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U.S. Army Corps of Engineers
New England District

FINAL
REMEDIAL INVESTIGATION REPORT
AREA OF CONTAMINATION (AOC) 57

VOLUME I OF III
TEXT SECTIONS 1 THROUGH 10,
FIGURES AND TABLES

CONTRACT DACA-31-94-D-0061
DELIVERY ORDER NUMBER 0001

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
CONCORD, MASSACHUSETTS

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Prepared for:

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

Prepared by:

Harding Lawson Associates
Portland, ME
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EXECUTIVE SUMMARY

Harding Lawson Associates (HLA) has prepared this Remedial Investigation (RI) Report on Area of Contamination (AOC) 57 to support Task Order 001 of Contract DACA-31-94-D-0061 under the oversight of the U.S. Army Corps of Engineers - New England District. This RI Report details the results of the RI and previous investigations completed at AOC 57 Areas 1, 2, and 3.

Fort Devens was identified for cessation of operations and closure under Public Law 101-510, the Defense Base Realignment and Closure Act of 1990, and was officially closed in September 1996. Portions of the property formerly occupied by Fort Devens were retained by the Army for reserve forces training and renamed the Devens Reserve Forces Training Area (RFTA). Areas not retained as part of the Devens RFTA were, or are in the process of being, transferred to new owners for reuse and redevelopment. AOC 57 is located in an area planned for transfer to the Massachusetts Government Land Bank for industrial/trade related development and recreation/open space.

SITE CONDITIONS

AOC 57 consists of three subsites, Areas 1, 2, and 3, located to the southeast of Barnum Road on what was formerly the Main Post (Figure ES-1). A storm water drain that collects rainfall from the paved areas around Building 3713 has been designated as Area 1.

Area 1 was investigated and addressed as part of the Groups 2 & 7 Site Investigation (SI) (ABB-ES, 1995a), the Area Requiring Environmental Evaluation (AREE) 70 (ADL, 1995) investigation, the Lower Cold Spring Brook SI (ABB-ES, 1995c), and the Study Area (SA) 57, Area 1 Contaminated Soil Removal (Weston, 1998). Following the 1997 contaminated soil removal, Area 1 was recommended for no further action; the decision is to be formalized in the AOC 57 Record of Decision. In accordance with recent USEPA requirements for site closure, a no further action decision must be supported by the demonstration that a site does not pose an unacceptable risk for future unrestricted land use. An assessment of Area 1 indicates that there are no unacceptable risks for future unrestricted land use.

Area 2 previously consisted of an eroded drainage ditch created by periodic precipitation runoff from a vehicle storage yard; however, following a 1994 removal action the area was regraded and a stone drainage swale installed which discharges into Cold Spring Brook. During the removal action it was discovered that the soil and groundwater contamination were more widespread than expected. The soil removal was stopped and AOC 57 Area 2 was administratively transferred to the RI/FS process. Area 3 is located approximately 600 feet to the northeast of Area 2, south of vehicle maintenance motor pools and north of the Cold Spring Brook floodplain. The site is characterized by an historic garage and vehicle waste disposal area. The focus of the RI was on Areas 2 and 3.

In general, the efforts associated with this RI have resulted in conceptual models that identify the sources of groundwater contamination at Areas 2 and 3 as contaminated soils above and in the water table. Contaminated soils at Area 2 are believed to be due to the historic disposal of vehicle maintenance related waste. Data acquired during the RI and previous investigations indicates that the soils in the vicinity of the soil removal excavation are the source of Area 2 groundwater contamination. The Area 3 contaminant source area was delineated by test pitting and consists of a former vehicle maintenance waste disposal area approximately 5 feet in depth and 40 feet square in the vicinity of test pit 57E-95-24X.

Detected Area 2 contaminants are comprised primarily of toluene, tetrachloroethene (PCE), trichloroethene (TCE), and naphthalene in soil and groundwater as well as PCBs and TPHC in surficial and subsurface soils. Reducing conditions caused by the contamination have also created elevated levels of naturally occurring arsenic in groundwater. The soil and groundwater contamination is located around the southern perimeter of the soil removal excavation from the ground surface to the water table at approximately 4 to 5 feet bgs. Low levels of site related contaminants detected in surface water samples confirm that Area 2 groundwater is discharging to the Cold Spring Brook wetland. Analytical data further indicates that Area 2 is not impacting the downstream portion of Cold Spring Brook. Distributions of TPHC, arsenic, and other inorganics within the Cold Spring Brook stream channel suggest an alternate upgradient source of these analytes. Elevated concentrations of TPHC, arsenic, and lead were detected in the area of the brook upstream from Area 2.

Detected Area 3 contaminants are comprised primarily of toluene, PCE, TCE, naphthalene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, PCBs, and TPHC. Soil contamination appears to have migrated south from the source area by advective groundwater transport and sorption. Groundwater contamination has been observed from the source area 175 feet south to the downgradient piezometer 57P-98-03X. Similar to Area 2, reducing conditions caused by the degradation of petroleum contaminants at Area 3 have resulted in elevated levels of naturally occurring arsenic in groundwater. A source area soil removal conducted by the Army in 1999 has eliminated the bulk of the soil contamination at Area 3. Residual EPH, PCB, and pesticides contamination remain in soils near the southern end of the excavation. Surface water and sediment sampling show low levels of contaminants present near the southern end of the removal excavation but not further into the wetland.

Human Health Risk

Possible health risks were evaluated for the current land uses, anticipated future land uses, and unrestricted future land uses at AOC 57. Although the site is presently not used for any specific purposes, and is not located near any properties with active land uses, exposures and risks for current site use were evaluated for a site maintenance worker (possible exposure to surface soil), and a trespasser ages 6 through 16 (possible exposure to surface soil, surface water, and sediment). The possible health risks associated with the anticipated future site use were evaluated assuming that the upland portion of the site will be redeveloped for commercial/industrial use, and included evaluation of a commercial industrial worker (possible exposure to surface soil and groundwater) and an excavation worker (possible exposure to surface soil and subsurface soil). Possible health risks for the future use of the wetland areas were evaluated assuming that the areas could be used for passive recreational/open space use. Therefore, the possible health risks associated with future use of the wetland area of the site were evaluated for a recreational child ages 6 through 16 (possible exposure to surface soil, surface water, and sediment) as well as a construction worker (possible exposure to surface soil and subsurface soil). In addition, to aid in risk management decision-making and to determine if additional response actions may be required at AOC 57, future unrestricted land use was evaluated by assuming that child and adult residents would live at the site (possible exposures to surface soil, subsurface soil, and groundwater). Since groundwater at and beneath AOC 57 is not used as a source of drinking or industrial water, and is not considered a groundwater resource by the State of Massachusetts, evaluation of potable groundwater use represents a hypothetical worst-case evaluation of potential exposures and risks.

