO	500	NO
magnesium	5600	3480	6930	4/4	YES	NA	NA
manganese	300	276	525	4/4	YES	7800	NO
mercury	0.22	0.163	0.163	1/4	NO	23	NO
nickel	14	17.5	29.9	4/4	YES	1600	NO
potassium	1700	1866	5080	4/4	YES	NA	NA
selenium	NA	0.7	0.718	2/4	NA	390	NO
sodium	131	229	360	4/4	YES	NA	NA
vanadium	28.7	18.5	41.1	4/4	YES	550	NO
zinc	35.5	51.3	78.2	4/4	YES	23000	NO
Other							
total petroleum hydrocarbons	NA	31.6	34.9	3/4	NA	NA	NA

Notes:
[a] Base-wide background soil inorganics database
[b] Surface soil samples from sampling stations 27M-92-01X to 27M-92-04X
NA = not available
ug/g = micrograms per gram

TABLE 5.3-7
HUMAN HEALTH PRE EVALUATION OF SUBSURFACE SOIL
SA 27 - WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Soil Background Concentration (ug/g)	Detected Concentration [b]		Frequency of Detection	Maximum Exceeds Background ?	Region III Commercial/Industrial Soil Concentration (ug/g)	Maximum Exceeds Region III Concentration?
		Average (ug/g)	Maximum (ug/g)				
Organics							
bis (2-ethylhexyl) phthalate		1	1	1/4		200	NO
tetrachloroethylene		0.001	0.001	1/4		55	NO
toluene		0.001	0.001	2/4		200,000	NO
trichlorofluoromethane		0.01	0.01	1/4		310,000	NO
Inorganics							
aluminum	15,000	8475	13600	4/4	NO	3,000,000	NO
arsenic	21	14	15	4/4	NO	1.6	YES
barium	42.5	33.5	53.3	4/4	YES	72,000	NO
beryllium	0.347	0.6	1.13	2/4	YES	0.67	YES
calcium	1,400	659	763	4/4	NO	NA	NA
chromium	31	17.5	24	4/4	NO	5,100	NO
cobalt	NA	6	8.12	4/4	NA	NA	NA
copper	8.39	14.3	15.7	4/4	YES	38,000	NO
iron	15,000	13675	19100	4/4	YES	NA	NA
lead[c]	48.4	12.4	18	4/4	NO	500	NO
magnesium	5,600	2822.5	4190	4/4	NO	NA	NA
manganese	300	274	419	4/4	YES	100,000	NO
mercury	0.22	0.073	0.073	1/4	NO	310	NO
nickel	14.0	16.1	20.5	4/4	YES	20,000	NO
potassium	1,700	1122	2010	4/4	YES	NA	NA
selenium	NA	0.7	0.956	2/4	NA	5,100	NO
sodium	131	212	214	3/4	YES	NA	NA
vanadium	28.7	13.6	22.4	4/4	NO	7,200	NO
zinc	35.5	34.5	45.7	4/4	YES	310,000	NO
Other							
total petroleum hydrocarbons	NA	38.1	40	3/4	NA	NA	NA

Notes:

[a] Base-wide background soil inorganics database

[b] Subsurface soil sample from sampling station 27M-92-01X to 27M-92-04X

[c] The USEPA interim soil cleanup level for lead was used as a surrogate for the commercial/industrial concentration of lead.

NA = not available

ug/g = micrograms per gram

TABLE 5.3-8
HUMAN HEALTH PRE EVALUATION OF GROUNDWATER
SA 27 - WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Groundwater Background Concentration (ug/L)	Detected Concentration [a]		Frequency of Detection	Maximum Exceeds Background?	Drinking Water Standard/Guideline [b] (ug/L)	Maximum Exceeds Standard/Guideline?
		Average (ug/L)	Maximum (ug/L)				
Organics							
cyclotetramethylenetetranitramine (HMX)		2.9	3.73	3/9		1800	NA
cyclonite (RDX)		5.8	12.3	7/9		0.77	YES
Inorganics							
aluminum	6870	39766.7	164000	9/9	YES	50-200	YES
antimony	3.03	11.1	12.9	2/9	YES	6	YES
arsenic	10.5	52.8	130	9/9	YES	50	YES
barium	39.6	195	806	9/9	YES	2000	NO
beryllium	5.0	7.3	7.3	1/9	YES	4	YES
calcium	14700	10777.8	22500	9/9	YES	NA	NA
chromium	14.7	69.1	288	9/9	YES	100	YES
cobalt	25.0	142.3	282	3/9	YES	10	YES
copper	8.09	122.2	553	8/9	YES	1300	NO
iron	9100	67143.3	305000	9/9	YES	300	YES
lead	4.25	53.9	230	9/9	YES	15	YES
magnesium	3480	12467.8	48300	9/9	YES	NA	NA
manganese	291	1630.2	6540	9/9	YES	50	YES
mercury	0.243	0.59	0.59	1/9	YES	2	NO
nickel	34.3	157.2	522	6/9	YES	100	YES
potassium	2370	8532.2	26300	9/9	YES	NA	NA
sodium	10800	3961.1	5870	9/9	NO	28000	NO
vanadium	11	69.5	264	8/9	YES	260	YES
zinc	21.1	204.8	795	9/9	YES	5000	NO
Anions/Cations							
nitrite/nitrate	NA	1080.8	3800	9/9	NA	10000	NO
Other							
total suspended solids	NA	1672500	4750000	4/4	NA	NA	NA

Notes:

[a] Based on unfiltered samples from Round 1 and Round 2

[b] Includes the lowest of either the EPA or MA drinking water standards, or if no federal standard or guideline is available, the Region III tap water concentration

SA 27 is represented by the following monitoring wells: 27M-92-01X through 27M-92-04X (including one duplicate sample)

NA = Not available

ug/L = micrograms per liter

TABLE 5.3–9
HUMAN HEALTH PRE EVALUATION OF SURFACE WATER
SA 27 – WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Detected Concentration [a] Average (ug/L)	Detected Concentration [a] Maximum (ug/L)	Frequency of Detection	Drinking Water Standard/Guideline(b) (ug/L)	Maximum Exceeds Drinking Water Standard/Guideline?
Inorganics					
aluminum	214.5	274	2/3	50–200	YES
barium	4.7	4.79	2/3	2000	NO
calcium	897.3	931	3/3	NA	NA
iron	539.7	819	3/3	300	YES
lead	13.8	18.2	3/3	15	YES
manganese	8.9	11.5	3/3	50	NO
potassium	682.7	739	3/3	NA	NA
sodium	1176.7	1230	3/3	28000	NO
Other					
total suspended solids	21333.3	31000	3/3	NA	NA

Notes:

[a] Surface water samples from sampling stations 27D–92–01X thru 27D–92–03X

[b] Includes the lowest of either the EPA or MA drinking water standards or, if no federal or state standard or guideline is available, the Region III tap water concentrations.

NA = not available

ug/L = micrograms per liter

TABLE 5.3–10
HUMAN HEALTH PRE EVALUATION OF SEDIMENT
SA 27 – WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Detected Concentration [a]		Frequency of Detection	Region III Residential Soil Concentrations (ug/g)	Maximum Exceeds Region III Concentration?
	Average (ug/g)	Maximum (ug/g)			
Organics					
4,4–DDD	0.017	0.017	1/3	7.1	NO
4,4–DDE	0.0110	0.011	1/3	5	NO
4,4–DDT	0.0019	0.019	1/3	5	NO
tetrachloroethylene	0.002	0.002	1/3	33	NO
Inorganics					
aluminum	3770.0	5120	3/3	230,000	NO
arsenic	10.1	16.3	3/3	0.97	YES
barium	14.1	24.1	3/3	5,500	NO
calcium	333.0	474	2/3	NA	NA
chromium	8.5	11.6	3/3	390	NO
copper	14.2	27.1	3/3	2,900	NO
iron	6896.7	9750	3/3	NA	NA
potassium	345.0	345	1/3	NA	NA
magnesium	1380.0	1680	3/3	NA	NA
manganese	67.7	91.9	3/3	7,800	NO
sodium	220.7	308	3/3	NA	NA
nickel	7.5	10.2	3/3	1,600	NO
lead	75.7	120	3/3	500	NO
vanadium	7.1	10.6	3/3	500	NO
zinc	19.8	29.4	3/3	23,000	NO
Other					
total petroleum hydrocarbons	60.6	74.7	2/3	NA	NA

Notes:
[a] Sediment samples from sampling stations 27D–92–01X to 27D–92–03X
NA = not available
ug/g = micrograms per gram

TABLE 5.3–11
ECOLOGICAL PRE EVALUATION OF SURFACE SOIL
SA 27 – WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Soil Background Concentration (ug/g)	Concentration [b]		Frequency of Detection	Maximum Exceeds Background?	Ecological Benchmarks (ug/g)	Maximum Exceeds Benchmark?
		Average (ug/g)	Maximum (ug/g)				
Organics							
bis (2–ethylhexyl) phthalate	NA	1	1	1/4	NA	84	NO
di–n–butyl phthalate	NA	1.4	1.4	1/4	NA	2650	NO
toluene	NA	0.001	0.001	1/4	NA	1800	NO
trichlorofluoromethane	NA	0.01	0.01	1/4	NA	2000	NO
Inorganics							
aluminum	15000	9737.5	20000	4/4	YES	15000	YES
antimony	NA	2.84	2.84	1/4	NA	7	NO
arsenic	21	14.7	19	4/4	NO		
barium	42.5	43.8	106	4/4	YES	42.5	YES
beryllium	0.347	1.3	1.78	2/4	YES	0.88	YES
chromium	31	20.6	37.3	4/4	YES	180	NO
cobalt	NA	6.8	13.3	4/4	NA	50	NO
copper	8.39	19.9	31.4	4/4	YES	34	NO
lead	48.4	19.5	24	4/4	NO		
manganese	300	276	525	4/4	YES	1500	NO
mercury	0.22	0.163	0.163	1/4	NO		
nickel	14.0	17.5	29.9	4/4	YES	100	NO
selenium	NA	0.7	0.718	2/4	NA	0.48	YES
vanadium	28.7	18.5	41.1	4/4	YES	28.7	YES
zinc	35.5	51.3	78.2	4/4	YES	640	NO

Notes:

[a] Base–wide background soil inorganics database

[b] Surface soil samples from sampling stations 27M–92–01X to 27M–92–04X

NA = not available

ug/g = micrograms per gram

TABLE 5.3–12
ECOLOGICAL PRE EVALUATION OF SURFACE WATER
SA 27 – WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Concentration [a] Average (ug/L)	Concentration [a] Maximum (ug/L)	Frequency of Detection	Ecological Benchmarks (ug/L)	Maximum Exceeds Benchmark?
Inorganics					
aluminum	214.5	274	2/3	87	YES
barium	4.7	4.79	2/3	NA	NA
iron	539.7	819	3/3	1000	NO
lead	13.8	18.2	3/3	0.047[b]	YES
manganese	8.9	11.5	3/3	NA	NA
Other					
total hardness	3666.7	6200	3/3	---	---
total suspended solids	21333.3	31000	3/3	---	---

Notes:

[a] Surface water samples from sampling stations 27D–92–01X thru 27D–92–03X

[b] Hardness dependent criterion. See Section 3.6.2 for methodology used to calculate site–specific hardness–dependent benchmark values. Because the regression equation used to calculate the lead AWQC may not be accurate at low hardnesses, the Cranberry Pond AWQC was re–calculated at 50 mg/l hardness (Chronic AWQC at 50 mg/l hardness = 1.3 ug/l).

ug/L = micrograms per liter

NA = Not available

––– = Analyte not a CPC for this medium

TABLE 5.3−13
ECOLOGICAL PRE EVALUATION OF SEDIMENT
SA 27 − WASTE EXPLOSIVE DETONATION RANGE (HOTEL)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Concentration [a] Average (ug/g)	Concentration [a] Maximum (ug/g)	Frequency of Detection	Ecological Benchmark (ug/g)	Maximum Exceeds Benchmark?
Organics					
4,4−DDD	0.017	0.017	1/3	0.00902[b]	YES
4,4−DDE	0.011	0.011	1/3	0.00902[b]	YES
4,4−DDT	0.019	0.019	1/3	0.00902[b]	YES
tetrachloroethylene	0.002	0.002	1/3	NA	NA
Inorganics					
aluminum	3770.0	5120	3/3	NA	NA
arsenic	10.1	16.3	3/3	5	YES
barium	14.1	24.1	3/3	NA	NA
chromium	8.5	11.6	3/3	26	NO
copper	14.2	27.1	3/3	19	YES
iron	6896.7	9750	3/3	24000	NO
manganese	67.7	91.9	3/3	428	NO
nickel	7.5	10.2	3/3	22	NO
lead	75.7	120	3/3	NA	NA
vanadium	7.1	10.6	3/3	NA	NA
zinc	19.8	29.4	3/3	85	NO
Other					
total organic carbon	10893.3	23900	3/3	−−−	−−−

Notes:

[a] Sediment samples from sampling stations 27D−92−01X to 27D−92−03X

[b] Benchmark is carbon−normalized using site−specific total organic carbon data (see Section 3.6.2)

NA = not available

ug/g = micrograms per gram

−−− = Analyte not a CPC for this medium

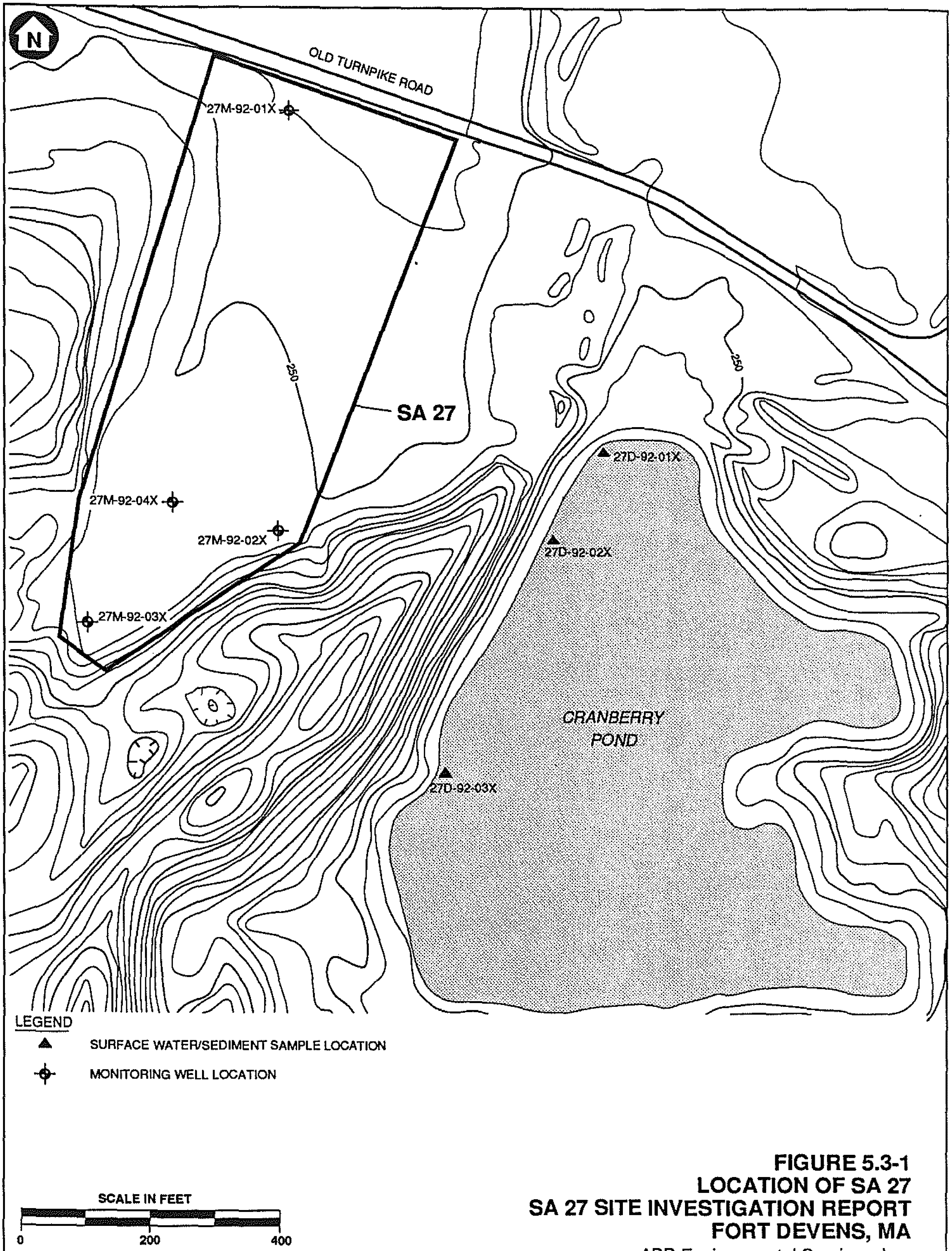


FIGURE 5.3-1
LOCATION OF SA 27
SA 27 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9304049(w) 12 4

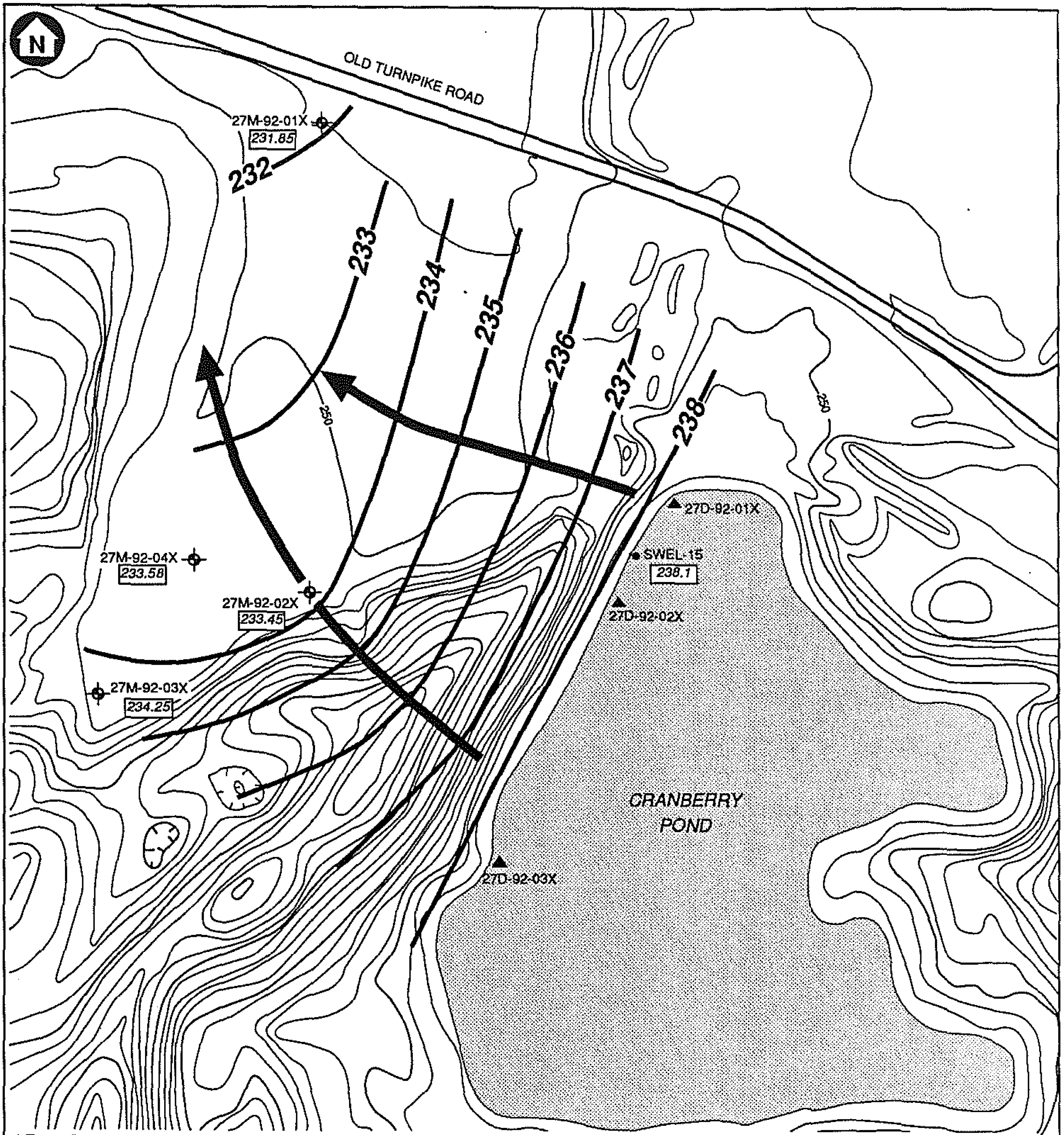


FIGURE 5.3-2
GROUNDWATER LEVELS AND INFERRED FLOW DIRECTIONS
SA 27 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

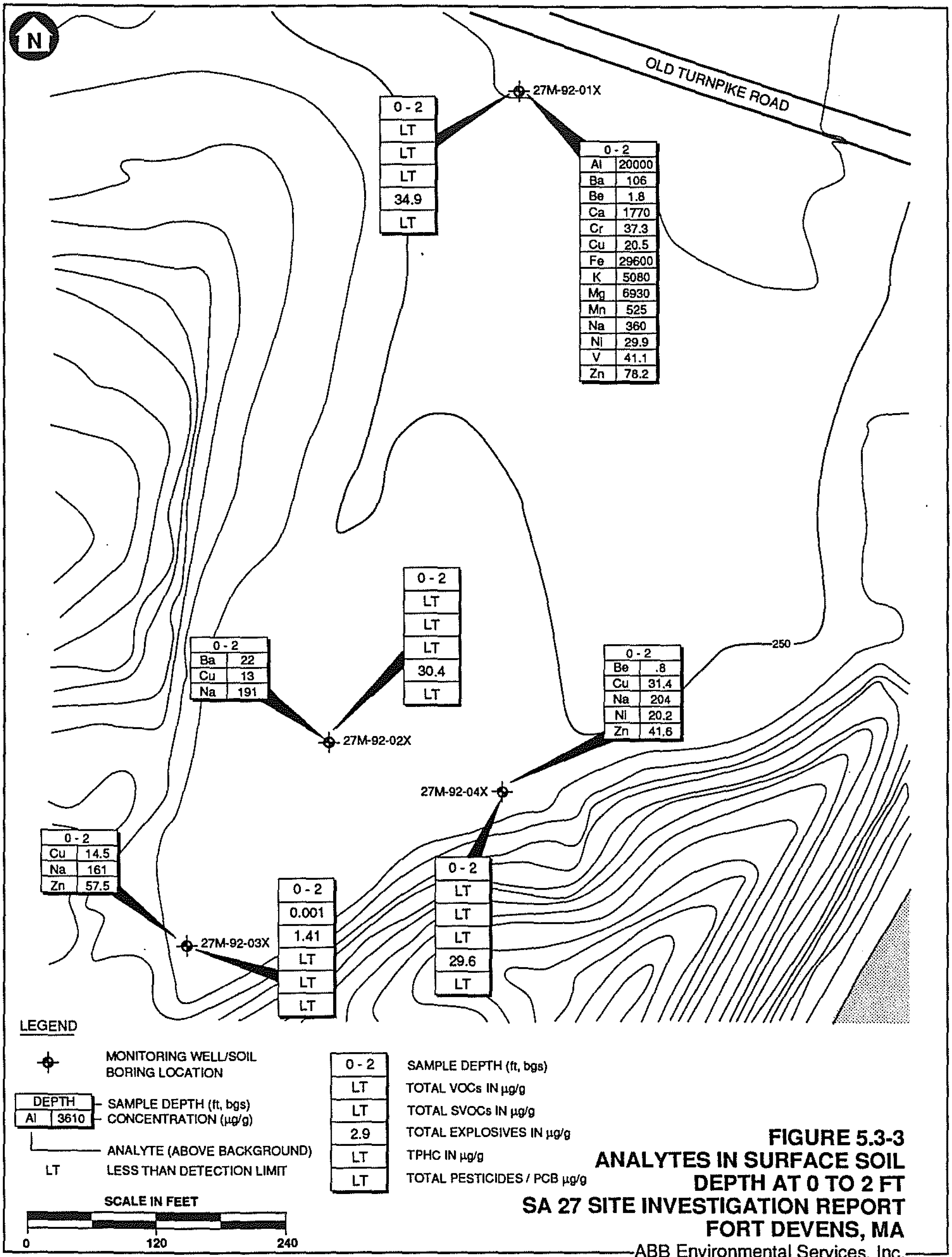
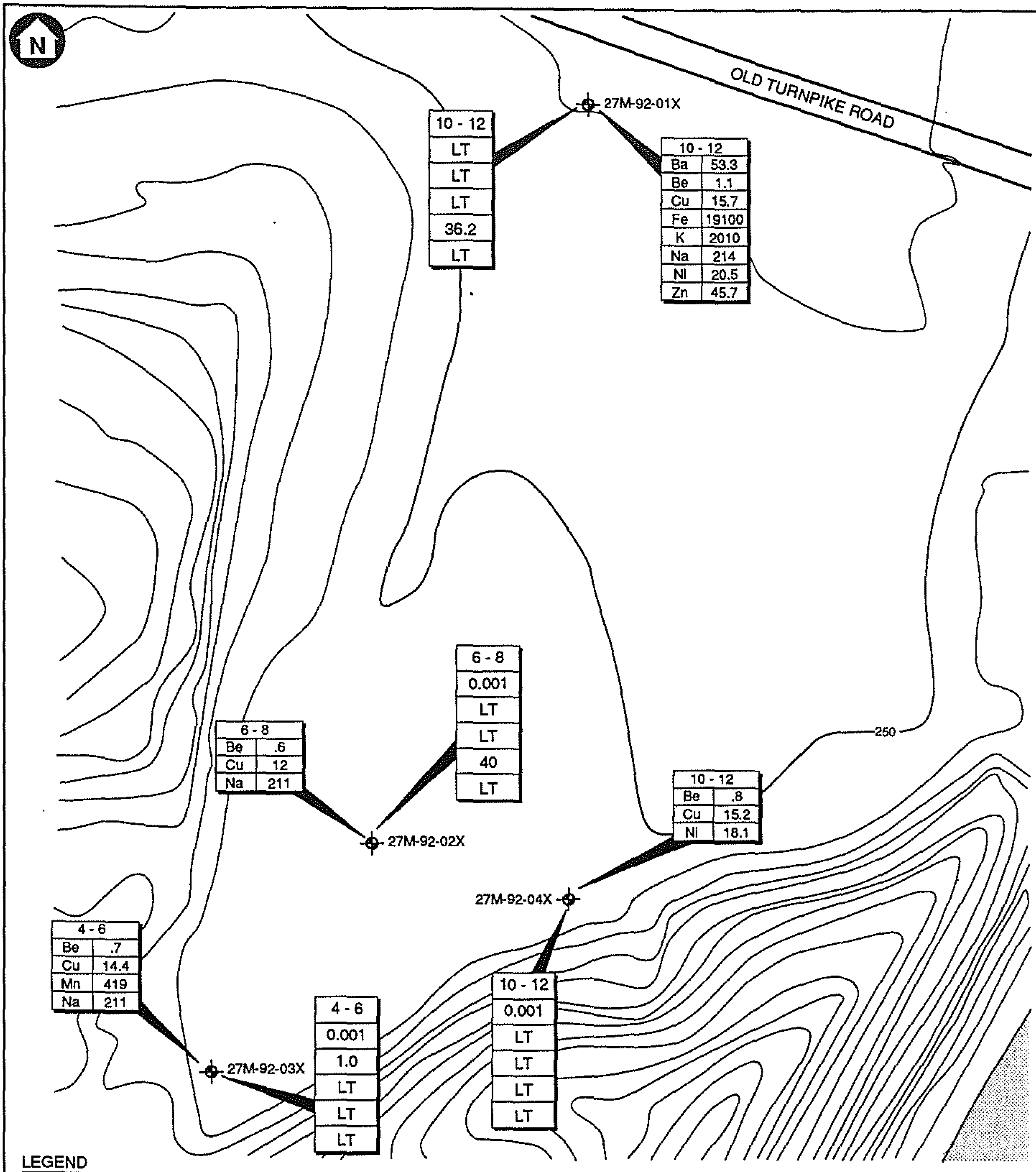


FIGURE 5.3-3
ANALYTES IN SURFACE SOIL
DEPTH AT 0 TO 2 FT
SA 27 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.



LEGEND

MONITORING WELL/ SOIL BORING LOCATION

DEPTH – SAMPLE DEPTH (ft, bgs)
Al 3610 – CONCENTRATION (µg/g)
ANALYTE (ABOVE GROUND)
LT LESS THAN DETECTION LIMIT

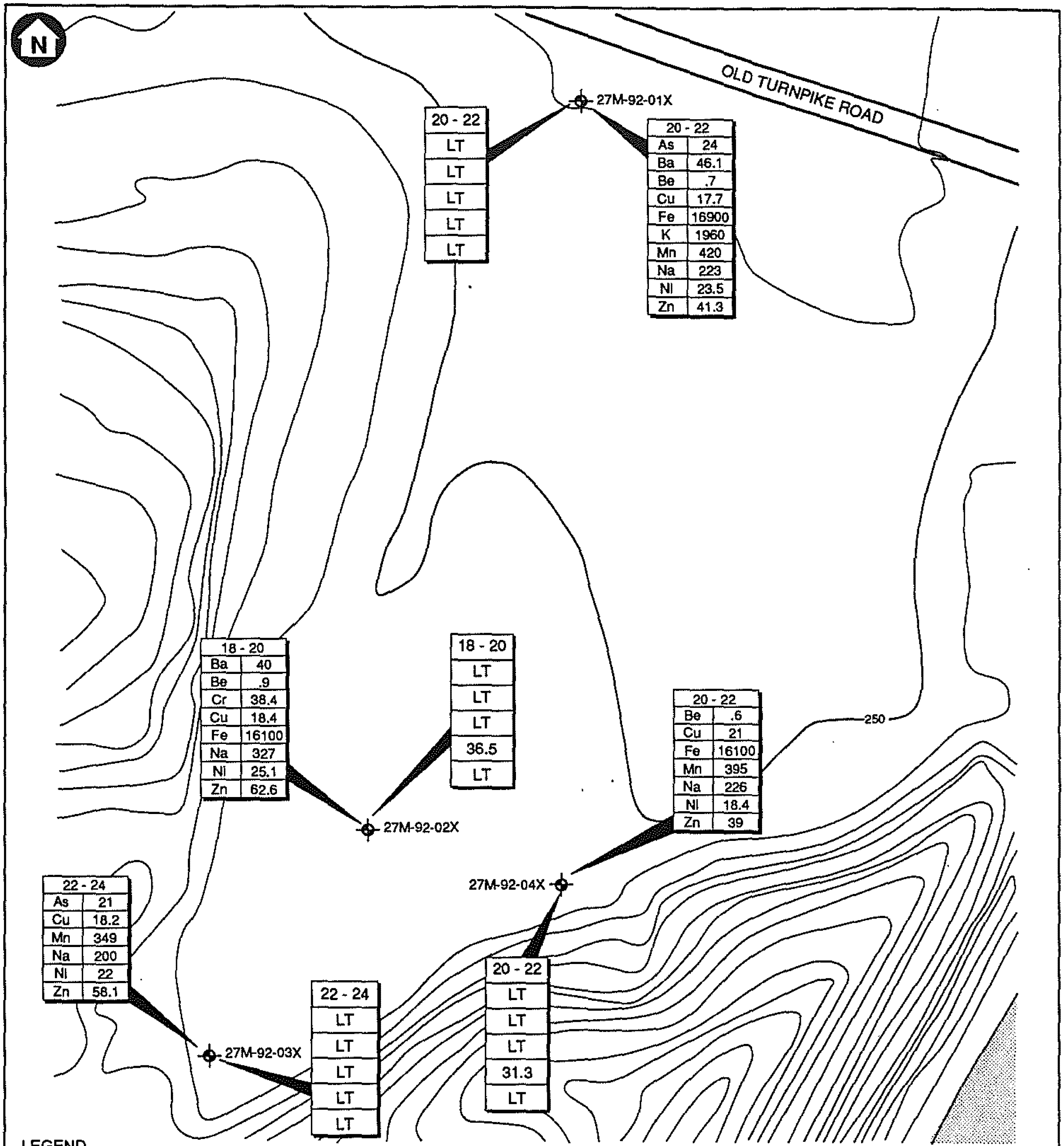
6 - 8	SAMPLE DEPTH (ft, bgs)
LT	TOTAL VOCs IN µg/g
LT	TOTAL SVOCs IN µg/g
2.9	TOTAL EXPLOSIVES IN µg/g
LT	TPHC IN µg/g
LT	TOTAL PESTICIDES / PCB µg/g

SCALE IN FEET
0 120 240

FIGURE 5.3-4
ANALYTES IN SUBSURFACE SOIL
DEPTH AT 4 TO 10 FT
SA 27 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9304049D(w1) 2 4



LEGEND

⌖ MONITORING WELL/ SOIL BORING LOCATION

DEPTH		SAMPLE DEPTH (ft, bgs)
Al	3610	CONCENTRATION (µg/g)

ANALYTE (ABOVE GROUND)

LT LESS THAN DETECTION LIMIT

6 - 8	SAMPLE DEPTH (ft, bgs)
LT	TOTAL VOCs IN µg/g
LT	TOTAL SVOCs IN µg/g
2.9	TOTAL EXPLOSIVES IN µg/g
LT	TPHC IN µg/g
LT	TOTAL PESTICIDES / PCB µg/g

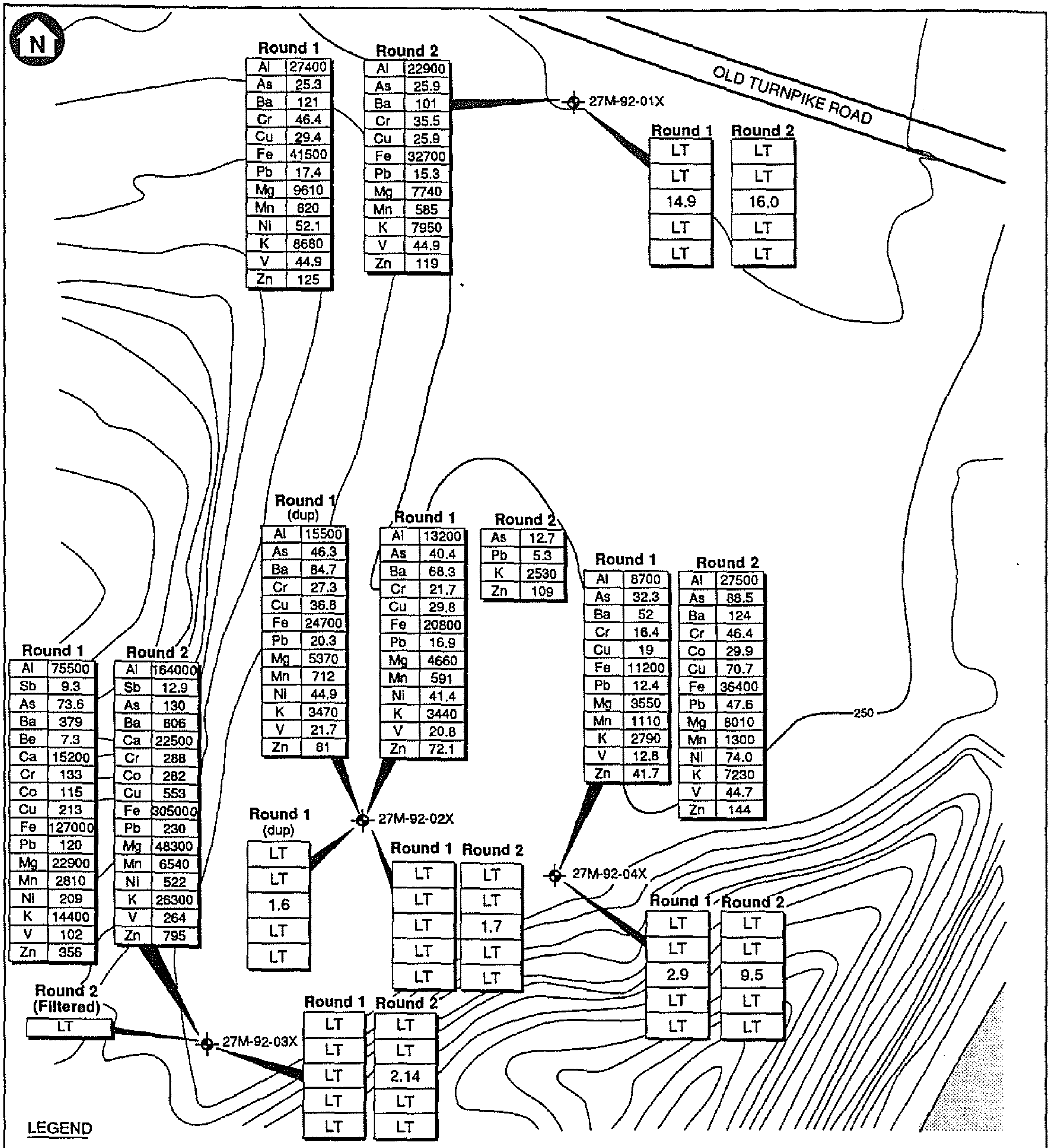
SCALE IN FEET

0 120 240

FIGURE 5.3-5
ANALYTES IN SUBSURFACE SOIL DEPTH AT 18 TO 22 FT
SA 27 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9304049D(w1) 2 5



LEGEND

⌖	MONITORING WELL LOCATION
Al 3610	CONCENTRATION (µg/L)
Al	ANALYTE (ABOVE BACKGROUND)
LT	LESS THAN DETECTION LIMIT
(dup)	DUPLICATE SAMPLE

LT	TOTAL VOCs IN µg/L
LT	TOTAL SVOCs IN µg/L
2.9	TOTAL EXPLOSIVES IN µg/L
LT	TPHC IN µg/L
LT	TOTAL PESTICIDES / PCB µg/L

SCALE IN FEET

0 120 240

FIGURE 5.3-6
ANALYTES IN GROUNDWATER
SA 27 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9304049D(w1) 2 8

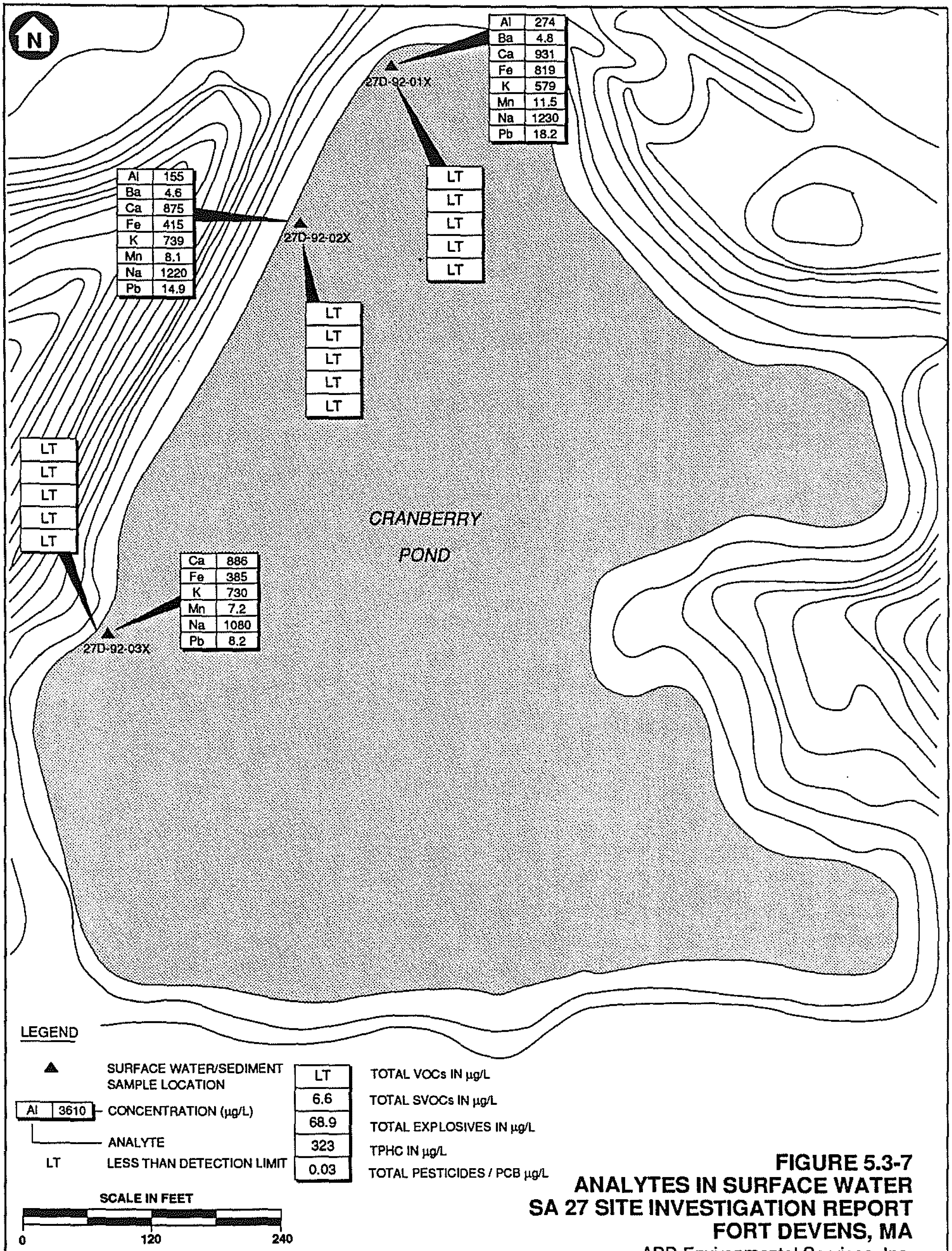
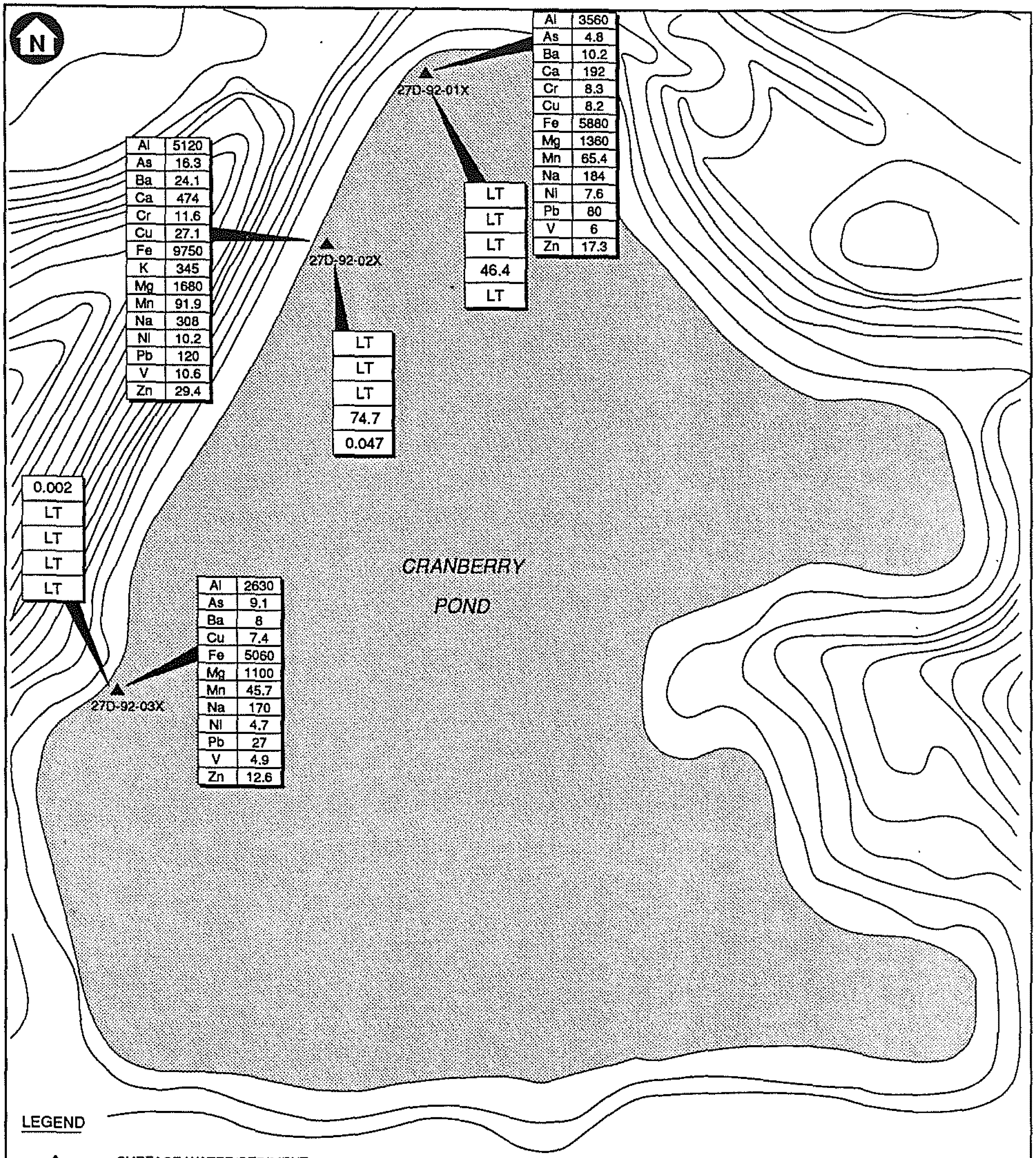


FIGURE 5.3-7
ANALYTES IN SURFACE WATER
SA 27 SITE INVESTIGATION REPORT
FORT DEVENS, MA
ABB Environmental Services, Inc.



LEGEND

▲ SURFACE WATER/SEDIMENT SAMPLE LOCATION

Al 3610 – CONCENTRATION (µg/g)

– ANALYTE

LT LESS THAN DETECTION LIMIT

LT	TOTAL VOCs IN µg/g
6.6	TOTAL SVOCs IN µg/g
68.9	TOTAL EXPLOSIVES IN µg/g
323	TPHC IN µg/g
0.03	TOTAL PESTICIDES / PCB µg/g

SCALE IN FEET

0 120 240

FIGURE 5.3-8
ANALYTES IN SEDIMENT
SA 27 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9304049(w2)12

5.4 SA 28 - WASTE EXPLOSIVE DETONATION RANGE (TRAINING AREA 14)

5.4.1 Study Area Background and Conditions

SA 28 is a 6-acre area located on Attu Road in the South Post formerly used as hand grenade range "J" (Figure 5.4-1). Presently, the southern portion of the area is used as the "medical litter obstacle course." It is bounded on the south by Slate Rock Pond (a manmade pond), on the east and west by woods and on the north by the northern South Post boundary. Attu Road runs east to west through the site. The "medical litter obstacle course" is comprised of a bunker (left over from the former hand grenade range) constructed of wooden railroad ties and several wooden obstacles (see Figure 5.4-1).

Hand grenade range "J" was established in the 1940s. No other weapons were used on this range. It is alleged that waste explosives were disposed of in this area. In the 1970s, the hand grenade range was moved and a portion of the range cleared of UXO debris and converted to a medical stretcher obstacle training course. Since being converted, several thousand soldiers have used the course and no hazards have been reported (Gates, 1987).

A review of maps at the installation indicate that this range was mapped as a UXO demolition area in 1941 (Construction Division Office of the Construction Quartermaster, 1941). It is believed that the most likely area to have been used for demolition is the clear area located at the northern portion of the site where several topographic depressions (possible impact craters used as burn pits) were discovered (see Figure 5.4-1).

5.4.2 Study Area Investigation Program Summary

The field investigation program at SA 28 consisted of soil borings for the collection of soil samples in the two suspected burn pits, the installation of monitoring wells upgradient and downgradient of the suspected burn pits and the "medical litter obstacle course", and the collection of groundwater samples to assess whether the historic use of the SA has adversely impacted groundwater quality. A UXO clearance survey was conducted to provide access clearance for a drill rig and downhole clearance at 4-foot intervals in each boring. These surveys were conducted in accordance with the UXO clearance procedures described in the POP, Volume I, Section 4.4.2 Unexploded Ordnance Clearance Survey.

Two soil borings (28E-92-01X and 28E-92-02X) were drilled to a depth of 4 feet in the centers of the two largest suspected burn pits to assess whether the historic use of pits had adversely impacted soil quality (see Figure 5.4-1). Two samples (from 0 to 2 and 2 to 4 feet bgs) were collected from each boring for laboratory analysis. The four samples were submitted for laboratory analysis of PAL organics and inorganics, TPHC, and PAL explosives. In addition to the analytical sample, one sample from each boring was submitted for grain size analysis to verify field classifications of soil.

Four soil borings (28M-92-01X through 28M-92-04X) were drilled to the water table for the installation of groundwater monitoring wells. The regional groundwater flow appeared to be south toward Slate Rock Pond; therefore, boring 28M-92-01X was located north of the SA to monitor upgradient groundwater quality. Borings 28M-92-02X through 28M-92-04X were installed crossgradient (east and west) and downgradient (south) of the burn pits and the "medical litter obstacle course," to evaluate whether the historic use of the SA has impacted the downgradient groundwater quality (see Figure 5.4-1). Soil samples were obtained at 5-foot intervals, except in 28M-92-03X where samples were collected continuously, using a 2-inch OD split spoon sampler. One soil sample was obtained from each of the borings at the water table for laboratory analysis of TOC. In addition to the analytical sample, one sample was collected from each boring for grain size analysis to verify field classifications of soil.

One monitoring well was installed in each of the soil borings described previously. The monitoring wells were constructed of 4-inch ID PVC and were screened across the water table to monitor for floating contaminants and to allow for seasonal fluctuations in the water table. Aquifer hydraulic conductivities were evaluated in each monitoring well by performing two rising-head tests per well in the newly installed monitoring wells.

Two rounds of groundwater samples were collected from each of the newly installed monitoring wells. The first round was collected in September 1992 and the second round was collected in January 1993. A total of four groundwater samples per round were submitted for laboratory analysis of PAL organics and inorganics, TPHC, PAL explosives, and PAL anions and cations. All of the groundwater samples from SA 28, analyzed for inorganics, were collected as non-filtered samples.

5.4.3 Field Investigation Results and Observations

SA 28 is located in the Shirley Quadrangle. Although the surficial geology of the Shirley Quadrangle has not been mapped, conditions reported in the Clinton Quadrangle (Koteff, 1966) can be projected northward to SA 28. It is inferred that the surficial materials at SA 28 are generally deltaic forest sediments associated with the Ayer Stage of glacial Lake Nashua. The geologic conditions of the South Post are presented in further detail in Section 2.0.

Soil types encountered in the four monitoring well borings are generally sands (typically fine sands), silty sands, and silts. Bedrock was not encountered in any of the soil boring. Grain size testing of five subsurface soil samples collected from the four soil borings, showed that sand content ranges from 93.4 to 39.3 percent, fines from 8.1 to 60.7 percent, and gravel from 0.0 to 0.9 percent. Water contents range from 13.6 to 28.2 percent. Soil boring logs are provided in Appendix B, and grain size results are provided in Appendix J.

Four monitoring wells (28M-92-01X through 28M-92-04X) were installed in the soil borings mentioned above at SA 28. Monitoring well screens were installed across the water table in each monitoring well. Well completion details are provided in Appendix C.

An installation-wide water-level survey of 139 monitoring wells and 15 surface water stations was conducted on December 22, 1992. Included in the survey were the SA 28 monitoring wells and a surface water measurement at Slate Rock Pond (station SWEL-10). The data from this round, and earlier rounds are presented in Appendix I.

Water levels and inferred flow directions are shown in Figure 5.4-2. SA 28 is elevated approximately 25 feet above Slate Rock Pond, which is located south of SA 28 and is an impoundment of Slate Rock Brook. The inferred groundwater flow directions are to the south southeast and toward the Slate Rock Pond.

South of Attu Road, horizontal hydraulic gradients are on the order of 0.03 ft/ft. North of the road, between wells 28M-92-01X and 28M-92-02X, the gradient is approximately 0.007 ft/ft.

Aquifer hydraulic conductivity of the soil at the water table was determined for all four wells. Conductivities range from 1 X 10^{-4} (in 28M-92-01X) to 2 X 10^{-3} (in 28M-92-01X and 28M-92-04X). The results of the hydraulic conductivity tests are provided in Appendix A.

One possible groundwater flow path would be approximately from 28M-92-01X, across the area of the suspected disposal pits, past 28M-92-04X and 28M-92-03X, to Slate Rock Pond. Assuming that the gradients measured between those wells and the geometric means of the conductivities determined for those wells are representative of average conditions along the flow path, and further assuming that the effective porosity of the aquifer is 0.30, the average rate of groundwater flow at the water table would be approximately 26 ft/yr from 28M-92-01X to 28M-92-02X, and 69 ft/yr from 28M-92-04X to Slate Rock Pond.

The major surface water body in the region is Slate Rock Pond and Slate Rock Brook which drains to the Nashua River. The water of the Nashua River has been assigned to Class B. Class B surface water is "designated for the uses of protection and propagation of fish, other aquatic life and wildlife, and for primary and secondary contact recreation" (314 CMR 4.03).

Groundwater in the surficial aquifer at the facility has been assigned to Class I under Commonwealth of Massachusetts regulations. Class I consists of groundwaters that are "found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated as a source of potable water supply" (314 CMR 6.03).

5.4.4 Nature and Distribution of Contamination

The objective of sampling program at SA 28 was to investigate for the presence of environmental contamination generated by the historical use of the explosives detonation range and demolition range and, if found, assess the vertical and horizontal distribution of contaminants, and to recommend further actions. Soil borings were advanced up and down gradient of the SA for the purposes of installing groundwater monitoring wells for the collection of groundwater samples. Shallow soil borings were drilled for the purpose of collecting soil samples in two suspected burn pits. The burn pits were selected for sampling because of visible evidence of ammunition debris based on the UXO survey conducted prior to the investigation. Soil samples from these suspected burn pits were submitted for laboratory analysis of PAL organics, PAL inorganics, pesticide/PCBs, TPHC, and PAL explosives. Groundwater samples were submitted for laboratory analysis of PAL organics and inorganics, pesticides/PCBs, TPHC, and PAL explosives.

5.4.4.1 Soil. Two soil samples were collected from a soil boring in two of the suspected burn pits. One soil sample from each boring was collected from the surface, and another from the depth interval 2 feet to 4 feet bgs. No VOCs were detected in any of the samples and bis (2-ethylhexyl) phthalate and n-nitrosodiphenylamine were the only SVOCs detected. Bis (2-ethylhexyl) phthalate is considered a common laboratory contaminant and does not appear to be a site contaminant. Subsection 3.2.2 discusses this compound as a laboratory contaminant. The n-nitrosodiphenylamine is a suspected degradation product of explosives. All four samples contained detectable concentrations of TPHC; the highest concentration (159 μg/g) was detected in the surface sample collected from 28E-92-02X. 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE were also detected at trace concentrations in 28E-92-01X at 2 feet to 4 feet and 28E-92-02X at 0 feet to 2 feet bgs (Table 5.4-1; Figure 5.4-3).

Inorganic analytes (beryllium, copper, iron, lead, sodium, and zinc) were detected at concentrations above the established Fort Devens background concentrations in the 2-foot to 4-foot sample from 28E-92-01X and the 0-foot to 2-foot sample from 28E-92-02X samples. The remaining two samples contained elevated sodium only (Table 5.4-2; Figure 5.4-4).

5.4.4.2 Groundwater. No organic analytes other than bis (2-ethylhexyl) phthalate were detected in groundwater samples collected from the four monitoring wells at SA 28. Bis (2-ethylhexyl) phthalate is considered a common laboratory contaminant and does not appear to be a site contaminant. Subsection 3.2.2 discusses this compound as a laboratory contaminant. Inorganic analytes were detected at concentrations above their established Fort Devens background concentration in three of the four groundwater samples (28M-92-02X through 28M-92-04X) collected during Round One. TSS analysis was not conducted on the samples collected during Round One. The results for the Round Two groundwater samples did not indicate the presence of any organic compounds. Inorganic analytes were detected above the established Fort Devens background concentrations but the number of inorganic analytes detected was less in Round Two. These analytes included barium and potassium in 28M-92-02X and zinc in 28M-92-01X through 28M-92-04X. As part of the Round Two groundwater sampling event, each groundwater sample was analyzed for TSS to evaluate the inorganic concentrations detected in the groundwater samples. The results of this analysis indicated that TSS was present in the groundwater samples collected from SA 28 ranging from 55 mg/L in 28M-92-01X to 108 mg/L in 28M-92-02X. Based on these results, it appears that the inorganics detected above their established background are a function of suspended solids (Table 5.4-3; Figure 5.4-5).

5.4.5 Source Evaluation and Migration Potential

The objective of the sampling program at SA 28 was to investigate the distribution of contaminants in soil and groundwater. The laboratory results of the shallow soil samples collected from the suspected burn pits indicate that the soil is contaminated with SVOCs, TPHC, and inorganic analytes (beryllium, copper, iron, lead, sodium, and zinc). Given the historical use of SA 28, the source of these analytes is likely from unexploded ordnance detonation/disposal. The presence of TPHC in near-surface soils is consistent with the presumed waste explosive detonation activities where diesel fuel was used in waste ammunition burning.

The source of the pesticides detected in SA 28 soil samples is not obvious given the presumed historical use of the SA. These pesticide residues are detected in other surface soil and sediment samples collected from other locations on the South Post, and distribution of these compounds suggest historical aerial pesticide use.

Groundwater contaminants, suspected to be at this SA, were not detected in the eight groundwater samples collected from SA 28. Bis (2-ethylhexyl) phthalate, was the only organic compound detected in groundwater samples collected from SA 28. This compound is suspected to be a laboratory contaminant. Inorganic analyte concentrations are consistent with background concentrations. The absence of contaminants in groundwater suggests that contaminants detected in the soil samples collected from the suspected burn pits, are not migrating to the groundwater.

5.4.6 Preliminary Human Health Risk Evaluation

A preliminary human health risk evaluation was prepared for SA 28 to determine if the contaminants detected at this SA pose a risk to human receptors. For this PRE, the future use of SA 28 is assumed to be residential. Tables 5.4-4 through

5.4-6 present summary statistics and human health standards and guidelines used in the PRE for SA 28.

5.4.6.1 Soils. As discussed in Section 3.5 (Preliminary Risk Evaluation Methodology), all soils to a depth of 3 feet are classified as surface soil and considered to be as accessible under a residential future use exposure scenario. All soils collected from 3-15 feet in depth are classified as subsurface and are considered to be accessible under a commercial/industrial future use exposure scenario. However, in the case of SA 28, soil samples were taken from two depths (0 to 2 feet and greater than 2 feet). For the purpose of this PRE, the samples taken at SA 28 from 0 to 2 feet will be considered surface soils and the samples taken from 2 feet and greater will be considered subsurface soils.

Surface Soils. Table 5.4-4 presents summary statistics on surface soil at SA 28 and USEPA Region III residential soil concentrations for comparison. Surface soil at SA 28 is represented by samples 28E-92-01X, 28E-92-02X, and 28M-92-04X. An assessment of the organic compound data for SA 28 surface soils shows that there is limited contamination from 4,4'-DDE, 4,4'-DDT, and bis (2-ethylhexyl) phthalate. The maximum detected concentrations of the organic compounds are, however, below the USEPA Region III residential soil concentrations.

When comparing against statistical background, the inorganic data for SA 28 surface soils show that there are several compound exceedances, most notably copper, sodium, and zinc. Of the three analytes detected above the established background concentrations, none of the analytes were detected at concentrations above their respective health-based soil guidelines. One additional analyte, arsenic, was detected at concentrations above the USEPA Region III residential soil concentrations. Although arsenic was detected at concentrations above the residential soil concentration (0.97 μg/g), the maximum detected concentration did not exceed the established Fort Devens background concentration for arsenic (21 μg/g).

Subsurface Soils. Table 5.4-5 presents summary statistics on subsurface soil at SA 28 and USEPA Region III commercial/industrial soil concentrations for comparison. Subsurface soil at SA 28 is represented by samples 28E-92-01X, 28E-92-02X, and 28M-92-01X through 28M-92-03X. An assessment of the organic compound data for SA 28 subsurface soils shows that there is limited contamination from 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and n-nitrosodiphenylamine. The maximum detected concentrations of the organic compounds are, however, below the USEPA Region III commercial/industrial soil concentrations.

When comparing against the established Fort Devens soil background, the inorganic data for SA 28 subsurface soils show that there are several compound exceedances, most notably beryllium, copper, iron, lead, sodium, and zinc. Of the six analytes detected above the established background levels, only beryllium was detected at a concentration (0.74 μg/g) above its respective health-based soil guideline (0.67 μg/g). Beryllium was detected in one of the two subsurface soil samples analyzed for inorganic analytes. One additional analyte, arsenic, was detected at concentrations above the USEPA Region III commercial/industrial soil concentrations. Although arsenic was detected at concentrations above the commercial/industrial soil concentration (1.6 μg/g), the maximum detected concentration (10.8 μg/g) did not exceed the base-wide background concentration for arsenic (21 μg/g).

5.4.6.2 Groundwater. Table 5.4-6 presents summary statistics on groundwater associated with SA 28 and drinking water standards/guidelines for comparison. Monitoring wells 28M-92-01X through 28M-92-04X represent the groundwater associated with SA 28.

Two organic compounds were detected in the groundwater associated with SA 28: bis (2-ethylhexyl) phthalate and chloroform. The maximum detected concentration of chloroform was below its drinking water standard/guideline. Bis (2-ethylhexyl) phthalate was detected in two of nine samples and the maximum and average concentrations exceeded the USEPA Region III tap water concentration; however, bis (2-ethylhexyl) phthalate is a common laboratory contaminant and is not considered to be a SA related contaminant.

An assessment of the inorganic data for SA 28 groundwater shows that there is inorganic analyte contamination directly surrounding the SA. When comparing groundwater concentrations to the statistical background, the inorganic data for SA 28 groundwater shows that there are several compound exceedances, most notably, aluminum and iron.

A drinking water standard or guideline is available for nine of the ten inorganic analytes detected above the established background concentrations. Of the nine inorganic analytes detected above the established background levels, two analytes were detected at concentrations above their respective drinking water standard/guideline. Aluminum and iron were detected in nine of nine samples collected and each average concentration exceeded its respective USEPA secondary MCL. (Secondary MCLs are set for aesthetic or economic reasons, not health reasons.) The average concentration of manganese in groundwater also exceeded the secondary MCL; however, the maximum detected concentration is below the established background. Based on this screening-level analysis, contaminants detected in groundwater at SA 28 are not expected to pose a significant risk to public health.

5.4.7 Preliminary Ecological Risk Evaluation

The purpose of the PRE at SA 28 is to provide a screening-level evaluation of actual and potential risks that environmental contaminants may pose to the resident and migratory ecological receptors at the site.

The obstacle course facility is an unpaved sand lot with little vegetation. Herbaceous species (predominantly graminoids) cover approximately 10 percent of the area; occasional sweet fern (*Comptonia peregrina*) also occurs at the obstacle course. This area provides minimal habitat for wildlife species.

The suspected burn pits occur in a mixed white pine (*Pinus strobus*)/oak (*Quercus spp.*) forest, with a moderately dense understory. Plant species observed in this region include gray birch (*Betula populifolia*), sweet fern (*Comptonia peregrina*), bracken fern (*Pteridium aquilinum*), and lowbush blueberry (*Vaccinium angustifolium*). The pits are small in size, and likely do not provide significant wildlife habitat. However, the sandy soils in the region do not permit water to remain on the surface for sufficient time to provide aquatic or vernal pool habitat (Poole, 1993).

No records exist documenting the current or historical presence of rare and endangered fauna in the region of SA 28. However, a state-listed plant species is known to occur at or in the vicinity of the site (Hunt and Zaremba, 1992).

Three organic analytes (4,4-DDT, 4,4-DDE, and bis (2-ethylhexyl) phthalate) were detected in two surface soil samples collected from the explosion craters: all three were chosen as CPCs. Eleven inorganic analytes were also detected in these two samples (Table 5.4-7). The maximum concentrations of copper and zinc were higher than background and these analytes were therefore chosen as surface soil CPCs. Copper occurred at both test pit locations at a maximum concentration of 306 μg/g. Zinc was detected in both samples at a maximum concentration of 8,300 μg/g.

Although the SA 28 pits provide minimal wildlife habitat, potential contaminant exposure pathways may exist for terrestrial receptors via incidental soil ingestion and terrestrial food web exposure.

5.4.7.1 Surface Soils. A screening-level evaluation of potential effects from explosion craters surface soil exposure was conducted by comparing the maximum concentrations of 4,4-DDT, 4,4-DDE, bis (2-ethylhexyl) phthalate, copper, and zinc to their respective surface soil benchmark values (see Table 5.4-7). The maximum concentrations of 4,4-DDT, 4,4-DDE, and bis (2-ethylhexyl) phthalate were less than their benchmark values. The maximum concentrations of copper and zinc, however, were greater than their established surface soil benchmark values. Copper was detected at concentrations ranging from 4 to 306 μg/g, with an average concentration of 155 μg/g. This average concentration is approximately 5 times the ecological benchmark for copper. Zinc was detected at a malcimum concentration of 8,300 μg/g, with an average concentration of 4,156 μg/g, approximately 6.5 times its benchmark value.

Because of the limited habitat associated with the suspected burn pits, it is unlikely that significant ecological risk results from the relatively low concentrations of zinc and copper in surface soil at SA 28.

5.4.8 Conclusions and Recommendations

The primary concern at SA 28 has been the residual contamination due to releases from historical waste explosives detonation. Sampling and analysis during the SI, however, revealed no significant soil or groundwater contaminant levels. PREs conducted for detected contaminants also indicated that no unacceptable ecological and human health risks are associated with this study area. Therefore, NFA is recommended for SA 28.

TABLE 5.4–1
ORGANIC ANALYTES IN SOIL
SA 28 – WASTE EXPLOSIVE DETONATION RANGE (TRAINING AREA 14)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BORING	28E–92–01X	28E–92–01X	28E–92–02X	28E–92–02X	28M–92–01X	28M–92–02X	28M–92–03X	28M–92–04X
	DEPTH	0 FT	2 FT	0 FT	2 FT	6 FT	2 FT	10 FT	0 FT
SEMIVOLATILES (ug/g)									
BIS (2–ETHYLHEXYL)PHTHALATE		1.1	< 0.6	< 0.6	< 0.6	NA	NA	NA	NA
N–NITROSODIPHENYLAMINE		< 0.2	< 0.2	< 0.2	1.5	NA	NA	NA	NA
PESTICIDES/PCBS (ug/g)									
4,4'–DDD		< 0.008	0.045	< 0.008	< 0.008	NA	NA	NA	NA
4,4'–DDE		< 0.008	0.38	0.016	< 0.008	NA	NA	NA	NA
4,4'–DDT		< 0.007	1.6	0.051	< 0.007	NA	NA	NA	NA
OTHER (ug/g)									
TOTAL ORGANIC CARBON		NA	NA	NA	NA	601.0	374.0	618.0	NA
TOTAL PETROLEUM HYDROCARBON		42.7	48.4	159.0	44.0	NA	NA	NA	NA

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT ANALYTE LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

NA = NOT ANALYZED

TABLE 5.4–2
INORGANIC ANALYTES IN SOIL
SA 28 – WASTE EXPLOSIVE DETONATION RANGE (TRAINING AREA 14)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	BACK–	BORING	28E–92–01X	28E–92–01X	28E–92–02X	28E–92–02X
ANALTE (ug/g)	GROUND	DEPTH	0 FT	2 FT	0 FT	2 FT
ALUMINUM	15000.0		3400.0	5340.0	4250.0	4550.0
ANTIMONY	NA		< 1.1	3.23	< 1.1	< 1.1
ARSENIC	21.0		3.31	8.05	8.05	10.8
BARIUM	42.5		17.5	27.0	20.6	25.6
BERYLLIUM	.347		< 0.5	0.74	< 0.5	< 0.5
CALCIUM	1400.0		747.0	260.0	277.0	642.0
CHROMIUM	31.0		<4.0	7.65	6.01	<4.0
COBALT	NA		< 1.4	2.51	< 1.4	< 1.4
COPPER	8.39		3.95	228.0	306.0	4.98
IRON	15000.0		4020.0	18300.0	6540.0	4340.0
LEAD	48.4		3.08	180.0	29.0	5.25
MAGNESIUM	5600.0		868.0	920.0	1010.0	972.0
MANGANESE	300.0		40.7	199.0	67.9	44.4
MERCURY	0.22		< 0.05	< 0.05	0.105	< 0.05
NICKEL	14.0		3.81	8.17	5.82	4.23
POTASSIUM	1700.0		588.0	393.0	495.0	693.0
SELENIUM	NA		< 0.25	0.584	< 0.25	< 0.25
SODIUM	131.0		213.0	182.0	173.0	229.0
VANADIUM	28.7		5.29	6.27	5.38	6.7
ZINC	35.5		13.6	8300.0	8300.0	16.3

NOTES:

TABLES LISTS DETECTED ANALYTES ONLY – SEE PROJECT ANALYTE LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

NA = NOT AVAILABLE

▨ = VALUE ABOVE BACKGROUND LEVEL

TABLE 5.4–3
ANALYTES IN GROUNDWATER
SA 28 – WASTE EXPLOSIVE DETONATION RANGE (TRAINING AREA 14)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		ROUND 1	ROUND 2	ROUND 1	ROUND 2
ANALYTE	**BACK–GROUND**	**28M–92–01X**	**28M–92–01X**	**28M–92–02X**	**28M–92–02X**
INORGANICS (µg/L)					
ALUMINUM	6870.0	2280.0	1860.0	11100.0	2340.0
ARSENIC	10.5	3.9	< 2.54	9.5	< 2.54
BARIUM	39.6	14.4	15.3	73.6	47.3
CALCIUM	14700.0	1910.0	1490.0	7530.0	7070.0
CHROMIUM	14.7	< 6.0	< 6.0	14.1	< 6.0
COPPER	8.09	< 8.0	< 8.0	8.9	< 8.0
IRON	9100.0	2410.0	1810.0	12300.0	2670.0
LEAD	4.25	2.2	1.52	4.8	2.17
MAGNESIUM	3480.0	693.0	545.0	3010.0	1120.0
MANGANESE	291.0	86.4	43.1	252.0	46.0
POTASSIUM	2370.0	461.0	1560.0	2790.0	3640.0
SILVER	4.6	< 4.6	< 4.6	< 4.6	< 4.6
SODIUM	10800.0	1380.0	1430.0	7760.0	8600.0
VANADIUM	11.0	< 11.0	< 11.0	13.5	< 11.0
ZINC	21.1	< 21.1	23.3	44.7	30.3
ANIONS/CATIONS (µg/L)					
NITRATE/NITRITE		26.9	11.1	1900.0	880.0
CHLORIDE		< 2120.0	< 2120.0	16000.0	11300.0
ALKALINITY		7000.0	5000.0	14000.0	12000.0
BICARBONATE		8540.0	6100.0	17100.0	14600.0
OTHER (µg/L)					
TOTAL SUSPENDED SOLIDS		NA	55.0	NA	108.0

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

▨ = VALUE ABOVE BACKGROUND LEVELS

NA = NOT ANALYZED

TABLE 5.4–3
ANALYTES IN GROUNDWATER
SA 28 – WASTE EXPLOSIVE DETONATION RANGE (TRAINING AREA 14)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		ROUND 1	ROUND 2	ROUND 2	ROUND 1	ROUND 2
ANALYTE	**BACK– GROUND**	**28M–92–03X**	**28M–92–03X**	**28M–92–03X DUP**	**28M–92–04X**	**28M–92–04X**
INORGANICS ($\mu g/L$)						
ALUMINUM	6870.0	7220.0	2740.0	2810.0	7610.0	1880.0
ARSENIC	10.5	9.4	2.88	< 2.54	15.9	3.09
BARIUM	39.6	31.9	15.2	16.0	40.4	37.3
CALCIUM	14700.0	3890.0	3180.0	3070.0	3120.0	3730.0
CHROMIUM	14.7	9.3	< 6.0	< 6.0	9.3	< 6.0
COPPER	8.09	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0
IRON	9100.0	6860.0	2320.0	2530.0	10200.0	2550.0
LEAD	4.25	4.5	1.95	2.17	2.6	1.41
MAGNESIUM	3480.0	1560.0	699.0	741.0	1950.0	1060.0
MANGANESE	291.0	223.0	108.0	110.0	184.0	49.7
POTASSIUM	2370.0	1610.0	1590.0	1680.0	2120.0	982.0
SILVER	4.6	< 4.6	< 4.6	< 4.6	4.9	< 4.6
SODIUM	10800.0	1610.0	1580	1520.0	3820.0	4430.0
VANADIUM	11.0	< 11.0	< 11.0	< 11.0	14.6	< 11.0
ZINC	21.1	51.8	42.5	48.8	34.0	31.3
ANIONS/CATIONS ($\mu g/L$)						
NITRATE/NITRITE		24.9	15.4	14.3	11.8	18.6
CHLORIDE		< 2120.0	< 2120.0	< 2120	4580.0	4710.0
ALKALINITY		9000.0	18000.0	11000.0	15000.0	< 5000.0
BICARBONATE		11000.0	22000.0	13400.0	18300.0	< 6100.0
OTHER ($\mu g/L$)						
TOTAL SUSPENDED SOLIDS		NA	93.0	86.0	NA	84.0

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

▨ = VALUE ABOVE BACKGROUND LEVELS

NA = NOT ANALYZED

TABLE 5.4-4
HUMAN HEALTH PRE EVALUATION OF SURFACE SOIL
SA 28 – WASTE EXPLOSIVE DETONATION RANGE (TRAINING AREA 14)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Soil Background Concentration [a] (ug/g)	Detected Concentration [b]		Frequency of Detection	Maximum Exceeds Background ?	Region III Residential Soil Concentration (ug/g)	Maximum Exceeds Region III Concentration ?
		Average (ug/g)	Maximum (ug/g)				
Organics							
4,4'-DDT		0.051	0.051	1/2		5	NO
4,4'-DDE		0.016	0.016	1/2		5	NO
bis (2-ethylhexyl) phthalate		1.1	1.1	1/2		120	NO
Inorganics							
aluminum	15,000	3825	4250	2/2	NO	230,000	NO
arsenic	21	5.7	8.05	2/2	NO	0.97	YES
barium	42.5	19.1	20.6	2/2	NO	5,500	NO
calcium	1,400	512	747	2/2	NO	NA	NA
chromium	31	6.01	6.01	1/2	NO	390	NO
copper	8.39	155	306	2/2	YES	2900	NO
iron	15,000	5280	6540	2/2	NO	NA	NA
lead	48.4	16	29	2/2	NO	500	NO
magnesium	5,600	939	1010	2/2	NO	NA	NA
manganese	300	54.3	67.9	2/2	NO	7,800	NO
mercury	0.22	0.105	0.105	1/2	NO	23	NO
nickel	14	4.8	5.82	2/2	NO	1,600	NO
potassium	1,700	541.5	588	2/2	NO	NA	NA
sodium	131	193	213	2/2	YES	NA	NA
vanadium	28.7	5.3	5.38	2/2	NO	550	NO
zinc	35.5	4156.8	8300	2/2	YES	23,000	NO
Other							
total petroleum hydrocarbons	NA	73.5	159	2/2	NA	NA	NA

Notes:
[a] Base-wide background soil inorganics database
[b] Surface soil samples from sampling stations 28E-92-01X, 28E-92-02X, and 28M-92-04X
NA = not available
ug/g = micrograms per gram

TABLE 5.4–5
HUMAN HEALTH PRE EVALUATION OF SUBSURFACE SOIL
SA 28 – WASTE EXPLOSIVE DETONATION RANGE (TRAINING AREA 14)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Soil Background Concentration [a] (ug/g)	Detected Concentration [b]		Frequency of Detection	Maximum Exceeds Background ?	Region III Commercial/Industrial Concentration (ug/g)	Maximum Exceeds Region III Concentration ?
		Average (ug/g)	Maximum (ug/g)				
Organics							
4,4'–DDT		1.6	1.6	1/2		8.4	NO
4,4'–DDD		0.045	0.045	1/2		12	NO
4,4'–DDE		0.38	0.38	1/2		8.4	NO
n–nitrosodiphenylamine		1.5	1.5	1/2		580	NO
Inorganics							
aluminum	15,000	4945	5340	2/2	NO	3,000,000	NO
antimony	NA	3.23	3.23	1/2	NA	410	NO
arsenic	21	9.4	10.8	2/2	NO	1.6	YES
barium	42.5	26.3	27	2/2	NO	72,000	NO
beryllium	0.347	0.74	0.74	1/2	YES	0.67	YES
calcium	1,400	451	642	2/2	NO	NA	NA
chromium	31	7.65	7.65	1/2	NO	5,100	NO
cobalt	NA	2.51	2.51	1/2	NA	NA	NA
copper	8.39	116.5	228	2/2	YES	38,000	NO
iron	15,000	11320	18300	2/2	YES	NA	NA
lead [c]	48.5	92.6	180	2/2	YES	500	NO
magnesium	5,600	946	972	2/2	NO	NA	NA
manganese	300	121.7	199	2/2	NO	100,000	NO
nickel	14	6.2	8.17	2/2	NO	20,000	NO
potassium	1,700	543	693	2/2	NO	NA	NA
selenium	NA	0.584	0.584	1/2	NA	5,100	NO
sodium	131	205.5	229	2/2	YES	NA	NA
vanadium	28.7	6.5	6.7	2/2	NO	7,200	NO
zinc	35.5	4158.2	8300	2/2	YES	310,000	NO
Other							
total petroleum hydrocarbons	NA	46.2	48.4	2/2	NA	NA	NA

Notes:

[a] Base–wide background soil inorganics database

[b] Subsurface soil samples from sampling stations 28E–92–01X, 28E–92–02X, 28M–92–01X to 28M–92–03X

[c] The Region III Residential Soil concentration for Lead was used as a surrogate for the commercial/industrial concentration for lead.

NA = not available

ug/g = micrograms per gram

TABLE 5.4-6
HUMAN HEALTH PRE EVALUATION OF GROUNDWATER
SA 28 – WASTE EXPLOSIVE DETONATION RANGE (TRAINING AREA 14)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Groundwater Background Concentration (ug/L)	Detected Concentration [a]		Frequency of Detection	Maximum Exceeds Background?	Drinking Water Standard/Guideline [b] (ug/L)	Maximum Exceeds Standard/Guideline?
		Average (ug/L)	Maximum (ug/L)				
Organics							
bis(2-ethylhexyl)phthalate		8.5	8.6	2/9		6.1	YES
chloroform		0.55	0.55	1/9		5	NO
Inorganics							
aluminum	6870	4426.7	11100	9/9	YES	50-200	YES
arsenic	10.5	7.4	15.9	6/9	YES	50	NO
barium	39.6	32.4	73.6	9/9	YES	2000	NO
calcium	14700	3887.8	7530	9/9	NO	NA	NA
chromium	14.7	10.9	14.1	3/9	NO	100	NO
copper	8.09	8.9	8.85	1/9	YES	1300	NO
iron	9100	4850	12300	9/9	YES	300	YES
lead	4.25	2.6	4.77	9/9	YES	15	NO
magnesium	3480	1264.2	3010	9/9	NO	NA	NA
manganese	291	122.5	252	9/9	NO	50	YES
potassium	2370	1825.9	3640	9/9	YES	NA	NA
silver	4.60	4.92	4.92	1/9	YES	50	NO
sodium	10800	3570	8600	9/9	NO	28000	NO
vanadium	11	14.1	14.6	2/9	YES	260	NO
zinc	21.1	38.3	51.8	8/9	YES	5000	NO
Anions/Cations							
nitrite/nitrate	NA	322.6	1900	9/9	NA	10000	NO
Other							
total suspended solids	NA	85200	108000	5/5	NA	NA	NA

Notes:

[a] Based on unfiltered samples from Round 1 and Round 2

[b] Includes the lowest of either the EPA or MA drinking water standards, or if no federal standard or guideline is available, the Region III tap water concentration

SA 28 is represented by the following monitoring wells: 28M-92-01X through 28M-92-04X (including one duplicate sample).

NA = Not available

ug/L = micrograms per liter

TABLE 5.4–7
ECOLOGICAL PRE EVALUATION OF SURFACE SOIL
SA 28 – WASTE EXPLOSIVE DETONATION RANGE (TRAINING AREA 14)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Soil Background Concentration [a] (ug/g)	Concentration [b]		Frequency of Detection	Maximum Exceeds Background?	Ecological Benchmarks (ug/g)	Maximum Exceeds Benchmark?
		Average (ug/g)	Maximum (ug/g)				
Organics							
4,4'–DDT	NA	0.051	0.051	1/2	NA	1.07	NO
4,4'–DDE	NA	0.016	0.016	1/2	NA	1.07	NO
bis (2–ethylhexyl) phthalate	NA	1.1	1.1	1/2	NA	84	NO
Inorganics							
aluminum	15000	3825	4250	2/2	NO		
arsenic	21	5.7	8.05	2/2	NO		
barium	42.5	19.1	20.6	2/2	NO		
chromium	31	6.01	6.01	1/2	NO		
copper	8.39	155	306	2/2	YES	34	YES
lead	48.4	16	29	2/2	NO		
manganese	300	54.3	67.9	2/2	NO		
mercury	0.22	0.105	0.105	1/2	NO		
nickel	14.0	4.8	5.82	2/2	NO		
vanadium	28.7	5.3	5.38	2/2	NO		
zinc	35.5	4156.8	8300	2/2	YES	640	YES

Notes:

[a] Base–wide background soil inorganics database

[b] Surface soil samples from sampling stations 28E–92–01X and 28E–92–02X. 28M–92–04X was sampled in this area, but was not analyzed

NA = not available

ug/g = micrograms per gram

––– = Analyte not a CPC for this medium

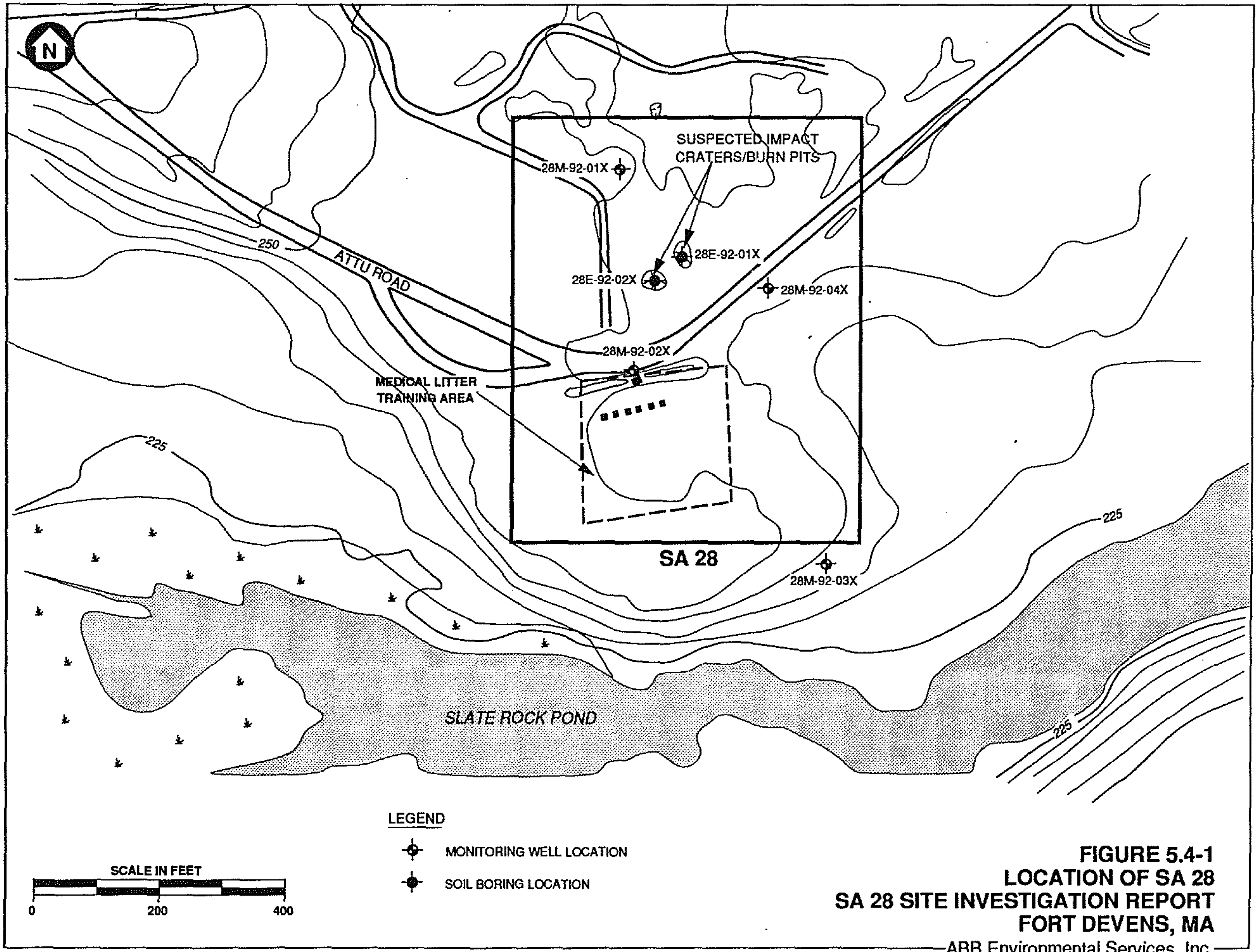


FIGURE 5.4-1
LOCATION OF SA 28
SA 28 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

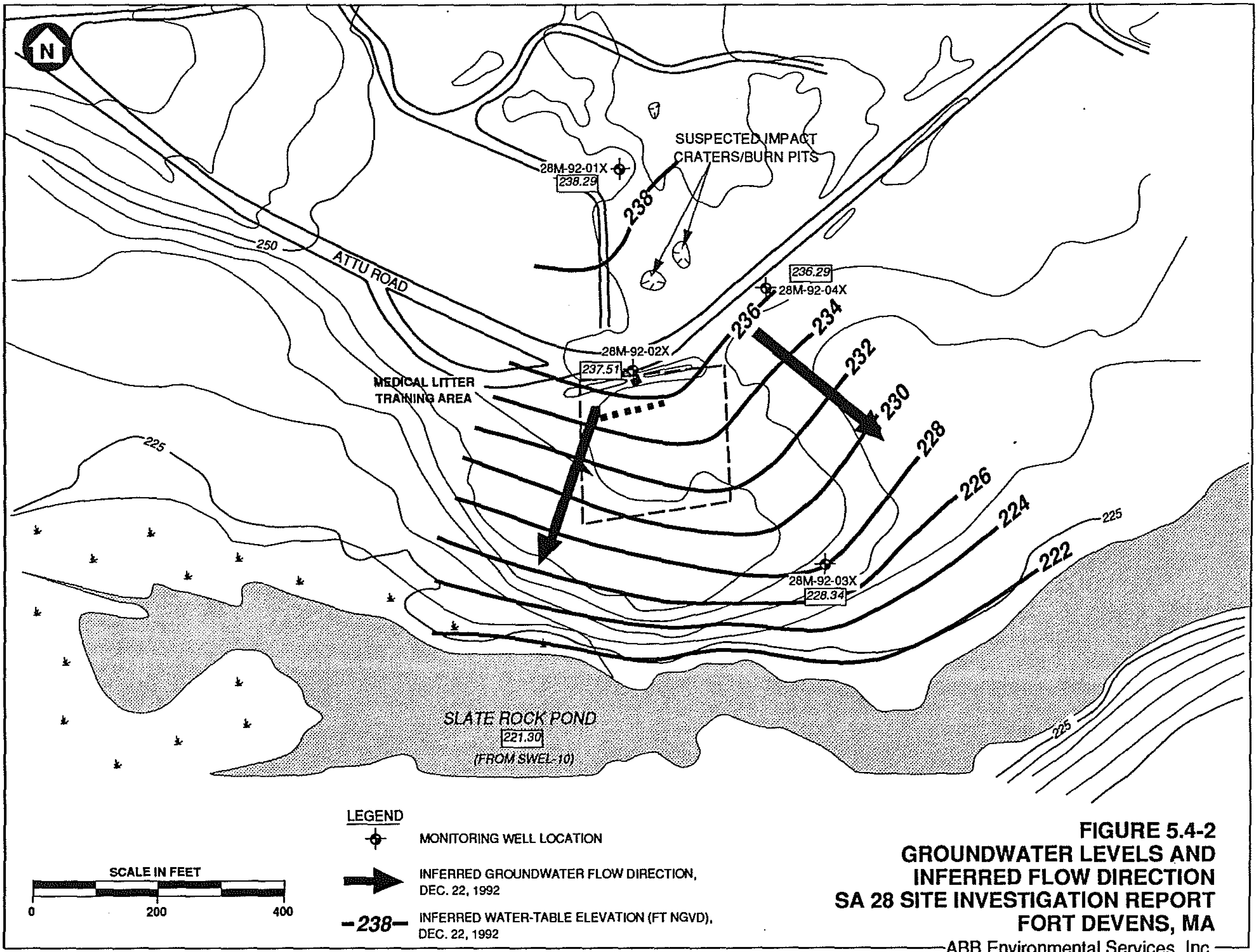


FIGURE 5.4-2
GROUNDWATER LEVELS AND INFERRED FLOW DIRECTION
SA 28 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9304049D(y) 1 3