The risk assessment evaluated post-removal action conditions for surface soil and subsurface soil. Chemicals of potential concern identified in surface soil and subsurface soil primarily included arsenic, iron, manganese, PCB, and petroleum compounds such as

EPH and VPH hydrocarbon fractions. CPCs identified in groundwater, surface water, and sediment were similar to those identified in soil, but also included chlorinated VOCs, which were detected at low concentrations. Petroleum compounds and PCBs are interpreted to be directly associated with the release of oils and vehicle maintenance wastes to soils at the site. Inorganic constituents selected as CPCs are interpreted to be indirectly associated with the petroleum release. The natural degradation of petroleum contaminants has caused reducing conditions at the aquifer, which in turn results in enhanced leaching of naturally-occurring inorganics from source area soils.

Possible health risks were quantified for carcinogenic and non-carcinogenic effects, for both reasonable maximum and central tendency exposure assumptions. Table 9-44 and Table 10-1 present a summary of the risk estimates. Estimated cancer and non-cancer risks associated with current land use conditions are within acceptable levels established by the USEPA (defined as a $1x10^{-4}$ to $1\text{-}10^{-6}$ excess risk). Estimated cancer and non-cancer risks associated with future open space use of the wetland areas of the site were within acceptable levels established the USEPA. However, estimated non-cancer risk for potential effects to the immune system exceed a hazard index (HI) of 1 for a construction worker exposure to Area 2 wetland subsurface soil. An HI of 1 is the threshold value typically applied by the USEPA to evaluate the significance of non-cancer risk. These non-cancer risks were primarily attributable to PCBs detected in soil samples at the toe of the Area 2 soil removal excavation. With the exception of potable use of Area 3 groundwater, estimated cancer and non-cancer risks associated with future commercial/industrial development and use of upland areas of the site were within acceptable levels established by the USEPA. The estimated cancer and non-cancer risks for commercial/industrial potable use of groundwater at Area 3 exceeds levels considered acceptable by the USEPA. Since groundwater at AOC 57 is not considered a potable water resource, potable use exposures are unlikely to occur. A more realistic potential use of AOC 57 groundwater is for industrial process water. It is unlikely that non-potable industrial uses of groundwater would result in an exposure scenario which would result in unacceptable levels of risk.

Estimated cancer and non-cancer risks associated with unrestricted land use exposures to soil by a hypothetical child or adult resident at upland portions of Area 2 and Area 3 do not exceed levels generally considered acceptable by USEPA. Estimated cancer risks for child and adult resident exposures to soil in the wetland portions of Areas 2 and 3 likewise do not exceed the USEPA risk range. However, non-cancer risks to a child resident potentially exposed to soils at these areas exceed target organ-based HI values of 1. At the Area 2 wetland soils, the principal risk contributors are arsenic, aroclor-1260, chromium, and C11-C22 aromatic EPH. For Area 3 wetland soils, the principal risk contributor is C11-C22 aromatic EPH.

With the exception of the upland portion of Area 2, estimated cancer and non-cancer risks for potable consumption of groundwater at AOC 57 exceed the USEPA Superfund cancer risk range and a HI of 1. However, due to the fact that groundwater at AOC 57 is not considered a groundwater resource by the State of Massachusetts, and the availability of public water supply at Devens, it is unlikely that groundwater beneath AOC 57 will be used as a source of potable water in the future.

The soil removal actions at AOC 57 significantly reduced petroleum contamination in soil, thereby mitigating possible exposures to petroleum-related CPCs and mitigation the leaching of naturally occurring inorganics. Therefore, the risk estimates presented in this risk assessment are worst-case estimates that are unlikely to be exceeded under conceivable future land use conditions.

Ecological Risks

Potential risks for ecological receptors at AOC 57 were evaluated for CPCs in surface soil, surface water, sediment, and groundwater using benchmarks from the literature and site-specific data (e.g., toxicity test results, bioaccumulation study results, and measurement of fish and crayfish tissue concentrations). The following exposure pathways were evaluated in the BERA:

- food chain risks to terrestrial and semi-aquatic mammals and birds that occur in the upland, forested floodplain, and open stream/marsh areas;
- direct contact risks to aquatic receptors (e.g., plants, invertebrates, amphibians, and fish) exposed to surface water and sediment; and
- direct contact risks to terrestrial plants and soil invertebrates exposed to surface soil.

The following summarizes the results of the AOC 57 BERA:

- mercury was detected in only one unfiltered surface water sample (at Area 2), and not at all in filtered surface water. The detection in the one unfiltered sample raises uncertainty about the bioavailability of mercury in Area 2 surface water. There are also doubts about the origin of mercury in the one sediment sample in which it was detected. These factors create significant uncertainty regarding the conclusion of the BERA that wading birds may be at risk from exposure to mercury from Area 2 surface water or sediment that may bioaccumulate in fish tissue;

- a survey of Area 2 showed no sign of contaminant induced stress to wetland or terrestrial vegetation, although the BERA indicated that there may be a risk to terrestrial plants from exposure to lead in Area 2 floodplain surface soil;

- analyses of surface water samples indicate that unfiltered concentrations of metals are elevated at both Areas 2 and 3; however, these concentrations may be related to the high turbidity of the samples, and may not be bioavailable to ecological receptors. Therefore, there is uncertainty regarding the finding that aquatic organisms may be at risk from iron in surface water at 57D-95-05X (located adjacent to Area 2);

- while potential risks were also identified for benthic macroinvertebrates from exposure to metals, pesticides, PCBs, and PAHs in Areas 2 and 3 sediment based on conservative benchmark comparisons, this conclusion is not supported by the apparent lack of adverse effects in bulk sediment toxicity studies. Benthic macroinvertebrates may be at risk from copper and lead concentrations in sediment at sample location 57D-95-04X (concentrations of these analytes may be correlated with observed adverse growth responses for *C. tentans* in toxicity tests).