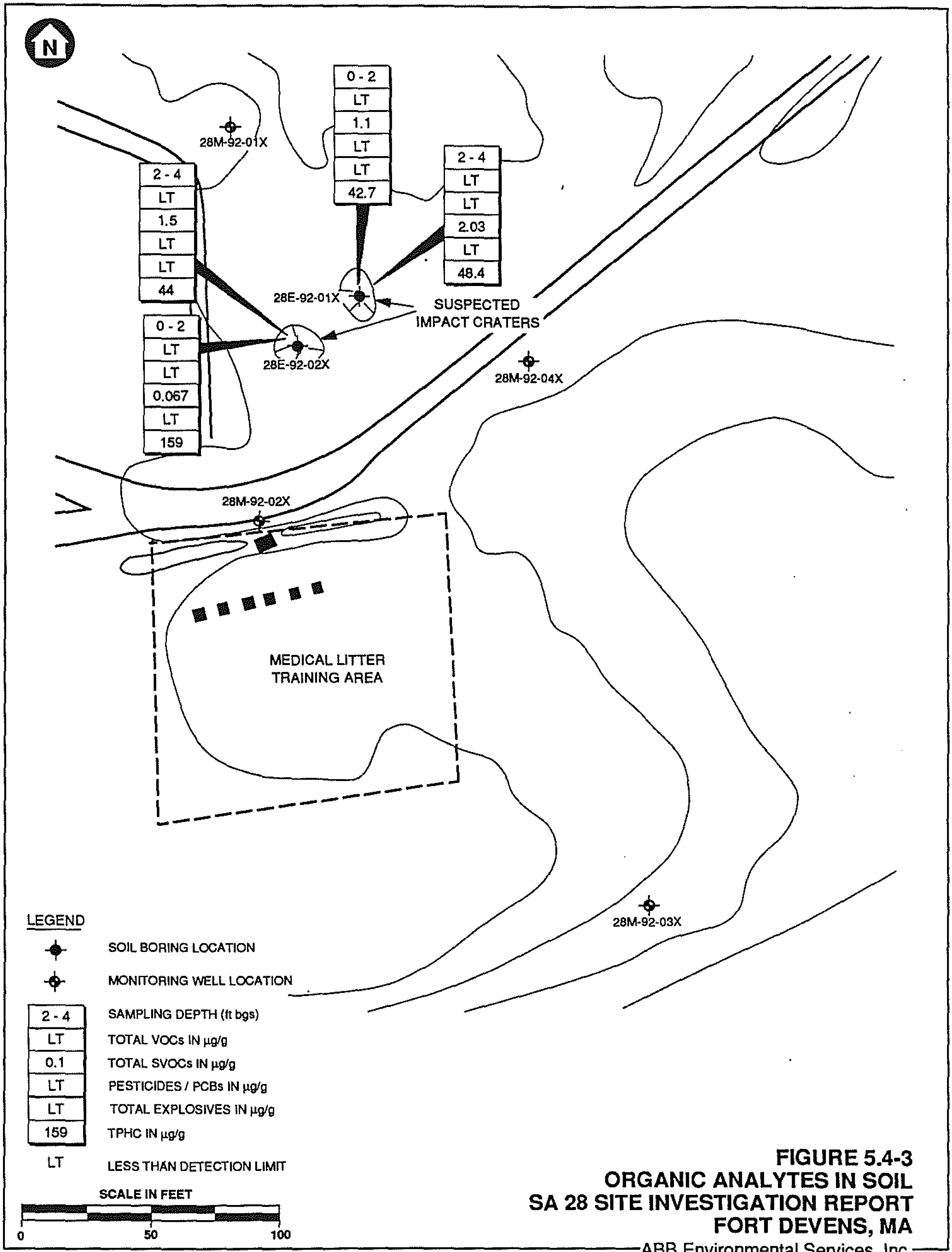


FIGURE 5.4-3
ORGANIC ANALYTES IN SOIL
SA 28 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9304049(y1) 1 3 6

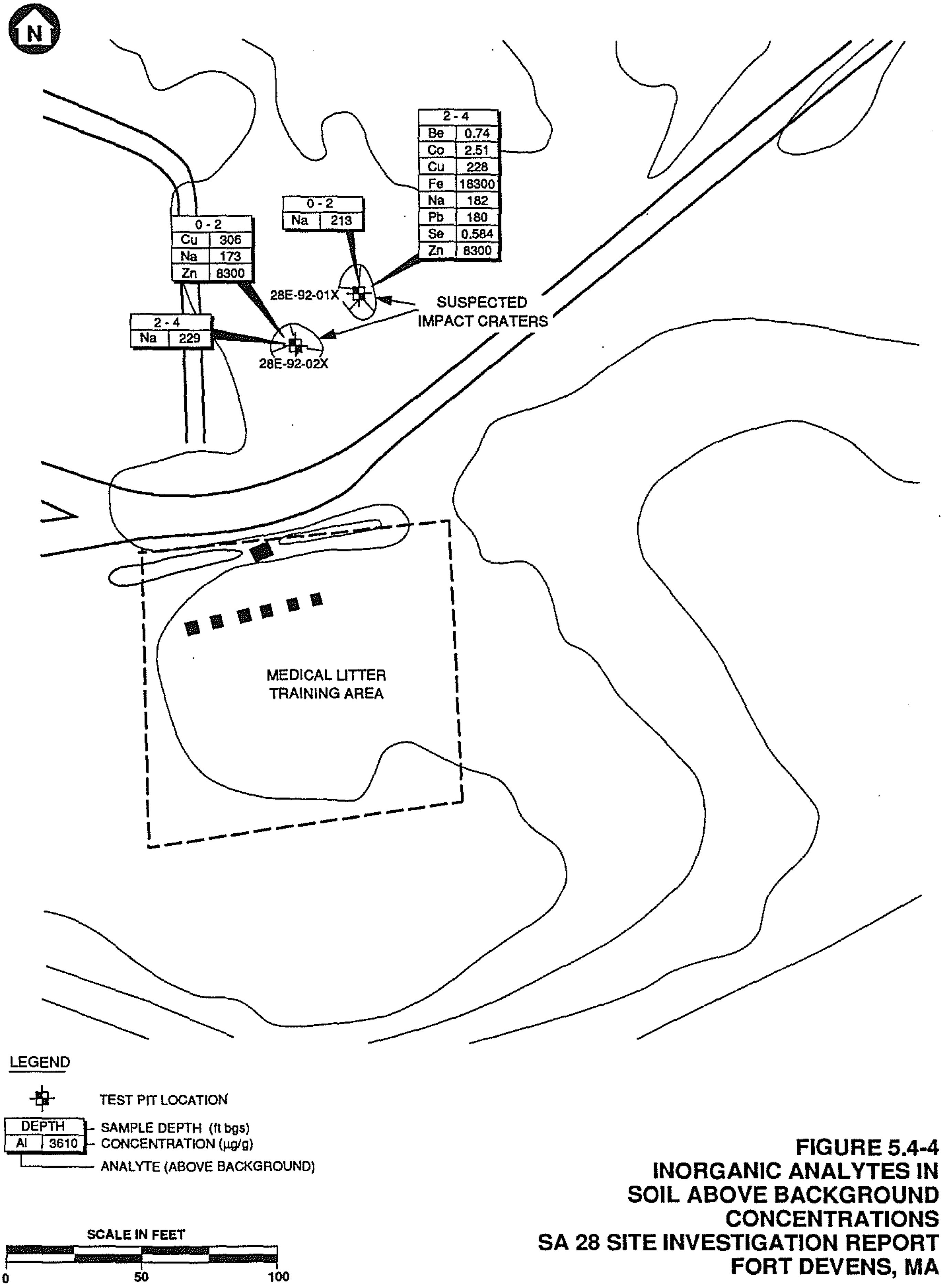


FIGURE 5.4-4
INORGANIC ANALYTES IN SOIL ABOVE BACKGROUND CONCENTRATIONS
SA 28 SITE INVESTIGATION REPORT
FORT DEVENS, MA

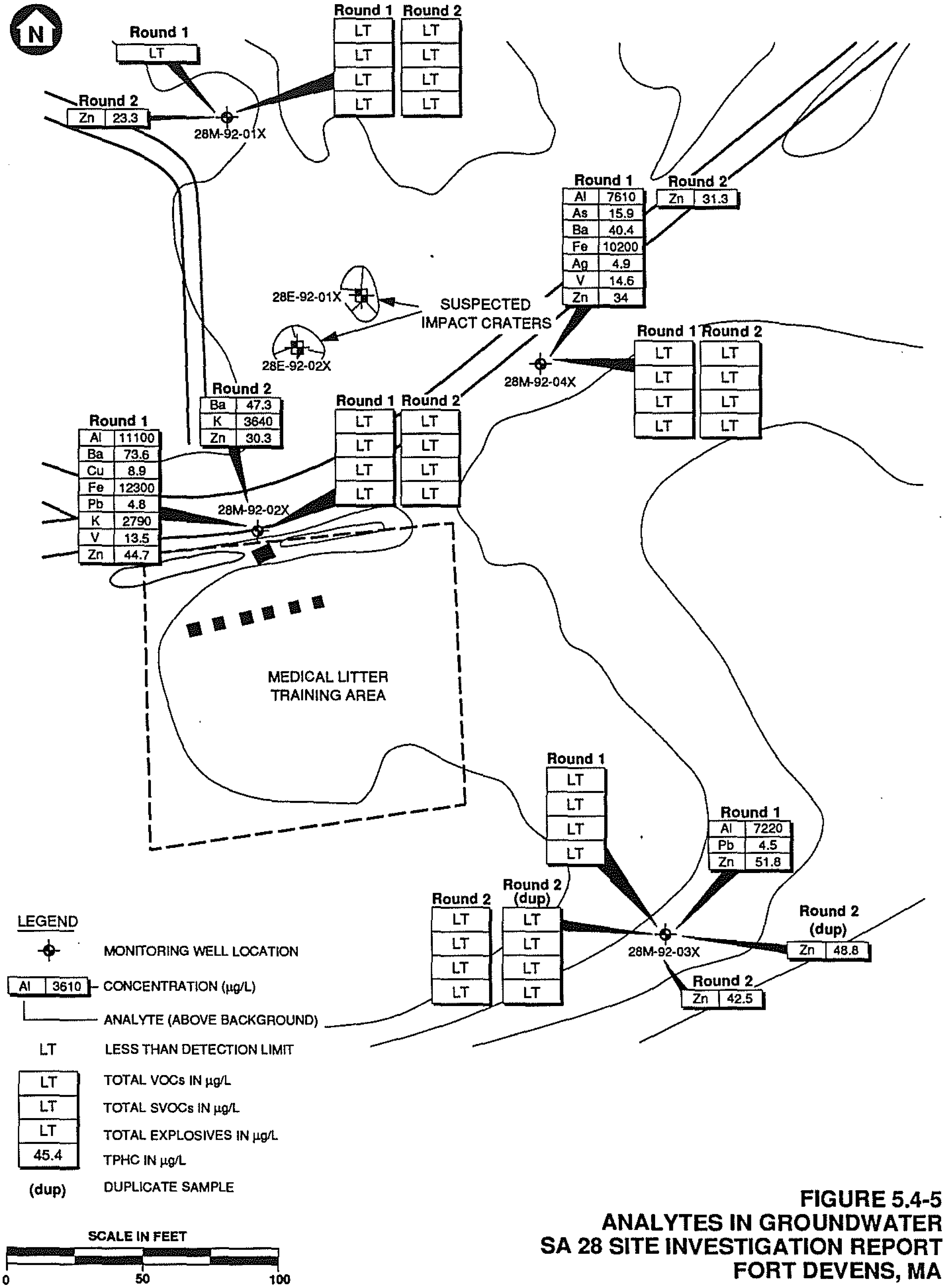


FIGURE 5.4-5
ANALYTES IN GROUNDWATER
SA 28 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

5.5 SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

5.5.1 Background and Conditions

SA 41 is approximately 1-acre in size and is located between Harvard Road, New Cranberry Pond, and an eastern portion of the impact area in the South Post (Figure 5.5-1). The landfill material appears to have been associated with an old brick-making kiln that was operated in this area in the 1800s. The SA is overgrown with trees and swampy vegetation, and no records are available detailing when the site was used or what type of material was disposed in this area. It is believed that this SA was used until the 1950s for disposal of nonexplosive military and household debris. The SA was originally thought to contain numerous brake fluid cans. Recent investigation has revealed that these cans are actually an old version of a beer can, as several with readable labels were discovered (White, 1990). The landfill is inferred to be an old farm dump. Miscellaneous debris is scattered over a small hill approximately 75 feet from New Cranberry Pond. The hill slopes down to the pond that is believed to be a surface expression of the groundwater table (see Figure 5.5-1). The water level in New Cranberry Pond is controlled by a culvert located on the eastern shore of the pond. A beaver dam periodically impedes the water flow which in turn increases the water level in the pond. Installation personnel attempt to keep the culvert clear in an effort to maintain a constant water level in the pond.

5.5.2 Site Investigation Program Summary

The SI at SA 41 was undertaken in June 1992, in accordance with the Final SI Task Order Work Plan (ABB-ES, 1992b) and in conformance to the provisions of the Project Operations Plan (ABB-ES, 1992d). The scope of the SI field investigation is presented in Table 5.5-1.

The field sampling program conducted at SA 41 consisted of drilling one soil boring for the installation of an upgradient monitoring well, the collection of 10 surface soil samples, four downgradient groundwater samples from dug sumps, and two surface water and sediment samples. These samples were collected to assess adverse impacts to SA media due to the historical use of the SA and to assess the threat to human health or the environment. The areal extent of the dump was flagged based on visual observations and the extent was surveyed for vertical and horizontal control (see Figure 5.5-1).

Groundwater flow is inferred to be southeast toward New Cranberry Pond. Therefore, boring 41M-92-01X was drilled to the water table upgradient (north) of SA 41 (see Figure 5.5-1). Soil samples were collected continuously to assess the geologic conditions at SA 41. One soil sample was collected from the water table for analysis of TOC. Three soil samples were obtained from this boring for grain size analysis to verify field classifications of soil.

One 4-inch ID PVC monitoring well was installed in the boring mentioned above. This monitoring well screen was installed to intersect the water table. Aquifer hydraulic conductivities of the soil at the water table were evaluated by performing two rising-head tests in the well after development and the first round of groundwater sampling.

Two rounds of groundwater samples (Round One and Two) were collected from the newly installed monitoring well. The first round was collected in September 1992 and the second round was collected in January 1993. As part of the Round One sampling, four downgradient groundwater samples were collected from sumps dug south of the landfill material (see Figure 5.5-1). The groundwater samples collected during Round One were not filtered for inorganic analysis. Round Two of groundwater sampling included the collection of an unfiltered and filtered groundwater sample from 41M-92-01X for inorganic analysis. Groundwater samples were not collected from the sumps during the second round. These samples were analyzed in an attempt to determine if the inorganics detected in the sample were dissolved or total. The groundwater samples from both rounds were submitted to the off-site laboratory for analysis of PAL VOCs, SVOCs, inorganics, pesticides/PCBs, TPHC, anions and cations, and explosives. The Round One groundwater samples collected from the sumps and the Round Two sample from 41M-92-01X were also analyzed for TSS.

Six surface soil samples (41S-92-01X through 41S-92-06X) from the soil cover on the fill area to assess whether the surface of the landfill poses a risk to human or ecological receptors. In addition to these soil samples, four soil samples were collected from the sumps dug between the landfill and New Cranberry Pond. These samples were obtained from 1-foot to 2-feet bgs and will be considered as surface soil (see Figure 5.5-1). The surface soil samples collected from the soil cover on the fill, were taken from areas where apparent visible contamination was observed. The surface soil samples were submitted for off-site laboratory analysis consisting of PAL VOCs, SVOCs, inorganics, pesticides/PCBs, explosives, TOC, and/or grain size.

Two surface water and sediment sample pairs (41D-92-01X and 41D-92-02X) were collected from the northern shore of New Cranberry Pond. These samples were used to assess whether the historic use of the SA has impacted surface water or sediments quality and; therefore, poses a threat to human or ecological receptors (Figure 5.5-1). Both of the surface water samples were submitted for laboratory analysis of PAL VOCs, SVOCs, inorganics, pesticide/PCBs, TPHC, explosives, and water quality parameters. The sediment samples were submitted for off-site laboratory analysis of PAL VOCs, SVOCs, inorganics pesticide/PCBs, TPHC, explosives, TOC, and grain size.

5.5.3 Supplemental Site Investigation Program Summary

The SSI at SA 41 was undertaken in September 1993, in accordance with the Task Order Work Plan (ABB-ES, 1993b) and in conformance to the provisions of the Project Operations Plan (ABB-ES, 1992d). The scope of the SSI field investigation is presented in Table 5.5-1.

The SSI was conducted to assess other potential sources of the groundwater contamination detected during the SI, further define the hydrogeologic conditions at this SA, and further investigate the potential for contaminant migration from the landfill waste material to New Cranberry Pond.

A surficial geophysical survey was conducted in the area directly north of SA 41, to determine if a source area of the chlorinated solvent contaminants, detected in the SI, could be found (see Figure 5.5-1). The geophysical survey consisted of a magnetometer survey and terrain conductivity survey. Based on the results of the surveys, no magnetic or ferrous metal anomalies were detected (Figures 5.5-2 and 5.5-3). These results of the surveys indicate that there did not appear to be source area for the detected groundwater contamination directly north of the waste material.

Five soil borings (41M-93-02A and B, 41M-93-03X, 41M-93-04X, and 41M-93-05X) were drilled upgradient and downgradient of SA 41, for the installation of groundwater monitoring wells (see Figure 5.5-1). Three soil samples were collected from the monitoring well boring at 41M-93-02B and one soil sample from 41M-93-03X, were submitted for off-site laboratory analysis consisting of PAL VOCs, SVOCs, inorganics, explosives, pesticides/PCBs, and TOC. One soil sample from each of the well points borings (41M-93-04X and 41M-93-05X) was analyzed for TOC, only. Grain-size distribution tests were performed on selected soil reference samples. Soil boring data are summarized in Table 5.5-2.

Five groundwater monitoring wells (41M-93-02A and 41M-93-02B, 41M-93-03X, 41M-93-04X, and 41M-93-05X) were installed in the soil borings mentioned above. Because the geophysical surveys did not identify a potential upgradient source, the monitoring well pair 41M-93-02A and B were installed in close proximity (approximately 60 feet north) to the existing monitoring well 41M-92-01X. This monitoring well pair location was designed to determine if the contaminants detected in the existing monitoring well were a localized occurrence. Monitoring well 41M-93-03X was installed to monitor apparent upgradient groundwater quality. Two well points were installed between the waste material and New Cranberry Pond to monitor apparent downgradient groundwater quality (see Figure 5.5-1). Table 5.5-3 summarizes the monitoring well constructions and monitoring well construction diagrams are presented in Appendix C.

The new monitoring wells were developed, and two hydraulic conductivity tests (slug tests) were performed in each monitoring well after Round Three groundwater sampling was completed.

Three sediment samples (41D-93-07X through 41D-93-09X) were collected from the wet area at the base of the waste material. No surface water samples were collected from these sampling points due to insufficient surface water volumes at the time of sampling. Two surface water and sediment pairs (41D-93-10X and 41D-93-11X) were to be collected from the northern side of New Cranberry Pond (see Figure 5.5-1). The surface water samples were analyzed for PAL VOCs, SVOCs, inorganics, explosives, pesticides/PCBs, and water quality parameters. All of the sediment samples collected from SA 41 were analyzed for PAL VOCs, SVOCs, inorganics, explosives, pesticides/PCBs, and TOC. Table 5.5-4 summarizes the soil classification for sediment samples collected form New Cranberry Pond.

Round Three groundwater samples were collected from the five newly installed monitoring wells and the existing monitoring well in October 1993. Round Four is scheduled for January 1994. The groundwater samples were analyzed for PAL VOCs, SVOCs, inorganics (both filtered and unfiltered), explosives, pesticides/PCBs, and TSS.

All newly installed monitoring wells and surface water and sediment sampling points were surveyed.

5.5.4 Field Investigation Results and Observations

Soil encountered in the monitoring well boring at 41M-93-02B were clay and silt. This material was mapped by Koteff (1966) as Ayer Stage lake deposits. This soil is very similar to the soils encountered in 41M-92-01X drilled during the SI. The soils encountered in 41M-93-03X were primarily a silty sand with some silt and clay layers as well as fine to medium sand layers. These soils appear to be more fluvial in nature and part of the Lake Nashua deposits.

This material was mapped by Koteff (1966) as Ayer Stage lake deposits, and it is a probable stratigraphic equivalent of the lake-bottom deposits mined by New England Brick Co. The boring log for this exploration is provided in Appendix B, and grain size results are provided in Appendix J.

Surface soil samples from shallow (4 to 5 feet bgs) sumps (41D-92-03X through 41D-92-06X) dug in the recent alluvium at SA 41 were submitted for grain size analysis. These samples consisted primarily of sand ranging from 56.7 to 93.0 percent silt and clay ranging from 2.0 to 12.4 percent and water content ranging from 16.9 to 24.0 percent. Two sediment samples from the deposits beneath New Cranberry Pond were also tested for grain size. One sample (from 41D-92-01X) was a silty sand with 38.6 percent fines, a water content of 241.1 percent, and some organics (vegetative matter). The other sample (from 41D-92-02X) was a well-graded sand with 18.1 percent gravel, 7.6 percent fines, water content of 37.0 percent, and a trace of organics (see Table 5.5-4). Grain size results are provided in Appendix J.

Monitoring well 41M-92-01X was installed as part of the SI at a location presumed to be upgradient of the landfill. The monitoring well was screened across the water table to monitor for floating contaminants and allow for seasonal fluctuations in the groundwater table. The SSI monitoring wells to better define the groundwater quality upgradient and downgradient of the SA. These monitoring wells were developed, and two hydraulic conductivity tests (slug tests) were performed in each monitoring well after Round Three groundwater sampling was completed.

Aquifer hydraulic conductivities for the soil at the water table were determined by conducting rising and falling head tests in monitoring well 41M-92-01X and using two different computational methods. The geometric mean of those tests is on the order of 1.73 X 10^{-5} cm/sec, consistent with the clayey nature of the soil. The results of the hydraulic conductivity test completed on SSI monitoring wells indicated that conductivity ranged from 4.0E^{-2} cm/sec at 4M-93-04X to 1.6E^{-5} at 41M-93-03X. Table 5.5-5 summarizes the hydraulic conductivity data collected.The results of these tests are provided in Appendix A.

Assuming that conductivity is representative of average conditions along a flow path from monitoring well 41M-92-01X to New Cranberry Pond, and assuming an aquifer effective porosity of 0.50 for silt/clay, the average rate of groundwater flow at the water table would be less than 1.0 ft/yr. It is likely, however, that flow rates nearer the pond would be greater, because of the higher conductivity and lower porosity associated with the apparent sandy soils.

Installation-wide water-level survey of monitoring wells and surface water stations was conducted have been conducted quarterly since May 1992. Included in these surveys were monitoring well completed during the SI and SSI field investigations and a nearby surface water measurement at New Cranberry Pond (station SWEL-12). The data from these round are presented in Appendix I.

The water table elevation data collected during the November 8, 1993 synoptic water-level round, was used to create a water table contour map was created (Figure 5.5-4). Based on these measurements, it appears that the surface water from New Cranberry pond is locally recharging groundwater south of SA 41 and causing the groundwater to flow to the north-northwest. This groundwater flow condition appears to happen when the outflow culvert for the pond is impeded by a beaver dam made of vegetation, and decline when installation personnel remove the vegetation from the pond outfall.

The major surface water body in the region is New Cranberry Pond which drains to the Nashua River. The water of the Nashua River has been assigned to Class B. Class B surface water is "designated for the uses of protection and propagation of fish, other aquatic life and wildlife, and for primary and secondary contact recreation" (314 CMR 4.03).

Groundwater in the surficial aquifer at the facility has been assigned to Class I under Commonwealth of Massachusetts regulations. Class I consists of groundwaters that are "found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated as a source of potable water supply" (314 CMR 6.03).

5.5.5 Nature and Distribution of Contamination (Laboratory Results)

The objective of sampling at SA 41 was to investigate the presence of environmental contamination generated by the historical use of the landfill, if found, assess the vertical and horizontal distribution of contaminants, and recommend further actions. Samples of soil and groundwater were collected to characterize local impacts from the landfill material. Groundwater and surface soil samples were collected for laboratory analysis to assess downgradient impacts from non-contaminated areas in the dump.

5.5.5.1 Surface Soil. Six surface soil samples were collected from visibly stained soils within the boundaries of the observed dumping area (see Figure 5.5-1). No VOCs were detected in any of the samples. SVOCs, in the form of PAHs, were detected in all six samples collected. Total concentrations of PAHs ranged from 0.16 μg/g at 41S-92-03X to 19.9 μg/g at 41S-92-02X. TPHC was detected in all but the samples collected at 41S-92-03X and 41S-92-04X. Pesticides, including 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, chlordane and heptachlor, were detected in each of the samples (Figure 5.5-5). The highest concentrations and greatest variety of these pesticides were observed in the sample collected from 41S-92-05X. No explosive compounds were detected in any of these surface soil samples (Table 5.5-6).

Inorganic analytes at concentrations greater than the established Fort Devens background concentrations were detected in all six of the surface soil samples collected from the landfill material. Barium, beryllium, copper, lead, sodium, and zinc were detected above background in five of the eight samples. Calcium, iron, manganese, nickel, cadmium, and silver were also found. The highest concentrations of these inorganic analytes were detected in the surface soil sample collected from 41S-92-05X (Table 5.5-7; Figure 5.5-6).

The soil samples collected from the sumps were initially collected as sediment samples, but will be used as surface soil samples. The results have been used to determine the soil quality downgradient of SA 41. Acetone was detected at 0.02 μg/g. This compound was the only VOC detected in 41D-92-04X. Sodium was the only inorganic analyte detected above the established Fort Devens background concentrations. PAHs were detected in the soil sample collected from 41D-92-03X and concentrations of pesticide residues were detected in samples collected from 41D-92-03X, 41D-92-05X, and 41D-92-06X. No observable lateral distribution of these contaminants is evident from the data collected (see Tables 5.5-6 and 5.5-7; Figures 5.5-5 and 5.5-6).

The off-site laboratory results for the subsurface soil samples collected during the SI and SSI at SA 41 are summarized in Tables 5.5-8 and 5.5-9 and Figures 5.5-7 and 5.5-8. No VOCs, explosives, or pesticide/PCBs were detected in the subsurface soil samples collected from SA 41. Di-n-butylphthalate was detected at concentrations ranging from 0.3 to 30 μg/g, and bis(2-ethylhexyl) phthalate was detected in the 30-foot soil sample at 1.2 μg/g. These compounds are common laboratory contaminants and are not considered to be site contaminants. Several inorganic analytes (aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, iron, magnesium, manganese, nickel, potassium, sodium, thallium, vanadium, and zinc) were detected above their established Fort Devens background concentration. The soil sample collected from 4 feet below ground surface (bgs) at 41M-93-02B had the largest number of inorganic analytes above background.

5.5.5.2 Groundwater. One groundwater sample was collected from 41M-92-01X during the two SI groundwater sampling rounds. Round One groundwater samples were also collected from the four sumps (41D-93-03X through 41D-93-06X) dug between the landfill and New Cranberry Pond. Chlorinated solvents 1,1,2,2-tetrachloroethane (1,1,2,2-TCA), tetrachloroethylene (PCE), and trichloroethylene (TCE) were detected in the Round One groundwater sample collected from 41M-92-01X. No SVOCs or TPHC were detected in the sample. The results of the Round Two analyses from 41M-92-01X confirmed the presence of chlorinated solvents 1,1,2,2-TCA (7.1 μg/L) and TCE (6.4 μg/L), however, the concentration of each compound was lower in Round Two. One pesticide (endrin) was detected in the Round Two sample at a concentration of 0.038 μg/L. The groundwater sample from Round One also contained detectable concentrations of nitrate/nitrite (11,000 μg/L) and the explosive compound

2,4,6-trinitrotoluene (0.718 μg/L). No explosive compound was detected in the Round Two analysis and nitrate/nitrite was detected at only 46.7 μg/L. No SVOC or TPHC were detected in the second round groundwater sample (Table 5.5-10; Figure 5.5-9).

All inorganic analytes detected in the Round One groundwater sample were above the established Fort Devens background concentrations except for mercury and sodium. This is likely the result of TSS in the groundwater, based on the typical correlation of aluminum concentration with TSS (see Table 5.5-10; Figure 5.5-10).

As part of the Round Two groundwater sampling, a filtered and unfiltered groundwater sample were collected for inorganic analysis. In addition, a TSS sample was also collected from 41M-92-01X. A comparison of the inorganic results from both samples, and using the TSS results, indicates that the elevated inorganic concentrations observed in the unfiltered Round One and Round Two inorganic analysis appears to be directly related to the concentration of TSS as opposed to dissolved inorganic analytes (see Table 5.5-10; Figure 5.5-10).

For the purposes of evaluating the downgradient impacts on groundwater for the SI, due to the historical use of the landfill, four sumps were dug for the collection of water samples for off-site laboratory analysis prior to the Round One groundwater sampling. The samples were collected as surface water from location 41D-92-03X through 41D-92-06X, but more accurately reflect groundwater conditions at those locations (see Figure 5.5-1). A trace concentration (4.1 μg/L) of chloroform was detected in 41D-92-04X, but is likely a laboratory contaminant. No other organic compounds were detected in these water samples. Due to the sampling method used to make the sumps and collect the groundwater samples, TSS concentrations ranged from 172,000 mg/L in 41D-92-06X to 2,020,000 mg/L in 41D-92-03X. The resulting inorganic analyte concentrations in these water samples were also above the established Fort Devens background groundwater concentrations. Groundwater samples were not collected from these sumps during the Round Two groundwater sampling event (see Table 5.5-10; Figure 5.5-9).

Several chlorinated solvents, toluene, and methylethyl ketone were detected in Round Three and Four SSI groundwater samples. The SSI groundwater results for 41M-92-01X indicated the presence of 1,1,2,2-TCA at 33 μg/L in the Round

Three sample and at 14 μg/L in the Round Four sample. In additional, TCE was detected at 40 μg/L in the Round Three sample and at 11 μg/L in the Round Four sample. The SSI results for 41M-93-02A indicated that toluene and methylethyl ketone were detected at 41 μg/L but was not detected in the Round 4 sample as well as methylethyl ketone at 83 μg/L in the Round Three sample. However, only benzene was present at 1.5 μg/L in the Round Four sample. The SSI results for 41M-93-02B showed that 1,2-Dichloroethene (1,2-DCE) was detected at 1.8 μg/L in the Round Four sample, only. 1,1,2,2-TCA was also detected at 41M-93-02B at 2.5 μg/L in the Round Three sample and at 2.0 μg/L in the Round Four sample, as was TCE at 9.1 μg/L in the Round Three sample and at 7.9 μg/L in the Round Four sample. The results for 41M-93-03X indicated that TCE was detected at 200 μg/L, and 200 μg/L in the duplicate sample, in the Round Three and at 150 μg/L in the Round Four sample. No other site-related contaminants were detected in the Round Three sample, but in the Round Four sample toluene was detected at 0.7 μg/L, as well. No site-related VOCs were detected in groundwater samples from monitoring wells 41M-93-04X or 41M-93-05X during either Round Three or Four. Bis(2-hexylmethyl)phthalate, a common laboratory contaminant, was the only SVOC detected in the Round Three and Four groundwater samples. No pesticides or PCB explosives were detected in the Round Three or Four samples. One explosive compound, nitroglycerin, was detected in the Round 4 sample collected from 41M-93-03X at 36.5 μg/L (see Table 5.5-10; Figure 5.5-9).

Several inorganic analytes were detected above their Fort Devens background concentration in the unfiltered groundwater samples collected during all four sampling rounds. However, only antimony, copper, potassium, and zinc were detected above their Fort Devens background concentrations in the filtered samples collected during Rounds Three and Four (see Table 5.5-10; Figure 5.5-10).

5.5.5.3 Surface Water and Sediment. Two surface water and sediment sample pairs were collected during the SI to assess whether the landfill material had impacted the surface water and sediment quality in New Cranberry Pond. Sampling sites 41D-92-01X and 41D-92-02X were located along the northern shore of New Cranberry Pond (see Figure 5.5-1).

Toluene was detected at 0.56 μg/L in the surface water sample collected from 41D-92-01X. No other organic compounds were detected in either surface water sample. Inorganic analyte concentrations appeared to be comparable with other surface water samples collected in the South Post (Table 5.5-11; Figure 5.5-11).

Only one organic compound (DCA at 1.3 μg/L) was detected in one of the SSI surface water samples (41D-93-10X) collected from New Cranberry Pond. DCA was detected in only one sampler blank (SBK-93-686) collected during the SSI. This compound was not reported above the certified reporting limit (CRL) in any of the laboratory blanks. However, it was determined that a deuterated form of DCA is used as a surrogate for the USAEC VOC method. Because of DCA's volatile nature it is unlikely that it would be found in surface water. Due to this information, it is likely that the DCA was introduced into the surface water sample at the laboratory. Therefore, DCA is not considered a SA-derived contaminant. No notable inorganic analyte concentrations were detected in surface water samples in either sample (see Table 5.5-11; Figure 5.5-11).

The results of the SI sediment sample collected from 41D-92-02X showed trace concentrations of acetone at 0.028 μg/L and heptachlor at 0.031 μg/L. Acetone is a common laboratory contaminant and is not considered a site contaminant. No inorganic analytes were detected above concentrations typical for South Post sediment samples. The results for the sample collected from 41D-92-01X indicated trace concentration of chloroform, 4,4'-DDD, and 4,4'-DDE. Concentrations of inorganic analytes including barium, copper, sodium, and zinc were also detected above the typical inorganic concentrations observed at Fort Devens (Table 5.5-12; Figure 5.5-12).

Several PAHs were detected in the three SSI sediment samples collected from the wet area at the base of the waste material. Total PAHs ranged from 0.08 μg/g at 41D-93-07X to 19.43 μg/g at 41D-93-09X (see Table 5.5-12; Figure 5.5-12). Lead (27.2 at 41D-93-09X) was the only inorganic analyte detected at notable concentration.

Acetone (0.079 μg/g at 41D-93-10X) was the only VOC detected in the two sediment samples (41D-93-10X and 41D-93-11X) collected from New Cranberry Pond during the SSI. Di-n-butylphthalate (0.29 μg/g at 41D-93-10X), which is a common laboratory contaminant, was the only SVOC detected in these two sediment samples. 4,4'-DDD was detect at 0.035 μg/g in 41D-93-11X while 4,4'-DDE was detected in both samples at concentrations of 0.015 μg/g and 0.02 μg/g, respectively. PCB 1260 was also detected in both sediment samples at concentrations of 0.217 μg/g and 0.316 μg/g, respectively. All of the PAL inorganic analytes were detected in both samples, with the exception of cobalt and chromium (see Table 5.5-12).

5.5.6 Source Evaluation and Migration Potential

The landfill is presumed to have been used for the disposal of nonexplosive military, farm, and/or household debris. The absence of explosive compounds in the surface soils is consistent with this historical use, but the source of PAH and TPHC contamination is not obvious, given this SA's presumed historical use. These compounds may be associated with surficial combustion byproduct deposition. The source of the pesticides found in surface soils is likely associated with historical installation-wide insect control spraying and not from the disposal of pesticides in the dump. No documented use of these pesticides has been discovered. The inorganic analytes detected, copper, lead, and zinc, are likely associated with the significant quantity of metallic debris observed in the surface debris. There is no observable pattern to the contaminant distribution. Surface soil samples collected at 41D-92-03X contained detectable concentrations of PAHS. These compounds are limited to 41D-92-03X. The source of these compounds is not obvious, but may be associated with the PAHs detected in soils up slope. Occasional elevated concentrations of the inorganic analytes barium, chromium, lead, and zinc, were observed. No clear correlation between the surface soil inorganics and sediment inorganics is obvious. Surface water runoff and mechanical particulate transport may account for the migration of inorganic analytes from the surface soils on the landfill to the sediment/surface soil downslope.

A suite of VOCs were detected in the groundwater sample collected from the existing and newly installed monitoring wells. Contaminants included chlorinated solvents and inorganic analytes. The source of the chlorinated solvents is not known, however, given the inferred groundwater flow direction, it would appear that the solvent contamination may be emanating from in or around the waste material in the landfill at SA 41. Because of the location of the monitoring wells (which were installed with the assumption that groundwater flow would be toward New Cranberry Pond) that actual source is unclear. The high concentrations of inorganic analytes in the unfiltered samples appear to be a result of fine grained soils at the site and elevated TSS. The detection of arsenic, antimony and manganese above their established background concentrations in the filtered samples may suggest that these analytes occurred at higher background concentrations in the soil in this portion of Fort Devens. These inorganic analytes do not appear to be present in the groundwater because of contaminant emanating from the waste material.

PAHs were detected in the sediment samples collected from the wet area at the base of the waste material. Similar PAHs were detected in surface soil samples collected from the top of the waste material during the SI. These compounds may be present at these locations because of overland transport of surface soil from the top of the waste material to the sediments at the base of the waste material via surface water runoff.

5.5.7 Preliminary Human Health Risk Evaluation

A preliminary human health risk evaluation was prepared for SA 41 to determine if contaminants detected at this SA, pose a risk to human receptors. For this PRE, the future use of SA 41 is assumed to be residential, however, based upon the BRAC 1991 Reuse Plan the South Post is designated to remain under the control of the Army. Because of this, it is highly unlikely that private residences would be built at or near SA 41. Tables 5.5-13 through 5.5-17 present summary statistics and human health standards and guidelines used in the PRE for SA 41.

5.5.7.1 Soils. As discussed in Section 3.5 (Preliminary Risk Evaluation Methodology), all soils to a depth of 3 feet are classified as surface soil and considered to be accessible under a residential future use exposure scenario.

Table 5.5-13 presents summary statistics on surface soil at SA 41 and USEPA Region III residential soil concentrations for comparison. Surface soil at SA 41 is represented by samples 41S-92-01X through 41S-92-06X collected from stained surficial soils, and 41D-92-03X through 41D-92-06X collected from shallow soil depths.

An assessment of the organic compound data for SA 41 soils shows that there is some contamination from TPHC, pesticide residues, and PAHs. The levels of the detected organic analytes in the surface soils are below the USEPA Region III residential soil concentrations, with the exception of benzo[a]pyrene, benzo[a]anthracene, benzo[b]fluoranthene and indeno[1,2,3-c,d]pyrene. The maximum detected concentration of benzo[a]pyrene (2.0 μg/g) exceeds the

USEPA Region III residential soil concentration of 0.23 μg/g. Benzo[a]pyrene was detected in only two of ten samples collected. Indeno[1,2,3-c,d]pyrene was detected in only one of ten samples at a concentration of 1 μg/g. This concentration only slightly exceeds the USEPA Region III residential soil concentration of 0.84 μg/g. While the maximum detected concentrations of benzo(a)anthracene (2 μg /g) and benzo[b]fluoranthene (2 μg/g) slightly exceed their USEPA Region III residential soil concentrations of 1.6 μg/g and 1.9 μg/g respectively, their average concentrations do not.

An assessment of the inorganic data for SA 41 surface soils shows that there is elevated inorganic analyte surface contamination particularly in the visually contaminated soils directly on top of the waste material (41S-92-01X to 14S-92-06X). When comparing concentrations of the surface soils at SA 41 to the statistical soil background, there are a number of compound exceedances, most notably iron, lead, manganese, and zinc. This was not unexpected since the soil samples were collected from visually stained areas. There are few exceedances in the soil samples collected from the shallow soil samples (locations 41D-92-03X through 41D-92-06X).

Of the twelve inorganic analytes detected above the established Fort Devens background concentrations, two analytes were detected at concentrations above their respective health-based soil guideline. Beryllium was detected (maximum: 2.2 μg/g) above the USEPA Region III residential soil concentration of 0.4 μg/g. The USEPA Superfund lead cleanup level of 500 μg/g was exceeded at two of ten sampling locations. One additional inorganic analyte, arsenic, was detected at concentrations above the USEPA Region III residential soil concentration. Arsenic was detected at concentrations above the residential soil concentration, but the maximum detected concentration did not exceed the established Fort Devens background concentration for arsenic of 21 μg/g. Based on this screening-level analysis, it appears that beryllium and lead at the reported sampling locations may pose a potential risk to human health.

During the SSI, three surface soil samples (41D-93-07X through 41D-93-09X) were collected from the low area at the base of the waste material. Table 5.5-14 presents summary statistics on surface soil at the base of the landfill and soil guidelines for comparison. Several PAHs, acetone, di-n-butylphthalate, and PCB-1260 were detected in the soil at sampling locations 41D-93-y07X through 41D-93-09X. Acetone and di-n-butyl phthalate were detected at concentrations below their respective screening guidelines. Five of the PAHs, each detected in only one of four samples (at 41D-93-09X), exceeded either the USEPA Region III residential soil concentration and/or the MCP S-2/GW-1 soil standard. PCB-1260 was detected in all four samples taken at concentrations above the Region III residential soil concentration but below the MCP S-2/GW-1 soil standard. Of the 16 inorganic analytes detected, only arsenic was detected at a concentration above the health screening guideline (specifically the USEPA Region III residential soil concentration). Arsenic was detected below the basewide background level and below the MCP S-2/GW-1 soil standard. It appears based on these comparisons, that only the PAHs detected at 41D-93-09X present a potential risk under a residential setting.

5.5.7.2 Groundwater. Table 5.5-15 presents summary statistics on unfiltered groundwater associated with SA 41 and drinking water standards/guidelines for comparison. Nine organic compounds were detected in the groundwater associated with SA 41; 1,1,2,2-TCA, chloroform, PCE, TCE, 2,4,6-trinitrotoluene, methylethyl ketone, 1,2-DCE, toluene, and the pesticide endrin. Chloroform was detected in one of 13 samples and did not exceed the Massachusetts drinking water guideline. Methylethyl ketone, 1,2-DCE, and toluene were each detected in one to two of 13 samples; the maximum detected concentration of each was below the respective drinking water standard/guideline for each compound. PCE and TCE were detected in two of 13 and eight of 13 samples, respectively, and each maximum concentration exceeded its respective USEPA primary MCL. 1,1,2,2-TCE was detected in five of 13 samples and its maximum concentration (170 μg/L) exceeded its Region III tap water concentration (0.052 μg/L). Endrin and the explosive compound 2,4,6-trinitrotoluene were detected in one of 13 samples and neither exceeded its respective drinking water standard or guideline.

An assessment of the inorganic data for SA 41 groundwater shows that there is inorganic analyte contamination directly surrounding the SA. When comparing unfiltered groundwater concentrations to the established Fort Devens background, the inorganic data for SA 41 groundwater shows that the maximum detected concentration of only one inorganic analyte, sodium, was below the background concentration. A drinking water standard or guideline is available for fifteen of the eighteen inorganic analytes detected above the base-wide background levels. Of the fifteen inorganic analytes, eight analytes were detected at concentrations above their respective drinking water standard/guideline. Nickel was detected in six of 13 samples, and the average detected concentration exceeded its USEPA primary MCL. Chromium was detected in 12 of 13 samples. The maximum concentration of chromium exceeded its USEPA primary MCL; however, the average concentration did not. Aluminum was detected in 13 of 13 samples, iron and manganese in 13 of 13; each average concentration exceeded its respective USEPA secondary MCL. (Secondary MCLs are set for aesthetic or economic reasons, not health reasons.) The maximum concentration of lead (48.6 μg/L) and the average (21.77 μg/L) exceeds the USEPA lead action level of 15 μg/L. The maximum concentrations of arsenic and beryllium each exceeded its USEPA primary MCL.

Based on this screening-level analysis, it appears that the consumption of groundwater at SA 41 may pose a potential risk to human health from detected VOC and inorganic concentrations. However, a comparison of unfiltered and filtered groundwater results indicated that filtered results were either below the detection limit or below the action level for each inorganic analyte detected. Based on these results, it appears that the inorganic contaminants detected are a result of suspended solids (from the fine grained soils at this SA) not SA-derived contaminants.