Based on a comparison of surface water data with upgradient groundwater data, Cold Spring Brook surface water in the vicinity of Area 2 may be impacted by groundwater discharge. However, there does not appear to be a risk to aquatic receptors from the chemicals common to both these media. Groundwater at Area 3 does not appear to be impacting downgradient surface water in the floodplain of Cold Spring Brook, based on the difference in chemicals detected in these media.

RECOMMENDATIONS

Based on the results and interpretations of the RI and the Human Health Risk Assessment, HLA recommends that a Feasibility Study be performed to evaluate alternatives to remove possible human health risks associated with potential future exposure to wetland soils by an excavation worker and hypothetical future residential exposures to soil and groundwater at AOC 57 Area 2.

A feasibility study is also recommended to evaluate alternatives to remove potential human health risks associated with potential future potable use of Area 3 groundwater and hypothetical future residential exposures to soil and groundwater.

No further action under CERCLA is recommended for Area 1 because unrestricted future land use does not pose any unacceptable risk.

1.0 INTRODUCTION

This Remedial Investigation (RI) Report (Data Item A009) for Area of Contamination (AOC) 57 was prepared by Harding Lawson Associates (HLA) as a component of Task Order 001 of Contract DACA31-94-D-0061 with the U.S. Army Corps of Engineers (USACE). This report details the results of the RI program at AOC 57, which was completed in accordance with relevant USACE, U.S. Army Environmental Center (USAEC), and U.S. Environmental Protection Agency (USEPA) guidance.

Fort Devens was identified for cessation of operations and closure under Public Law 101-510, the Defense Base Realignment and Closure Act of 1990, and was officially closed in September 1996. Portions of the property formerly occupied by Fort Devens were retained by the Army for reserve forces training and renamed the Devens Reserve Forces Training Area (RFTA). Areas not retained as part of the Devens RFTA were, or are in the process of being, transferred to new owners for reuse and redevelopment. AOC 57 is located in an area planned for transfer to the Massachusetts Government Land Bank for industrial/trade related development and recreation/open space.

1.1 PURPOSE AND SCOPE

The scope of work for the RI at AOC 57 was specified by the Army based on contaminants previously detected in groundwater and subsurface soil at AOC 57.

SITE CONDITIONS

AOC 57 consists of three subsites, Areas 1, 2, and 3, located to the southeast of Barnum Road on what was formerly the Main Post (Figure ES-1). A storm water drain that collects rainfall from the paved areas around Building 3713 has been designated as Area 1. Area 1 was investigated and addressed as part of the Area Requiring Environmental Evaluation (AREE) 70 (ADL, 1995), the Lower Cold Spring Brook Site Investigation (SI) (ABB-ES, 1995), the Lower Cold Spring Brook SI (ABB-ES, 1995c), and the Study Area (SA) 57, Area 1 Contaminated Soil Removal (Weston, 1998). Area 2 previously consisted of an eroded drainage ditch created by periodic precipitation runoff from a vehicle storage yard; however, following a 1994 removal action the area was regraded and a stone drainage swale installed which discharges into Cold Spring Brook. During the removal action it was discovered that the soil and groundwater contamination were more widespread than expected. The soil removal was stopped and AOC 57 Area 2 was administratively transferred to the RI/FS process. Area 3 is located approximately 600 feet to the northeast of Area 2, south of former vehicle maintenance motor pools and north of the Cold Spring Brook floodplain. The site is characterized by a historic garage and vehicle waste disposal area. The focus of the RI was on Areas 2 and 3.

RI field work at AOC 57 proceeded in three phases, the initial RI field work in the Fall of 1995, the Modification field work in the Fall of 1996, and the Supplemental Investigation in the Spring of 1998.

The Fall 1995 field work focused primarily on Area 2; however, based upon historical photos which suggested soil staining, several test pits, Terraprobe points, and a monitoring well were installed in an area approximately 600 feet to northeast of Area 2. This location would be designated Area 3 and become the focus of the 1996 RI field investigation.

The following activities were included in the 1995 and 1996 field investigations:

- Background research of historical records, personnel interviews, areal photographic interpretation, and literature search was completed.
- A geophysical survey was completed at Areas 2 and 3 of the AOC to determine if any additional site-related contaminant source areas were present.
- Soil sampling with field analysis from test pits, soil borings, and Terraprobes™ were completed to define the horizontal and vertical distribution of soil contamination;
- Soil boring and test pit subsurface soil sampling for off-site laboratory analysis to confirm and supplement the field analysis;
- Installation of groundwater monitoring wells, piezometers, and the sampling of groundwater for off-site laboratory analyses;

- Surface water and sediment sampling for off-site laboratory analysis as well as biological and whole sediment sampling and analysis;
- Ecological survey and wetlands investigation;
- Aquifer testing;
- Vertical and horizontal location surveys.

The 1998 Supplemental RI field investigation was performed following the issuance of the AOC 57 Draft RI Report. The purpose of the 1998 investigation was to delineate the downgradient extent of contamination at Areas 2 and 3. Field activities consisted of:

- Collection and analyses of surface soils;
- Surface water and sediment sampling for off-site laboratory analysis;
- Installation and sampling of groundwater monitoring points.

As a result of the data obtained from the RI investigation, a contaminated soil removal was performed at AOC 57 Area 3. The removal action, focused on polychlorinated biphenyls (PCBs) and extractable petroleum hydrocarbons (EPH) in soil, was performed in three phases between March and June of 1999. A total of 1,860 cubic yards of soil were removed from Area 3. Confirmatory soil samples were collected from the excavation floor and walls to help direct the excavation.

1.2 REPORT ORGANIZATION

Preparation of this RI Report consisted of characterizing the geologic and hydrogeologic conditions and assessing the distribution, migration, potential receptors, and potential effects of identified chemicals on human and ecological receptors. The content and presentation of this report relies heavily upon figures and tables which present the data in the context of exploration locations on site maps. The text within the report supports the figures and tables, and provides detail, interpretation, and analysis that cannot be presented in figures and tables.

After acquiring and evaluating the field and off-site laboratory data and identifying chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs), HLA prepared this RI Report for AOC 57 in accordance with USEPA and Army guidance. The report describes the field methods employed, and presents, summarizes, and evaluates the relevant background information, field and laboratory data, results and conclusions from previous investigations, and assesses the potential human health and ecological risks.