5.5.7.3 Surface Water and Sediment. Tables 5.5-16 and 5.5-17 present summary statistics on surface water and sediment associated with SA 41. Four surface water and sediment sampling locations (41D-92-01X, 41D-92-02X, 41D-93-10X, and 41D-93-11X) and one duplicate (41D-92-02X) were established in New Cranberry Pond immediately south of the dump area during the SI and SSI.

Two organic compounds, toluene and DCA were detected in the surface waters associated with SA 41. The maximum concentrations of both are below their respective primary Maximum Contaminant Level (MCL). The concentrations of four inorganic analytes that were detected in the surface water exceed their respective drinking water standard/guideline. The average concentration of lead detected in New Cranberry Pond (21.7 μg/L) exceeds the USEPA lead action level of 15 μg/L. Aluminum, iron, and manganese each exceeded its respective USEPA secondary MCL. (Secondary MCLs are set for aesthetic or economic reasons, not health reasons.)

The magnitude and frequency of exposure to surface water associated with SA 41 would be expected to be much less than that upon which drinking water guidelines are based. The use of drinking water guidelines for comparison to surface water concentrations in a pond is a conservative approach and is used due to a lack of available health-based guidelines for exposure to surface water. Because exposure to surface waters in New Cranberry Pond is anticipated to be restricted to wading or swimming in the future, it is not likely that an individual would encounter inorganic analyte concentrations that would pose a threat to public health.

Several organic analytes, including pesticide residues, acetone, chloroform, and PCB-1260, were detected in sediment samples. Acetone and chloroform are common laboratory contaminants and are not considered to be SA-related contaminants. The levels of all pesticide residues detected in the sediment are below the USEPA Region III residential soil concentrations and MCP S-2/GW-1 soil standards. The concentration of PCB-1260 exceeds the Region III residential soil concentration but not the MCP S-2/GW-1 soil standard. Of the inorganic analytes detected in the sediment, only one analyte, arsenic, exceeds its USEPA Region III residential soil concentration, however, it does not exceed the MCP S-2/GW-1 soil standard. Exposure to analytes in New Cranberry Pond sediment, through wading and swimming, would be much less than that in a residential setting. The residential soil concentrations assume exposure occurs 350 days per year for 30 years. The concentrations of inorganic analytes (including arsenic) associated with SA 41 are not expected to present a risk to public health under present or foreseeable future uses of the SA.

One organic compound, toluene, was detected in the surface waters associated with SA 12. The maximum concentration of toluene detected in surface water (0.56 μg/L at 41D-92-01X) is below its primary drinking water MCL.

The concentrations of four inorganic analytes that were detected in the surface water exceed their respective drinking water standard/guideline. The average concentration of lead detected in New Cranberry Pond (21.7 μg/L) exceeds the USEPA lead action level of 15 μg/L. Aluminum, iron, and manganese were detected in all samples collected and each exceeded its respective USEPA secondary MCL. (Secondary MCLs are set for aesthetic or economic reasons, not health reasons.)

The magnitude and frequency of exposure to surface water associated with SA 41 would be expected to be much less than that upon which drinking water guidelines are based. The use of drinking water guidelines for comparison to surface water concentrations in a pond is a conservative approach and is used due to a lack of available health-based guidelines for exposure to surface water. Because exposure to surface waters in New Cranberry Pond is anticipated to be restricted to wading or swimming in the future, it is not likely that an individual would encounter inorganic analyte concentrations that would pose a threat to public health.

5.5.8 Preliminary Ecological Risk Evaluation

The purpose of the PRE at SA 41 is to provide a screening-level evaluation of actual and potential risks that environmental contaminants may pose to the resident and migratory ecological receptors at the site. This PRE includes off-site analytical laboratory results from both the SI and SSI.

SA 41 is located in a low-lying woodland dominated by gray birch saplings (*Betula populifolia*) and young oaks (*Quercus alba* and *Q. rubra*). Some areas of standing water occur at the dump area. The shrub layer is moderately dense. Other plant species observed at SA 41 include white pine (*Pinus strobus*), pitch pine (*Pinus rigida*), speckled alder (*Alnus rugosa*), honeysuckle (*Lonicera* sp.), lowbush blueberry (*Vaccinium angustifolium*), and steeplebush (*Spiraea tomentosa*).

Because of its small size and disturbed nature, it is unlikely that the landfill at SA 41 currently provides significant wildlife habitat. However, small mammals, passerine songbirds, and other ecological receptors may occasionally use the site as a foraging or loafing area. In addition, an American woodcock (*Scolopax minor*) was observed at the site, and a wild turkey (*Meleagris gallopavo*) was heard in the vicinity of the site.

New Cranberry Pond is a fairly shallow, eutrophic pond characterized by dense growth of aquatic macrophytic vegetation. A submerged channel roughly bisects the pond, carrying water from west to east. The eastern end of New Cranberry Pond abuts the South Post perimeter road. Water from the pond drains through a spillway, and is piped underneath the perimeter road. According to Poole (1993), beaver (*Castor canadensis*) periodically dam the pond outfall adjacent to the perimeter road. This pond has been further characterized in the Fort Devens Group 1A Final RI Addendum Report (ABB-ES, 1993d).

It is likely that New Cranberry Pond provides habitat for wetlands and semi-terrestrial wildlife, including mammals such as the beaver, raccoon (*Procyon lotor*), or muskrat (*Ondatra zibethicus*). Amphibians, such as the green frog (*Rana clamitans*), and various species of reptiles (e.g., eastern painted turtle [*Chrysemys picta*]) may also occur in this aquatic resource area. In addition, wading birds and waterfowl in the region may feed on plants, aquatic invertebrates, and fishes in New Cranberry Pond.

No records exist documenting the current or historical presence of rare and endangered species in the region of SA 41.

The Final SI PRE reported that no organic compounds in surface soil exceeded their established benchmark values; however, the maximum detected concentrations of the inorganics antimony, barium, beryllium, cadmium, copper, lead, and zinc exceeded their respective benchmark values. Concentrations of analytes that exceeded benchmark values were associated primarily with samples collected from the landfill surface (samples 41S-92-01X through 41S-92-06X) (Table 5.5-18).

Subsequent to the Final SI, three surface soil samples (41D-93-07X through 41D-93-09X) (including one duplicate) were collected at SA 41 downgradient of the landfill (see Figure 5.5-1). These samples were originally collected as sediment samples, but since the locations and depth of the samples (within 3 feet) better represent surface soil conditions in this area, the results will be used as such. With the exception of cobalt (for which no background data are available), the maximum detected concentrations of all inorganics were less than Fort Devens background concentrations and thus were not retained as surface soil CPCs (Table 5.5-19).

In addition to inorganics, 16 organic compounds, including a PCB, and 13 PAHs, were detected in the four downgradient SA 41 surface soils and retained as CPCs. Maximum detected concentrations of PAHs ranged from 0.1 $\mu g/g$ (naphthalene) to 2.8 $\mu g/g$ (fluoranthene). PCB-1260 was detected in four surface soil samples at a maximum concentration of 0.39 $\mu g/g$.

Potential contaminant exposure pathways exist at SA 41 for terrestrial receptors via incidental soil ingestion and terrestrial food web exposure. A screening-level evaluation of potential effects from surface soil exposure was conducted by comparing the maximum concentrations of all surface soil CPCs to their respective surface soil benchmark values (see Table 5.5-18). No surface soil benchmark values were exceeded by the maximum detected concentrations of analytes associated with the four surface soil samples collected during the SSI.

Although the maximum concentrations of several analytes associated with surface soil samples collected during the SI exceeded ecological benchmark values, ecological risks at the site are likely to be minimal. Analyte concentrations that exceeded surface soil benchmarks were generally associated with samples taken directly from the landfill. Contaminated surface soils do not appear to be posing a risk to ecological receptors elsewhere at SA 41.

During the SSI, two surface water samples (plus one duplicate) were collected from locations near the northern shore of New Cranberry Pond during the SSI (see Figure 5.5-1). These data were combined with surface water sample data from the Final SI to result in a data set of five surface water samples. Two organic compounds DCA and toluene (which are likely laboratory contaminants) and fourteen inorganic analytes were detected and retained as CPCs. Nutrients and aluminum were detected at concentrations in excess of 1,000 μg/L (Table 5.5-20).

The maximum concentrations of aluminum, copper, iron, lead, and zinc in SA 41 surface water exceeded their benchmark values (see Table 5.5-20). Aluminum was detected at a maximum concentration of 8,100 μg/L, approximately 93 times its benchmark value. Lead was detected at a maximum concentration of 43.9 μg/L, approximately 85 times greater than its benchmark value. Iron was detected at a maximum concentration of 16,400 μg/L, approximately 16 times greater than its benchmark value. The maximum detected concentration of zinc exceeded its benchmark by less than a factor of two.

Although five inorganic analytes (aluminum, copper, iron, lead, and zinc) exceeded surface water screening values, the maximum concentrations of these analytes were all detected in one surface water sample (41D-92-01X). Copper and zinc were undetected in all other surface water samples. As discussed elsewhere in this Revised Final SI Report, aluminum and iron are present at naturally high levels in background soils and groundwater at Fort Devens, and the presence of these analytes in New Cranberry Pond may be reflective of background conditions, rather than landfill impacts. Furthermore, the AWQC documents for lead and aluminum indicate that larval salmonids (e.g., trout) are among the most sensitive ecological receptors with regard to lead and aluminum exposure. Because no trout are likely to occur in SA 41 wetlands, it is unlikely that the levels of aluminum and lead in surface water will have adverse effects on the site's ecological receptors, which are likely to be considerably more tolerant of aluminum and lead than larval trout. Lastly, it is likely that the use of unfiltered (rather than dissolved) surface water inorganics data over-estimates the bioavailable fraction of inorganics at the site.

During the SSI, two sediment samples were collected at SA 41 at the identical locations as the two surface water samples. These data were combined with sediment sample data from the Final SI to result in a data set of four sediment samples. Seven organic compounds and eleven inorganic analytes were detected and retained as CPCs (Table 5.5-21). Acetone and di-n-butylphthalate (likely laboratory contaminants) were detected in one and two samples, respectively. PCB-1260 was detected in two samples at a maximum concentration of 0.316 µg/g. 4,4'-DDD and 4,4'-DDE were detected in two and three samples, respectively, at a maximum concentrations of 0.041 µg/g and 0.024 µg/g, respectively. With the exception of chromium, all inorganics were detected in all four samples. Maximum detected concentrations ranged from 6.9 µg/g (chromium) to 9,510 µg/g (iron).

The maximum concentrations of 4,4'-DDD, 4,4'-DDE, heptachlor, arsenic, lead, and zinc in sediments were detected at levels greater than their benchmark values (see Table 5.5-21). Arsenic was detected in all samples at a maximum concentration of 13.5 µg/L, over twice its benchmark value. Lead was detected in both samples at a maximum concentration of 40 µg/L, approximately 1.5 times greater than its benchmark value. The maximum detected concentrations of zinc and heptachlor slightly exceeded their benchmarks.

Although six analytes in New Cranberry Pond sediment were detected at levels in excess of ecological benchmark values (4,4'-DDD, 4,4'-DDE, heptachlor, arsenic, lead, and zinc), the maximum concentrations of these analytes were all detected in one sediment sample (41D-92-01X). The average concentrations of all three inorganic analytes were at or near the benchmark value, indicating that it is highly unlikely that arsenic, lead, or zinc are posing a risk to aquatic receptors at New Cranberry Pond. As described in Appendix S of the Fort Devens Group 1A Final RI Addendum Report (ABB-ES, 1993d), the interim Sediment Quality Criteria for 4,4'-DDT and its breakdown products likely represents an extremely conservative guideline for use at Fort Devens. Therefore, it is unlikely that these pesticides in New Cranberry Pond sediments pose a risk to ecological receptors.

5.5.9 Conclusions and Recommendations

The preliminary human health risk evaluation conducted at SA 41 indicated that there is potential risk to human receptors in a residential exposure scenario associated with PAHs and inorganics in soil and VOCs and inorganics in groundwater. The preliminary ecological risk evaluation indicated that there is potential risk to ecological receptors due to exposure to inorganics (particularly lead) in landfill soil.

Based on the results of the SI and SSI, an Remedial Investigation/Feasibility Study (RI/FS) is recommended at SA 41 to further assess the chlorinated solvent contamination detected in groundwater.

TABLE 5.5-1
SUMMARY OF TECHNICAL APPROACH
SA 41 – UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ACTIVITY	PURPOSE	SITE IDENTIFICATION	RATIONALE FOR SELECTED LOCATIONS
SI PROGRAM			
SURFACE SOIL SAMPLING	* COLLECT SAMPLES FOR OFF-SITE LABORATORY ANALYSIS * DETERMINE PHYSICAL CHARACTERISTICS OF LANDFILL COVER	41S-92-01X 41S-92-02X 41S-92-03X 41S-92-04X 41S-92-05X 41S-92-06X	* WITHIN LANDFILL LIMITS
SURFACE WATER AND SEDIMENT SAMPLING	* COLLECT SAMPLES FOR OFF-SITE LABORATORY ANALYSIS * DETERMINE PHYSICAL CHARACTERISTICS OF SEDIMENT	41D-92-01X 41D-92-02X	* DETERMINE IF LANDFILL CONTAMINANTS ARE IMPACTING NEW CRANBERRY POND
SOIL BORINGS AND SUBSURFACE SOIL SAMPLING	* INSTALL MONITORING WELLS * CHARACTERIZE SOILS	41M-92-01X	* UPGRADIENT AND DOWNGRADIENT OF LANDFILL WASTE
MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING	* MONITOR GROUNDWATER LEVELS * MONITOR GROUNDWATER QUALITY * DETERMINE AQUIFER CONDUCTIVITIES	41M-92-01X	* UPGRADIENT AND DOWNGRADIENT GROUNDWATER QUALITY
SI PROGRAM			
SOIL BORINGS AND SUBSURFACE SOIL SAMPLING	* INSTALL MONITORING WELLS * CHARACTERIZE SOILS	41M-93-02A 41M-93-02B 41M-93-03X 41M-93-04X 41M-93-05X	* UPGRADIENT AND DOWNGRADIENT OF LANDFILL WASTE * OUTSIDE OF LANDFILL WASTE
MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING	* MONITOR GROUNDWATER LEVELS * MONITOR GROUNDWATER QUALITY * DETERMINE AQUIFER CONDUCTIVITIES	41M-92-01X 41M-93-02A 41M-93-02B 41M-93-03X 41M-93-04X 41M-93-05X	* UPGRADIENT AND DOWNGRADIENT GROUNDWATER QUALITY
SURFACE WATER AND SEDIMENT SAMPLING	* COLLECT SAMPLES FOR OFF-SITE LABORATORY ANALYSIS * DETERMINE PHYSICAL CHARACTERISTICS OF SEDIMENT	41D-93-07X 41D-93-08X 41D-93-09X 41D-93-10X 41D-93-11X	* DETERMINE IF LANDFILL CONTAMINANTS ARE IMPACTING NEW CRANBERRY POND * DOWN SLOPE OF LANDFILL WASTE

TABLE 5.5–2
SUMMARY OF SOIL BORINGS
SA 41 – UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

EXPLORATION ID	COMPLETION DEPTH (FEET BGS)	REFERENCE SAMPLE INTERVALS (FEET BGS)	ANALYTICAL SAMPLES COLLECTED	SOIL TYPE (USCS)	TOTAL VOCs BY PID (PPM)
41M–92–01X	36	0–2		SP	BKG
		2–4		SW	BKG
		4–6		ML	BKG
		6–8		ML	BKG
		8–10		ML	––
		10–12		ML	BKG
		12–14		CL	BKG
		14–16		CL	BKG
		16–18		CL	BKG
		18–20		CL	BKG
		20–22		CL	BKG
		22–24		ML	BKG
		24–26		ML	BKG
		26–28	26–28	SM	BKG
		28–30		SM	BKG
		30–32		SM	BKG
		32–34		SM	BKG
		34–36		SM	BKG
41M–93–02A	8	0–2	NA	SP	BKG
		5–7		ML	BKG
41M–93–02B	32	0–2	0–2	SP	BKG
		5–7	5–7	ML	BKG
		10–12		ML	BKG
		15–17		ML	BKG
		20–22		ML	BKG
		25–27	25–27	ML/SP	BKG
		30–32		SM	BKG
41M–93–03X	47	0–2		SM	BKG
		5–7		SP	BKG
		10–12		SP	BKG
		15–17		SP	BKG
		20–22		ML	BKG
		25–27		SP	BKG
		30–32		SP	BKG
		35–37		SP	BKG
		40–42		SP	BKG
		45–47	45–47	SM/SP	BKG
41M–93–04X	7	0–2		SP	BKG
		5–7	5–7	SP	BKG
41M–93–05X	7	0–2		SP	BKG
		5–7	5–7	SP	BKG

Notes:

bgs = below ground surface
VOCs = Volatile organic compounds
USCS = Unified soil classification system
ppm = parts per million

TABLE 5.5–3
MONITORING WELL COMPLETION DETAILS
SA 41 – UNAUTHORIZED DUMPING AREA

SITE INVESTIGATION REPORT
FORT DEVENS, MA

WELL IDENTIFICATION	SOIL DRILLING METHOD	BEDROCK DRILLING METHOD	MEDIA SCREENED	WELL SCREEN DEPTH (FEET BGS)	WELL SCREEN ELEVATION (FEET NGVD)	COMPLETION DEPTH (FEET BGS)	CONSTRUCTION MATERIAL
41M–92–01X	HOLLOW STEM AUGER	NA	SOIL	25.1–35.1	222.11 – 2212.11	36.0	4" ID PVC
41M–93–02A	HOLLOW STEM AUGER	NA	SOIL	3.0–8.0	245.35 – 240.35	8.0	2" ID PVC
41M–93–02B	HOLLOW STEM AUGER	NA	SOIL	22.0–32.0	226.14 – 216.14	33.0	4" ID PVC
41M–93–03X	HOLLOW STEM AUGER	NA	SOIL	34.0–44.0	222.47 – 212.47	45.0	4" ID PVC
41M–93–04X	HOLLOW STEM AUGER	NA	SOIL	4.0–8.0	216.82 – 220.82	10.0	2" ID PVC
41M–93–05X	HOLLOW STEM AUGER	NA	SOIL	2.0–7.0	220.10 – 225.10	10.0	2" ID PVC

Notes:

bgs = below ground surface

NGVD = National geodetic vertical datum

NA= Not Applicable

ID=Inside Diameter

TABLE 5.5–4
SOIL CLASSIFICATION OF SEDIMENT SAMPLES
SA 41 – UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

SAMPLE ID	USCS SYMBOL	GRAVEL (2) DRY WT %	SAND (2) DRY WT %	SILT (2) DRY WT %	CLAY (2) DRY WT %
41M–92–01X	ML	0.0	2.8	97.2	NA
41M–93–02B	ML	0.0	6.7	61.7	31.6
41M–93–03X	ML	0.0	24.5	56.2	19.3
41D–92–01X	SM	4.7	56.7	38.6	NA
41D–92–02X	SW/SM	18.1	74.3	7.6	NA
41D–92–03X	SM	2.5	85.1	12.4	NA
41D–92–04X	SP	10.8	84.6	4.6	NA
41D–92–05X	SP	2.3	93.0	4.7	NA
41D–92–06X	SP	7.9	90.1	2.0	NA
41D–93–07X	SM	8.1	58.1	25.1	8.7
41D–93–08X	SW–SM	12.7	63.4	21.0	2.9
41D–93–09X	SM	4.2	77.3	16.5	2.1
41D–93–10X	ML	0.0	52.6	26.9	20.8
41D–93–11X	ML	0.0	68.0	28.6	3.4

Notes:

USCS = Unified soil classification system.
DRY WT % = Dry weight percentage.
(1) Water content = 100 x weight of water / dry weight of soil.
(2) Dry wt.% = 100 x dry weight of soil fraction / total dry weight of soil.

TABLE 5.5-5
SUMMARY OF WATER LEVELS AND HYDRAULIC CONDUCTIVITIES STUDY AREA 41 – UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

WELL ID	ELEVATION[1]	DEPTH TO WATER (FEET BGS)	ELEVATION OF WATER (FEET NGVD)	CONDUCTIVITY HVORSLEV[2] (CM/SEC)
41M-92-01X	249.58	22.4	227.18	1.0E-05
41M-93-02B	251.47	29.48	221.99	1.4E-05
41M-93-03X	258.70	38.44	220.26	1.6E-05
41M-93-04X	228.51	7.02	221.49	1.5E-02
41M-93-05X	229.95	7.83	222.12	4.0E-03

Notes:

bgs = below ground surface.
cm/sec = centimeters per second.
NGVD = National Geodetic Vertical Datum.
1 = elevation of top of pvc.
2 = averaged value of two tests.
Water levels measured on Nov. 8, 1993.

TABLE 5.5–6
ORGANIC COMPOUNDS IN SURFACE SOIL
SA 41 – UNAUTHORIZED DUMPING AREA

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	BORING	41S–92–01X	41S–92–02X	41S–92–03X	41S–92–04X	41S–92–05X	41S–92–06X
	DEPTH	0 FT	0 FT	0 FT	0 FT	0 FT	0 FT
SEMIVOLATILES (ug/g)							
ACENAPHTHYLENE		< 0.03	0.3	< 0.03	< 0.03	0.064	< 0.03
ANTHRACENE		< 0.03	0.3	< 0.03	< 0.03	< 0.03	< 0.03
BENZO(A)ANTHRACENE		< 0.17	1.0	< 0.17	< 0.17	< 0.17	< 0.17
BENZO(A)PYRENE		< 0.25	2.0	< 0.25	< 0.25	< 0.25	< 0.25
BENZO(B)FLUORANTHENE		< 0.21	2.0	< 0.21	< 0.21	< 0.21	< 0.21
BENZO(G,H,I)PERYLENE		< 0.25	0.7	< 0.25	< 0.25	< 0.25	< 0.25
BENZO(K)FLUORANTHENE		< 0.06	0.5	< 0.06	< 0.06	< 0.06	< 0.06
CARBAZOLE		< 0.03	0.1 S	< 0.03	< 0.03	< 0.03	< 0.03
CHRYSENE		< 0.12	2.0	< 0.12	< 0.12	< 0.12	< 0.12
FLUORANTHENE		0.11	6.0	0.17	0.1	0.34	0.12
INDENO(1,2,3–C,D)PYRENE		< 0.29	1.0	< 0.29	< 0.29	< 0.29	< 0.29
PHENANTHRENE		0.047	1.0	0.05	< 0.03	0.15	0.046
PYRENE		0.068	3.0	0.11	0.052	0.18	0.067
PESTICIDE/PCBS (ug/g)							
ALPHA–CHLORDANE		< 0.005	< 0.005	< 0.005	< 0.005	0.007 S	< 0.005
GAMMA–CHLORDANE		0.014 S	0.007 S	0.019 S	< 0.01	0.044 S	0.014 S
HEPTACHLOR		0.038	0.03	0.033	0.025	0.038	0.026
4,4'–DDD		< 0.008	0.013	< 0.008	< 0.008	< 0.008	< 0.008
4,4'–DDE		0.065	0.12	0.048	0.089	0.21	0.085
4,4'–DDT		0.054	0.083	0.036	0.033	0.34	0.061
OTHER (ug/g)							
TOTAL ORGANIC CARBON		NA	NA	NA	NA	NA	NA
TOTAL PETROLEUM HYDROCARBON		58.3	77.0	< 27.7	< 27.9	64.0	40.7

NOTES:

TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT ANALYTE LIST FOR SUMMARY

< = LESS THAN DETECTION LIMIT SHOWN

NA = NOT ANALYZED

S = RESULTS BASED ON INTERNAL STANDARD

TABLE 5.5–6
ORGANIC COMPOUNDS IN SURFACE SOIL
SA 41 – UNAUTHORIZED DUMPING AREA

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BORING DEPTH	41D–92–03X	41D–92–04X	41D–92–05X	41D–92–06X
ORGANICS (μg/g)					
ACETONE		< 0.01	0.02	< 0.01	< 0.01
SEMIVOLATILES (μg/g)					
ANTHRACENE		0.3	< 0.03	< 0.03	< 0.03
BENZO[A]ANTHRACENE		2.0	< 0.17	< 0.17	< 0.17
BENZO[A]PYRENE		2.0	< 0.25	< 0.25	< 0.25
BENZO[B]FLUORANTHENE		1.0	< 0.21	< 0.21	< 0.21
BENZO[K]FLUORANTHENE		2.0	< 0.06	< 0.06	< 0.06
CHRYSENE		2.0	< 0.12	< 0.12	< 0.12
FLUORANTHENE		5.0	< 0.10	< 0.10	< 0.10
PHENANTHRENE		2.0	< 0.03	< 0.03	< 0.03
PYRENE		5.0	< 0.07	< 0.07	< 0.07
PESTICIDE/PCBS (μg/g)					
GAMMA–CHLORDANE		< 0.01	< 0.01	< 0.01	0.008 S
HEPTACHLOR		0.04	< 0.006	0.029	0.043
OTHER (μg/g)					
TOTAL ORGANIC CARBON		16100.0	NA	652.0	829.0

NOTES:

Table lists detected analytes only – see project analyte list for summary.

< = Less than detection limit shown.

NA = Not Analyzed.

S = Results based on internal standard.

TABLE 5.5–7
INORGANIC ANALYTES IN SURFACE SOIL
SA 41 – UNAUTHORIZED DUMPING AREA

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Background	Boring Depth	41S–92–01X	41S–92–02X	41S–92–03X	41S–92–04X	41S–92–05X
			0 FT	0 FT	0 FT	0 FT	0 FT
INORGANICS (ug/g)							
ALUMINUM	15000.0		7050.0	12700.0	7980.0	4740.0	6820.0
ANTIMONY	NA		3.72	19.5	< 1.1	< 1.1	9.67
ARSENIC	21.0		14.0	10.6	9.41	6.88	9.65
BARIUM	42.5		42.8	53.0	307.0	23.2	88.6
BERYLLIUM	.347		2.2	1.19	0.998	< 0.5	1.03
CADMIUM	2.0		1.93	< 0.7	< 0.7	< 0.7	15.5
CALCIUM	1400.0		2270.0	1100.0	1280.0	753.0	8620.0
CHROMIUM	31.0		17.4	21.5	16.1	6.88	22.9
COBALT	NA		9.3	5.14	3.71	3.05	7.36
COPPER	8.39		37.3	11.1	22.6	6.7	54.4
IRON	15000.0		80000.0	13500.0	12900.0	8140.0	23400.0
LEAD	48.4		580.0	300.0	320.0	26.0	1400.0
MAGNESIUM	5600.0		1070.0	2380.0	1590.0	1320.0	1280.0
MANGANESE	300.0		940.0	264.0	223.0	222.0	782.0
MERCURY	.22		< 0.05	0.081	< 0.05	< 0.05	0.077
NICKEL	14.0		22.2	13.2	11.3	9.02	12.7
POTASSIUM	1700.0		315.0	1210.0	755.0	508.0	702.0
SELENIUM	NA		0.382	< 0.25	< 0.25	< 0.25	< 0.25
SILVER	.086		0.733	< 0.58	< 0.25	< 0.25	< 0.25
SODIUM	131.0		218.0	227.0	240.0	187.0	288.0
VANADIUM	28.7		< 3.3	19.0	11.2	7.74	10.9
ZINC	35.5		360.0	74.9	163.0	40.4	9200.0

Notes:

NA = Not Available.

= Value above background level.

TABLE 5.5-7
INORGANIC ANALYTES IN SURFACE SOIL
SA 41 – UNAUTHORIZED DUMPING AREA

SITE INVESTIGATION REPORT
FORT DEVENS, MA

Analyte	Background	Boring	41S-92-06X	41D-92-03X	41D-92-04X	41D-92-05X	41D-92-06X
		Depth	0 FT	0 FT	0 FT	0 FT	0 FT
INORGANICS (ug/g)							
ALUMINUM	15000.0		6490.0	7130.0	2620.0	4570.0	3170.0
ARSENIC	21.0		12.2	8.54	4.59	4.67	4.44
BARIUM	42.5		89.2	34.6	19.6	20.8	12.7
BERYLLIUM	.347		0.882	0.68	< 0.5	< 0.5	< 0.5
CALCIUM	1400.0		1650.0	349.0	207.0	240.0	181.0
CHROMIUM	31.0		18.6	10.4	5.83	7.1	< 4.0
COBALT	NA		4.28	3.75	3.04	1.93	2.45
COPPER	8.39		19.7	7.33	4.17	4.79	3.8
IRON	15000.0		16300.0	9440.0	4940.0	5820.0	4890.0
LEAD	48.4		240.0	7.0	1.86	2.36	1.59
MAGNESIUM	5600.0		1990.0	1930.0	960.0	1310.0	955.0
MANGANESE	300.0		251.0	164.0	158.0	56.4	85.4
NICKEL	14.0		14.4	9.36	5.42	6.86	5.24
POTASSIUM	1700.0		668.0	1200.0	633.0	720.0	477.0
SODIUM	131.0		197.0	181.0	152.0	168.0	164.0
VANADIUM	28.7		10.9	9.83	4.75	6.89	4.47
ZINC	35.5		119.0	25.9	17.6	20.7	15.5

NOTES:
TABLE LISTS DETECTED ANALYTES ONLY – SEE PROJECT ANALYTE LIST FOR SUMMARY
< = LESS THAN DETECTION LIMIT SHOWN
NA = NOT AVAILABLE
= VALUE ABOVE BACKGROUND LEVEL

TABLE 5.5–8
ORGANIC COMPOUNDS IN SUBSURFACE SOIL
SA 41 – UNAUTHORIZED DUMPING AREA

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SI	SSI						
ANALYTE	**41M–92–01X**	**41M–93–02B**	**41M–93–02B**	**41M–93–02B**	**41M–93–02B**	**41M–93–03X**	**41M–93–04X**	**41M–93–05X**
ORGANICS (ug/g)	**26 FT**	**0 FT**	**5 FT**	**25 FT**	**DUP 25 FT**	**45 FT**	**5 FT**	**5 FT**
BIS (2–ETHYLHEXYL) PHTHALATE	NA	< 0.62	< 0.62	1.2	< 0.62	< 0.62	NA	NA
DI–N–BUTYL PHTHALATE	NA	0.4	0.3	30	0.62	30	NA	NA
OTHER (ug/g)								
*TOTAL ORGANIC CARBON	248	NA	NA	700	< 360	659	643	745

Notes:

< = Less than detection limit

TABLE 5.5-9
INORGANIC ANALYTES IN SUBSURFACE SOIL
SA 41 - UNAUTHORIZED DUMPING AREA

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BACKGROUND	SSI						
		41M-93-02B	41M-93-02B	41M-93-02B	41M-93-02B	41M-93-03X	41M-93-04X	41M-93-05X
INORGANICS (ug/g)		0 FT	5 FT	25 FT	DUP 25 FT	45 FT	5 FT	5 FT
ALUMINUM	15000.0	14200	37600	6290	6600	4080	NA	NA
ARSENIC	21.0	14	25	24	18	13	NA	NA
BARIUM	42.5	80.5	224	29.7	29.3	23.4	NA	NA
BERYLLIUM	0.347	< 0.5	1.95	< 0.5	< 0.5	< 0.5	NA	NA
CALCIUM	1400.0	1370	2280	1970	2080	1200	NA	NA
CHROMIUM	31.0	24.8	70.3	15.6	17.7	11.7	NA	NA
COBALT	NA	9.78	17	7.09	6.44	5.28	NA	NA
COPPER	8.39	16.1	40.4	10.8	11.1	7.39	NA	NA
IRON	15000.0	24100	50300	11700	12400	7900	NA	NA
LEAD	36.9	9.5	22	6.05	7.93	3.94	NA	NA
MAGNESIUM	5600.0	5500	12700	2700	2900	2050	NA	NA
MANGANESE	300.0	392	541	384	188	147	NA	NA
NICKEL	14.0	19.5	51.5	16.3	16.9	13.1	NA	NA
POTASSIUM	1700.0	4140	11500	1380	1570	859	NA	NA
SODIUM	131.0	449	669	458	497	388	NA	NA
THALLIUM		< 0.5	1.12	< 0.5	< 0.5	< 0.5	NA	NA
VANADIUM	28.7	33.9	87.7	12.1	12.4	8.28	NA	NA
ZINC	35.3	66.3	148	28	34.3	22.4	NA	NA

Notes:

< = Less than.

Shaded values exceed background limits.

TABLE 5.5-10
ANALYTES IN GROUNDWATER
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		ROUND 1					ROUND 2		ROUND 3	
Site ID:	**Fort Devens Background Concentrations**					**41M-92-01X**	**41M-92-01X**	**41M-92-01X**	**41M-92-01X**	**41M-92-01X**
Sample Date:						**09/25/92**	**01/07/93**	**01/07/93**	**10/15/93**	**10/15/93**
Depth:						**27**	**27**	**27**	**30**	**30**
Field Sample Number:		**41D-92-03X**	**41D-92-04X**	**41D-92-05X**	**41D-92-06X**	**MX4101X1**	**MX4101X2**	**MX4101X2**	**MX4101X3**	**MX4101X3**
PAL CATIONS/ANIONS (µg/L)										
Chloride						< 2120	< 2120	NA	NA	NA
Phosphate		1500.0	347.0	178.0	158.0	NA	NA	NA	NA	NA
Sulfate		12100.0	< 100000	< 100000	< 100000	< 10000	< 10000	NA	NA	NA
PAL METALS (µg/L)										
Aluminum	6870	53700.0	13800.0	5470.0	4960.0	7000	52600	302 F	34100	< 141 F
Antimony	3.03	3.93	< 3.03	< 3.03	< 3.03	4.2	< 3.03	< 3.03 F	< 3.03	3.84 F
Arsenic	10.5	37.7	8.64	68.0	60.3	38.5	59.2	4.26 F	28.3	< 2.54 F
Barium	39.6	199.0	47.0	27.4	22.7	268	228	< 5 F	158	< 3820 F
Beryllium	5	< 5.0	< 5.0	< 5.0	< 5.0	6.06	< 5	< 5 F	< 5	< 5 F
Calcium	14700	49800.0	5500.0	2100.0	2180.0	18300	11600	3370 F	14800	8.09 F
Chromium	14.7	58.5	15.5	< 6.0	< 6.0	149	88.9	< 6.02 F	62.8	< 99.8 F
Cobalt	25	< 25.0	< 25.0	< 25.0	< 25.0	58.6	44.4	< 25 F	34.1	< 1.26 F
Copper	8.09	46.1	8.88	< 8.09	< 8.09	93.7	72.9	< 8.09 F	57	< 1460 F
Iron	9100	61100.0	13600.0	25900.0	20500.0	110000	74600	333 F	48600	58.5 F
Lead	4.25	47.3	10.6	6.72	4.88	44.6	42.2	< 1.26 F	32.5	< 0.243 F
Magnesium	3480	18800.0	3540.0	1620.0	1570.0	26300	17100	1420 F	13200	34.3 F
Manganese	291	1150.0	239.0	236.0	282.0	1420	893	57.4 F	681	1590 F
Mercury	0.243	<0.243	<0.243	<0.243	<0.243	< 0.243	< 0.243	< 0.243 F	< 0.246	< 4.6 F
Nickel	34.3	64.5	< 34.3	< 34.3	< 34.3	178	113	< 34.3 F	73.6	< 6680 F
Potassium	2370	12500.0	5190.0	3830.0	3460.0	18800	15100	2610 F	9890	11 F
Silver	4.6	< 4.6	< 4.6	< 4.6	< 4.6	6.2	< 4.6	< 4.6 F	< 4.6	< 4.6 F
Sodium	10800	5610.0	2270.0	2250.0	2140.0	8870	9340	6640 F	8700	6680 F
Vanadium	11	79.4	20.4	< 11.0	< 11.0	119	102	< 11 F	65.6	< 11 F
Zinc	21.1	144.0	38.0	< 21.1	< 21.1	267	219	< 21.1 F	140	< 21.1 F
PAL PESTICIDES/PCBS										
Endrin		< 0.024	< 0.024	< 0.024	< 0.024	< 0.0238	0.0381	NA	< 0.0238	NA
PAL EXPLOSIVES (µg/L)										
Nitroglycerin		<10	<10	<10	<10	< 10	< 10	NA	< 10	NA
PAL SEMIVOLATILE ORGANICS (µg/L)										
*Bis (2-ethylhexyl) Phthalate		<4.8	<4.8	<4.8	<4.8	< 4.8	< 4.8	NA	14	NA
PAL VOLATILE ORGANICS (µg/L)										
1,2-dichloroethylenes (cis And Trans Isomers)		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA
1,1,2,2-tetrachloroethane		< 0.5	< 0.5	< 0.5	< 0.5	170	7.1	NA	33	NA
*Chloroform		< 0.5	1.4	< 0.5	< 0.5	< 9.5	< 0.5	NA	< 0.5	NA
Methylethyl Ketone / 2-butanone		<6.4	<6.4	<6.4	<6.4	< 6.4	< 6.4	NA	< 6.4	NA
Tetrachloroethylene / Tetrachloroethene		<1.6	<1.6	<1.6	<1.6	10	< 1.6	NA	2.4	NA
*Toluene		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA
Benzene		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA
Trichloroethylene / Trichloroethene		< 0.5	< 0.5	< 0.5	< 0.5	220	6.4	NA	40	NA
2,4,6-Trinitrotoluene		<0.63	<0.63	<0.63	<0.63	0.718	< 0.63	NA	< 0.63	NA
PAL WATER QUALITY PARAMETERS (µg/L)										
alkalinity		138000.0	14000.0	14000.0	11000.0	27000	39000	NA	NA	NA
nitrite, Nitrate-non Specific		25.5	< 10.0	< 10.0	< 10.0	11000	46.7	NA	NA	NA
nitrogen By Kjeldahl Method		619.0	210.0	1430.0	1810.0	NA	NA	NA	NA	NA
total Dissolved Solids						NA	NA	NA	NA	NA
total Hardness		135000.0	16400.0	9200.0	10600.0	NA	NA	NA	NA	NA
total Suspended Solids		2020000.0	392000.0	180000.0	172000.0	NA	1870000	NA	2180000	NA

TABLE 5.5-10
ANALYTES IN GROUNDWATER
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	Fort Devens Background Concentrations	ROUND 4		ROUND 3	ROUND 4	ROUND 3		ROUND 4	
Site ID:		41M-92-01X	41M-92-01X	41M-93-02A	41M-93-02A	41M-93-02B	41M-93-02B	41M-93-02B	41M-93-02B
Sample Date:		01/26/94	01/26/94	10/15/93	01/26/94	10/15/93	10/15/93	01/26/94	01/26/94
Depth:		30	30	27	27	27	27	27	27
Field Sample Number:		MX4101X2	MX4101X2	MD4102A1	MX4102A2	MX4102B1	MX4102B1	MX4102B2	MX4102B2
PAL CATIONS/ANIONS (µg/L)									
Chloride		NA	NA	NA	NA	NA	NA	NA	NA
Phosphate		NA	NA	NA	NA	NA	NA	NA	NA
Sulfate		NA	NA	NA	NA	NA	NA	NA	NA
PAL METALS (µg/L)									
Aluminum	6870	82800	< 141 F	NA	NA	16400	< 141 F	48500	< 141 F
Antimony	3.03	3.84	< 3.03 F	NA	NA	< 3.03	3.75 F	2.95	< 3.03 F
Arsenic	10.5	56.6	< 2.54 F	NA	NA	24.2	3.3 F	78	2.77 F
Barium	39.6	461	< 5 F	NA	NA	75.3	< 5 F	231	< 5 F
Beryllium	5	< 5	< 5 F	NA	NA	< 5	< 5 F	< 5	< 5 F
Calcium	14700	39200	3200 F	NA	NA	9170	5170 F	16400	5520 F
Chromium	14.7	149	< 6.02 F	NA	NA	25.5	< 6.02 F	81.5	< 6.02 F
Cobalt	25	88.9	< 25 F	NA	NA	< 25	< 25 F	42.8	< 25 F
Copper	8.09	147	13.2 F	NA	NA	25.7	< 8.09 F	75.7	< 8.09 F
Iron	9100	110000	152 F	NA	NA	24200	119 F	73200	166 F
Lead	4.25	48.6	< 1.26 F	NA	NA	11.8	< 1.26 F	34.3	2.49 F
Magnesium	3480	30800	1340 F	NA	NA	7430	2470 F	17200	2500 F
Manganese	291	1820	34.4 F	NA	NA	348	15.4 F	1210	37.6 F
Mercury	0.243	< 0.243	< 0.243 F	NA	NA	< 0.243	< 0.243 F	< 0.243	< 0.243 F
Nickel	34.3	170	< 34.3 F	NA	NA	< 34.3	< 34.3 F	95.7	< 34.3 F
Potassium	2370	20500	1600 F	NA	NA	6120	2020 F	14400	3100 F
Silver	4.6	< 4.6	< 4.6 F	NA	NA	< 4.6	< 4.6 F	< 4.6	< 4.6 F
Sodium	10800	9710	6550 F	NA	NA	10000	8560 F	11100	9480 F
Vanadium	11	147	< 11 F	NA	NA	31.7	< 11 F	78.9	< 11 F
Zinc	21.1	466	< 21.1 F	NA	NA	53.1	< 21.1 F	326	< 21.1 F
PAL PESTICIDES/PCBS									
Endrin		< 0.0238	NA	NA	NA	< 0.0238	NA	< 0.0238	NA
PAL EXPLOSIVES (µg/L)									
Nitroglycerin		< 10	NA	NA	NA	< 10	NA	< 10	NA
PAL SEMIVOLATILE ORGANICS (µg/L)									
*Bis (2-ethylhexyl) Phthalate		< 4.8	NA	NA	NA	NA	NA	13	NA
PAL VOLATILE ORGANICS (µg/L)									
1,2-dichloroethylenes (cis And Trans Isomers)		< 0.5	NA	< 0.5	< 0.5	< 0.5	NA	1.8	NA
1,1,2,2-tetrachloroethane		< 14	NA	< 0.5	< 0.5	2.5	NA	2	NA
*Chloroform		< 0.5	NA	< 0.5	< 0.5	< 0.5	NA	< 0.5	NA
Methylethyl Ketone / 2-butanone		< 6.4	NA	83	< 6.4	< 6.4	NA	< 6.4	NA
Tetrachloroethylene / Tetrachloroethene		< 1.6	NA	< 1.6	< 1.6	< 1.6	NA	< 1.6	NA
*Toluene		< 0.5	NA	41	< 0.5	< 0.5	NA	< 0.5	NA
Benzene		< 0.5	NA	< 0.5	1.5	< 0.5	NA	< 0.5	NA
Trichloroethylene / Trichloroethene		11	NA	< 0.5	< 0.5	9.1	NA	7.9	NA
2,4,6-Trinitrotoluene		< 0.63	NA	< 0.63	< 0.63	< 0.63	NA	< 0.63	NA
PAL WATER QUALITY PARAMETERS (µg/L)									
alkalinity		NA	NA	NA	NA	NA	NA	NA	NA
nitrite, Nitrate-non Specific		NA	NA	NA	NA	NA	NA	NA	NA
nitrogen By Kjeldahl Method		NA	NA	NA	NA	NA	NA	NA	NA
total Dissolved Solids		110000	NA	NA	NA	NA	NA	96000	NA
total Hardness		NA	NA	NA	NA	NA	NA	NA	NA
total Suspended Solids		1800000	NA	NA	NA	378000	NA	5200000	NA