Section 2.0 of this report describes the history and physical setting of the Devens area. Section 3.0 summarizes the RI analytical program, including the field procedures, off-site analytical procedures, QA and QC, and data management. Section 4.0 presents potential ARARs and background concentrations of inorganic analytes in soil and groundwater. Section 5.0 of this report summarizes the AOC 57 background and physical conditions, previous investigations, technical objectives of the RI, and RI sampling and investigatory techniques. Section 6.0 presents the interpretation of geologic and hydrogeologic conditions at AOC 57. Section 7.0 presents the results of previous investigations and the nature and distribution of site contaminants detected during the RI field investigations and 1999 Area 3 removal action. Section 8.0 outlines the fate and transport of the detected site contaminants. Section 9.0 presents the human health and ecological baseline risk assessment. Section 10.0 presents the conclusions and recommendations for AOC 57 Areas 1, 2, and 3. Figures and tables associated with each section are presented at the end of each section.

This RI Report will be presented as a Draft Final version, and after regulatory review, a Final version.

1.3 PROJECT OBJECTIVES

The objective of the project at AOC 57 was to perform an RI in accordance with relevant MADEP and USEPA guidance and in compliance with Army-approved field methods and procedures. The purpose of the RI conducted at AOC 57 was to further define the site contaminants detected in the soil and groundwater during previous site activities conducted at this AOC, and to determine whether remediation of the site contaminants is warranted.

1.4 PROJECT APPROACH

To meet the project objectives, a significant amount of effort was focused on the production of several RI planning documents. The planning documents were developed in compliance with the appropriate regulatory guidance for remedial investigations, regulatory and USAEC comments, and results of previous investigations.

The project plans were designed to answer data gaps identified from the previous investigations and gather additional data on the physical conditions of the AOC, the nature and distribution of site-related contaminants, and assess the risks to human and ecological receptors.

1.4.1 Project Operations Plan

The principal planning document was the HLA Fort Deven's Project Operations Plan (POP) (ABB-ES, 1995b), which provides detailed descriptions and discussions of the elements essential to conducting field investigation activities. The POP was revised before the 1995 RI field investigation to include new sampling techniques. The purpose of this plan was to define responsibilities and authorities for data quality, and to define requirements such that the field investigation activities undertaken by HLA at Devens would be 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. USEPA has prepared guidance on the preparation of a POP in "Guidance for Preparation of Combined Work/Quality Assurance Project Plans for Environmental Monitoring"; (USEPA, 1984). The guidance was designed to eliminate the necessity for preparation of multiple, redundant documents.

The requirements of the POP were applied to HLA and subcontractor activities related to the collection of environmental data at 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 HLA Devens POP provides guidance and specifications to ensure that samples are obtained under controlled conditions using appropriate, documented procedures; and that 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 POP in accordance with the same schedule and review requirements (ABB-ES, 1995b, Appendix A). The HASP complies with USAEC's EM 385-1-1, AMC-R-385-100, and 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 Devens. The HASP portion of the 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 Plans

The background, rationale, and specific scope for the RI are set forth in a second companion planning document, the Task Order Work Plan. The Revised Final Task Order Work Plan (ABB-ES, 1996a), Final Task Order Work Plan Addendum (ABB-ES, 1996b), and the Draft Supplemental Work Plan (HLA, 1998) for AOC 57 were prepared under Contract DAC31-94-D-0061 Task Order No. 001 and Modifications 001 and 004. The Work Plans were developed to comply with the Massachusetts Contingency Plan (MCP) (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 Work Plans was performed in accordance with the provisions of the FFA

(USEPA and U.S. Army, 1991) and USAEC guidelines.

The background information provided in the Revised Final Task Order Work Plan, the Work Plan Addendum, and the Draft Supplemental Work Plan for AOC 57 was based largely on information in the Master Environmental Plan (MEP) (Biang et. al, 1992), review of installation documents, observations made during site visits conducted by HLA, interviews with installation personnel, and previous investigations. Summaries of each of these activities and discussions of specific field activities to be conducted under Task Order 001 and Modification 001 were included in the Revised Final Task Order Work Plan, the Work Plan Addendum, and the Draft Supplemental Work Plan. The discussions focused specifically on the objectives and scope of proposed RI activities.

2.0 INSTALLATION DESCRIPTION

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 property occupies approximately 9,260 acres and was previously divided into the North Post, the Main Post, and the South Post (Figure 2-1).

Fort Devens was identified for cessation of operations and closure under Public Law 101-510, the Defense Base Realignment and Closure Act of 1990, and was officially closed in September 1996. Portions of the property formerly occupied by Fort Devens were retained by the Army for reserve forces training and renamed the Devens Reserve Forces Training Area (RFTA). Areas not retained as part of the Devens RFTA were, or are in the process of being, transferred to new owners for reuse and redevelopment. AOC 57 is located in an area planned for transfer to the Massachusetts Government Land Bank for industrial/trade related development and recreation/open space.

Over 6,000 acres at Fort Devens were used for training and military maneuvers, and over 3,000 acres were 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], 1992).

The former South Post is located south of Massachusetts Route 2 and is largely undeveloped. The former Main Post and North Post primarily contain developed lands, including recreational areas, training areas, and an airfield. AOC 57 is located on the former Main Post (Figure 2-2).

The following subsections describe the history and physical setting of 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 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 cadets, and the Civilian Military Training Corps. 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 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.

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. Fort Devens served as an active army facility from that time until the Spring of 1996 when the Fort was officially closed.

2.2 PHYSICAL SETTING

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

2.2.1 Climate

The climate of Devens is typical of the northeastern United States, with long cold winters and short hot summers. Climatological data were reported for 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 former Main and North Posts at Devens are primarily characterized by urban and developed cover types. Approximately 56 percent of these areas are covered by developed lands. Early successional forest cover types (primarily black cherry-aspen hardwoods) cover 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 former North and Main Posts are characterized by various coniferous species, shrub habitat, and herbaceous cover types.

Much of the former 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 former South and North Post areas of 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

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 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. Devens is generally reverting back to a forested state.

There are 1,313 acres of wetlands at 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 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 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, 1992).

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 Devens aquatic systems has not been fully defined.

Rare and endangered species at 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 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 Devens.

2.2.4 Physiography

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 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 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 former Main Post is the most prominent example.

A similar but more common terrain at 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 former Main Post) to elongated hills (drumlins) whose orientations reflect the direction of glacier movement (such as Whittemore Hill on the former 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 Devens. 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 the air field and the wastewater infiltration beds are located on the former 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 former 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 former Main Post occupy another conspicuous kettle.

2.2.5 Soils

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 Devens consist generally of three associations. Three associations also have been mapped in the Middlesex County portions of 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 2-3, and descriptions of the soil series in those associations are provided below.

WORCESTER COUNTY (SCS, 1985)

<u>Winooski-Limerick-Saco Association:</u>

> <u>Winooski Series</u>. 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: The soils at AOC 57 are comprised of this soil type (See Figure 2-3). (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

Devens lies in three topographic quadrangles: Ayer, Clinton, and Shirley. The surficial geology of 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 Devens. The glacial units consist of till, deltaic deposits of glacial Lake Nashua, and deposits of glacial meltwater streams.

The surficial geology at AOC 57 can be placed in the following geologic setting. 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 former Main Post (such as in the area of Lake George Street) and on the former 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 Wisconsinian 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 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 forest 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 former 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

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, that 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. 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 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 Devens (in an outcrop 0.25 mile west of the old Howard Johnson rest stop on Route 2).

Figure 2-4 is a generalized summary of the bedrock geology of 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 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 Devens, cataclastic zones have been observed (Robinson, 1978). The bedrock below AOC 57 belongs to this formation.

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 at Devens indicate that it may not be intrusive.

Bedrock is typically unweathered to only slightly weathered at 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

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 Devens are Nonacoicus Brook and Walker Brook on the former North Post; Cold Spring Brook (which is a tributary of Nonacoicus Brook) on the former Main Post; and Spectacle Brook and Ponakin Brook (tributaries of the North Nashua River), Slate Rock Brook, and New Cranberry Pond Brook on the former South Post. Cold Spring Brook is located at the southern boundary of AOC 57 (see Figure 2-5).

There are two ponds on Devens' South Post that are called Cranberry Pond. 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 Devens. In aquifer tests performed as part of previous investigations, 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 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 2-5 shows aquifer transmissivities at 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 feet into bedrock and yield less than 10 gpm. Higher yields are associated with deeper bedrock wells.)

In Figure 2-5, the zones of highest transmissivity are found in areas of thick glacial meltwater deposits on the former North and Main Posts, and these encompass the Sheboken, Patton, and McPherson production wells and the largely inactive Grove Pond well-field. AOC 57 is located between Patton production well and the Grove Pond wells. Groundwater from AOC 57 does not appear to flow toward either well as it discharged to Cold Spring Brook (see Figure 2-5). The zones of lowest transmissivity are associated with exposed till and bedrock and are located on the former Main Post surrounding Shepley's Hill and between Jackson Gate and the parade ground, and on the former 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 Devens is available in a report by Engineering Technologies Associates, Inc. (ETA) (1995).

According to ETA (1995), 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. Figures 2-6 and 2-7, respectively, present ETA's regional overburden and bedrock groundwater flow maps (ETA, 1995).

3.0 ANALYTICAL PROGRAM

Based on data obtained from previous investigations summarized in the Final Task Order Work Plan for AOC 57, 63AX, and 69W (ABB-ES, 1996), an analytical program for the RI was established to identify contaminants that were potentially present at AOC 57 due to historical activities. Fuel hydrocarbons and chlorinated solvent contaminants were discovered in past investigations at AOC 57. The purpose of the following subsection is to outline only those analytical procedures used during the RI program. Analytical results generated during previous activities including Site Investigations, AREE 70, and Soil Removal Action will be included in the RI; however, the analytical programs are not described in this document. Previously published documents containing information on analytical programs from historical activities are referenced in Section 7.0.

The AOC 57 RI analytical program included field analysis as well as off-site laboratory analyses for a predetermined set of organic and inorganic analytes. The specific analyses implemented for these investigations are outlined in Subsection 3.1 for the on-site methods and Subsection 3.2 for the off-site analytical program. Samples were collected during RI field investigations completed in 1995 and 1996, the 1998 Supplemental field investigation, and Area 3 source area soil removal completed in 1999. The following subsections describe the field and off-site analytical programs implemented for the RI completed by HLA at AOC 57 Areas 2 and 3.

3.1 FIELD ANALYTICAL METHODS

Samples were analyzed in the field during the RI investigation to provide real-time chemical data. Soil and groundwater samples were analyzed for selected volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPHC). Data were primarily used to evaluate the distribution of benzene, toluene, ethylbenzene, and xylene (BTEX), chlorinated solvents, and TPHC contamination in groundwater and soil at AOC 57. A discussion of field analytical procedures, data quality objectives, field documentation procedures, and quality control steps are outlined in Subsection 4.6 of the POP (ABB-ES, 1995b). Target compounds and detection limits for on-site field analysis compounds are outlined in Table 3-1.

TPHC analyses using a Miran Fixed Filter Infrared Spectrophotometer (IR) was the primary field method for evaluating semivolatile petroleum hydrocarbons in soil samples. This method is similar to USEPA Method 418.1. A soil microextraction sample preparation technique was developed for use in a field laboratory. This method provides qualitative data on the presence and absence, and relative concentration, of hydrocarbons. Diesel Range Organics (DRO) gas chromatography (GC)/Flame Ionization Detector (FID) analysis was also conducted on a subset of soils to provide semiquantitative data on medium molecular weight range petroleum hydrocarbons. DRO analysis was conducted for a subset of samples that exhibited hydrocarbon characteristics on the VOC analysis.

A Hewlett Packard 5890 Series II GC, in series with a Tekmar 3000 purge and trap concentrator, was used to measure concentrations of VOCs in the different matrices. Target analytes included BTEX, chlorinated solvents, and gasoline range organics (GRO) to measure the volatile petroleum reaction of hydrocarbons. Several detectors were used in conjunction with the GC during the field programs. Detectors included a FID, photoionization detector (PID), and electron capture detector (ECD).

3.1.1 Instrument Calibration

For analysis of samples for target compounds using a GC, an initial calibration was established. The initial calibration was accomplished through the analysis of three to five different concentrations of working standards. The response of the instrument to each standard was plotted versus the concentrations of standards to establish a calibration curve. The range of standards used to create the calibration curve was determined by the anticipated range of VOC contamination. Once all points were established on the calibration curve, the linearity was measured using linear regression analysis. The r^2 value, which provided a measure of this linearity, was required to be a minimum of 0.95 for all target analytes.

Prior to analysis of samples, a continuing calibration check standard was analyzed each day to ensure that the response of the instrument had not changed from the initial calibration. The concentration of the check standard was at mid-level in the calibration curve. The initial calibration remained valid if concentrations obtained for the target analytes were no greater than 30 percent different from values obtained from the initial calibration. If greater than two target compounds for multianalyte analysis for BTEX and chlorinated compounds were outside the 30 percent difference, a new initial calibration was created.