TABLE 5.5-10
ANALYTES IN GROUNDWATER
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		ROUND 3				ROUND 4		ROUND 3	
Site ID:		41M-93-03X	41M-93-03X	41M-93-03X	41M-93-03X	41M-93-03X	41M-93-03X	41M-93-04X	41M-93-04X
Sample Date:	Fort Devens	10/14/93	10/14/93	10/14/93	10/14/93	01/20/94	01/20/94	10/14/93	10/14/93
Depth:	Background	39	39	39	39	39	39	6.5	6.5
Field Sample Number:	Concentrations	MX4103X1	MX4103X1	MX4103X1	MX4103X1	MX4103X2	MX4103X2	MX4104X1	MX4104X1
PAL CATIONS/ANIONS (µg/L)				DUP	DUP				
Chloride		NA	NA	NA	NA	NA	NA	NA	NA
Phosphate		NA	NA	NA	NA	NA	NA	NA	NA
Sulfate		NA	NA	NA	NA	NA	NA	NA	NA
PAL METALS (µg/L)									
Aluminum	6870	6300	< 141 F	6330 D	< 141 DF	22600	< 141 F	< 141	< 141 F
Antimony	3.03	< 3.03	3.38 F	< 3.03 D	< 3.03 DF	< 3.03	< 3.03 F	< 3.03	< 3.03 F
Arsenic	10.5	9.4	< 2.54 F	12.2 D	< 2.54 DF	83.4	35.2 F	19.5	15.4 F
Barium	39.6	30	< 5 F	30 D	< 5 DF	158	< 5 F	12.1	12.3 F
Beryllium	5	< 5	< 5 F	< 5 D	< 5 DF	< 5	< 5 F	< 5	< 5 F
Calcium	14700	6200	3440 F	6290 D	3470 DF	15000	8190 F	2310	2420 F
Chromium	14.7	9.61	< 6.02 F	10.3 D	< 6.02 DF	35.8	< 6.02 F	< 6.02	< 6.02 F
Cobalt	25	< 25	< 25 F	< 25 D	< 25 DF	< 25	< 25 F	< 25	< 25 F
Copper	8.09	11.9	< 8.09 F	14 D	< 8.09 DF	36	< 8.09 F	< 8.09	< 8.09 F
Iron	9100	8360	< 38.8 F	8580 D	117 DF	33500	138 F	5870	5640 F
Lead	4.25	4.12	< 1.26 F	4.12 D	< 1.26 DF	22.9	< 1.26 F	< 1.26	< 1.26 F
Magnesium	3480	3130	1410 F	3180 D	1430 DF	8340	1090 F	< 500	< 500 F
Manganese	291	177	< 2.75 F	178 D	3.9 DF	1210	< 2.75 F	135	138 F
Mercury	0.243	< 0.243	< 0.243 F	< 0.243 D	< 0.243 DF	< 0.243	< 0.243 F	< 0.243	< 0.243 F
Nickel	34.3	< 34.3	< 34.3 F	< 34.3 D	< 34.3 DF	43.5	< 34.3 F	< 34.3	< 34.3 F
Potassium	2370	2690	1130 F	2850 D	1170 DF	8540	2760 F	1560	1660 F
Silver	4.6	< 4.6	< 4.6 F	< 4.6 D	< 4.6 DF	< 4.6	< 4.6 F	< 4.6	< 4.6 F
Sodium	10800	6020	5340 F	6080 D	5410 DF	7910	6840 F	1720	1790 F
Vanadium	11	12.7	< 11 F	17 D	< 11 DF	36.6	< 11 F	< 11	< 11 F
Zinc	21.1	24.6	< 21.1 F	30.5 D	< 21.1 DF	146	< 21.1 F	< 21.1	< 21.1 F
PAL PESTICIDES/PCBS									
Endrin		< 0.0238	NA	< 0.0238	NA	< 0.0238	NA	< 0.0238	NA
PAL EXPLOSIVES (µg/L)									
Nitroglycerin		< 10	NA	NA	NA	36.5	NA	< 10	NA
PAL SEMIVOLATILE ORGANICS (µg/L)									
*Bis (2-ethylhexyl) Phthalate		7.5	NA	< 4.8 D	NA	5.5	NA	< 4.8	NA
PAL VOLATILE ORGANICS (µg/L)									
1,2-dichloroethylenes (cis And Trans Isomers)		< 1	NA	< 1 D	NA	< 0.5	NA	< 0.5	NA
1,1,2,2-tetrachloroethane		< 1	NA	< 1 D	NA	< 0.5	NA	< 0.5	NA
*Chloroform		< 1	NA	< 1 D	NA	< 0.5	NA	< 0.5	NA
Methylethyl Ketone / 2-butanone		< 10	NA	< 10 D	NA	< 6.4	NA	< 6.4	NA
Tetrachloroethylene / Tetrachloroethene		< 1	NA	< 1 D	NA	< 1.6	NA	< 1.6	NA
*Toluene		< 1	NA	< 1 D	NA	0.7	NA	< 0.6	NA
Benzene		< 0.5	NA	< 0.5	NA	< 0.5	NA	< 0.5	NA
Trichloroethylene / Trichloroethene		200	NA	200 D	NA	150	NA	< 0.5	NA
2,4,6-Trinitrotoluene		< 0.63	NA	< 0.63 D	NA	< 0.63	NA	< 0.63	NA
PAL WATER QUALITY PARAMETERS (µg/L)									
alkalinity		NA	NA	NA D	NA	NA	NA	NA	NA
nitrite, Nitrate-non Specific		NA	NA	NA D	NA	NA	NA	NA	NA
nitrogen By Kjeldahl Method		NA	NA	NA D	NA	NA	NA	< NA	NA
total Dissolved Solids		NA	NA	NA D	NA	84000	NA	NA	NA
total Hardness		NA	NA	NA D	NA	NA	NA	NA	NA
total Suspended Solids		447000	NA	540000 D	NA	2900000	NA	7000	NA

TABLE 5.5-10
ANALYTES IN GROUNDWATER
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

		ROUND 4		ROUND 3		ROUND 4	
Site ID:		**41M-93-04X**	**41M-93-04X**	**41M-93-05X**	**41M-93-05X**	**41M-93-05X**	**41M-93-05X**
Sample Date:	**Fort Devens**	**01/26/94**	**01/26/94**	**10/15/93**	**10/15/93**	**01/26/94**	**01/26/94**
Depth:	**Background**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**
Field Sample Number:	**Concentrations**	**MX4104X2**	**MX4104X2**	**MX4105X1**	**MX4105X1**	**MX4105X2**	**MX4105X2**
PAL CATIONS/ANIONS (µg/L)							
Chloride		NA	NA	NA	NA	NA	NA
Phosphate		NA	NA	NA	NA	NA	NA
Sulfate		NA	NA	NA	NA	NA	NA
PAL METALS (µg/L)							
Aluminum	6870	2870	< 141 F	12900	< 141 F	22900	< 141 F
Antimony	3.03	< 3.03	< 3.03 F	< 3.03	< 3.03 F	< 3.03	< 3.03 F
Arsenic	10.5	20.1	< 2.54 F	24.8	17.5 F	43.2	12.7 F
Barium	39.6	20.8	10.5 F	59.4	12.2 F	83.4	7.3 F
Beryllium	5	< 5	< 5 F	< 5	< 5 F	< 5	< 5 F
Calcium	14700	2510	2440 F	3840	3320 F	3510	2530 F
Chromium	14.7	6.12	< 6.02 F	14.4	< 6.02 F	31.7	< 6.02 F
Cobalt	25	< 25	< 25 F	< 25	< 25 F	< 25	< 25 F
Copper	8.09	< 8.09	< 8.09 F	11.9	< 8.09 F	21.9	< 8.09 F
Iron	9100	6390	1090 F	23500	8250 F	35700	7590 F
Lead	4.25	3.4	< 1.26 F	6.18	< 1.26 F	10.7	< 1.26 F
Magnesium	3480	991	< 500 F	3140	< 500 F	5230	611 F
Manganese	291	86.1	68 F	530	333 F	432	173 F
Mercury	0.243	< 0.243	< 0.243 F	< 0.243	< 0.243 F	< 0.243	< 0.243 F
Nickel	34.3	< 34.3	< 34.3 F	< 34.3	< 34.3 F	< 34.3	< 34.3 F
Potassium	2370	1490	1190 F	3850	1370 F	5470	1420 F
Silver	4.6	< 4.6	< 4.6 F	< 4.6	< 4.6 F	< 4.6	< 4.6 F
Sodium	10800	1620	1610 F	2380	1830 F	2320	1720 F
Vanadium	11	< 11	< 11 F	20.9	< 11 F	29.7	< 11 F
Zinc	21.1	42.5	36.4 F	34.2	< 21.1 F	54.4	25.4 F
PAL PESTICIDES/PCBS							
Endrin		< 0.0238	NA	< 0.0238	NA	NA	NA
PAL EXPLOSIVES (µg/L)							
Nitroglycerin		< 10	NA	< 10			
PAL SEMIVOLATILE ORGANICS (µg/L)							
*Bis (2-ethylhexyl) Phthalate		< 4.8	NA	10	NA	< 4.8	NA
PAL VOLATILE ORGANICS (µg/L)							
1,2-dichloroethylenes (cis And Trans Isomers)		< 0.5	NA	< 0.5	NA	< 0.5	NA
1,1,2,2-tetrachloroethane		< 0.5	NA	< 0.5	NA	< 0.5	NA
*Chloroform		< 0.5	NA	< 0.5	NA	< 0.5	NA
Methylethyl Ketone / 2-butanone		< 6.4	NA	< 6.4	NA	< 6.4	NA
Tetrachloroethylene / Tetrachloroethene		< 1.6	NA	< 1.6	NA	< 1.6	NA
*Toluene		< 0.6	NA	< 0.6	NA	< 0.6	NA
Benzene		< 0.5	NA	< 0.5	NA	< 0.5	NA
Trichloroethylene / Trichloroethene		0.5	NA	< 0.5	NA	< 0.5	NA
2,4,6-Trinitrotoluene		< 0.63	NA	< 0.63	NA	< 0.63	NA
PAL WATER QUALITY PARAMETERS (µg/L)							
alkalinity		NA	NA	NA	NA	NA	NA
nitrite, Nitrate-non Specific		NA	NA	< NA	NA	NA	NA
nitrogen By Kjeldahl Method		NA	NA	NA	NA	NA	NA
total Dissolved Solids		15000	NA	25000	NA	NA	NA
total Hardness		NA	NA	NA	NA	NA	NA
total Suspended Solids		57000	NA	350000	NA	700000	NA

TABLE 5.5-11
ANALYTES IN SURFACE WATER
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SS1		S1		
ANALYTE SITE ID	41D-93-10X	41D-93-11X	41D-92-01X	41D-92-02X	41D-92-02X
ORGANICS (ug/L)					
1,2-DICHLOROETHANE	1.3	< 0.5	< 0.5	< 0.5	< 0.5
TOLUENE	< 0.5	< 0.5	0.56	< 0.5	< 0.5
INORGANICS (ug/L)					
ALUMINUM	< 141	< 141	8100	1120	250
ARSENIC	3.09	2.77	17	6.72	4.16
BARIUM	< 5	< 5	64.8	16.3	7.65
CALCIUM	2530	2540	7600	4450	3530
CHROMIUM	< 6.02	< 6.02	8.82	< 6.02	< 6.02
COPPER	< 8.09	< 8.09	15.8	< 8.09	< 8.09
IRON	695	555	16400	3030	1510
LEAD	< 1.26	< 1.26	43.9	18.3	2.93
MAGNESIUM	725	770	2170	1060	852
MANGANESE	20.1	18.6	976	215	110
POTASSIUM	< 375	464	2570	1410	545
SODIUM	1670	1740	4260	3510	3290
VANADIUM	< 11	< 11	24.9	< 11	< 11
ZINC	< 21.1	< 21.1	98	< 21.1	< 21.1
OTHER (ug/L)					
ALKALINITY	7000	6000	14000	11000	11000
CHLORIDE	< 2120	< 2120	4610	< 2120	< 2120
NITROGEN BY KJELDAHL METHOD	610	790	3330	1620	1710
PHOSPHATE	21.2	23.1	287	99	149
TOTAL HARDNESS	9800	10400	29200	26000	16600
TOTAL SUSPENDED SOLIDS	38000	6000	362000	30000	32000

Notes:
< = Less than detection limit.

TABLE 5.5–12
ANALYTES IN SEDIMENT
SA 41 – UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE SIDE ID	LOW AREA				CRANBERRY POND			
	SSI						SI	
	41D–93–07X	41D–93–08X (DUP)	41D–93–08X	41D–93–09X	41D–93–10X	41D–93–11X	41D–92–01X	41D–92–02X
ORGANICS (ug/g)								
ACETONE	< 0.017	0.076	< 0.017	< 0.017	0.079	< 0.017	< 0.017	0.028
CHLOROFORM	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.012	< 0.001
ACENAPHTHYLENE	< 0.033	< 0.033	< 0.033	0.15	< 0.033	< 0.033	< 0.033	< 0.033
ANTHRACENE	< 0.033	< 0.033	< 0.033	0.14	< 0.033	< 0.033	< 0.033	< 0.033
BENZO [A] ANTHRACENE	< 0.17	< 0.17	< 0.17	1.6	< 0.17	< 0.17	< 0.17	< 0.17
BENZO [A] PYRENE	< 0.25	< 0.25	< 0.25	2.1	< 0.25	< 0.25	< 0.25	< 0.25
BENZO [B] FLUORANTHENE	< 0.21	< 0.21	< 0.21	2.4	< 0.21	< 0.21	< 0.21	< 0.21
BENZO [G,H,I] PERYLENE	< 0.25	< 0.25	< 0.25	1.3	< 0.25	< 0.25	< 0.25	< 0.25
BENZO [K] FLUORANTHENE	< 0.066	< 0.066	< 0.066	0.69	< 0.066	< 0.066	< 0.066	< 0.066
CHRYSENE	< 0.12	< 0.12	< 0.12	2.4	< 0.12	< 0.12	< 0.12	< 0.12
DI–N–BUTYL PHTHALATE	< 0.061	< 0.061	0.41	0.51	0.29	< 0.061	< 0.061	< 0.061
FLUORANTHENE	0.083	< 0.068	0.13	2.8	< 0.068	< 0.068	< 0.068	< 0.068
INDENO [1,2,3–C,D] PYRENE	< 0.29	< 0.29	< 0.29	1.6	< 0.29	< 0.29	< 0.29	< 0.29
NAPHTHALENE	< 0.037	< 0.037	< 0.037	0.1	< 0.037	< 0.037	< 0.037	< 0.037
PHENANTHRENE	< 0.033	< 0.033	0.1	0.92	< 0.033	< 0.033	< 0.033	< 0.033
PYRENE	0.073	< 0.033	0.16	2.6	< 0.033	< 0.033	< 0.033	< 0.033
4,4–DDD	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008	0.035	0.046	< 0.008
4,4–DDE	< 0.008	< 0.008	< 0.008	< 0.008	0.015	0.02	0.038	< 0.008
HEPTACHLOR	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	0.031
PCB 1260	0.2	0.182	0.224	0.393	0.217	0.316	< 0.08	< 0.08
INORGANICS (ug/g)								
ALUMINUM	5630	4830	5060	5090	4360	6380	9430	4220
ARSENIC	4.34	4.73	4.83	2.3	4.18	4.56	13.5	3.56
BARIUM	14.4	10	11.3	15.7	13.5	18.1	63.9	19.7
CALCIUM	345	433	378	345	656	617	1370	427
CHROMIUM	8.02	6.39	6.9	9.69	< 4.05	< 4.05	< 4.05	6.92
COBALT	2.08	< 1.42	< 1.42	1.76	< 1.42	< 1.42	< 1.42	< 1.42
COPPER	5.49	5.97	6.64	5.12	4.08	5.38	13.6	3.31
IRON	6510	6900	6390	6270	5590	5060	9510	4250
LEAD	9.4	16	24	27	6.28	22	40	17
MAGNESIUM	1500	1330	1280	1530	1170	970	1790	1130
MANGANESE	65.8	82.2	66.5	78.6	56.9	71.5	178	62
NICKEL	7.29	6.68	6.32	7.21	4.51	5.81	12.2	5.3
POTASSIUM	586	403	450	470	258	336	1130	377
SODIUM	286	564	330	544	783	493	609	205
VANADIUM	8.89	6.88	7.46	8.69	7.32	8.21	19.3	5.28
ZINC	24.2	25.4	25.9	30.1	19.6	22.6	98.1	18.6
OTHER (ug/g)								
TOTAL ORGANIC CARBON	2750	3360	5790	8330	22300	27600	22000	8830

Notes:
< = Less than detection limit.
DUP = Duplicate sample.

TABLE 5.5-13
HUMAN HEALTH PRE EVALUATION OF SURFACE SOIL
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS

ANALYTE	SOIL BACKGROUND CONCENTRATION [a] (ug/g)	DETECTED CONCENTRATION [b]		FREQUENCY OF DETECTION	MAXIMUM EXCEEDS BACKGROUND	REGION III RESIDENTIAL SOIL CONCENTRATION (ug/g)	MAXIMUM EXCEEDS REGION III CONCENTRATION ?
		AVERAGE (ug/g)	MAXIMUM (ug/g)				
SELENIUM	NA	0.382	0.382	1/10	NA	390	NO
SILVER	0.086	0.733	0.733	1/10	YES	390	NO
SODIUM	131	202.2	288	10/10	YES	NA	NA
VANADIUM	28.7	9.52	19	9/10	NO	550	NO
ZINC	35.5	1003.7	9200	10/10	YES	23,000	NO
OTHER							
TOTAL PETROLEUM HYDROCARBONS	NA	60	77	4/10	NA	NA	NA

Notes:

[a] Base-wide background soil inorganics database.

[b] Surface soil samples from sampling stations 41S-92-01X thru 41S-92-06X and 41D-92-03X thru 41D-92-06X.

[c] The Region III residential soil concentration was used as a surrogate for alpha- and gamma-chlordane.

NA = not available.

ug/g = micrograms per gram.

TABLE 5.5-14
HUMAN HEALTH PRE RISK EVALUTATION OF SURFACE SOIL (LOW AREA)
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	SOIL BACKGROUND CONCENTRATION [a] (ug/g)	CONCENTRATION [b] AVERAGE (ug/g)	CONCENTRATION [b] MAXIMUM (ug/g)	FREQUENCY OF DETECTION	MAXIMUM EXCEEDS BACKGROUND?	REGION III RESIDENTIAL CONCENTRATIONS (ug/g)	MCP S-2 STANDARD (ug/g)	MAXIMUM EXCEEDS GUIDELINE
ORGANICS								
ACENAPHTHYLENE	NA	0.15	0.15	1/4	NA	-	100	NO
ACETONE	NA	0.076	0.076	1/4	NA	7800	3	NO
ANTHRACENE	NA	0.14	0.14	1/4	NA	23000	1000	NO
BENZO [A] ANTHRACENE	NA	1.6	1.6	1/4	NA	0.87	0.7	YES
BENZO [A] PYRENE	NA	2.1	2.1	1/4	NA	0.088	0.7	YES
BENZO [B] FLUORANTHEN	NA	2.4	2.4	1/4	NA	0.87	0.7	YES
BENZO [G,H,I] PERYLENE	NA	1.3	1.3	1/4	NA	-	30	NO
BENZO [K] FLUORANTHEN	NA	0.69	0.69	1/4	NA	8.8	0.7	NO
CHRYSENE	NA	2.4	2.4	1/4	NA	87	0.7	YES
DI-N-BUTYLPHTHALATE	NA	0.46	0.51	2/4	NA	7800	-	NO
FLUORANTHENE	NA	1.0	2.8	3/4	NA	3100	600	NO
INDENO [1,2,3-C,D] PYREN	NA	1.6	1.6	1/4	NA	0.87	0.7	YES
NAPHTHALENE	NA	0.1	0.1	1/4	NA	3100	4	NO
AROCLOR-1260	NA	0.25	0.393	4/4	NA	0.083	2	REGION III
PHENANTHRENE	NA	0.51	0.92	2/4	NA	-	100	NO
PYRENE	NA	0.94	2.6	3/4	NA	2300	500	NO
INORGANICS								
ALUMINUM		5152	5630	4/4	NO	230000	-	NO
ARSENIC	21	4.05	4.83	4/4	NO	0.36	30	REGION III
BARIUM	42.5	12.9	15.7	4/4	NO	5500	-	NO
CALCIUM	1400	375	433	4/4	NO	-	-	-
CHROMIUM	31	7.75	9.69	4/4	NO	390	200	NO
COBALT	NA	1.92	2.08	2/4	NA	-	-	-
COPPER	8.39	5.8	6.64	4/4	NO	2900	-	NO
IRON	15000	6518	6900	4/4	NO	-	-	-
LEAD	36.9	19.1	27	4/4	NO	500	300	NO
MANGANESE	300	73.3	82.2	4/4	NO	-	-	NO
NICKEL	14.0	6.88	7.29	4/4	NO	23	300	NO
VANADIUM	28.7	7.98	8.89	4/4	NO	550		NO
ZINC	35.5	26.4	30.1	4/4	NO	23000	2500	NO

Notes:
[a] Base-wide background soil inorganics database.
[b] Surface soil samples from sampling stations 41D-93-07X thru 41D-93-09X (plus one dup).
NA = not available.
ug/g = micrograms per gram.

TABLE 5.5-15
HUMAN HEALTH PRE RISK EVALUATION OF GROUNDWATER
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a]		GROUNDWATER BACKGROUND CONCENTRATION (µg/L)	MAXIMUM EXCEEDS BACKGROUND ?	DRINKING WATER STANDARD/ GUIDELINE [b] (µg/L)	MAXIMUM EXCEEDS STANDARD/ GUIDELINE ?
		AVERAGE (µg/L)	MAXIMUM (µg/L)				
ORGANICS							
1,1,2,2-TETRACHLOROETHANE	5/13	44.9	170	NA	-	0.052	YES
2,4,6-TRINITROTOLUENE	1/13	0.718	0.718	NA	-	2.2	NO
CHLOROFORM	1/13	0.73	0.73	NA	-	5	NO
ENDRIN	1/13	0.038	0.038	NA	-	2	NO
METHYLETHYL KETONE / 2-BUTANONE	1/13	83	83	NA	-	350	NO
TETRACHLOROETHYLENE	2/13	6.2	10	NA	-	5	YES
TOLUENE	2/13	20.8	41	NA	-	1000	NO
TRICHLOROETHYLENE	8/13	86.8	220	NA	-	5	YES
1,2-DICHLOROETHLENES	1/13	1.8	1.8	NA	-	70	NO
INORGANICS							
ALUMINUM	13/13	24253	82800	6870	YES	50-200	YES
ANTIMONY	6/13	3.65	4.2	3.03	YES	6	NO
ARSENIC	13/13	38.26	83.4	10.5	YES	50	YES
BARIUM	13/13	139.6	268	39.6	YES	2000	NO
BERYLLIUM	1/13	6.06	6.06	5	YES	4	YES
CALCIUM	13/13	11471.5	39200	14700	YES	NA	-
CHROMIUM	12/13	55.38	149	14.7	YES	100	YES
COBALT	4/13	67.2	88.9	25	YES	NA	-
COPPER	11/13	52.06	147	8.09	YES	1300	NO
IRON	13/13	43268.4	110000	9100	YES	300	YES
LEAD	12/13	21.77	48.6	4.25	YES	15	YES
MAGNESIUM	12/13	11336.75	30800	3480	YES	NA	-
MANGANESE	13/13	701.5	1820	291	YES	50	YES
NICKEL	6/13	112.3	178	34.3	YES	100	YES
POTASSIUM	13/13	8558.46	20500	2370	YES	NA	-
SILVER	1/13	6.2	6.2	4.6	YES	100	-
SODIUM	13/13	6597.7	10000	10800	NO	2800	NO
VANADIUM	11/13	60.09	147	11	YES	260	NO
ZINC	12/13	150.27	466	21.1	YES	5000	NO
ANION/CATION							
NITRITE, NITRATE-NON SPECIFIC	3/6	3690.733	11000	NA	-	10000	YES

Notes:

[a] Unfiltered samples from four rounds of samples from 41M-92-01X and two rounds from 41M-93-02B thru 41M-93-05X.

[b] Includes the lowest of either the EPA or MA drinking water standards, or if no federal standard or guideline is available, the Region III tap water concentration.

NA = not available

µg/L = micrograms per liter

- = not applicable

Shaded compounds exceed standard or guideline.

TABLE 5.5-16
HUMAN HEALTH PRE RISK EVALUATION OF SURFACE WATER
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a] AVERAGE (µg/L)	DETECTED CONCENTRATION [a] MAXIMUM (µg/L)	DRINKING WATER STANDARD/GUIDELINE [b] (µg/L)	MAXIMUM EXCEEDS DRINKING WATER STANDARD/GUIDELINE ?
ORGANICS					
1,2-DICHLOROETHANE	1/5	1.3	1.3	5	NO
TOLUENE	1/5	0.56	0.56	1000	NO
INORGANICS					
ALUMINUM	3/5	3156.667	8100	50-200	YES
ARSENIC	5/5	6.748	17	50	NO
BARIUM	3/5	29.583	64.8	2000	NO
CALCIUM	5/5	4130	7600	NA	-
CHROMIUM	1/5	8.82	8.82	100	NO
COPPER	1/5	15.8	15.8	1300	NO
IRON	5/5	4438	16400	300	YES
LEAD	3/5	21.71	43.9	15	YES
MAGNESIUM	5/5	1115.4	2170	NA	-
MANGANESE	5/5	267.94	976	50	YES
POTASSIUM	4/5	1247.25	2570	NA	-
SODIUM	5/5	2894	4260	28000	NO
VANADIUM	1/5	24.9	24.9	260	NO
ZINC	1/5	98	98	5000	NO

Notes:

[a] Surface water from sampling locations 41D-92-01X, 41D-92-02X with 1 duplicate, 41D-93-10X, and 91D-93-11X.

[b] Includes the lowest of either the USEPA or MADEP drinking water standards, or if no federal or state standard or guideline is available, the Region III tap water concentration.

NA = not available

µg/L = micrograms per Liter

- = not applicable

Shaded compounds exceed standard or guideline.

TABLE 5.5-17
HUMAN HEALTH PRE RISK EVALUATION OF SEDIMENT - NEW CRANBERRY POND
SA 41 UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a]		REGION III RESIDENTIAL SOIL CONCENTRATION (µg/g)	MCP S-2 STANDARD (µg/g)	MAXIMUM EXCEEDS GUIDELINES ?
		AVERAGE (µg/g)	MAXIMUM (µg/g)			
ORGANICS						
4,4'-DDD	2/4	0.041	0.046	2.7	3	NO
4,4'-DDE	3/4	0.024	0.038	1.9	2	NO
ACETONE	2/4	0.054	0.079	7800	3	NO
CHLOROFORM	1/4	0.012	0.012	100	0.1	NO
DI-N-BUTYL PHTHALATE	1/4	0.29	0.29	7800	NA	NO
HEPTACHLOR	1/4	0.031	0.031	0.14	0.2	NO
PCB 1260	2/4	0.267	0.316	0.083	2	REGION III
INORGANICS						
ALUMINUM	4/4	6097.5	9430	230000	NA	NO
ARSENIC	4/4	6.45	13.5	0.36	30	REGION III
BARIUM	4/4	28.8	63.9	5500	NA	NO
CALCIUM	4/4	767.5	1370	NA	NA	-
CHROMIUM	1/4	6.92	6.92	390	600	NO
COPPER	4/4	6.593	13.6	2900	NA	NO
IRON	4/4	6102.5	9510	NA	NA	-
LEAD	4/4	21.32	40	500	600	NO
MAGNESIUM	4/4	1265	1790	NA	NA	-
MANGANESE	4/4	92.1	178	390	NA	NO
NICKEL	4/4	6.955	12.2	1600	700	NO
POTASSIUM	4/4	525.25	1130	NA	NA	-
SODIUM	4/4	522.5	783	NA	NA	-
VANADIUM	4/4	10.028	19.3	550	NA	NO
ZINC	4/4	39.725	98.1	23000	2500	NO

Notes:

[a] Sediment from sampling locations 41D-92-01X, 41D-92-02X, 41D-93-10X, and 41D-93-11X.

NA = not available

- = not applicable

µg/g = micrograms per gram

MCP = Massachusetts Contingency Plan

Shaded compounds exceed standard or guideline.

TABLE 5.5–18
ECOLOGICAL PRE EVALUATION OF SURFACE SOIL
SA 41 – UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	SOIL BACKGROUND CONCENTRATION [a] (ug/g)	CONCENTRATION [b] AVERAGE (ug/g)	CONCENTRATION [b] MAXIMUM (ug/g)	FREQUENCY OF DETECTION	MAXIMUM EXCEEDS BACKGROUND?	ECOLOGICAL BENCHMARKS (ug/g)	MAXIMUM EXCEEDS BENCHMARK?
ORGANICS							
4,4'–DDT	NA	0.1	0.34	6/10	NA	1.07	NO
4,4'–DDD	NA	0.013	0.013	1/10	NA	1.07	NO
4,4'–DDE	NA	0.1	0.21	6/10	NA	1.07	NO
ACENAPHTHYLENE	NA	0.2	0.3	2/10	NA	2600	NO
ACETONE	NA	0.02	0.02	1/10	NA	2000	NO
ALPHA–CHLORDANE	NA	0.007	0.007	2/10	NA	0.29	NO
ANTHRACENE	NA	0.3	0.3	2/10	NA	14000	NO
BENZO [A] ANTHRACENE	NA	1.5	2	2/10	NA	8.9	NO
BENZO [A] PYRENE	NA	2	2	2/10	NA	5.5	NO
BENZO [B] FLUORANTHENE	NA	1.5	2	2/10	NA	180	NO
BENZO [G,H,I] PERYLENE	NA	0.7	0.7	1/10	NA	440	NO
BENZO [K] FLUORANTHENE	NA	1.25	2	2/10	NA	320	NO
CARBAZOLE	NA	0.3	0.5	2/10	NA	43	NO
CHRYSENE	NA	2	2	2/10	NA	440	NO
FLUORANTHENE	NA	1.7	6	7/10	NA	1100	NO
GAMMA–CHLORDANE	NA	0.02	0.044	6/10	NA	0.29	NO
HEPTACHLOR	NA	0.03	0.043	9/10	NA	0.64	NO
INDENO [1,2,3–C,D] PYRENE	NA	1	1	1/10	NA	320	NO
PHENANTHRENE	NA	0.6	2	6/10	NA	510	NO
PYRENE	NA	1.2	5	7/10	NA	550	NO
INORGANICS							
ALUMINUM	15000	6327	12700	10/10	NO		
ANTIMONY	NA	11	19.5	3/10	NA	7	YES
ARSENIC	21	8.5	14	10/10	NO		
BARIUM	42.5	69.2	307	10/10	YES	42.5	YES
BERYLLIUM	0.347	1.2	2.2	6/10	YES	0.88	YES
CADMIUM	2	8.7	15.5	2/10	YES	2	YES
CHROMIUM	31	14.1	22.9	9/10	NO		
COBALT	NA	4.4	9.3	10/10	NA	50	NO
COPPER	8.39	17.2	54.4	10/10	YES	34	YES
LEAD	48.4	287.9	1400	10/10	YES	48.4	YES
MANGANESE	300	314.6	940	10/10	YES	1500	NO
MERCURY	0.22	0.079	0.081	2/10	NO		
NICKEL	14.0	10.97	22.2	10/10	YES	100	NO
SELENIUM	NA	0.382	0.382	1/10	NA	0.48	NO
SILVER	0.086	0.733	0.733	1/10	YES	72	NO
VANADIUM	28.7	9.52	19	9/10	NO		
ZINC	35.5	1003.7	9200	10/10	YES	640	YES

Notes:
[a] Base–wide background soil inorganics database.
[b] Surface soil samples from sampling stations 41S–92–01X thru 41S–92–06X and 41D–92–03X thru 41D–92–06X.
NA = not available.
ug/g = micrograms per gram.

TABLE 5.5-19
ECOLOGICAL PRE RISK EVALUTATION OF SURFACE SOIL (LOW AREA)
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	SOIL BACKGROUND CONCENTRATION [a] (ug/g)	CONCENTRATION [b] AVERAGE (ug/g)	CONCENTRATION [b] MAXIMUM (ug/g)	FREQUENCY OF DETECTION	MAXIMUM EXCEEDS BACKGROUND?	ECOLOGICAL BENCHMARKS (ug/g)	MAXIMUM EXCEEDS BENCHMARK?
ORGANICS							
ACENAPHTHYLENE	NA	0.15	0.15	1/4	NA	2600	NO
ACETONE	NA	0.076	0.076	1/4	NA	2000	NO
ANTHRACENE	NA	0.14	0.14	1/4	NA	14000	NO
BENZO [A] ANTHRACENE	NA	1.6	1.6	1/4	NA	8.9	NO
BENZO [A] PYRENE	NA	2.1	2.1	1/4	NA	5.5	NO
BENZO [B] FLUORANTHENE	NA	2.4	2.4	1/4	NA	180	NO
BENZO [G,H,I] PERYLENE	NA	1.3	1.3	1/4	NA	440	NO
BENZO [K] FLUORANTHENE	NA	0.69	0.69	1/4	NA	320	NO
CHRYSENE	NA	2.4	2.4	1/4	NA	440	NO
DI-N-BUTYLPHTHALATE	NA	0.46	0.51	2/4	NA	2650	NO
FLUORANTHENE	NA	1.0	2.8	3/4	NA	1100	NO
INDENO [1,2,3-C,D] PYRENE	NA	1.6	1.6	1/4	NA	320	NO
NAPHTHALENE	NA	0.1	0.1	1/4	NA	170	NO
AROCLOR-1260	NA	0.25	0.393	4/4	NA	3.1	NO
PHENANTHRENE	NA	0.51	0.92	2/4	NA	530	NO
PYRENE	NA	0.94	2.6	3/4	NA	550	NO
INORGANICS							
ALUMINUM		5152	5630	4/4	NO		
ARSENIC	21	4.05	4.83	4/4	NO		
BARIUM	42.5	12.9	15.7	4/4	NO		
CHROMIUM	31	7.75	9.69	4/4	NO		
COBALT	NA	1.92	2.08	2/4	NA	50	NO
COPPER	8.39	5.8	6.64	4/4	NO		
LEAD	48.4	19.1	27	4/4	NO		
MANGANESE	300	73.3	82.2	4/4	NO		
NICKEL	14.0	6.88	7.29	4/4	NO		
VANADIUM	28.7	7.98	8.89	4/4	NO		
ZINC	35.5	26.4	30.1	4/4	NO		

Notes:

[a] Base-wide background soil inorganics database.

[b] Surface soil samples from sampling stations 41D-93-07X thru 41D-93-09X (plus one dup).

NA = not available.

ug/g = micrograms per gram.

TABLE 5.5-20
ECOLOGICAL PRE RISK EVALUATION OF SURFACE WATER - NEW CRANBERRY POND
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	CONCENTRATION [a] AVERAGE (ug/L)	CONCENTRATION [a] MAXIMUM (ug/L)	FREQUENCY OF DETECTION	ECOLOGICAL BENCHMARK (ug/L)	MAXIMUM EXCEEDS BENCHMARK?
ORGANICS					
1,2-DICHLOROETHANE	1.3	1.3	1/5	20,000	NO
TOLUENE	0.56	0.56	1/5	1750	NO
INORGANICS					
ALUMINUM	3,157	8,100	3/5	87	YES
ARSENIC	6.75	17	5/5	190	NO
BARIUM	29.6	64.8	3/5	NA	NA
CALCIUM	4,130	7,600	5/5	NA	NA
CHROMIUM	8.82	8.82	1/5	11	NO
COPPER	15.8	15.8	1/5	3.6 [b]	YES
IRON	4,438	16,400	5/5	1,000	YES
LEAD	21.7	43.9	3/5	0.54 [b]	YES
MAGNESIUM	1,115	2,170	5/5	NA	NA
MANGANESE	268	976	5/5	NA	NA
POTASSIUM	1,247	2,570	4/5	NA	NA
SODIUM	2,894	4,260	5/5	NA	NA
VANADIUM	24.9	24.9	1/5	NA	NA
ZINC	98	98	1/5	32.7 [b]	YES
OTHER					
TOTAL HARDNESS	18,400	29,200	5/5	---	---
TOTAL SUSPENDED SOLIDS	93,600	362,000	5/5	---	---

Notes:

[a] Surface water samples from sampling stations 41D-92-01X, 41D-92-02X, (plus dup), 41D-93-10X, and 41D-93-11X (plus two dups).

[b] Hardness-dependent criterion; 25 mg/l $CaCO_3$ used because site-specific hardness value (18.4 mg/l) is below the hardness range (25 to 400 mg/l) for which the hardness function is valid (Federal Register, 1992). See Section 3.6.2 of ABB-ES (1993) for methodology used to calculate site-specific hardness-dependent benchmark values.

ug/L = micrograms per liter.

NA = Not available.

--- = Analyte not a CPC for this medium.

TABLE 5.5-21
ECOLOGICAL PRE RISK EVALUATION OF SEDIMENT - NEW CRANBERRY POND
SA 41 - UNAUTHORIZED DUMPING AREA (SITE A)

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	CONCENTRATION [a] AVERAGE (ug/g)	CONCENTRATION [a] MAXIMUM (ug/g)	FREQUENCY OF DETECTION	ECOLOGICAL BENCHMARK (ug/g)	MAXIMUM EXCEEDS BENCHMARK?
ORGANICS					
ACETONE	0.054	0.79	2/4	NA	NA
CHLOROFORM	0.012	0.012	1/4	NA	NA
4,4'-DDD	0.041	0.046	2/4	0.018	YES
4,4'-DDE	0.024	0.038	3/4	0.018	YES
DI-N-BUTYLPHTHALATE	0.29	0.29	1/4	NA	NA
HEPTACHLOR	0.031	0.031	1/4	0.022 [b]	YES
AROCLOR 1260	0.267	0.316	2/4	0.39	NO
INORGANICS					
ALUMINUM	6,098	9,430	4/4	NA	NA
ARSENIC	6.5	13.5	4/4	5	YES
BARIUM	28.8	63.9	4/4	NA	NA
CHROMIUM	6.92	6.92	1/4	26	NO
COPPER	6.6	13.6	4/4	19	NO
IRON	6,103	9,510	4/4	24,000	NO
LEAD	21.3	40	4/4	27	YES
MANGANESE	92.1	178	4/4	428	NO
NICKEL	7.0	12.2	4/4	22	NO
VANADIUM	10.2	19.3	4/4	NA	NA
ZINC	39.7	98.1	4/4	85	YES
OTHER					
TOTAL ORGANIC CARBON	20,183	27,600	4/4	---	---

Notes:

[a] Sediment samples from sampling stations 41D-92-01X, 41D-92-02X, 41D-93-10X and 41D-93-11X.

[b] Benchmark is carbon-normalized using site-specific total organic carbon data (see Section 3.6.2 of ABB-ES, 1993).

NA = not available.

ug/g = micrograms per gram.

--- = Analyte not a CPC for this medium.

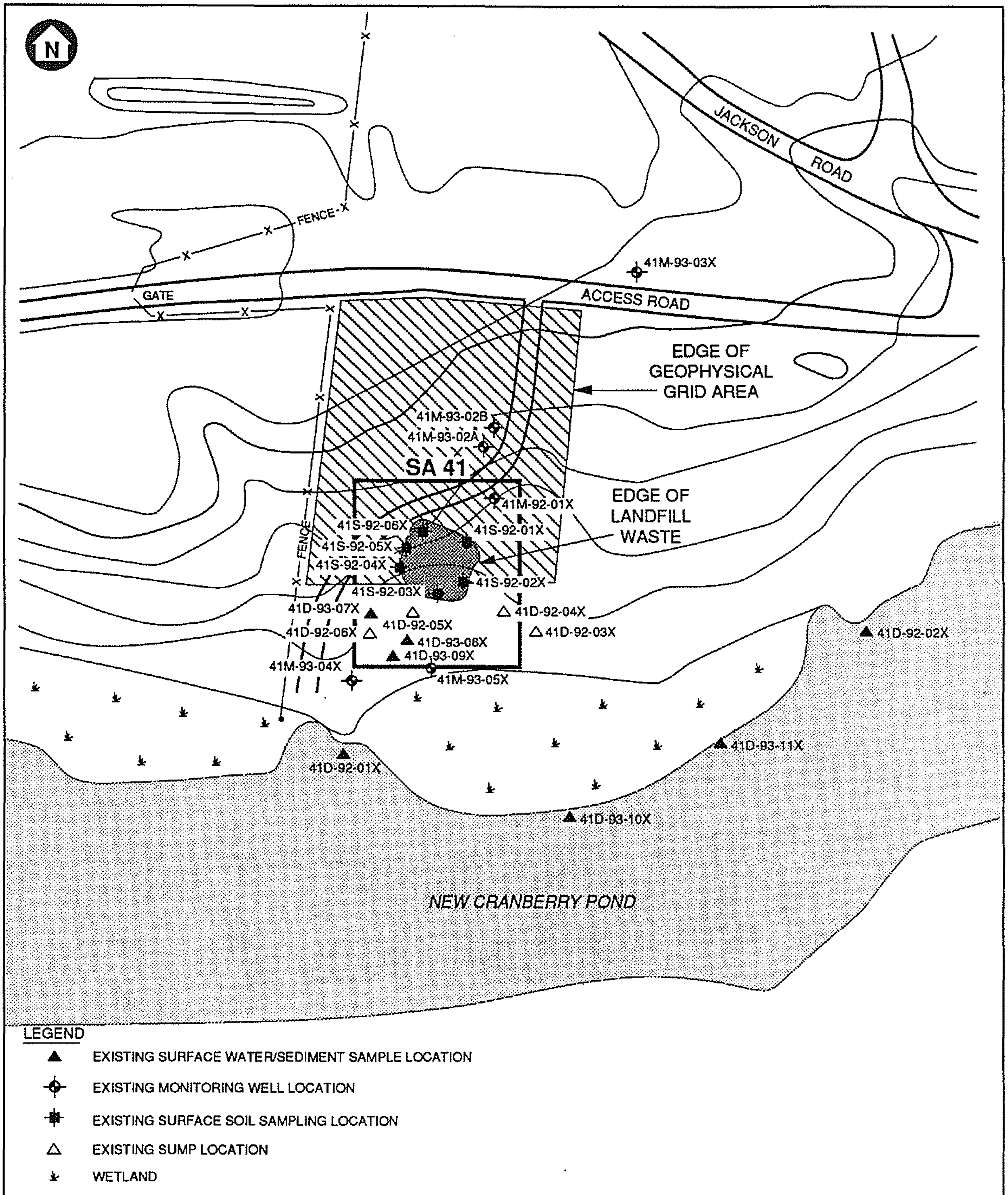


FIGURE 5.5-1
EXPLORATION LOCATIONS
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(t) 3,4,5,A