3.1.2 Sample Preparation and Analysis

Sample preparation for the total petroleum hydrocarbon procedure (IR analysis) is detailed in Subsection 4.6.2 of the Fort Devens POP (ABB-ES, 1995b). The IR analysis was used for gross hydrocarbon measurements and to indicate the presence or absence of contamination. A freon-113 extraction similar to that described above for DRO was used to prepare samples. Samples were analyzed by USEPA Method 418.1 (USEPA, 1983).

Sample preparation techniques for GC VOCs and GRO were adapted from protocols outlined in USEPA Method 8010 and 8015 (USEPA, 1986). Soil samples were prepared for field analysis by the measurement of 5 grams into a soil sparger. For water samples, the amount used was 5 milliliters (mL). Both soil and groundwater samples were loaded onto the purge and trap concentrator. Helium was purged through the sample to carry compounds onto a cold, compound-capturing silica/charcoal trap. The trap was heated to 235 degrees Celsius (°C) to liberate volatile compounds into a DB-624 capillary column which was installed in the gas chromatograph. The capillary column served the purpose of separating out the various compounds. The amount of time spent in the capillary column (retention time) by each compound was influenced by its molecular weight and the temperature program of the GC. A retention time window of +/- 3 percent was used for the identification of target compounds.

For DRO analysis sample preparation, techniques were adapted from USEPA Method 3550 and Method 8015 (USEPA, 1986). The extraction procedure required the measurement of 2 grams of soil into a test tube with the addition of 2 grams of sodium sulfate and 2 mL of methylene chloride (solvent). The supernatant was then transferred to an injection vial labeled with the sample identification. The GC, equipped with an autosampler for a 2 microliters (µL) sample volume injection, then analyzed the sample for identification and quantitation of DRO concentration. Additional solvent may have been added if a sufficient volume of supernatant was not initially achieved. If additional solvent was added, a dilution factor was incorporated during sample quantitation.

3.1.3 Target Compound Concentrations Calculations

Target VOC concentrations were determined from comparisons of responses of compounds in samples versus responses from standards in the initial calibration curves described in

Subsection 3.1.1. Soil compound concentrations were reported on a dry weight basis. Solid fraction data was used to calculate final VOC, GRO, DRO, and IR concentrations. Dilutions performed on both water and soil samples also were used to calculate final VOC, GRO, DRO, and IR concentrations. Dilution factors were calculated for any analyses where sample amounts were modified due to high concentrations of chemicals present in samples. Final sample results were calculated by dividing original unadjusted sample results by fraction of solid and multiplying results by any dilution factors.

Based on secondary data reviews conducted by the HLA Quality Assurance Officer and project chemist, possible data bias was identified in the GRO and DRO data set. The possible data bias is discussed below for GRO and DRO.

The results of the GRO analyses contain a possible positive bias which over-estimated the measured concentration by approximately 20 percent of the true value. The bias was introduced during the preparation of the stock standard for the GRO analysis. The density of GRO was approximated as the density of benzene (0.88 grams per milliliter [g/mL]), however, according to information in the Installation Restoration Program Toxicology Guide (U.S. Air Force) gasoline has a density of approximately 0.73 g/mL.

The results of the DRO analyses should be considered estimated. Possible impacts on quantitation of hydrocarbons was introduced during the set-up of the GC analytical run program. The instrument conditions used for DRO analyses caused the loss of approximately 25 percent of the light end hydrocarbons within the diesel hydrocarbon range. The primary purpose of the DRO analysis was to estimate concentrations of fuel oils or waste oils at the site. The analytical run would effectively detect the medium to heavy molecular weight fraction of oil products; however, concentrations should be considered estimated within approximately 0.5 to 2 times the reported concentration.

3.1.4 Field Documentation Procedures

Instrument logbooks were completed for each instrument used during each of the field analytical programs. A log of all chromatography runs was recorded in these logbooks. The logbooks recorded the concentrations for all calibration standards used, sample run number, sample identification, date, standard preparation records, instrument maintenance records, percent solid determination data, sample volume or weight, and any additional comments or observations of the field chemist. In addition, the results from each GC run were saved into a computerized database.

At the conclusion of the RI field efforts, raw data from the GC analyses and instrument logbooks were transferred for storage at HLA's Portland, Maine office. Raw data includes chromatograms, quantitation reports, and instrument and notebook records to document analyses.

3.1.5 Field Analytical Quality Control

A QC program for the field analytical results was established prior to commencement of the RI on-site laboratory analysis. This program was developed to ensure that the data generated at the field laboratory was of sufficient quality to be considered satisfactory for its intended use. QC parameters for the RI field analytical program included initial and daily calibration check standard runs, mid-level calibration check standards after every ten samples, low-level and mid-level method blanks, cleaning blanks, and field or laboratory duplicates. QC objectives for the on-site laboratory analyses are outlined in the Fort Devens POP (ABB-ES, 1995b) and Appendix D of this report. QC sample results for the on-site laboratory are assessed in Appendix D.

Method blanks were analyzed daily to document that the analytical system was free of contamination. Samples were not run if the there were any target compounds detected above the Practical Quantitation Limit (PQL) in the method blank. In addition to the low-level method blank, a mid-level method blank was run in instances where methanol extractions were necessary. One hundred μL of methanol were added to deionized water and analyzed to ensure that it was free of contamination.

During VOC GC analyses, cleaning blanks were run at the beginning of each day to show that the analytical system was clean. They were also run after particularly heavily contaminated samples were run through the GC.

For VOC analyses, a surrogate was added to every sample to determine if the matrix was having an effect on the recovery of the target compounds. The surrogate used for all field investigations was 4-Bromofluorobenzene. This surrogate was used because it is chemically similar to the target compounds and responds well on the detectors selected for the field programs. Surrogate recoveries had to be from 30 percent to 170 percent to be considered acceptable. Samples for which the surrogate did not meet this criteria were reanalyzed and/or qualified.

Field duplicate samples were also analyzed to determine the precision of sampling and analytical techniques. Reported concentrations of target compounds for each sample and associated duplicate pair were compared by calculating the relative percent difference (RPD) of the results. RPDs were compared to criteria from USEPA (hazardous site evaluation division) Region I laboratory data validation functional guidelines for evaluating organics analyses to evaluate the precision of measurements. Duplicate results for the RI are presented in Appendix D.