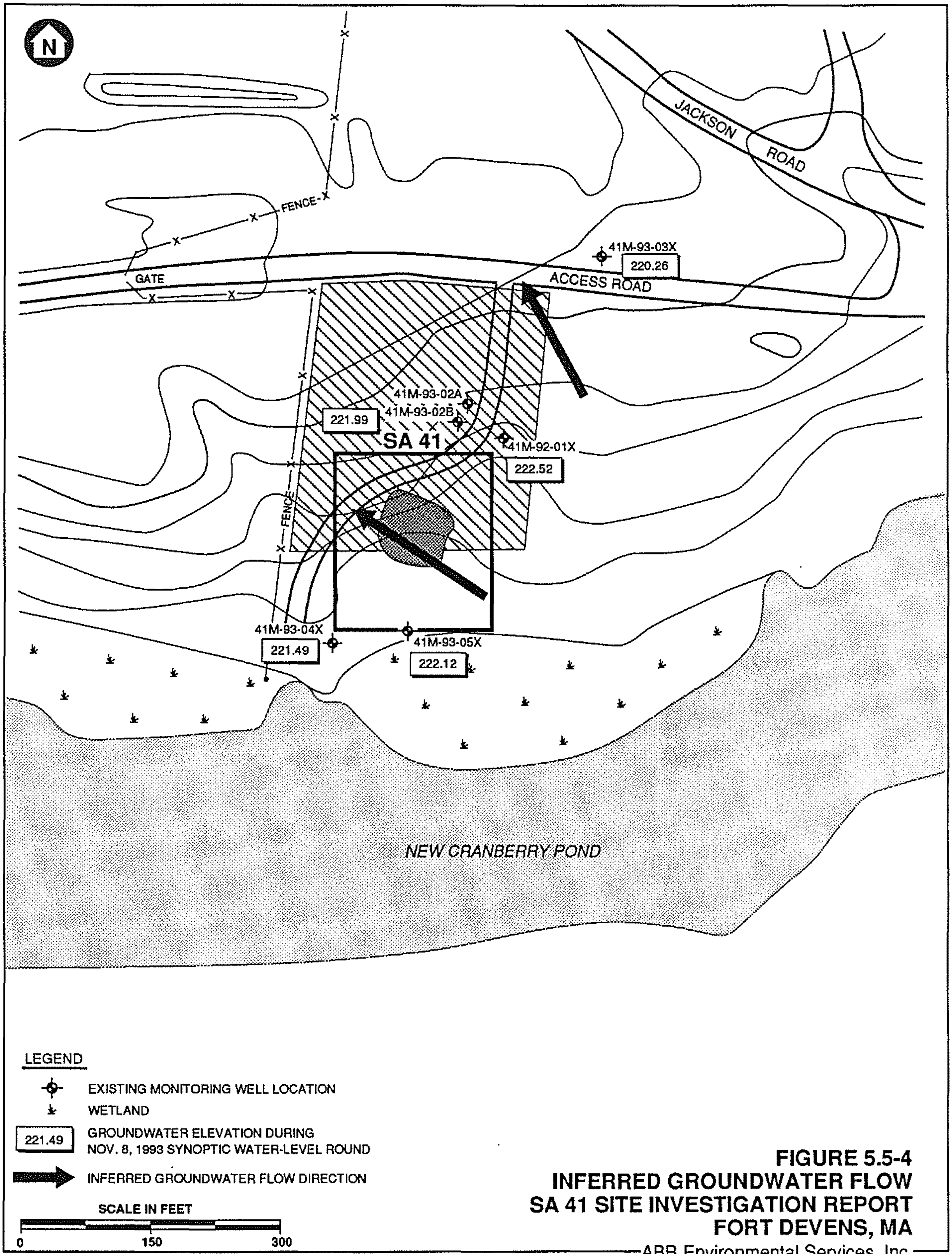
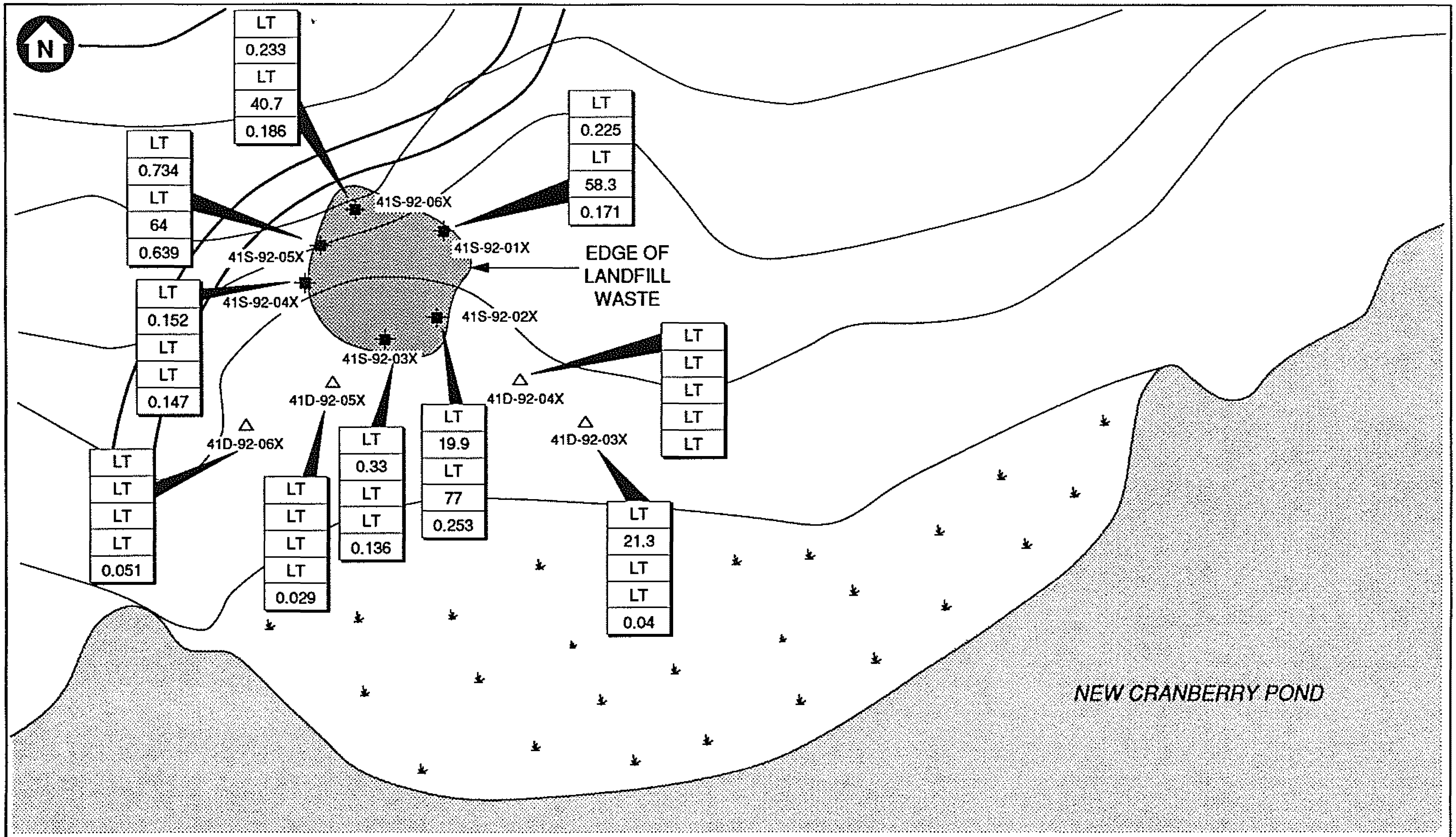


FIGURE 5.5-4
INFERRED GROUNDWATER FLOW
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(t) 2 ,4,8



LEGEND

⊕	SURFACE SOIL SAMPLING LOCATION
LT	LESS THAN DETECTION LIMIT
△	SUMP LOCATION

LT	TOTAL VOCs IN µg/g
6.6	TOTAL SVOCs IN µg/g
68.9	TOTAL EXPLOSIVES IN µg/g
323	TPHC IN µg/g
0.03	TOTAL PESTICIDES / PCB µg/g

SCALE IN FEET

0 80 160

FIGURE 5.5-5
ORGANIC ANALYTES IN SURFACE SOIL
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

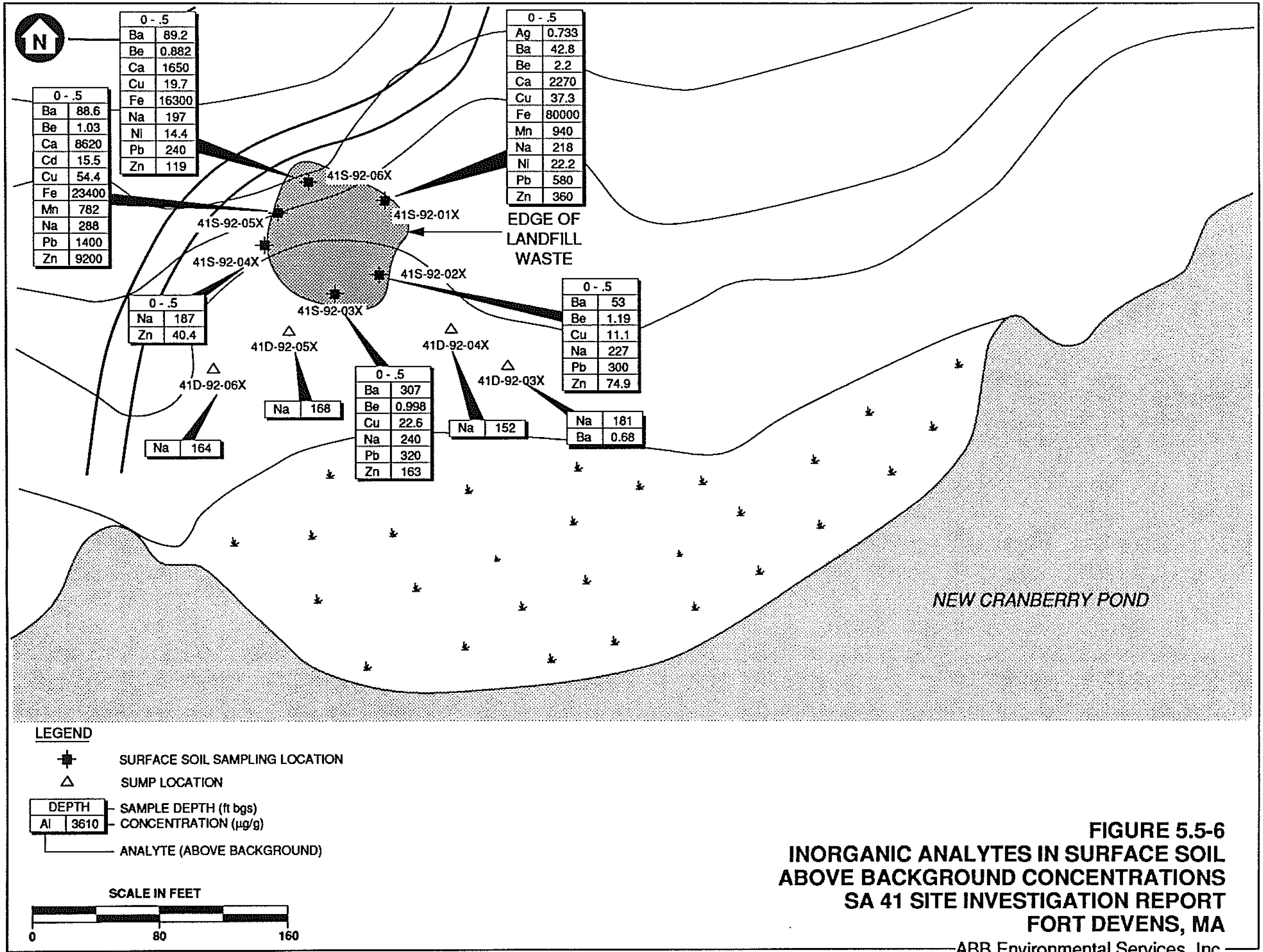


FIGURE 5.5-6
INORGANIC ANALYTES IN SURFACE SOIL ABOVE BACKGROUND CONCENTRATIONS
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(t1)1 3 6

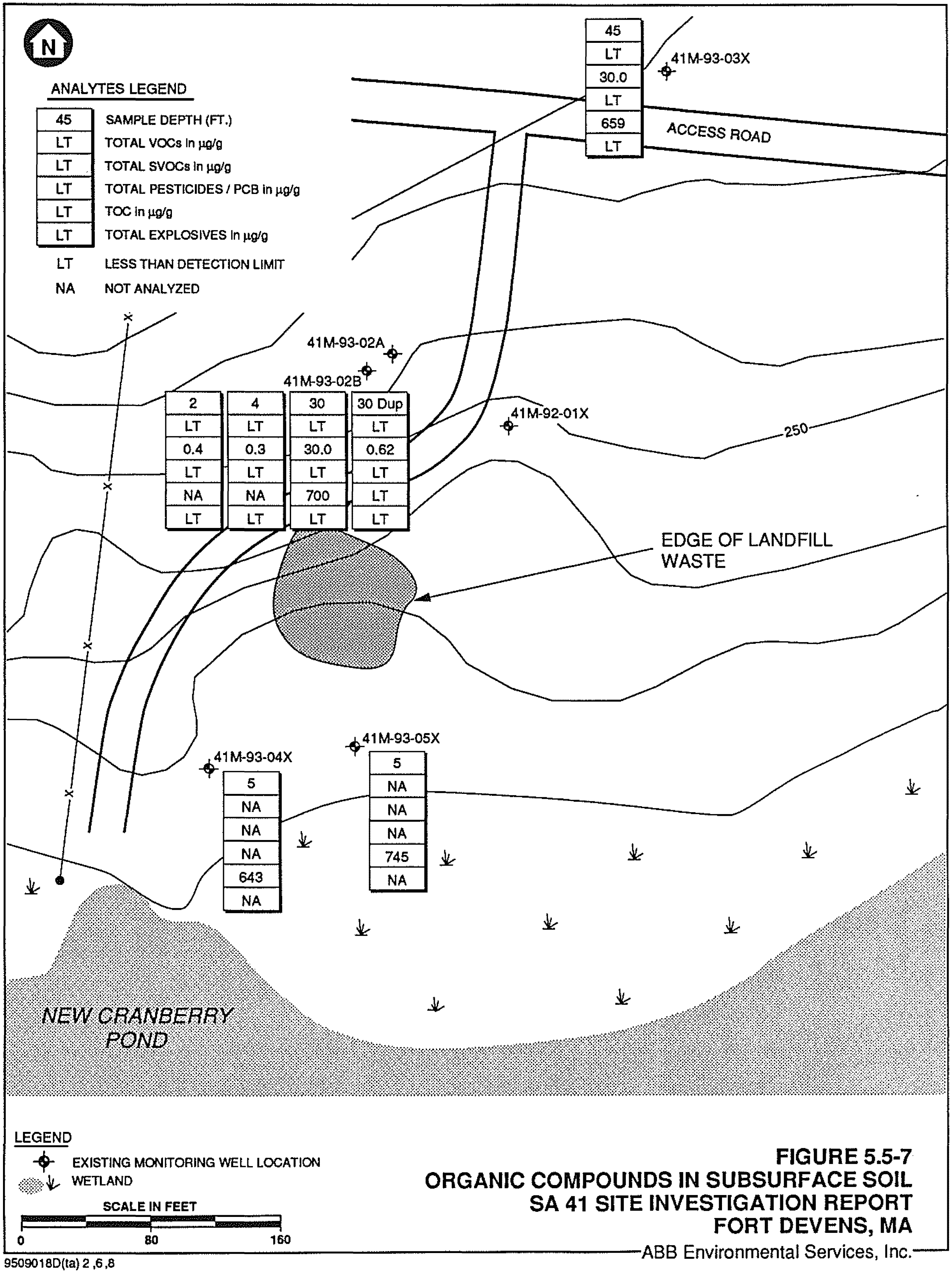
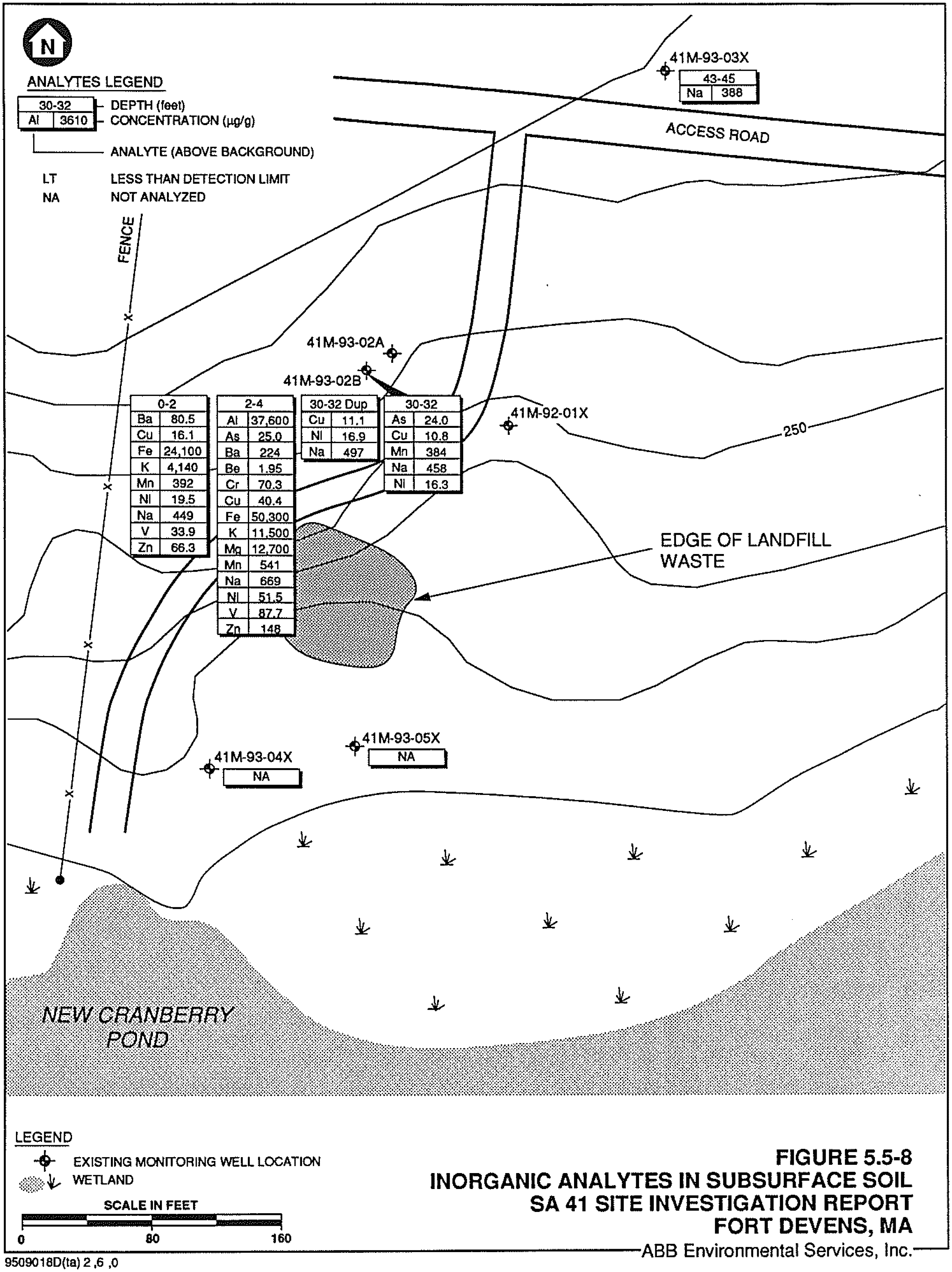


FIGURE 5.5-7
ORGANIC COMPOUNDS IN SUBSURFACE SOIL
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(ta) 2 ,6 ,8



41M-93-03X

43-45	
Na	388

41M-93-02B

0-2	
Ba	80.5
Cu	16.1
Fe	24,100
K	4,140
Mn	392
Ni	19.5
Na	449
V	33.9
Zn	66.3

2-4	
Al	37,600
As	25.0
Ba	224
Be	1.95
Cr	70.3
Cu	40.4
Fe	50,300
K	11,500
Mg	12,700
Mn	541
Na	669
Ni	51.5
V	87.7
Zn	148

30-32 Dup	
Cu	11.1
Ni	16.9
Na	497

30-32	
As	24.0
Cu	10.8
Mn	384
Na	458
Ni	16.3

FIGURE 5.5-8
INORGANIC ANALYTES IN SUBSURFACE SOIL
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

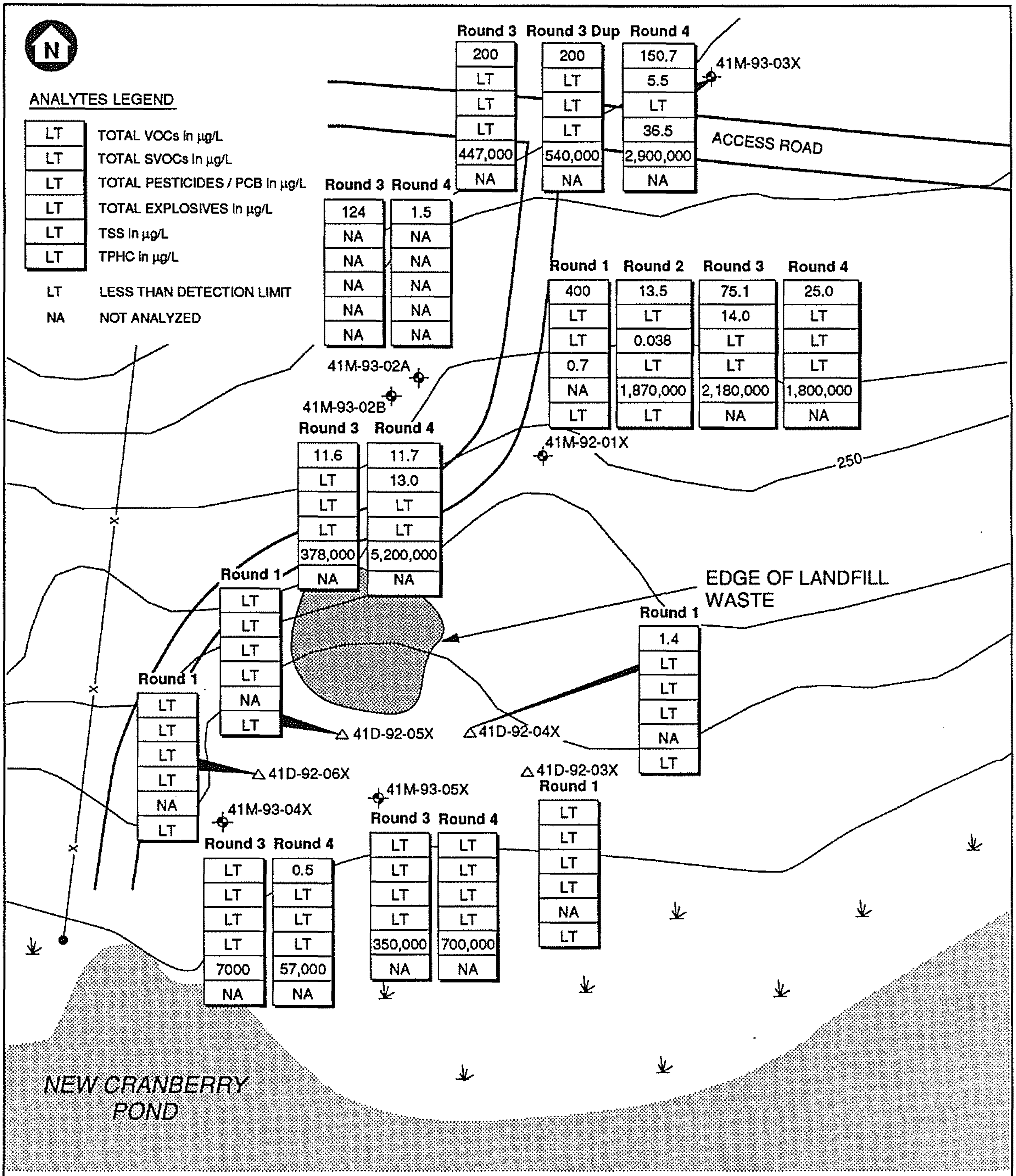
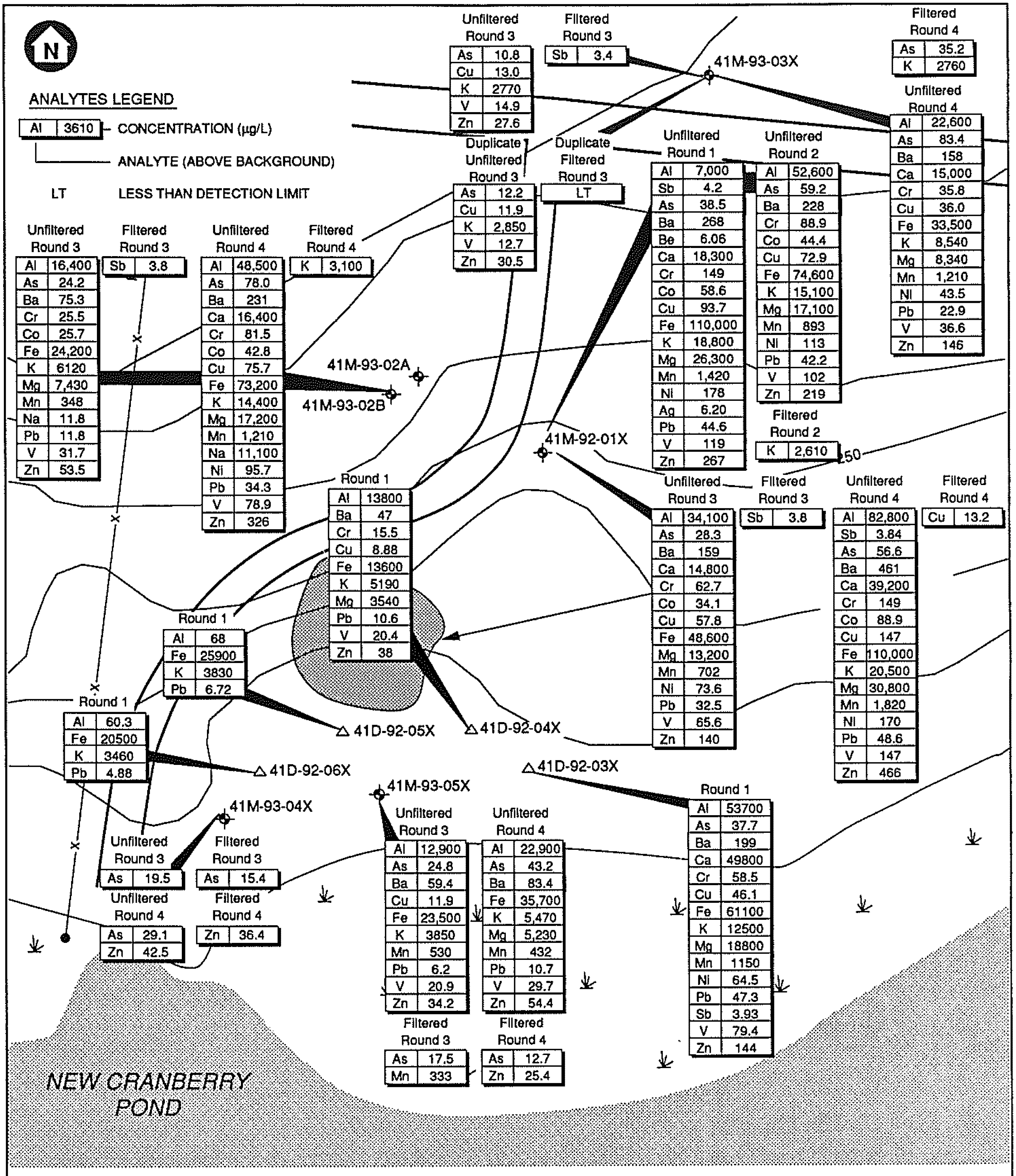


FIGURE 5.5-9
ORGANIC COMPOUNDS IN GROUNDWATER
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA
ABB Environmental Services, Inc.



ANALYTES LEGEND

Al	3610

- CONCENTRATION (µg/L)

ANALYTE (ABOVE BACKGROUND)

LT LESS THAN DETECTION LIMIT

Unfiltered Round 3

Al	16,400
As	24.2
Ba	75.3
Cr	25.5
Co	25.7
Fe	24,200
K	6120
Mg	7,430
Mn	348
Na	11.8
Pb	11.8
V	31.7
Zn	53.5

Filtered Round 3

Sb	3.8

Unfiltered Round 4

Al	48,500
As	78.0
Ba	231
Ca	16,400
Cr	81.5
Co	42.8
Cu	75.7
Fe	73,200
K	14,400
Mg	17,200
Mn	1,210
Na	11,100
Ni	95.7
Pb	34.3
V	78.9
Zn	326

Filtered Round 4

K	3,100

Unfiltered Round 3

As	10.8
Cu	13.0
K	2770
V	14.9
Zn	27.6

Filtered Round 3

Sb	3.4

Filtered Round 4

As	35.2
K	2760

Unfiltered Round 4

Al	22,600
As	83.4
Ba	158
Ca	15,000
Cr	35.8
Cu	36.0
Fe	33,500
K	8,540
Mg	8,340
Mn	1,210
Ni	43.5
Pb	22.9
V	36.6
Zn	146

Duplicate Unfiltered Round 3

As	12.2
Cu	11.9
K	2,850
V	12.7
Zn	30.5

Duplicate Filtered Round 3

LT

Unfiltered Round 1

Al	7,000
Sb	4.2
As	38.5
Ba	268
Be	6.06
Ca	18,300
Cr	149
Co	58.6
Cu	93.7
Fe	110,000
K	18,800
Mg	26,300
Mn	1,420
Ni	178
Ag	6.20
Pb	44.6
V	119
Zn	267

Unfiltered Round 2

Al	52,600
As	59.2
Ba	228
Cr	88.9
Co	44.4
Cu	72.9
Fe	74,600
K	15,100
Mg	17,100
Mn	893
Ni	113
Pb	42.2
V	102
Zn	219

Filtered Round 2

K	2,610

Unfiltered Round 3

Al	34,100
As	28.3
Ba	159
Ca	14,800
Cr	62.7
Co	34.1
Cu	57.8
Fe	48,600
Mg	13,200
Mn	702
Ni	73.6
Pb	32.5
V	65.6
Zn	140

Filtered Round 3

Sb	3.8

Unfiltered Round 4

Al	82,800
Sb	3.84
As	56.6
Ba	461
Ca	39,200
Cr	149
Co	88.9
Cu	147
Fe	110,000
K	20,500
Mg	30,800
Mn	1,820
Ni	170
Pb	48.6
V	147
Zn	466

Filtered Round 4

Cu	13.2

Round 1

Al	13800
Ba	47
Cr	15.5
Cu	8.88
Fe	13600
K	5190
Mg	3540
Pb	10.6
V	20.4
Zn	38

Round 1

Al	68
Fe	25900
K	3830
Pb	6.72

Round 1

Al	60.3
Fe	20500
K	3460
Pb	4.88

Unfiltered Round 3

As	19.5

Filtered Round 3

As	15.4

Unfiltered Round 4

As	29.1
Zn	42.5

Filtered Round 4

Zn	36.4

Unfiltered Round 3

Al	12,900
As	24.8
Ba	59.4
Cu	11.9
Fe	23,500
K	3850
Mn	530
Pb	6.2
V	20.9
Zn	34.2

Unfiltered Round 4

Al	22,900
As	43.2
Ba	83.4
Fe	35,700
K	5,470
Mg	5,230
Mn	432
Pb	10.7
V	29.7
Zn	54.4

Filtered Round 3

As	17.5
Mn	333

Filtered Round 4

As	12.7
Zn	25.4

Round 1

Al	53700
As	37.7
Ba	199
Ca	49800
Cr	58.5
Cu	46.1
Fe	61100
K	12500
Mg	18800
Mn	1150
Ni	64.5
Pb	47.3
Sb	3.93
V	79.4
Zn	144

LEGEND

△	SUMP LOCATIONS
⌖	EXISTING MONITORING WELL/WELL POINT LOCATION
▨ ⊻	WETLAND

SCALE IN FEET

0 80 160

FIGURE 5.5-10
INORGANIC ANALYTES IN GROUNDWATER
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(ta) 23,6A

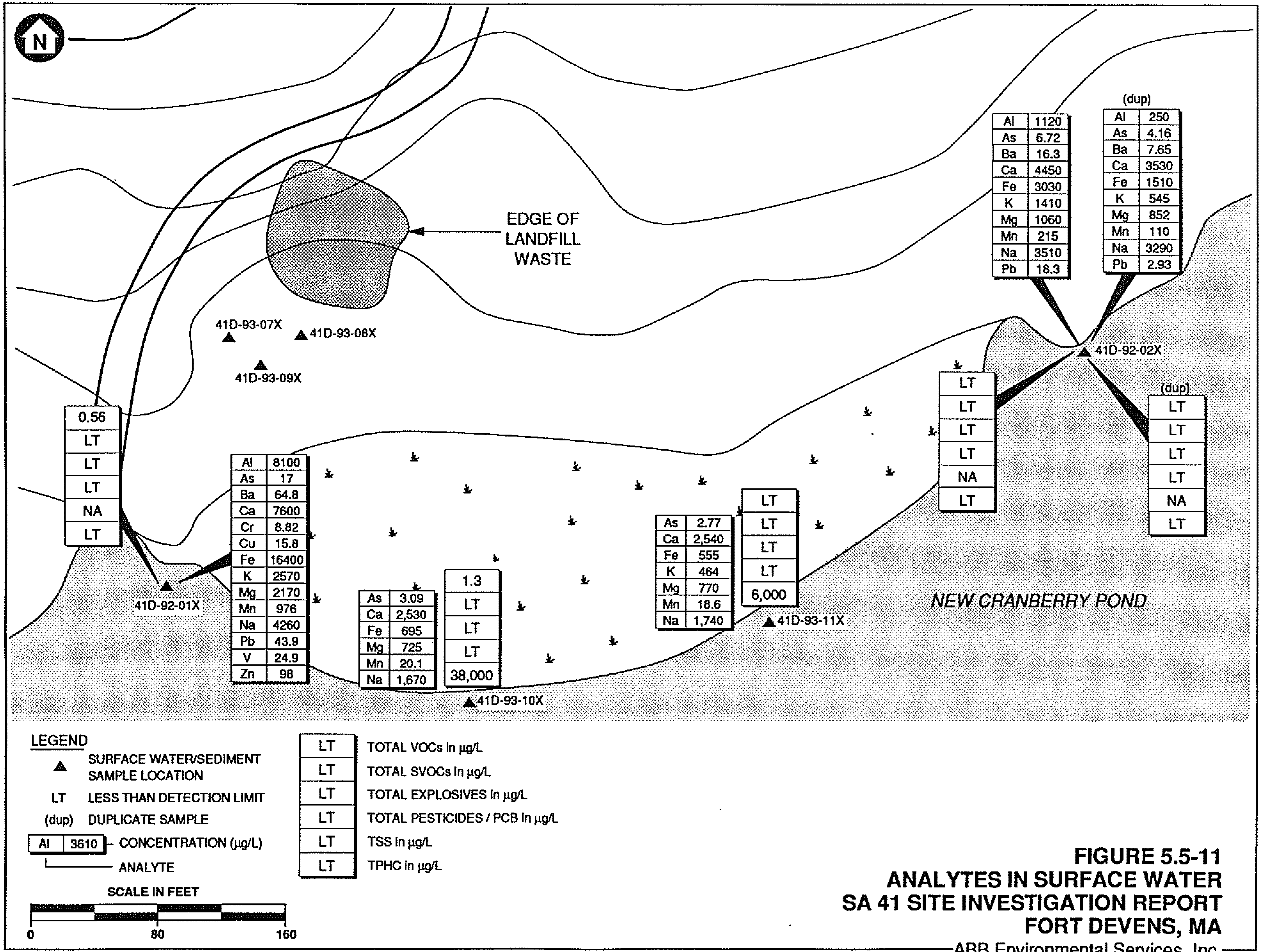


FIGURE 5.5-11
ANALYTES IN SURFACE WATER
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA
ABB Environmental Services, Inc.

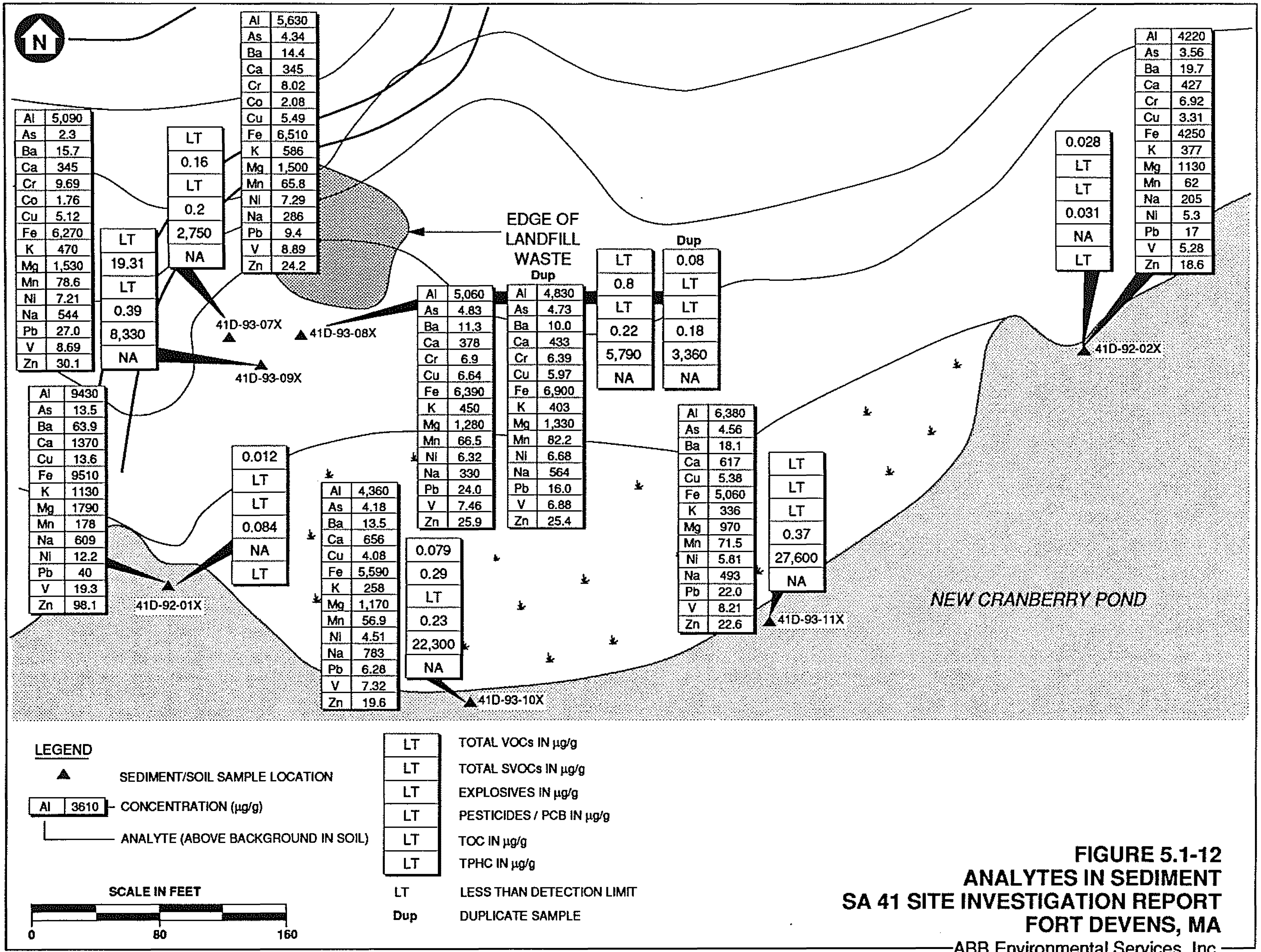


FIGURE 5.1-12
ANALYTES IN SEDIMENT
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA
ABB Environmental Services, Inc.

5.6 SA 42 - POPPING FURNACE

5.6.1 Background and Conditions

SA 42 is located in the South Post on the southeast side of Trainfire Road (see Figure 5.6-1). The SA itself is only approximately 1-acre in size. Because activities at the site were not documented, its history is largely unknown. The furnace is located on the northwest side of what appears to be a glacial kettle pond. Below the furnace, a steep slope leads to a wetland located in the bottom of the kettle pond. The kettle pond does not appear to have either an inlet or an outlet for surface water. The area is not secured by any form of fencing and is accessible to both human and ecological receptors.

Reportedly, the Popping Furnace has not been used since World War II (Biang et al., 1992). The SA consists of the "furnace" in which it is believed that small-caliber ammunition was burned. Waste material (ash and casings) are visible leading from the furnace and down the 30-foot hillside to the shore of the kettle pond below. Large rusty drums and parts of the Popping Furnace were observed at the base of the hill in a swampy area, and some of the furnace parts and drums are partially submerged in the swampy area. Other debris (i.e., large metal objects) are located at the base of the slope. The kettle ponds below the furnace are a reported habitat for the Blanding's turtle, which is a state-threatened species in Massachusetts.

5.6.2 Site Investigation Summary Program

The SI at SA 42 was undertaken in July 1992, in accordance with the Final SI Task Order Work Plan (ABB-ES, 1992b), and in conformance to the provision of the Project Operations Plan (ABB-ES, 1992d). The field sampling program for SA 42 consisted of drilling four shallow soil borings for the collection of soil samples, collecting four surface water and sediment samples, and collecting two surface soil samples to assess whether the historic use of the SA had generated conditions that pose a risk to human or ecological receptors (see Figure 5.6-1). Table 5.6-1 summarizes the scope of the SI.

Four soil borings (42B-92-01X through 42B-92-04X) were drilled east and west of the furnace to a depth of 4 feet to assess whether the historic use of the SA had adversely impacted soils quality around the furnace. Boring 42B-92-01X was drilled to the west and up slope of the furnace to evaluate the SA specific background soil quality. Borings 42B-92-02X, 42B-92-03X, and 42B-92-04X were drilled east of the furnace to evaluate whether the historic use of the furnace has impacted the soil quality in this area. The soil samples from 0 feet to 2 feet and 2 feet to 4 feet bgs, from each boring were submitted for off-site laboratory analysis of PAL VOCs, SVOCs, inorganics, pesticides/PCBs, and explosives. In addition to the analytical sample, one sample from each boring was tested for grain size to verify field classifications of soil (see Figure 5.6-1).

Four surface water and sediment samples (42D-92-01X through 41D-92-04X) were collected from the northwestern shore of the kettle pond wetland to assess whether surface water and sediments quality had been adversely impacted by the historic use of the SA (see Figure 5.6-1). Surface water and sediment sample locations, 42D-92-02X and 42D-92-03X, were chosen to assess the potential impact directly downslope of the furnace. Sampling locations 42D-92-01X and 42D-92-04X were chosen to assess the surface water and sediment quality in the kettle pond north and south of the SA. The surface water samples were submitted for off-site laboratory analysis of PAL VOCs, SVOCs, inorganics, pesticides/PCBs, explosives, and water quality parameters. The sediment samples were submitted for off-site laboratory analysis of PAL VOCs, SVOCs, inorganic analytes, pesticides/PCBs, explosives, TOC, and grain size.

Two surface soil samples (42S-92-01X and 42S-92-02X) were collected from the area directly downslope of the furnace to assess whether the surface soil has been adversely impacted by contaminant migration from the Popping Furnace (see Figure 5.6-1). Surface soil sample 42S-92-01X was collected halfway down the slope and surface soil sample 42S-92-02X was collected at the base of the slope, next to the western shore of the kettle pond. The surface soil samples were submitted for laboratory analysis of PAL VOCs, SVOCS, inorganic analytes, pesticides/PCBs, and explosives. Soil samples were collected from 0 to 0.5 feet bgs.

5.6.3 Supplemental Site Investigation Summary Program

The SSI at SA 42 was undertaken in August 1993, in accordance with the Final SSI Task Order Work Plan (ABB-ES, 1993b), and in conformance to the provision of the Project Operations Plan (ABB-ES, 1992d). The SSI sampling program was conducted to better define the potential distribution of SA 42 derived contaminants in the surface water and sediment of Kettle Pond. Table 5.6-1 summarizes the scope of the SSI.

A total of five surface water and sediment sample pairs (42D-93-05X through 42D-93-09X) were collected from the central and southern portions of Kettle Pond (see Figure 5.6-1). The surface water samples were submitted for laboratory analysis consisting of PAL VOCs, SVOCs, inorganic, explosives, pesticides/PCBs, and water quality parameters. Sediment samples were analyzed for PAL VOCs, SVOCs, inorganics, explosives, pesticides/PCBs, and TOC.

5.6.4 Field Investigation Results and Observations

SA 42 is located on material mapped by Koteff (1966) as Ayer Stage lake deposits. It is located at the top of a 30-foot-high slope that descends into a kettle hole in which the pond has matured to a habitat transitional to a wetland, as a result of the growth of woody vegetation.

Soil samples were collected from four 4-foot-deep borings drilled east and west of the furnace (see Figure 5.6-1). The soils ranged from well-graded sand with gravel, to fine silty sand. The finer soils may be wind-reworked materials deposited in immediate post-glacial time. The geology of the area around SA 42 is described in detail in Subsection 2.0. The boring logs for each of the soil borings is provided in Appendix B.

Four sediment samples from the wetland were submitted for grain size analysis. These samples consisted of silty sands, with silty clay content ranging from 13.9 to 34.4 percent, water contents ranging from 51.5 to 247.3 percent, and organics (vegetative matter) reported in three of the four samples (Table 5.6-2).

The major surface water body in the region is the Nashua River, located approximately one-quarter mile east of SA 42. Higher ground is located to the west of SA 42. Under these conditions, local groundwater would be expected to flow generally eastward from SA 42 toward the river. This interpretation is consistent with the installation-wide model of Engineering Technologies Associates, Inc. (1992, Figure III-20).

No monitoring wells were installed at SA 42 as part of this SI, and no existing monitoring wells were present. Consequently no groundwater levels nor aquifer properties were measured.

5.6.4 Nature and Distribution of Contamination (Laboratory Results)

The objective of the SI and SSI sampling programs at SA 42 was to investigate for the presence or absence of environmental contamination generated by the historical use of the Popping Furnace and, if found, assess the vertical and horizontal distribution of contamination, and recommend further actions. The primary environmental concern at SA 42 is the proximity of the furnace waste material (ash and shell casings) and other debris, to the wetlands established in the kettle pond downslope of the furnace. The investigation focused on assessing the potential releases of contaminants from the existing surficial waste material and from other historical releases associated with the operation of the Popping Furnace. Surface and subsurface soil samples were collected to characterize local impacts from the furnace. Surface water and sediment samples were collected from the western shore (directly downslope of the Popping Furnace) of the wetlands, and from the wetland, to assess potential contaminant migration.

5.6.4.1 Surface Soil. Six surface soil samples were collected from the area around the popping furnace during the SI. These samples included the 0-foot to 2-foot soil samples from 42B-92-01X through 42B-92-04X and the two surface soil samples (42S-92-01X and 42S-92-02X). No VOCs were detected in any of the surface soil samples except for chloroform which was detected in 42B-92-01X. Several SVOCs including bis (2-ethylhexyl) phthalate and di-n-butylphthalate, were detected in four of the six samples. Chloroform, bis (2-ethylhexyl) phthalate, and di-n-butylphthalate are considered common laboratory contaminants and do not appear to be site contaminants. Subsection 3.2.2 discusses these compounds as laboratory contaminants. The remaining SVOCs were detected in the surface soil sample from 42B-92-03X, 42B-92-04X, 42S-92-01X and 42S-92-02X. No SVOCs were detected in surface soil samples collected from 42B-92-01X and 42B-92-02X. Pesticides 4,4'-DDT and 4,4'-DDE were detected in three of the six surface soil samples collected. Explosive compounds including 2,4-dinitrotoluene, 2,6-dinitrotoluene, and nitroglycerine were detected in 42B-92-03X, 42B-92-04X, and 42S-92-02X (Table 5.6-3; Figure 5.6-2).

Concentrations of the inorganic analyte antimony, barium, beryllium, iron, copper, lead, manganese, mercury, nickel, sodium, and zinc were detected above the established Fort Devens background concentrations in up to three of the six samples. The highest concentrations and greatest number of these inorganic analytes were detected in 42S-92-02X. The surface soil sample from 42B-92-04X and 42B-92-01X contained inorganic analytes, including barium, copper, sodium, and zinc, above their established Fort Devens background concentrations. None of the inorganic analytes, except for sodium, were detected above the calculated Fort Devens background concentrations in 42B-92-01X, 42B-92-02X, and 42B-92-03X (Table 5.6-4; Figure 5.6-3).

5.6.4.2 Subsurface Soil. Four subsurface soil samples were collected from the soil borings (42B-92-01X through 42B-92-04X) advanced east and west of the former popping furnace during the SI. Each sample was collected from the depth interval from 2-feet to 4-feet bgs. Contaminant concentrations in these subsurface soils typically contained fewer and lower concentrations of contaminants. Chloroform was detected in all four samples ranging from 0.00092 μg/g to 0.001 μg/g. Chloroform is considered a common laboratory contaminant and is not considered a site contaminant. No SVOCs or explosives were detected in any of the subsurface soil samples. 4,4'-DDT was detected at 0.012 μg/g in 42B-92-03X, only (see Table 5.6-3; Figure 5.6-4).

No inorganic analytes, except for sodium, were detected above the calculated background concentrations in subsurface soil samples collected from 42B-92-01X, 42B-92-02X, and 42B-92-03X. The sample from 42B-92-04X exhibited elevated concentrations of sodium, copper, lead, and zinc (see Table 5.6-4; Figure 5.6-5).

5.6.4.3 Surface Water and Sediment. Four surface water and sediment pairs were collected from the western shore of the wetlands located down slope from the popping furnace during the SI (see Figure 5.6-1). Toluene was observed in surface water samples collected at 42D-92-03X and 42D-92-04X. Styrene and bis (2-ethylhexyl) phthalate were also detected in 42D-92-04X. Bis (2-ethylhexyl) phthalate is considered a common laboratory contaminant and does not appear to be a site contaminant. Subsection 3.2.2 discusses this compound as a laboratory contaminant. These two sampling location were the southern-most sampling points along the western shore of the wetlands. No other SVOCs, pesticides/PCBs, or explosive compounds were detected in any of the surface water samples. Inorganic analytes were detected in each of the surface water samples collected from SA 42. Barium, copper, lead, manganese, and zinc were detected at concentrations above the typical South Post concentrations (Table 5.6-5; Figure 5.6-6).

No PAL VOCs, SVOCs, explosives, or pesticides/PCBs were detected in any of the surface water samples collected from the wetland in Kettle Pond during the SSI. Iron was detected at 1,060 micrograms per Liter (μg/L) in the surface water sample collected from 42D-93-06X. Lead was detected at 2.17 μg/L in 42D-93-08X and at 10.2 in the duplicate sample from 42D-93-07X.

Toluene was detected in the sediment sample collected from 42D-92-02X. No other VOCs or SVOCs were detected in any of the sediment samples collected. No explosive compounds were detected in any of the sediment samples collected. 4,4'-DDD was detected in sediment samples collected from all four sampling locations and 4,4'-DDE and/or 4,4'-DDT were detected in at least two of the locations. Inorganic analytes (antimony, lead, sodium, and zinc) and the organic compound, toluene, were detected in the sample collected from 42D-92-02X (see Table 5.6-6; Figure 5.6-7).

Acetone (0.6 μg/g at 42D-93-05X) and trichlorofluoromethane (0.054 μg/g in 42D-93-05X), which are common laboratory contaminants, were the only PAL VOC detected in the sediment samples collected during the SSI. Di-n-butylphthalate (a common laboratory contaminant) was detected in four of the five sediment samples at concentrations ranging from 0.15 to 0.40 μg/g. 4,4'-DDT, 4,4'-DDD and 4,4'-DDE were detected in 42D-93-06X. Heptachlor, 4,4'-DDT and 4,4'-DDD were detected in 42D-93-08X, while heptachlor and/or 4,4'-DDD were detected in 42D-93-07X and 42D-93-09X (see Table 5.5-5; Figure 5.5-7).

Several inorganics were detected in the sediment samples collected from the wetland in Kettle Pond. The highest concentration of inorganics, were detected in 42D-93-05X (see Table 5.6-6; Figure 5.5-7).

5.6.5 Source Evaluation And Migration Potential

Surface water samples collected from the wetlands did not exhibit contaminants similar to nearby surface soil and sediment samples (particularly lead and zinc) collected during the SI. The fact that these contaminants were detected below the human health and ecological benchmark value at the SSI sample locations closest to the popping furnace, suggests that the quality of the surface water in the wetland at is not being impacted by contaminants from SA 42. No PCBs or explosive compounds were detected in surface water or sediment samples.

The inorganic results for the sediment sample collected during the SSI indicated that the concentrations of lead, copper, and antimony were all below the ecological benchmark values for these analytes. The detection of these inorganic analytes appears to suggest that contaminants may have migrated into the sediments in the wetland below SA 42 but do not appear to be causing an unacceptable risk to ecological receptors.

5.6.6 Preliminary Human Health Risk Evaluation

A preliminary human health risk evaluation was prepared for SA 42 to determine if the contaminants detected pose a risk to human receptors. For this PRE, the future use of SA 42 is assumed to be residential. Tables 5.6-7 through 5.6-10 present summary statistics and human health standards and guidelines used in the PRE for SA 42.

5.6.6.1 Soils. As discussed in Section 3.5 (Preliminary Risk Evaluation Methodology), all soils to a depth of 3 feet are classified as surface soil and considered to be accessible under a residential future use exposure scenario. All soils collected from 3-15 feet in depth are classified as subsurface and are considered to be accessible under a commercial/industrial future use exposure scenario. However, in the case of SA 42, soil samples were taken from two depths (0 to 2 feet and 2 to 4 feet). For the purpose of this PRE, the samples taken at SA 42 from 0 to 2 feet will be considered surface soils and the samples taken from 2 to 4 feet will be considered subsurface soils.

Surface Soils. Table 5.6-7 presents summary statistics on surface soil at SA 42 and USEPA Region III residential soil concentrations for comparison. Surface soil at SA 42 is represented by samples 42B-92-01X through 42B-92-04X, 42S-92-01X and 42S-92-02X. An assessment of the organic compound data for SA 42 soils shows that there is some surface contamination from PAHs, pesticide residues, and explosives residues. The maximum detected concentrations of the organic compounds are, however, below the USEPA Region III residential soil concentrations.

An assessment of the inorganic data for SA 42 surface soils shows that there is significant surface contamination directly downslope from the furnace, but little contamination laterally. When comparing soil concentrations at the downslope locations 42B-92-04X, 42S-92-01X, and 42S-92-02X to the established Fort Devens background, the inorganic data for SA 42 surface soils show that there are several compound exceedances, most notably copper, lead, and zinc.

Of the ten inorganic analytes detected above the established background concentrations, only two analytes were detected at concentrations above their respective health-based soil guideline. Although beryllium was detected at 1.23 μg/g, above the USEPA Region III residential soil concentration of 0.4 μg/g, it was detected in only one of six samples. The USEPA Superfund lead cleanup level of 500 μg/g was exceeded at locations 42S-92-01X (3,000 μg/g) and 42S-92-02X (6,600 μg/g). Two additional inorganic analytes, antimony and arsenic, were detected at concentrations above the USEPA Region III residential soil concentrations. Arsenic was detected at concentrations above the residential soil concentration, but the maximum detected concentration did not exceed the base-wide background concentration for arsenic of 21 μg/g. Antimony was detected in two samples (42S-92-01X at 43.0 μg/g, and 42S-92-02X at 85.0 μg/g) at concentrations above the USEPA Region III residential soil concentration of 31 μg/g. Based on this screening-level analysis, it appears that antimony and lead at the downslope locations may pose a potential risk to human health.

Subsurface Soils. Table 5.6-8 presents summary statistics on subsurface soil at SA 42 and USEPA Region III commercial/industrial soil concentrations for comparison. Subsurface soil at SA 42 is represented by samples 42B-92-01X through 42B-92-04X. An assessment of the organic compound data for SA 42 subsurface soils shows that there is limited contamination from 4,4'-DDE, 4,4'-DDT, and chloroform. The maximum detected concentrations of these compounds are, however, below the USEPA Region III commercial/industrial soil concentrations.

When comparing against the established Fort Devens background, the inorganic data for SA 42 subsurface soils show that there are four compound exceedances, including copper, lead, sodium, and zinc. Of the four inorganic analytes detected above the established background concentrations, none of the analytes were detected at concentrations above their respective health-based soil guidelines. One additional analyte, arsenic, was detected at concentrations above the USEPA

Region III commercial/industrial soil concentration. The maximum detected concentration of arsenic was 8.31 μg/g and this did not exceed the established background concentration for arsenic of 21 μg/g.

5.6.6.2 Surface Water and Sediment. Tables 5.6-9 and 5.6-10 present summary statistics on surface water and sediment in the wetlands located downslope and downgradient from SA 42. Four sampling locations were established on the western shore of the kettle pond immediately east of the popping furnace (42D-92-01X through 42D-92-04X).

Three organic compounds were detected in the surface water associated with SA 42: bis(2-ethylhexyl)phthalate, styrene, and toluene. The maximum detected concentrations of styrene and toluene were below their respective MCLs. Bis(2-ethylhexyl)phthalate exceeded the Massachusetts drinking water standard in the one sample of ten in which it was detected. However, bis(2-ethylhexyl)phthalate is a common laboratory contaminant and is not considered a site-related contaminant at SA 42.

The concentrations of five inorganic analytes detected in the surface water exceed their respective drinking water standard/guideline. The maximum concentration of lead detected at location 42D-92-02X (41.8 μg/L) exceeds the USEPA lead drinking water action level of 15 μg/L; however, the average concentration of lead in the ten surface water samples (14.4 μg/L) is below the action level. Iron and manganese were detected in all samples collected and each exceeded its respective secondary MCL. Aluminum, detected in all of the five samples taken in the first round and none of the samples from the second round, exceeded its secondary MCL. Antimony was detected in one of ten samples at a concentration (6.34 μg/L) which slightly exceeds its MCL of 6 μg/L.

The use of drinking water guidelines for comparison to surface water concentrations in a wetland is a conservative approach and is used due to a lack of available health-based guidelines for exposure to surface water. The magnitude and frequency of exposure to surface water in this wetland would be expected to be much less than that upon which drinking water guidelines are based. Because exposure to surface waters in the wetlands is anticipated to be restricted to wading in the future, it is not likely that an individual would encounter inorganic analyte concentrations that would pose a threat to public health.

The levels of contaminants detected in sediment are generally below the USEPA Region III residential soil concentrations and MCP S-2/GW-1 soil standards. The exception is arsenic which was detected above the USEPA Region III residential soil concentration. The maximum arsenic concentration did not exceed the MCP S-2/GW-1 soil standard. The use of residential soil concentrations for comparison to sediment concentrations in a wetland is also a conservative approach and is used due to a lack of available health-based guidelines for exposure to sediment. The USEPA Region III residential soil concentration is designed to be protective for exposures that could occur 350 days per year for a residential lifetime of 30 years. Exposure to sediment in SA 42 would be much less than that expected in a residential setting. Therefore, the concentrations of arsenic detected in sediment associated with SA 42 are not expected to present a risk to public health under present or foreseeable future uses of the wetland.

5.6.7 Preliminary Ecological Risk Evaluation

The purpose of the ecological PRE at SA 42 is to provide a screening-level evaluation of actual and potential risks that environmental contaminants may pose to the resident and migratory ecological receptors at the site.

The top of the slope, at the level of the furnace is an open, grassy woodland dominated by oak (*Quercus alba* and *Q. rubra*) and white pine (*Pinus strobus*) saplings. Other plant species observed in this region include beech saplings (*Fagus grandifolia*), Pennsylvania sedge (*Carex pennsylvanicus*), sweet fern (*Comptonia peregrina*), and little bluestem grass (*Andropogon scoparius*). At the base of the slope is a shrubby wetland, dominated by buttonbush (*Cephalanthus occidentalis*). An occasional highbush blueberry (*Vaccinium corymbosum*) and swamp white oaks (*Quercus bicolor*) occur on the perimeter of this wetland.

Although the upland slopes at SA 42 are limited in surface area, occasional wildlife may visit the site for foraging activities. However, it is likely that the wetland downgradient from the Popping Furnace provides significant wildlife habitat for a variety of species. A diverse assemblage of invertebrates, fish, amphibians, reptiles, mammals, and birds are expected to seasonally or permanently inhabit the SA 42 wetland.

The largest known New England population of the Blanding's turtle (*Emydoidea blandingii*), a state-threatened species in Massachusetts, is located in the vicinity of

Fort Devens (Butler, 1992). The status of this population has been well documented and Blanding's turtles are known to occur in the vicinity of SA 42. In addition, the blue-spotted salamander (*Ambystoma laterale*), a state-listed species of special concern, is known to occur in woodland ponds in the vicinity of the Popping Furnace.

Fifteen inorganic analytes were detected in six surface soil samples collected from SA 42. The maximum concentrations of barium, beryllium, copper, lead, manganese, mercury, nickel, and zinc were higher than background, and these analytes were therefore chosen as surface soil CPCs. No background data were available for antimony or cobalt, so these two analytes were also chosen as CPCs. Barium and copper were detected in all samples, at maximum concentrations of 309 μg/g and 1,160 μg/g, respectively. Lead was detected in all samples, at an average concentration of 1,609 μg/g, and a maximum concentration of 6,600 μg/g (Table 5.6-11).

Twelve organic contaminants, including two pesticides, were detected in SA 42 surface soils. All were chosen as CPCs for SA 42. 4,4-DDT was detected in all samples, at a maximum concentration of 0.26 μg/g. N-nitrosodiphenylamine was detected in 4 out of 6 samples, at a maximum concentration of 4.1 μg/g. Other surface soil CPCs include 4,4-DDE, 2,4-dinitrotoluene, 2,6-dinitrotoluene, 2-methylnaphthalene, bis (2-ethylhexyl) phthalate, chloroform, di-n-butylphthalate, naphthalene, nitroglycerine, and phenanthrene.

Ten surface water samples were collected during the SI and the SSI from nine locations throughout Kettle Pond (i.e, nine samples plus one duplicate). Three organic compounds and eight inorganics were detected and retained as CPCs (Table 5.6-12). Iron and manganese were detected in all samples, at maximum concentrations of 4660 μg/L and 143 μg/L, respectively. Barium and lead were each detected in six samples, at maximum concentrations of 15.6 and 41.8 μg/L, respectively. Antimony and copper were identified in one sample, at concentrations of 6.34 μg/L and 27.6 μg/L, respectively.

Eleven sediment samples were collected from the same sampling locations as the SA 42 surface water samples (i.e., nine samples plus two duplicates). Eight organic compounds and ten inorganics were detected and retained as CPCs (Table 5.6-13). Acetone, toluene, (likely laboratory contaminants) and trichlorofluoromethane were each detected in one sample at concentrations ranging from 0.004 μg/g (toluene) to 0.6 μg/g (acetone). Heptachlor and di-n-butylphthalate were each detected in four samples. The pesticides 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were detected in eight, eleven, and four samples, respectively, at maximum detected concentrations of 0.21 μg/g, 0.07 μg/g, and 0.16 μg/g, respectively. Aluminum, arsenic, copper, iron, lead, and manganese were detected in at least ten out of eleven samples. Maximum concentrations ranged from 4.14 μg/L (arsenic) to 8140 μg/L (aluminum). Antimony, nickel, and zinc were detected in three or less samples at concentrations ranging from 4.35 μg/L (antimony) to 51.9 μg/L (zinc).

5.6.7.1 Surface Soils. A screening-level evaluation of potential effects from surface soil exposure was conducted by comparing the maximum concentrations of all CPCs to their respective surface soil benchmark values (see Table 5.6-11). The maximum concentrations of antimony, barium, beryllium, copper, and lead exceeded their respective benchmark values. Lead was detected in all samples, at a maximum concentration of 6,600 μg/g, approximately 137 times greater than its benchmark value of 48.8 μg/g (the background lead concentration in soils). Copper was detected in all samples, at a maximum concentration of 1,160 μg/g, approximately 34 times greater than the benchmark for copper. Antimony was detected in three out of the six samples, at a maximum concentration of 85 μg/g, approximately 12 times greater than its benchmark.

5.6.7.2 Surface Water and Sediments. Risks to aquatic receptors in wetlands surface water were evaluated through comparison of maximum CPC concentrations to aquatic benchmark values AWQC. The maximum concentrations of aluminum, copper, iron, and lead and zinc in SA 42 wetlands surface water were detected at levels greater than their benchmark values (see Table 5.6-12).

Lead was detected in surface water at SA 42 in six out of ten samples at a maximum concentration of 41.8 μg/L (sample 42D-92-02X), well above the chronic AWQC value. However, lead concentrations in the remaining surface water samples in which lead was detected in were substantially lower, ranging from 2.17 μg/L (sample 42D-93-08X) to 12.3 μg/L (sample 42D-92-03X). Lead was not detected in samples 42D-93-05X, 06X, 07X, or 09X. The maximum detected concentration of zinc also exceeded its surface water benchmark value. As with lead, the zinc concentration that exceeded the benchmark value was associated with sample 42D-92-02X. This trend suggests that lead and zinc concentrations exceeding surface water benchmarks are associated with samples collected from a localized area at the toe of the popping furnace slope.

Aluminum was detected in five surface water samples at a maximum concentration of 439 μg/L, approximately 5 times the chronic AWQC (87 μg/L), but considerably less than the acute AWQC (750 μg/L). Aluminum is naturally present at high levels in background soils and groundwater at Fort Devens, and it is likely that the presence of aluminum in the SA 42 wetlands surface water is reflective of background conditions, and not of SA impacts. Likewise, iron was detected at concentrations in excess of the chronic AWQC (1,000 μg/L) in three of the ten samples in which it was identified. Iron is present at similar levels in background soils and groundwater at Fort Devens, and it is possible that the presence of iron in the SA 42 wetlands sediments is reflective of background conditions, and not of Popping Furnace slope impacts. Furthermore, many surface water samples collected in other studies at Fort Devens (i.e., Cold Spring Brook and the Nashua River) contained iron in excess of 1,000 μg/L; this finding supports the contention that iron is present at background conditions in excess of the chronic AWQC.

An uncertainty is associated with use of data from surface water samples analyzed for total, rather than dissolved, analytes. Recent USEPA national guidance recommends that dissolved contaminant data can be used for ecological risk assessments evaluating surface water (USEPA, 1993a). Dissolved contaminant data better represent the bioavailable fraction of analytes present in surface water. Therefore, the use of total contaminant surface water data (rather than the dissolved fraction) may result in an over-estimate of risk associated with surface water exposures by aquatic organisms.

Risks to ecological aquatic receptors from wetlands sediments were evaluated through comparison of maximum CPC concentrations to sediment benchmark values (see Table 5.6-13). The maximum detected concentrations of heptachlor, 4,4'-DDD, 4,4'-DDT, antimony, copper, and lead in SA 42 sediment exceeded their respective sediment benchmark values.

Lead was detected in all eleven SA 42 sediment samples at a maximum concentration of 97 μg/g, approximately 3.5 times its sediment benchmark value. However, only the maximum detected concentrations in two samples, 42D-92-02X (97 μg/g) and 42D-92-03X (36 μg/g) located near the toe of the slope exceeded the benchmark value (27 μg/g). Detected concentrations of lead in the other nine samples were well below the sediment benchmark for lead, ranging from 1.25 μg/g to 10.2 μg/g. Although the antimony benchmark was exceeded by a factor of two, it was only detected in one sediment sample (42D-92-02X). Although copper was detected in ten samples, only the detected concentration in sample 42D-92-02X (28.4 μg/g) exceeded the benchmark value (19 μg/g); detected concentrations in other samples were well below the benchmark value. The concentrations of heptachlor in the four samples in which it was identified slightly exceeded the heptachlor sediment benchmark value. The maximum detected concentration of 4,4'-DDT 0.16 (μg/g) marginally exceeded its carbon-normalized benchmark value (0.091 μg/g). Detected concentrations of 4,4'-DDD that exceeded the sediment benchmark were associated with sediment samples that were obtained nearest to the popping furnace slope (i.e., 42D-92-01X, 02X, and 03X, and 06X). Sediment benchmark values were not exceeded by the average sediment concentrations of 4,4'-DDD or 4,4'-DDT. Additionally, as described in Appendix S of the Fort Devens Group 1A Final RI Addendum Report (ABB-ES, 1993d) the interim SQC for 4,4'-DDE represents an extremely conservative guideline for use at Fort Devens.

In summary, the maximum concentrations of several inorganic analytes in surface soils at SA 42 exceed ecological benchmark values. Antimony, copper, and lead are present in surface soil at concentrations well in excess of their benchmark values. Although antimony, lead and copper in wetlands surface water and sediments may also contribute to ecological risk at this site, the maximum detected concentrations of antimony, copper, and lead that exceeded sediment and surface water benchmark values are associated with sample 42D-92-02X, which is at the foot of the slope below the popping furnace. Other samples associated with analyte concentrations that exceeded benchmark values are also in close vicinity to the popping furnace slope.

5.6.7 Conclusions and Recommendations

The preliminary risk evaluations conducted at SA 42 indicated that there is potential risk to human health associated with inorganics in surface soils, and there is potential ecological risk due primarily to exposure to inorganics (particularly lead and copper) in surface soil. Likewise the pesticide compound 4,4-DDT and its breakdown products (4,4-DDT and 4,4-DDD) were detected in sediment directly below the popping furnace, at concentrations which may represent an ecological risk.

A soil removal action for the soil contamination detected during the SI is recommended for SA 42.

TABLE 5.6-1
SUMMARY OF TECHNICAL APPROACH
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ACTIVITY	PURPOSE	SITE IDENTIFICATION	RATIONALE FOR SELECTED LOCATIONS
SI PROGRAM			
SOIL BORINGS AND SUBSURFACE SOIL SAMPLING	* COLLECT SOIL SAMPLES FOR OFF-SITE LABORATORY ANALYSIS * CHARACTERIZE SOILS	42B-92-01X	* OUTSIDE POPPING FURNACE
		42B-92-02X 42B-92-03X 42B-92-04X	* WITHIN THE AREA EFFECTED BY POPPING FURNACE ACTIVITIES
SURFACE SOIL SAMPLING	* COLLECT SOIL SAMPLES FOR OFF-SITE LABORATORY ANALYSIS	42S-92-01X 42S-92-02X	* WITHIN THE AREA EFFECTED BY POPPING FURNACE ACTIVITIES
SURFACE WATER AND SEDIMENT SAMPLING	* COLLECT SAMPLES FROM THE KETTLE POND FOR OFF-SITE LABORATORY ANALYSIS	42D-92-01X 42D-92-02X 42D-92-03X 42D-92-04X	* CHARACTERIZE SURFACE WATER AND SEDIMENTS QUALITY FROM THE EGDE OF THE KETTLE POND DIRECTLY DOWNHILL OF THE POPPING FURNACE
SSI PROGRAM			
SURFACE WATER AND SEDIMENT SAMPLING	* COLLECT SAMPLES FROM KETTLE POND FOR OFF-SITE LABORATORY ANALYSIS	42D-93-05X 42D-93-06X 42D-93-07X 42D-93-08X 42D-93-09X	* CHARACTERIZE SURFACE WATER AND SEDIMENTS QUALITY FROM THE BOTTOM OF THE KETTLE POND

TABLE 5.6–2
SOIL CLASSIFICATION OF SEDIMENT SAMPLES
SA 42 – POPPING FURNACE

SUPPLEMENTAL SITE INVESTIGATION DATA PACKAGE
FORT DEVENS, MA

SAMPLE ID	USCS SYMBOL	WATER CONTENT	GRAVEL (2) DRY WT %	SAND (2) DRY WT %	SILT (2) DRY WT %	CLAY (2) DRY WT %
42D–92–01X	SM	7.4	0.3	76.2	23.5	–
42D–92–02X	SM	62.9	3.7	61.9	34.4	–
42D–92–03X	SM	5.2	4.5	81.6	13.9	–
42D–92–04X	SM	2.2	18.7	65.5	15.8	–
42D–93–05X	ML	53.1	0.0	28.5	62.3	9.2
42D–93–06X	SM	35.3	0.0	36.7	59.3	4.0
42D–93–07X	ML	62.0	0.0	8.4	67.2	24.4
42D–93–08X	ML	36.8	0.0	29.5	58.3	12.2
42D–93–09X	ML	32.7	0.0	19.3	78.6	2.1

Notes:

USCS = Unified soil classification system.
DRY WT % = Dry weight percentage.
(1) Water content = 100 x weight of water / dry weight of soil.
(2) Dry Weight % = 100 x dry weight of soil fraction / total dry weight of soil.
– = Data not available.

TABLE 5.6–3
ORGANIC ANALYTES IN SOIL
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BORING DEPTH	42B–92–01X 0 FT	42B–92–01X 2 FT	42B–92–02X 0 FT	42B–92–02X 2 FT	42B–92–03X 0 FT	42B–92–03X 2 FT
VOLATILES (ug/g)							
CHLOROFORM		0.001	0.00095	< 0.0008	0.00093	< 0.0008	0.001
SEMIVOLATILES (ug/g)							
N–NITROSODIPHENYLAMINE		< 0.19	< 0.19	< 0.19	< 0.19	0.66	< 0.19
PESTICIDES/PCBS (ug/g)							
4,4'–DDE		0.024	< 0.008	0.029	< 0.008	0.066	< 0.008
4,4'–DDT		0.073	< 0.007	0.076	< 0.007	0.1	0.012
EXPLOSIVES (ug/g)							
2,4–DINITROTOLUENE		< 0.42	< 0.42	< 0.42	< 0.42	11	< 0.42
2,6–DINITROTOLUENE		< 0.52	< 0.52	< 0.52	< 0.52	0.47	< 0.52

NOTES:

Table lists detected analytes only – see project analyte list for summary.

< = Less than detection limit shown.

TABLE 5.6–3
ORGANIC ANALYTES IN SOIL
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BORING	42B–92–04X	42B–92–04X	42S–92–01X	42S–92–02X
	DEPTH	0 FT	2 FT	0 FT	0 FT
VOLATILES (ug/g)					
CHLOROFORM		< 0.0008	0.00092	< 0.0008	< 0.0008
SEMIVOLATILES (ug/g)					
2–METHYLNAPHTHALENE		< 0.05	< 0.05	< 0.05	0.24
BIS (2–ETHYLHEXYL)PHTHALATE		< 0.6	< 0.6	< 0.6	0.71
DI–N–BUTYL PHTHALATE		0.51	< 0.06	2.1	10
NAPHTHALENE		< 0.037	< 0.037	< 0.037	0.073
N–NITROSODIPHENYLAMINE		1.1	< 0.19	1.2	4.1
PHENANTHRENE		< 0.03	< 0.03	< 0.03	0.11
PESTICIDES/PCBS (ug/g)					
4,4'–DDE		< 0.008	< 0.008	0.044	0.044 P
4,4'–DDT		0.01	< 0.007	0.26	0.15
EXPLOSIVES (ug/g)					
2,4–DINITROTOLUENE		1.7	< 0.42	< 0.42	< 0.42
NITROGLYCERINE		< 4.0	< 4.0	< 4.0	13.6

Notes:

Table lists detected analytes only – site project analyte list for summary

< = Less than detection limit shown.

TABLE 5.6–4
INORGANIC ANALYTES IN SOIL
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BACKGROUND	BORING	42B–92–01X	42B–92–01X	42B–92–02X	42B–92–02X	42B–92–03X	42B–92–03X
		DEPTH	0 FT	2 FT	0 FT	2 FT	0 FT	2 FT
ALUMINUM	15000.0		3500.0	2480.0	3310.0	5310.0	4380.0	3690.0
ARSENIC	21.0		4.57	4.0	3.59	4.29	3.92	3.93
BARIUM	42.5		15.0	13.4	23.2	19.0	17.2	18.4
CALCIUM	1400.0		147.0	183.0	250.0	589.0	298.0	299.0
CHROMIUM	31.0		< 4.0	< 4.0	< 4.0	8.18	5.37	5.62
COBALT	NA		2.3	1.96	1.93	2.46	2.04	2.22
COPPER	8.39		3.11	2.84	4.96	4.18	5.59	3.14
IRON	15000.0		4170.0	3790.0	4170.0	5560.0	5290.0	4870.0
LEAD	48.4		9.19	2.36	29.0	4.2	12.0	3.95
MAGNESIUM	5600.0		833.0	736.0	701.0	964.0	708.0	1020.0
MANGANESE	300.0		67.6	67.8	58.7	61.6	87.4	56.6
MERCURY	.22		0.074	< 0.05	< 0.05	< 0.05	< 0.05	0.062
NICKEL	14.0		4.64	3.85	4.19	7.42	4.67	4.76
POTASSIUM	1700.0		675.0	520.0	512.0	414.0	429.0	803.0
SODIUM	131.0			168.0	204.0	220.0	184.0	186.0
VANADIUM	28.7		4.96	< 3.3	5.22	6.06	5.53	6.42
ZINC	35.5		16.2	12.7	16.3	18.8	17.2	18.0

Notes:

Table lists detected analytes only – see project analyte for summary.

< = Less than detection limit shown.

= Value above background level.

TABLE 5.6-4
INORGANIC ANALYTES IN SOIL
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	BACKGROUND	BORING DEPTH	42B-92-04X 0 FT	42B-92-04X 2 FT	42S-92-01X 0 FT	42S-92-02X 0 FT
ALUMINUM	15000.0		2700.0	3640.0	3390.0	4100.0
ANTIMONY	NA		20.5	12.0	43.0	85.0
ARSENIC	21.0		4.46	8.31	10.5	13.0
BARIUM	42.5		46.7	26.9	54.3	309.0
BERYLLIUM	0.347		< 0.5	< 0.5	< 0.5	1.23
CALCIUM	1400.0		419.0	668.0	429.0	769.0
CHROMIUM	31.0		5.54	7.15	6.2	13.5
COBALT	NA		2.38	2.31	4.3	8.83
COPPER	8.39		108.0	133.0	910.0	1160.0
IRON	15000.0		6170.0	8420.0	8530.0	36500.0
LEAD	48.4		3.69	190.0	3000.0	6600.0
MAGNESIUM	5600.0		835.0	1300.0	646.0	699.0
MANGANESE	300.0		79.1	128.0	209.0	330.0
MERCURY	.22		< 0.05	< 0.05	< 0.05	0.261
NICKEL	14.0		5.74	6.92	9.26	29.3
POTASSIUM	1700.0		579.0	777.0	268.0	436.0
SELENIUM	NA		< 0.25	< 0.25	0.449	< 0.25
SODIUM	131.0		182.0	223.0	161.0	201.0
VANADIUM	28.7		4.04	4.93	4.25	< 3.3
ZINC	35.5		126.0	122.0	612.0	435.0

Notes:

Table lists detected analytes only – see project analyte for summary.

< = Less than detection limit shown.

= Value above background level

TABLE 5.6–5
SUMMARY OF ANALYTES IN SURFACE WATER
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI					
ANALYTE **SITE ID**	**42D–93–05X**	**42D–93–06X**	**42D–93–07X**	**42D–93–07X**	**42D–93–08X**	**42D–93–09X**
ORGANICS (ug/L)				**DUP**		
STYRENE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
TOLUENE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
BIS (2–ETHYLHEXYL) PHTHALATE	< 4.8	< 4.8	< 4.8	< 4.8	< 4.8	< 4.8
INORGANICS (ug/L)						
ALUMINUM	< 141	< 141	< 141	< 141	< 141	< 141
ANTIMONY	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03
BARIUM	< 5	< 5	< 5	< 5	10.6	< 5
CALCIUM	668	1200	634	612	781	879
COPPER	< 8.09	< 8.09	< 8.09	< 8.09	< 8.09	< 8.09
IRON	341	1060	319	297	689	425
LEAD	< 1.26	< 1.26	< 1.26	10.2	2.17	< 1.26
MANGANESE	45.4	143	64.8	61.1	76.5	72.4
POTASSIUM	842	1060	1090	818	1700	637
SODIUM	1890	1370	1710	1590	1150	1600
ZINC	< 21.1	< 21.1	< 21.1	< 21.1	< 21.1	< 21.1
OTHER (ug/L)						
ALKALINITY	< 5000	< 5000	< 5000	< 5000	5000	< 5000
CHLORIDE	3390	< 2120	2580	2650	< 2120	< 2120
NITROGEN BY KJELDAHL METHOD	1240	714	876	886	2380	905
PHOSPHATE	66.3	34.5	36.3	30.7	192	30.7
TOTAL HARDNESS	5200	3800	2800	8000	3600	3600
TOTAL SUSPENDED SOLIDS	12	4000	4000		49000	4000

Notes:

< = Less than detection limit.

TABLE 5.6–5
SUMMARY OF ANALYTES IN SURFACE WATER
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SI				
ANALYTE **SITE ID**	**42D–92–01X**	**42D–92–02X**	**42D–92–03X**	**42D–92–03X**	**42D–92–04X**
ORGANICS (ug/L)					
STYRENE	< 0.5	< 0.5	< 0.5	< 0.5	0.9
TOLUENE	< 0.5	< 0.5	0.54	0.6	2
BIS (2–ETHYLHEXYL) PHTHALATE	< 4.8	< 4.8	< 4.8	< 4.8	11
INORGANICS (ug/L)					
ALUMINUM	429	430	253	213	439
ANTIMONY	< 3.03	6.34	< 3.03	< 3.03	< 3.03
BARIUM	7.95	15.6	7.72	12.2	15.2
CALCIUM	858	1170	1270	1150	1920
COPPER	< 8.09	27.6	< 8.09	< 8.09	< 8.09
IRON	451	4660	767	673	1290
LEAD	6.72	41.8	12.3	11.9	11.6
MANGANESE	81.7	106	97.7	90.8	124
POTASSIUM	1760	1520	2070	2210	1660
SODIUM	799	1040	828	825	974
ZINC	< 21.1	58.1	< 21.1	< 21.1	30.9
OTHER (ug/L)					
ALKALINITY	5000	11000	8000	9000	5000
CHLORIDE	< 2120	< 2120	< 2120	< 2120	< 2120
NITROGEN BY KJELDAHL METHOD	1810	5700	2480	2000	19000
PHOSPHATE	168	366	178	228	990
TOTAL HARDNESS	6200	5600	17800	8800	11200
TOTAL SUSPENDED SOLIDS	78000	267000	136000	175000	249000

Notes:

< = Less than detection limit.

TABLE 5.6-6
SUMMARY OF ANALYTES IN SEDIMENT
SA 42 - POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

	SSI						SI			
ANALYTE SITE ID	42D-93-05X	42D-93-06X	42D-93-07X	42D-93-08X	42D-93-09X	42D-93-09X	42D-92-01X	42D-92-02X	42D-92-03X	42D-92-04X
ORGANICS (ug/g)						DUP				
ACETONE	0.6	< 0.017	< 0.017	< 0.017	< 0.08	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
TOLUENE	< 0.001	< 0.001	< 0.001	< 0.001	< 0.004	< 0.001	< 0.001	0.004	< 0.001	< 0.001
TRICHLOROFLUOROMETHANE	0.054	< 0.006	< 0.006	< 0.006	< 0.03	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006
DI-N-BUTYL PHTHALATE	< 0.1	0.4	0.15	0.23	< 0.061	0.25	< 0.061	< 0.061	< 0.061	< 0.061
4,4'-DDT	< 0.007	0.16	< 0.007	0.021	< 0.007	< 0.007	< 0.007	0.072	0.026	< 0.007
4,4'-DDD	< 0.008	0.19	0.02	0.049	< 0.008	0.016	0.019	0.21	0.11	0.092
4,4'-DDE	< 0.008	0.068	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008	0.069	0.035	0.023
HEPTACHLOR	< 0.006	< 0.006	0.019	0.039	0.022	0.014	< 0.006	< 0.006	< 0.006	< 0.006
INORGANICS (ug/g)										
ALUMINUM	8140	6730	3370	6120	2120	1610	2330	3740	1660	2710
ANTIMONY	< 1.09	< 1.09	< 1.09	< 1.09	< 1.09	< 1.09	< 1.09	4.35	< 1.09	< 1.09
ARSENIC	4.14	2.37	0.784	2	< 0.25	0.635	1.01	1.5	0.971	0.754
BARIUM	91	25	9.55	30.8	8.58	< 5.18	11.7	24.8	16.3	12.2
CALCIUM	5550	689	197	592	448	328	< 100	< 100	193	302
COPPER	18.9	6.28	3.36	4.42	1.72	1.67	3.46	28.4	5.13	1.79
IRON	3210	2590	472	1040	578	623	272	3220	1380	2190
LEAD	9.34	7.33	3.42	6.62	1.25	3.34	4.5	97	36	10.2
MAGNESIUM	< 100	470	< 100	< 100	168	< 100	< 100	295	315	677
MANGANESE	141	43.9	7.75	22.4	12.8	11.2	5.95	30.6	24.1	27.8
NICKEL	< 1.71	5.44	< 1.71	< 1.71	< 1.71	< 1.71	< 1.71	< 1.71	< 1.71	2.82
POTASSIUM	< 100	242	< 100	< 100	< 100	< 100	< 100	< 100	222	< 100
SODIUM	2440	605	375	850	515	410	223	469	173	167
ZINC	< 8.03	< 8.03	< 8.03	< 8.03	< 8.03	< 8.03	< 8.03	51.9	12.8	14.4
OTHER (ug/g)										
TOTAL ORGANIC CARBON	829000	81200	41300	58700	34500	1740	14800	11600	14000	20900

Notes:
< = Less than detection limit

TABLE 5.6–7
HUMAN HEALTH PRE EVALUATION OF SURFACE SOIL
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a]		SOIL BACKGROUND CONCENTRATION [b] (ug/g)	MAXIMUM EXCEEDS BACKGROUND ?	REGION III RESIDENTIAL SOIL CONCENTRATION (ug/g)	MCP S–1 (ug/g)	MAXIMUM EXCEEDS GUIDELINE CONCENTRATION ?
		AVERAGE (ug/g)	MAXIMUM (ug/g)					
ORGANICS								
4,4'–DDT	6/6	0.1	0.26	NA	–	1.9	2	NO
4,4'–DDE	5/6	0.04	0.066	NA	–	1.9	2	NO
2,4–DINITROTOLUENE	2/6	6.4	11	NA	–	160	0.7	NO
2,6–DINITROTOLUENE	1/6	0.47	0.47	NA	–	0.94	NA	NO
2–METHYLNAPHTHALENE	1/6	0.24	0.24	NA	–	3100 [c]	0.7	NO
BIS (2–ETHYLHEXYL) PHTHALATE	1/6	0.71	0.71	NA	–	46	100	NO
CHLOROFORM	1/6	0.001	0.001	NA	–	100	0.1	NO
DI–N–BUTYL PHTHALATE	3/6	4.2	10	NA	–	7800	NA	NO
N–NITROSODIPHENYLAMINE	4/6	1.8	4.1	NA	–	130	NA	NO
NAPHTHALENE	1/6	0.073	0.073	NA	–	3100	4	NO
NITROGLYCERINE	1/6	13.6	13.6	NA	–	391		NO
PHENANTHRENE	1/6	0.11	0.11	NA	–	NA	100	NO
INORGANICS								
ALUMINUM	6/6	3563.3	4380	15000	NO	230000	NA	NO
ANTIMONY	3/6	49.5	85	NA	–	31	10	YES
ARSENIC	6/6	6.7	13	21	NO	0.36	30	REGION III
BARIUM	6/6	77.6	309	42.5	YES	5500	NA	NO
BERYLLIUM	1/6	1.23	1.23	0.347	YES	0.15	0.4	YES
CALCIUM	6/6	385.3	769	1400	NO	NA	NA	–
CHROMIUM	4/6	7.7	13.5	31	NO	390	200	NO
COBALT	6/6	3.6	8.83	NA	–	NA	NA	–
COPPER	6/6	365.3	1160	8.39	YES	2900	NA	NO
IRON	6/6	10805	36500	15000	YES	NA	NA	–
LEAD	6/6	1609	6600	48.4	YES	500	300	YES
MAGNESIUM	6/6	737	835	5600	NO	NA	NA	–
MANGANESE	6/6	138.6	330	300	YES	7800	NA	NO
MERCURY	2/6	0.2	0.261	0.22	YES	23	10	NO

TABLE 5.6-7
HUMAN HEALTH PRE EVALUATION OF SURFACE SOIL
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a] AVERAGE (ug/g)	DETECTED CONCENTRATION [a] MAXIMUM (ug/g)	SOIL BACKGROUND CONCENTRATION [b] (ug/g)	MAXIMUM EXCEEDS BACKGROUND ?	REGION III RESIDENTIAL SOIL CONCENTRATION (ug/g)	MCP S-1 (ug/g)	MAXIMUM EXCEEDS GUIDELINE CONCENTRATION ?
NICKEL	6/6	9.6	29.3	14	YES	1600	300	NO
POTASSIUM	6/6	483.2	675	1700	NO	NA	NA	–
SELENIUM	1/6	0.449	0.449	NA	–	390	300	NO
SODIUM	5/6	186.4	204	131	YES	NA	NA	–
VANADIUM	5/6	4.8	5.53	28.7	NO	550	NA	NO
ZINC	6/6	203.8	612	35.5	YES	23000	2500	NO

Notes:

[a] Surface soil samples from sampling stations 42B-92-01X to 42B-92-04X, 42S-92-01X and 42S-92-02X

[b] Base-wide background soil inorganics database.

[c] The Region III residential soil concentration for napthalene was used as a surrogate for 2-methylnapthalene.

NA = not available

ug/g = micrograms per gram

– = not applicable

Shaded compounds exceed standard or guideline.

TABLE 5.6-8
HUMAN HEALTH PRE EVALUATION OF SUBSURFACE SOIL
SA 42 - POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a]		SOIL BACKGROUND CONCENTRATION [b] (ug/g)	MAXIMUM EXCEEDS BACKGROUND ?	REGION III COMMERCIAL/ INDUSTRIAL CONCENTRATION (ug/g)	MCP S-2 (ug/g)	MAXIMUM EXCEEDS GUIDELINE CONCENTRATION ?
		AVERAGE (ug/g)	MAXIMUM (ug/g)					
ORGANICS								
4,4'-DDT	2/8	0.02	0.02	NA	-	8.4	2	NO
4,4'-DDE	1/8	0.008	0.008	NA	-	8.4	2	NO
CHLOROFORM	4/4	0	0.001	NA	-	470	0.1	NO
INORGANICS								
ALUMINUM	4/4	3780	5310	15000	NO	1000000	NA	NO
ANTIMONY	1/4	12	12	NA	NA	410	40	NO
ARSENIC	4/4	5.1	8.31	21	NO	1.6	30	REGION III
BARIUM	4/4	19.4	26.9	42.5	NO	72000	NA	NO
CALCIUM	4/4	434.8	668	1400	NO	NA	NA	-
CHROMIUM	3/4	6.983	8.18	31	NO	5100	600	NO
COBALT	4/4	2.2	2.46	NA	NA	NA	NA	-
COPPER	4/4	35.8	133	8.39	YES	38000	NA	NO
IRON	4/4	5660	8420	15000	NO	NA	NA	-
LEAD	4/4	50.1	190	48.4	YES	500	600	NO
MAGNESIUM	4/4	1005	1300	5600	NO	NA	NA	-
MANGANESE	4/4	78.5	128	300	NO	100000	NA	NO
MERCURY	1/4	0.062	0.062	0.22	NO	310	60	NO
NICKEL	4/4	5.7	7.42	14.0	NO	20000	700	NO
POTASSIUM	4/4	628.5	803	1700	NO	NA	NA	-
SODIUM	4/4	199.3	223	131	YES	NA	NA	-
VANADIUM	3/4	5.8	6.42	28.7	NO	7200	NA	NO
ZINC	4/4	42.9	122	35.5	YES	310000	2500	NO

Notes:

[a] Subsurface soil samples from sampling stations 42B-92-01X to 42B-92-04X.