In some instances, data qualifiers were used to address data quality issues associated with a particular sample. The following qualifiers were used during the RI at Fort Devens:

J - Denotes target compound concentrations that are estimated.

E - Denotes target compound concentrations that exceed the highest standard of the calibration curve.

U - Denotes sample concentrations that are less than PQLs.

N - Denotes a value that is a possible false positive due to method blank contamination.

Results of the on-site sample analyses are presented in discussions of the nature and distribution of site contaminants, in Section 7.0 and Appendix M of this report.

3.1.6 Method Detection Limits and Data Qualifiers

Method Detection Limits (MDLs) were established during the RI for the electronic conductivity detector (ELCD), PID, and the FID detector target compounds. The MDL study was completed for all VOC target compounds to provide data to support the PQLs established for the various field programs. MDLs were calculated based on procedures published in CFR Appendix B, Part 136, vol. 49, no. 209. The MDL study provides an estimation of the lower concentration limit of what the detectors were able to measure. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. For each compound, this was determined by running seven consecutive runs of a premixed standard at a concentration believed to be near the threshold of detection. The concentration for all target compounds in the MDL study was 2 micrograms per liter (µg/L). 1,1-Dichloroethane was not observed at this concentration with reliability, and the MDL was not determined. The 1,1-dichloroethane PQL was set at 5 µg/L. The MDLs obtained during the RI field analytical program are presented in Table 3-1.

The PQL was established to provide a margin of error from the MDL, since the MDL identifies the threshold concentration of what the detector was capable of measuring. PQLs for the RI program are outlined on Table 3-1.

3.2 OFF-SITE LABORATORY ANALYTICAL PARAMETERS

Soil and groundwater samples collected during the RI from AOC 57 were analyzed at an off-site laboratory for chemical parameters on the Fort Devens/Devens Project Analyte List (PAL). Off-site laboratory analyses for PAL organics and inorganics are considered definitive data (USEPA, 1993). The Fort Devens/Devens PAL and off-site laboratory methods are described in the Fort Devens POP (ABB-ES, 1995b) and Appendix D of this report.

Off-site laboratories performing the analytical work for Fort Devens/Devens during remedial investigations completed before 1999 were required to implement the 1990 U.S. Army Toxic and Hazardous Materials Agency (USATHAMA, now USAEC) QA Program (USATHAMA, 1990). Method performance demonstrations, data management, and oversight for previous USATHAMA analytical procedures were performed by the USAEC. The off-site laboratory contracted to implement the analytical program for the RI at AOC 57 was Environmental Science and Engineering, Inc. (ESE) of Gainesville, Florida (later QST Environmental). This laboratory completed analyses using USATHAMA and USEPA methods. Analyses were completed while implementing the 1990 USATHAMA QA Program. Specific performance demonstration and QC components of the 1990 USATHAMA QA Plan are detailed in Subsection 3.2.3 of this report.

Samples collected during the Source Area 3 removal action included hydrocarbon analyses using Massachusetts volatile petroleum hydrocarbon (VPH) and EPH methods (MADEP, 1998), and pesticide and PCB analyses using USEPA SW846 methods (USEPA, 1996). Samples were analyzed by a USACE certified laboratory. A data quality review was performed by the HLA project chemist. A data quality review is provided in Appendix D5, and results are reported in Section 7.0. Results from the Source Area 3 removal action are not reported on the USAEC IRDMIS.

The following subsection describes the procedures implemented to achieve the objectives of the USAEC QA program and any additional quality control processes implemented during the RI.

3.2.1 Off-Site Laboratory Certification

In accordance with the 1990 USATHAMA QA Program, laboratories were required to demonstrate competency by performance demonstration of the PAL analytical methods conducted in association with field investigations. The USAEC requires that a laboratory demonstrate proficiency in performing USAEC methods for specific analytes. Analytical methods are based on USEPA procedures (USEPA 1983; 1986). Laboratories demonstrate proficiency by submitting data from runs of pre-certification calibration standards.

Performance samples are then sent for analysis to the laboratory by the USAEC. The true concentrations of the analytes in the performance samples are unknown by the laboratory. The data obtained from the analyses of these samples are then sent to the USAEC to determine the laboratory's precision and accuracy. Qualifications to perform USAEC methods are awarded to laboratories based on this performance. Certified Reporting Limits (CRLs) are also determined through this process. A method code associated with each USAEC analysis and laboratory is then assigned and reported with the results. Listings of USAEC certified analytical methods used during the RI, target analytes, and CRLs are presented in Appendix D, Table D-1.

Some standard USEPA methods such as hardness, total organic carbon (TOC), TPHC, and total suspended solids (TSS) have no associated USAEC certification. The USAEC recognizes standard USEPA protocols or internal laboratory methods for these analyses. Laboratories are required to submit information on procedures for analyzing samples using these methods to the USAEC Chemistry Branch before they are implemented. Listings of USEPA analytical methods used during the RI and project reporting limits are presented in Appendix D, Table D-1 for the 1995 and 1996 Field Investigations.

3.2.2 Off-Site Laboratory Methods Quality Control

All field samples sent to the laboratory were organized into lots which were assigned a lot code. 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 high and low concentrations of specific analytes that help monitor ESE's precision and accuracy. The recoveries of these spikes were plotted on control charts generated by ESE and submitted to the USAEC. Data generated during the performance demonstration process were 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. Control charts are generated with each lot providing a continuous benchmark for trend evaluation of laboratory performance.

Method blanks were also analyzed at ESE to evaluate the potential for target analytes to be introduced during the processing and analysis of samples. One method blank was included with each analytical lot. Because analytical lots included samples from several areas, method blank results are presented and discussed for all AOCs investigated during the RI.

3.2.3 Data Reduction, Validation, and Reporting

Initial responsibility for accuracy and completeness of Devens analytical data packages rested with ESE. All data submissions to the USAEC first underwent a review process, including checks on the data quality, which evaluated completeness of the ESE data, accuracy of reporting limits, compliance with QC limits and holding times, and correlation of ESE data to associated laboratory tests.

The following items were also validated by ESE before submission to the USAEC:

- COC 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 integration);
- 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/matrix spike (MS) library search of unknown compounds; and
- transfer files and records to ensure agreement with analysis results.