[b] Base-wide background soil inorganics database.

NA = not available

ug/g = micrograms per gram

\- = not applicable

Shaded compounds exceed standard or guideline.

TABLE 5.6-9
HUMAN HEALTH PRELIMINARY RISK EVALUATION OF SURFACE WATER
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF DETECTION	DETECTED CONCENTRATION [a] AVERAGE (ug/L)	DETECTED CONCENTRATION [a] MAXIMUM (ug/L)	DRINKING WATER STANDARD/GUIDELINE [b] (ug/L)	MAXIMUM EXCEEDS DRINKING WATER STANDARD/GUIDELINE ?
ORGANICS					
BIS (2-ETHYLHEXYL) PHTHALATE	1/10	11	11	6	YES
STYRENE	1/10	0.9	0.9	100	NO
TOLUENE	3/10	1.047	2	1000	NO
INORGANICS					
ALUMINUM	5/10	352.8	439	50–200	YES
ANTIMONY	1/10	6.34	6.34	6	YES
BARIUM	6/10	11.545	15.6	2000	NO
CALCIUM	10/10	1053	1920	NA	–
COPPER	1/10	27.6	27.6	1300	NO
IRON	10/10	1067.5	4660	300	YES
LEAD	6/10	14.415	41.8	15	YES
MANGANESE	10/10	90.23	143	50	YES
POTASSIUM	10/10	1454.9	2210	NA	–
SODIUM	10/10	1218.6	1890	28000	NO
ZINC	2/10	44.5	58.1	5000	NO

Notes:

[a] Surface water from sampling locations 42D-92-01X to 42D-92-03X with 1 duplicate, and 42D-93-04X to 42D-93-09X.

[b] Includes the lowest of either the EPA or MA drinking water standards, or if no federal or state standard or guideline is available, the Region III tap water concentration.

NA = not available.

ug/L = micrograms per Liter.

– = not applicable.

Shaded compounds exceed standard or guideline.

TABLE 5.6–10
HUMAN HEALTH PRELIMINARY RISK EVALUATION OF SEDIMENT
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	FREQUENCY OF FREQUENCY	DETECTED CONCENTRATION [a]		REGION III RESIDENTIAL SOIL CONCENTRATION (ug/g)	MCP S–2 (ug/g)	MAXIMUM EXCEEDS GUIDELINES ?
		AVERAGE (ug/g)	MAXIMUM (ug/g)			
ORGANICS						
4,4'–DDT	4/11	0.07	0.16	1.9	2	NO
4,4'–DDD	8/11	0.088	0.21	2.7	3	NO
4,4'–DDE	4/11	0.049	0.069	1.9	2	NO
ACETONE	1/11	0.6	0.6	7800	3	NO
DI–N–BUTYL PHTHALATE	4/11	0.258	0.4	7800	NA	NO
HEPTACHLOR	4/11	0.024	0.039	0.14	0.2	NO
TOLUENE	1/11	0.004	0.004	16000	90	NO
TRICHLOROFLUOROMETHANE	1/11	0.054	0.054	23000	NA	NO
INORGANICS						
ALUMINUM	10/11	3853	8140	230000	NA	NO
ANTIMONY	1/11	4.35	4.35	31	40	NO
ARSENIC	10/11	1.757	4.14	0.36	30	REGION III
BARIUM	9/11	25.548	91	5500	NA	NO
CALCIUM	9/11	990.111	5550	NA	NA	–
COPPER	10/11	7.513	28.4	2900	NA	NO
IRON	11/11	1442.909	3220	NA	NA	–
LEAD	11/11	17.2	97	500	600	NO
MAGNESIUM	5/11	385	677	NA	NA	–
MANGANESE	11/11	35.327	141	390	NA	NO
NICKEL	2/11	4.13	5.44	1600	700	NO
POTASSIUM	3/11	427.333	818	NA	NA	–
SODIUM	11/11	710.636	2440	NA	NA	–
ZINC	3/11	26.367	51.9	23000	2500	NO

Notes:
[a] = Sediment from sampling locations 42D–92–01X to 42D–92–04X and 42D–93–05X to 42D–93–09X including 2 duplicates.
NA = not available
– = not applicable
ug/g = micrograms per gram
MCP = Massachusetts Contingency Plan.
Shaded compounds exceed standard or guideline.

TABLE 5.6-11
ECOLOGICAL PRE EVALUATION OF SURFACE SOIL
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	SOIL BACKGROUND CONCENTRATION [a] (ug/g)	CONCENTRATION [b] AVERAGE (ug/g)	CONCENTRATION [b] MAXIMUM (ug/g)	FREQUENCY OF DETECTION	MAXIMUM EXCEEDS BACKGROUND?	ECOLOGICAL BENCHMARK (ug/g)	MAXIMUM EXCEEDS BENCHMARKS?
ORGANICS							
4,4'-DDT	NA	0.1	0.26	6/6	NA	1.07	NO
4,4'-DDE	NA	0.04	0.066	5/6	NA	1.07	NO
2,4-dINITROTOLEUNE	NA	6.4	11	2/6	NA	270	NO
2,6-DINITROTOLUENE	NA	0.47	0.47	1/6	NA	270	NO
2-METHYLNAPHTHALENE	NA	0.24	0.24	1/6	NA	143	NO
BIS (2-ETHYLHEXYL) PHTHALATE	NA	0.71	0.71	1/6	NA	84	NO
CHLOROFORM	NA	0.001	0.001	1/6	NA	676	NO
DI-N-BUTYL PHTHALATE	NA	4.2	10	3/6	NA	2650	NO
N-NITROSO DIPHENYLAMINE	NA	1.8	4.1	4/6	NA	200	NO
NAPHTHALENE	NA	0.073	0.073	1/6	NA	170	NO
NITROGLYCERINE	NA	13.6	13.6	1/6	NA	240	NO
PHENANTHRENE	NA	0.11	0.11	1/6	NA	510	NO
INORGANCIS							
ALUMINUM	15000	3563.3	4380	6/6	NO		
ANTIMONY	NA	49.5	85	3/6	NA	7	YES
ARSENIC	21	6.7	13	6/6	NO		
BARIUM	42.5	77.6	309	6/6	YES	42.5	YES
BERYLLIUM	0.347	1.23	1.23	1/6	YES	0.88	YES
CHROMIUM	31	7.7	13.5	4/6	NO		
COBALT	NA	3.6	8.83	6/6	NA	50	NO
COPPER	8.39	365.3	1160	6/6	YES	34	YES
LEAD	48.4	1609	6600	6/6	YES	48.4	YES
MANGANESE	300	138.6	330	6/6	YES	1500	NO
MERCURY	0.22	0.2	0.261	2/6	YES	3.6	NO
NICKEL	14.0	9.6	29.3	6/6	YES	100	NO
SELENIUM	NA	0.449	0.449	1/6	NA	0.48	NO
VANADIUM	28.7	4.8	5.53	5/6	NO		
ZINC	35.5	203.8	612	6/6	YES	640	NO

Notes:
[a] Base-wide background soil inorganics database.
[b] Surface soil samples from sampling stations 42B-92-01X to 42B-92-04X, 42S-92-01X and 42S-92-02X
NA = not available
ug/g = micrograms per gram

TABLE 5.6-12
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SURFACE WATER
SA 42 - POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	CONCENTRATION [a] AVERAGE (ug/L)	CONCENTRATION [a] MAXIMUM (ug/L)	FREQUENCY OF DETECTION	ECOLOGICAL BENCHMARKS (ug/L)	MAXIMUM EXCEEDS BENCHMARKS?
ORGANICS					
BIS(2-ETHYLHEXYL)PHTHALATE	11	11	1/10	360	NO
STYRENE	0.9	0.9	1/10	NA	NA
TOLUENE	1.047	2	3/10	1750	NO
INORGANICS					
ALUMINUM	353	439	5/10	87	YES
ANTIMONY	6.34	6.34	1/10	30	NO
BARIUM	11.5	15.6	6/10	NA	NA
COPPER	27.6	27.6	1/10	3.6 [b]	YES
IRON	1068	4660	10/10	1000	YES
LEAD	14.4	41.8	6/10	0.54 [b]	YES
MANGANESE	90.2	143	10/10	NA	NA
ZINC	44.5	58.1	2/10	32.7 [b]	YES
OTHER					
TOTAL HARDNESS	6860	17800	10/10	---	---
TOTAL SUSPENDED SOLIDS	106890	267000	9/10	---	---

Notes:

[a] Surface water samples from sampling stations 42D-92-01X to 42D-92-04X plus one duplicate, and 42D-93-05X to 42D-93-09X.

[b] Hardness-dependent criterion; 25 mg/l $CaCO_3$ used because site-specific hardness value (6.9 mg/l) is below the hardness range (25 to 400 mg/l) for which the hardness function is valid (Federal Register, 1992). See Section 3.6.2 (ABB-ES, 1993) for methodology used to calculate site-specific hardness-dependent benchmark values.

ug/L = micrograms per liter.

NA = Not available.

--- = Analyte not a CPC for this medium.

TABLE 5.6–13
ECOLOGICAL PRELIMINARY RISK EVALUATION OF SEDIMENT
SA 42 – POPPING FURNACE

SITE INVESTIGATION REPORT
FORT DEVENS, MA

ANALYTE	CONCENTRATION [a]		FREQUENCY OF DETECTION	ECOLOGICAL BENCHMARKS (ug/g)	MAXIMUM EXCEEDS BENCHMARK?
	AVERAGE (ug/g)	MAXIMUM (ug/g)			
ORGANICS					
ACETONE	0.6	0.6	1/11	NA	NA
4,4'–DDD	0.088	0.21	8/11	0.091	YES
4,4'–DDE	0.049	0.069	11/11	0.091	NO
4,4'–DDT	0.07	0.16	4/11	0.091	YES
DI–N–BUTYLPHTHALATE	0.258	0.4	4/11	NA	NA
HEPTACHLOR	0.024	0.039	4/11	0.012 [b]	YES
TOLUENE	0.004	0.004	1/11	NA	NA
TRICHLOROFLUOROMETHANE	0.054	0.054	1/11	NA	NA
INORGANICS					
ALUMINUM	3853	8140	10/11	NA	NA
ANTIMONY	4.35	4.35	1/11	2	YES
ARSENIC	1.757	4.14	10/11	5	NO
BARIUM	25.548	91	9/11	NA	NA
COPPER	7.513	28.4	10/11	19	YES
IRON	1442.909	3220	11/11	24000	NO
LEAD	17.2	97	11/11	27	YES
MANGANESE	35.327	141	11/11	428	NO
NICKEL	4.13	5.44	2/11	22	NO
ZINC	26.367	51.9	3/11	85	NO
OTHER					
TOTAL ORGANIC CARBON	110774	829000	10/10	---	---

Notes:

[a] Sediment samples from sampling stations 42D–92–01X to 42D–92–04X, and 42D–93–05X to 42D–93–09X plus two duplicates.
[b] Benchmark is carbon–normalized using site–specific total organic carbon data (see Section 3.6.2 of ABB–ES, 1993).
NA = not available.
ug/g = micrograms per gram.
--- = Analyte not a CPC for this medium.
Shaded compounds exceed standard or guideline.

FIGURE 5.6-1
SAMPLING LOCATIONS
SA 42 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

9509018D(u) 123 5

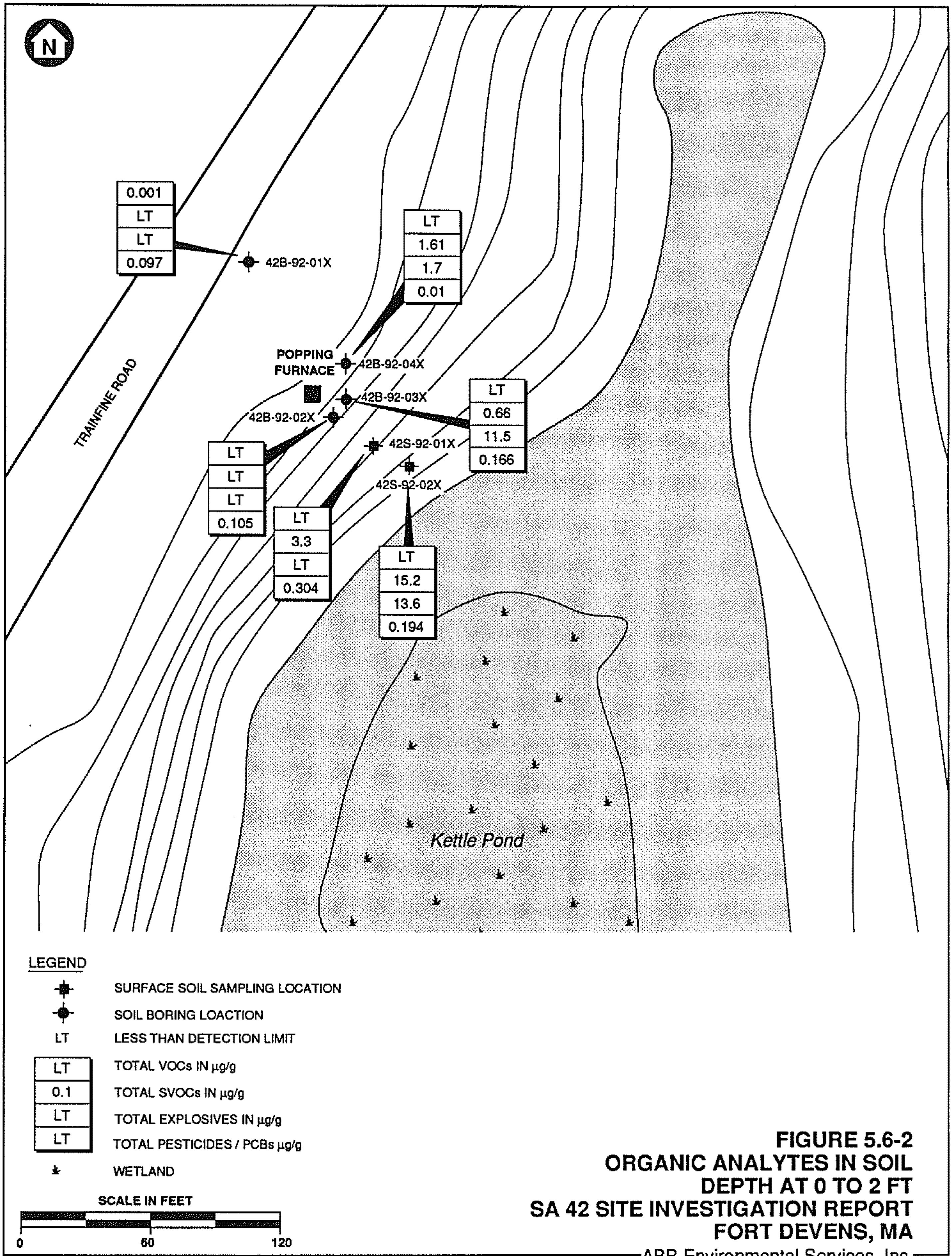


FIGURE 5.6-2
ORGANIC ANALYTES IN SOIL
DEPTH AT 0 TO 2 FT
SA 42 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

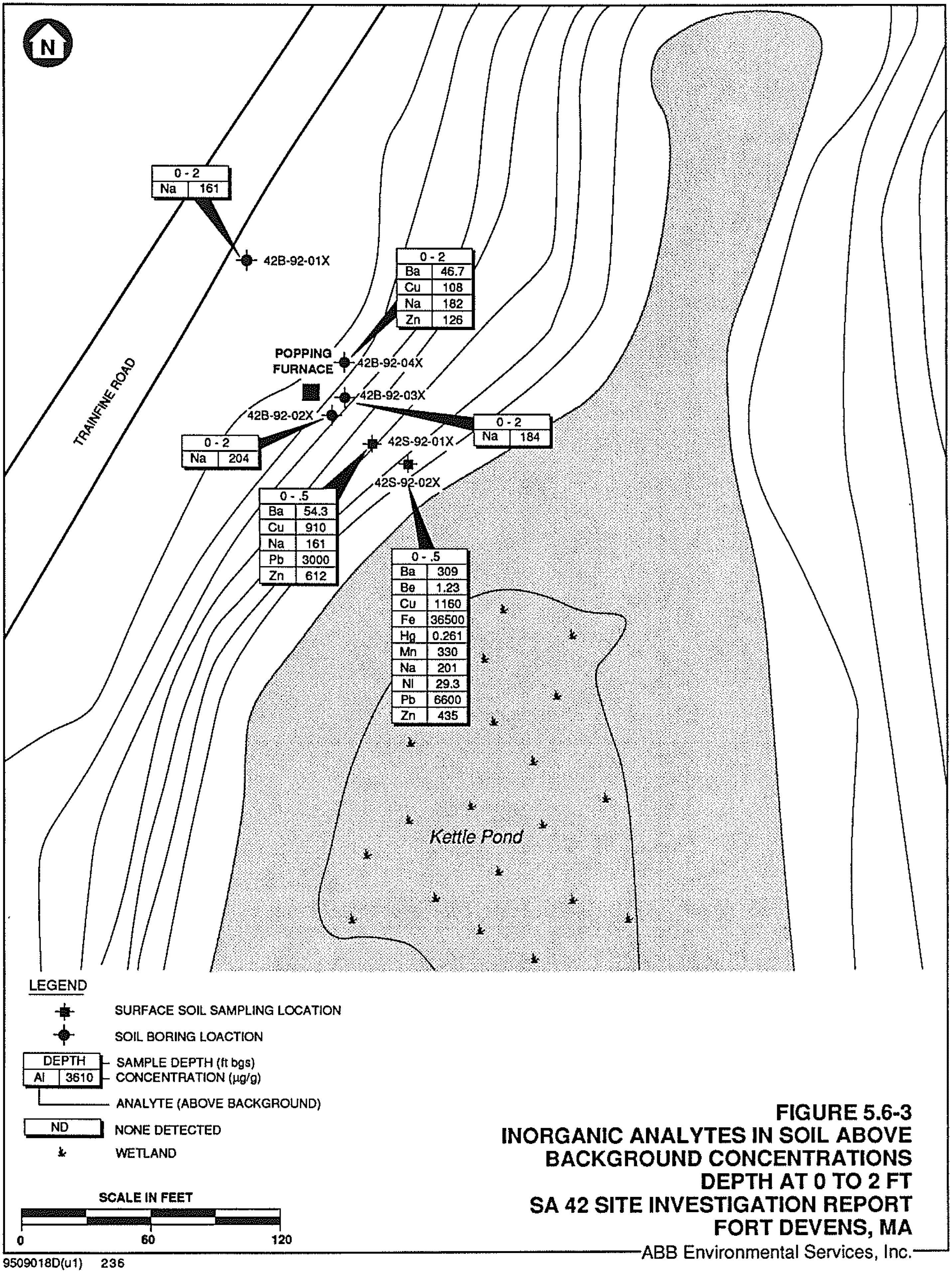


FIGURE 5.6-3
INORGANIC ANALYTES IN SOIL ABOVE BACKGROUND CONCENTRATIONS DEPTH AT 0 TO 2 FT
SA 42 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

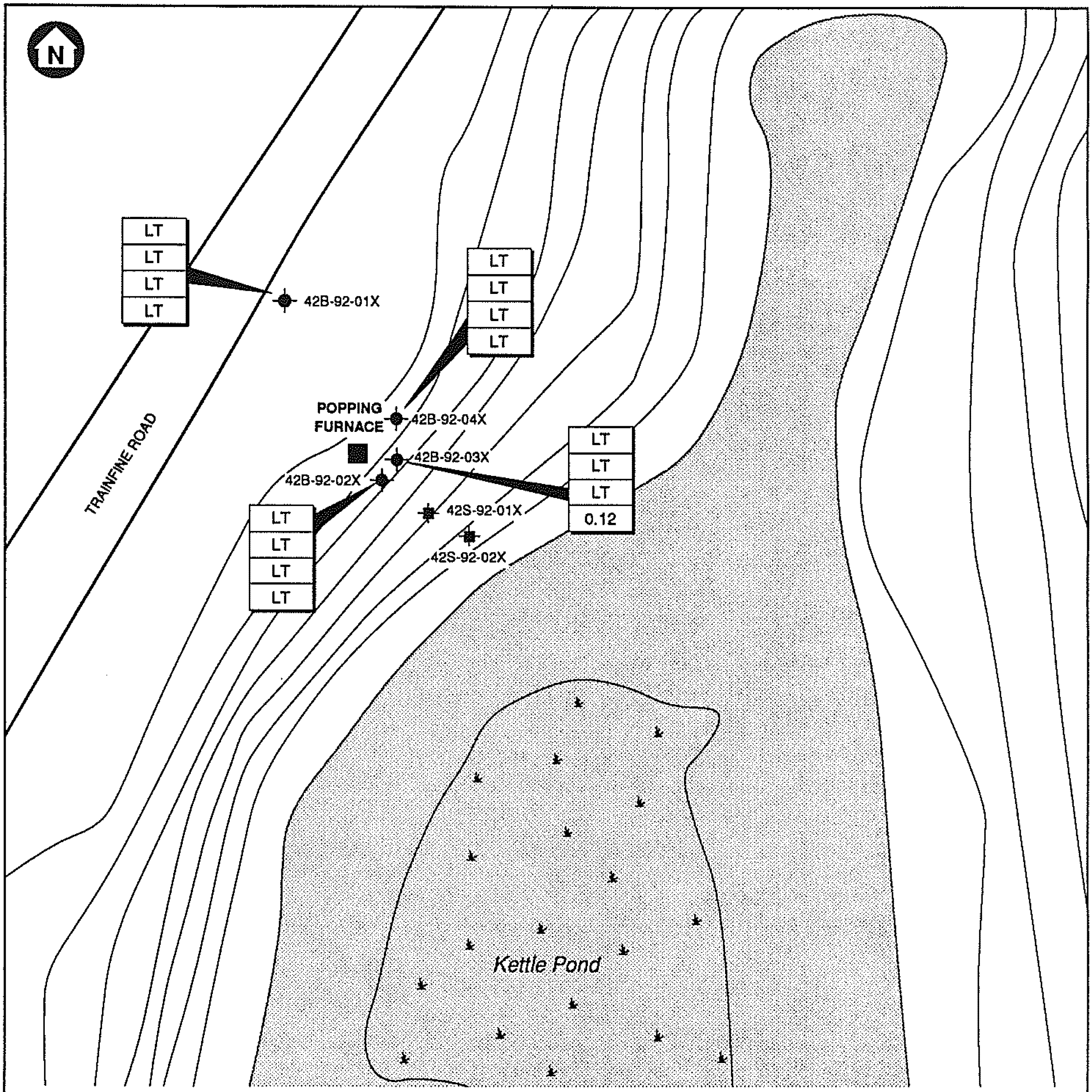
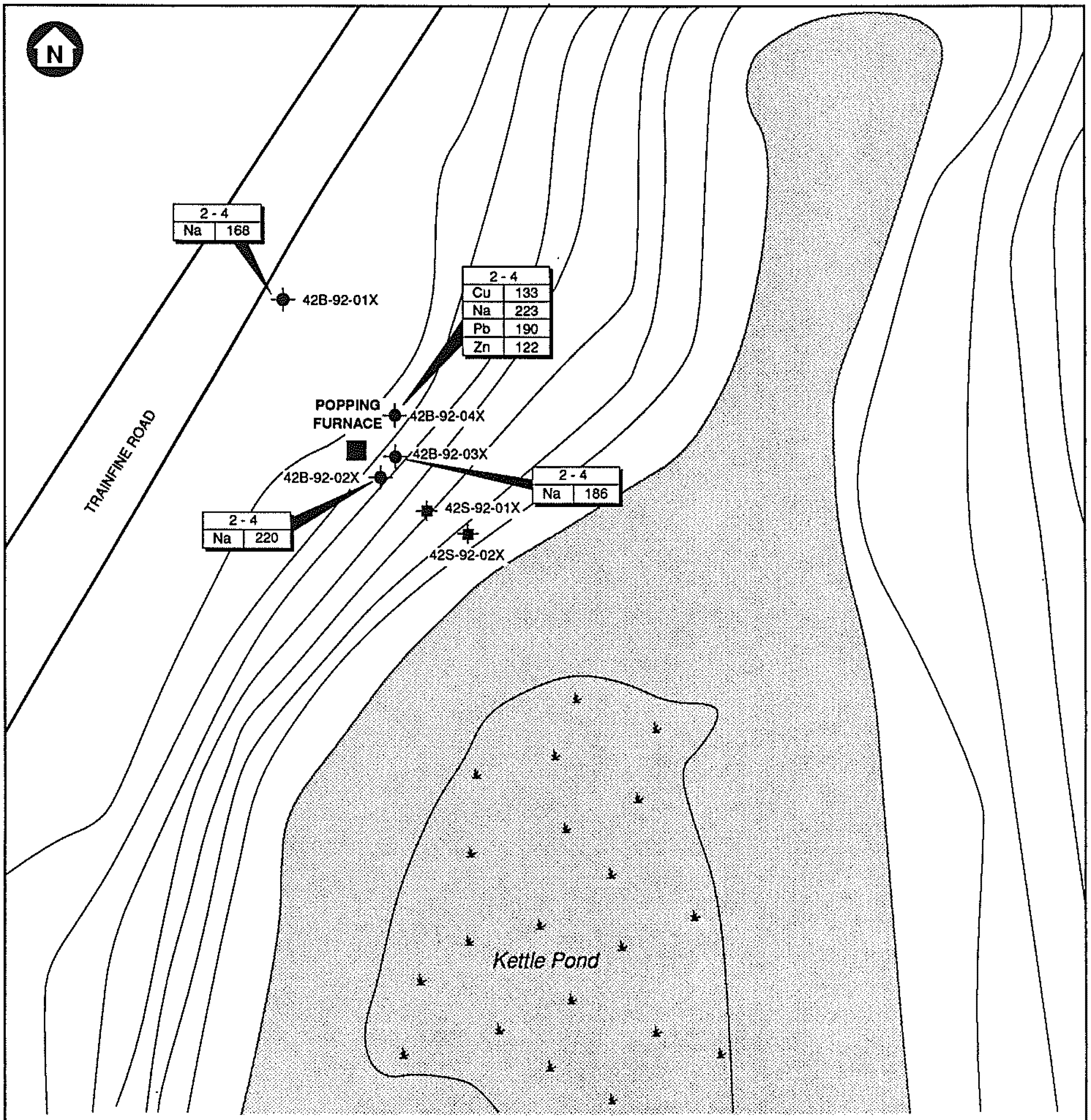


FIGURE 5.6-4
ORGANIC ANALYTES IN SOIL DEPTH AT 2 TO 4 FT
SA 42 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.



LEGEND

- ⊕ SURFACE SOIL SAMPLING LOCATION
- ● SOIL BORING LOACTION
- DEPTH – SAMPLE DEPTH (ft bgs)
- Al | 3610 – CONCENTRATION (µg/g)
- Al – ANALYTE (ABOVE BACKGROUND)
- ⚘ WETLAND

SCALE IN FEET

0 60 120

FIGURE 5.6-5
INORGANIC ANALYTES IN SOIL ABOVE BACKGROUND CONCENTRATIONS DEPTH AT 2 TO 4 FT
SA 42 SITE INVESTIGATION REPORT FORT DEVENS, MA

ABB Environmental Services, Inc.

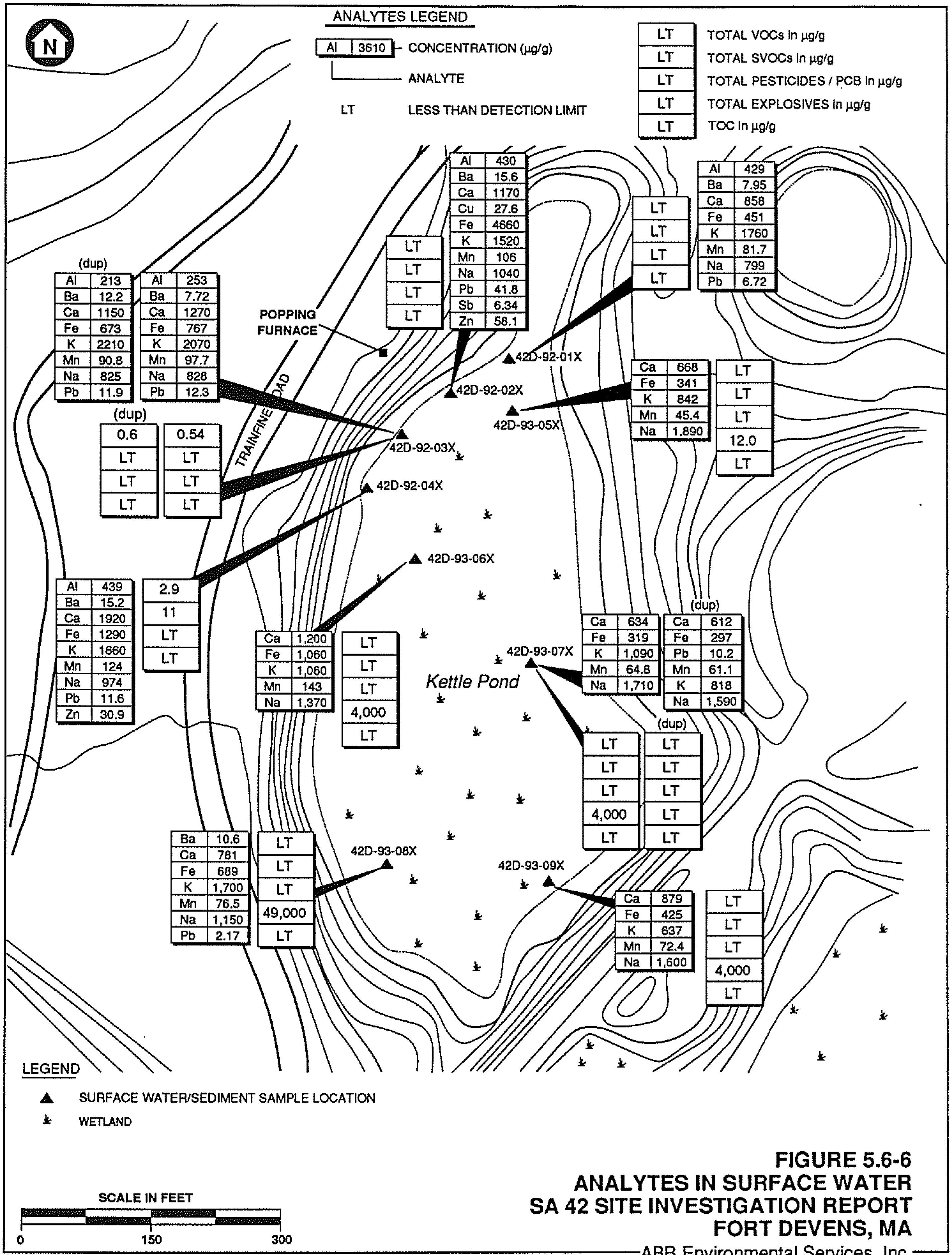
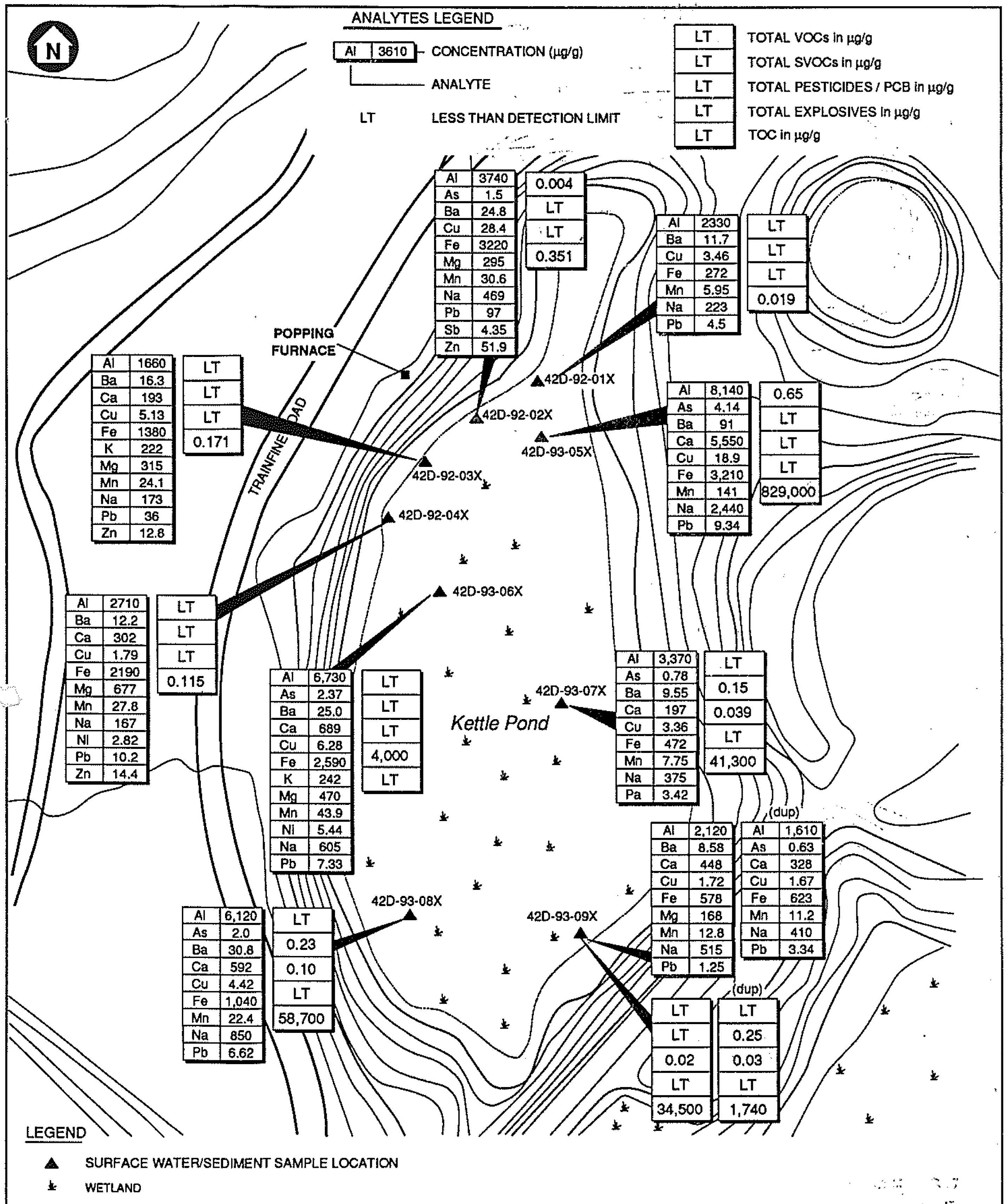


FIGURE 5.6-6
ANALYTES IN SURFACE WATER
SA 42 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.



Al	3740
As	1.5
Ba	24.8
Cu	28.4
Fe	3220
Mg	295
Mn	30.6
Na	469
Pb	97
Sb	4.35
Zn	51.9

0.004
LT
LT
0.351

Al	2330
Ba	11.7
Cu	3.46
Fe	272
Mn	5.95
Na	223
Pb	4.5

LT
LT
LT
0.019

Al	1660
Ba	16.3
Ca	193
Cu	5.13
Fe	1380
K	222
Mg	315
Mn	24.1
Na	173
Pb	36
Zn	12.8

LT
LT
LT
0.171

Al	8,140
As	4.14
Ba	91
Ca	5,550
Cu	18.9
Fe	3,210
Mn	141
Na	2,440
Pb	9.34

0.65
LT
LT
LT
829,000

Al	2710
Ba	12.2
Ca	302
Cu	1.79
Fe	2190
Mg	677
Mn	27.8
Na	167
Ni	2.82
Pb	10.2
Zn	14.4

LT
LT
LT
0.115

Al	6,730
As	2.37
Ba	25.0
Ca	689
Cu	6.28
Fe	2,590
K	242
Mg	470
Mn	43.9
Ni	5.44
Na	605
Pb	7.33

LT
LT
LT
4,000
LT

Al	3,370
As	0.78
Ba	9.55
Ca	197
Cu	3.36
Fe	472
Mn	7.75
Na	375
Pa	3.42

LT
0.15
0.039
LT
41,300

Al	2,120
Ba	8.58
Ca	448
Cu	1.72
Fe	578
Mg	168
Mn	12.8
Na	515
Pb	1.25

(dup)

Al	1,610
As	0.63
Ca	328
Cu	1.67
Fe	623
Mn	11.2
Na	410
Pb	3.34

Al	6,120
As	2.0
Ba	30.8
Ca	592
Cu	4.42
Fe	1,040
Mn	22.4
Na	850
Pb	6.62

LT
0.23
0.10
LT
58,700

	(dup)
LT	LT
LT	0.25
0.02	0.03
LT	LT
34,500	1,740

SCALE IN FEET

0 150 300

FIGURE 5.6-7
ANALYTES IN SEDIMENT
SA 42 SITE INVESTIGATION REPORT
FORT DEVENS, MA

ABB Environmental Services, Inc.

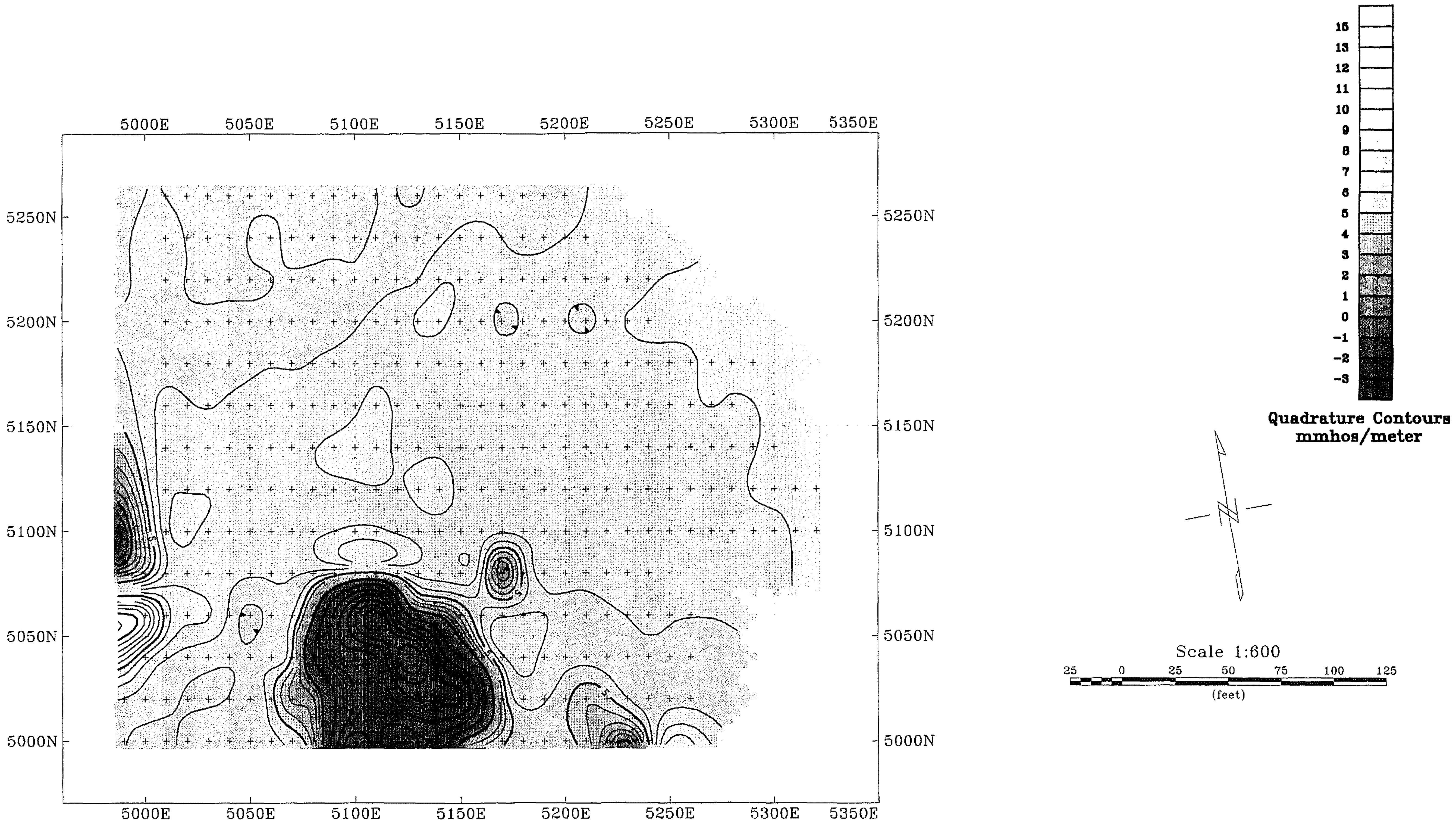


FIGURE 5.5-2
TERRAIN CONDUCTIVITY SURVEY RESULTS
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA

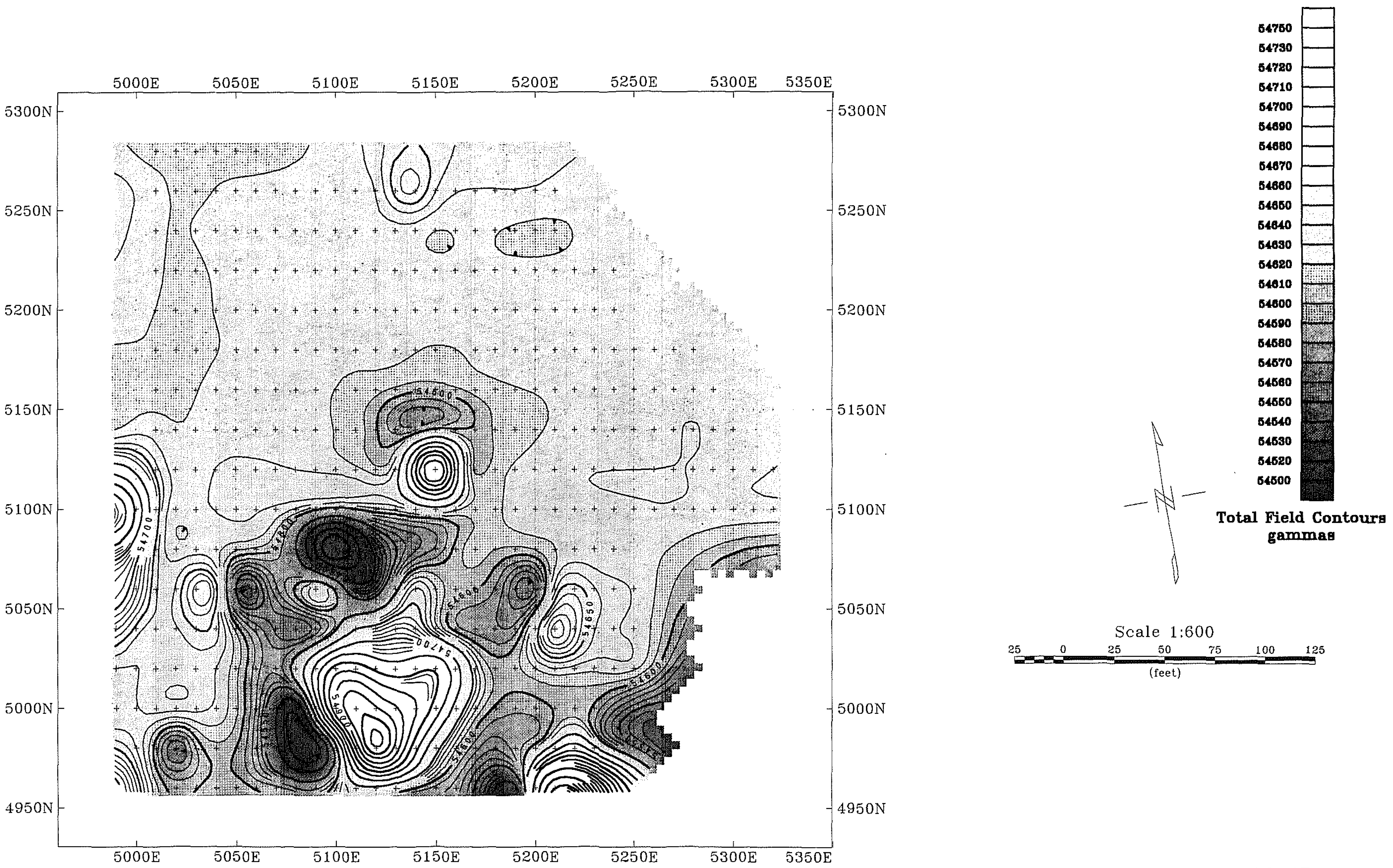


FIGURE 5.5-3
MAGNETOMETER SURVEY RESULTS
SA 41 SITE INVESTIGATION REPORT
FORT DEVENS, MA