3.2.4 Data Reporting

After review and validation by ESE, the data were encoded for transmission into the USAEC's Installation Restoration Data Management Information System (IRDMIS) as Level 1 Data. IRDMIS, a computerized data management system used by the USAEC, is described in detail in Subsection 3.3. Once the data were entered into the system, a group and records check was completed. Data were then transferred to USAEC's data management contractor. During this phase, the data were elevated to Level 2. Another group and records check was performed and the data were reviewed by the USAEC Chemistry Branch. When errors were identified, the data were returned to ESE for correction. Control charts were produced by ESE that plotted recoveries of high and low concentrations of laboratory control spikes of the target analytes. The control charts provided the USAEC with information about the accuracy of the analytical methods performed by ESE. Once data were reviewed by the USAEC Chemistry Branch, the determination was made on a lot-by-lot basis whether the data were acceptable. Qualifiers may be added to results to identify quality issues related to data quality. Two types of qualifiers are used for data entered into the IRDMIS data base. Qualifiers include flagging codes which are entered by the subcontract laboratory and data qualifiers which are entered by USAEC Chemistry Branch during the secondary review process described in Subsection 3.2.2. Flagging codes and data qualifier codes used on the IRDMIS are described in Table 3-1. The data that were accepted were then elevated to Level 3 and made available to USAEC personnel and HLA by modem to a main frame computer. Data summary tables presented in this report were generated using the IRDMIS data base. Off-site results are presented in Section 7.0 and Appendix L-2.

3.2.5 Field Quality Control Samples

Field QC samples which were collected during the RI included a field blank exploration and decontamination, MS/matrix spike duplicates (MSDs), field duplicate samples, rinse blanks and trip blanks.

Before field investigations were initiated, a sample of water, collected from the source, was used for sampling equipment decontamination. The water source for the RI at AOCs 57 was the South Post Water Point (Well D-1). For the purpose of off-site laboratory QC, this was identified as the field blank (source water sample). The field blank data were sent to the USAEC Chemistry Branch where approval was granted for the use of this water in decontamination procedures. The information gained from the analysis of the field blank provided data on the quality of the USAEC-approved water used in the decontamination of the sampling equipment.

As specified in the Fort Devens POP, (ABB-ES, 1995), MS/MSDs were spiked and analyzed for PAL inorganics, and pesticides/PCBs, as well as several USEPA Methods for hardness, total petroleum hydrocarbons, (TPHC) by USEPA Methods 9071 and 8105, TOC, total phosphate, nitrate and nitrite-nitrogen, and kjeldahl-nitrogen. HLA personnel made the determination of which samples were to be designated as MS/MSDs. This was noted on the COC forms submitted to ESE.

Samples designated as MS/MSDs were spiked at the off-site laboratory with specified concentrations of analytes to determine matrix effects based on USAEC and USEPA method guidelines. MS/MSD data were also used to assess the accuracy of the analyses used. MS/MSD samples were collected at a rate of one set per 20 samples. During the 1995 RI field investigations, samples were collected from AOCs 57, 69W and 57 simultaneously. Therefore, assessments of MS/MSD data, contained in Appendix D, were made for these AOCs collectively.

Field duplicate samples were also collected at a rate of one per 20 field samples. The purpose of duplicate sample analysis was to assess the sampling and off-site laboratory precision for particular methods. Since two AOCs were investigated simultaneously during the RI field effort, field duplicates were collected for each media sampled at each AOC. Duplicate data were assessed collectively for the RIs. Duplicates submitted to ESE were analyzed for the same parameters as the corresponding field samples. Duplicate sample results are presented in Appendices D.

Rinse blanks were collected and analyzed for PAL analytes and TPHC by USEPA Methods 418.1 and 8015. Rinse blanks consisted of previously analyzed deionized water which was poured over sampling equipment. Analysis of this water provided information used to evaluate the potential for sample contamination during sample collection. The results were also used to assess decontamination procedures for the sampling equipment. As specified in the Fort Devens POP (ABB-ES, 1995), rinse blanks were collected at a rate of one per 20 samples. Rinse blank results from the RIs are included in the data quality reports in Appendices D. Discussions regarding rinse blank contamination are relevant to both AOCs investigated during the RIs.

For every shipment of VOC samples to ESE, trip blanks accompanied the samples. The purpose of analyzing trip blanks was to determine if there was any VOC cross contamination during the shipment and handling of samples. The trip blanks consisted of previously analyzed deionized water that was bottled at ESE. Trip blanks were shipped in sealed containers to the job site. As needed, trip blanks were then included with shipments of VOC field samples. Since the VOC field samples were taken from AOCs 57, 69W, and 57 simultaneously, trip blank data collected was associated with both AOCs. Data were included for trip blanks sent with any samples from all AOCs investigated during the RI. Trip blank data are presented in Appendices D.

3.2.6 Off-Site Analytical Data Quality Evaluation

Off-site data quality reviews were conducted by the project chemist for results generated during the RI. In addition to USAEC laboratory data reviews described in Subsection 3.2.2, precision and accuracy of results were assessed by reviewing MS/MSD results, field duplicate results, and surrogate recovery. QC sample results were compared to goals outlined in the Fort Devens POP (ABB-ES, 1995) and USEPA Region I validation guidelines (USEPA, 1988; USEPA, 1989). QC blank results were also evaluated as discussed below, to assess the potential for sample contamination during sample collection or at the off-site laboratory. Detailed discussions of these reviews are contained in Appendices D. Conclusions on the precision and accuracy of analytical measurements are summarized in Subsection 7.1.2.

Off-site laboratory data collected during the RIs at Devens were evaluated for possible off-site laboratory or sampling-related contamination. This evaluation did not include validation according to USEPA guidelines. Sample results reported and discussed in this 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 by the USEPA to be common laboratory contaminants. Examples of these contaminants include the VOCs acetone, methylene chloride, and the phthalate semivolatile organic compounds (SVOCs). Likewise, action levels for other analytes using the 5X rule application were not established. Analytes that would have been below these action levels were not removed from the data as they would have been 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 the detection and the concentrations of these analytes. A summary of blank contamination is presented in Subsection 7.1.2 of this report. Some analytes are interpreted to represent non-site related contamination in the contamination assessments presented in Section 7.0.

3.3 CHEMICAL DATA MANAGEMENT

Chemical data from the AOC were managed by HLA's Sample Tracking System and the USAEC's IRDMIS. These systems are described in the following sections.

3.3.1 Sample Tracking System

HLA employed its computerized Sample Management System to track environmental samples from field collection to shipment to the off-site laboratory. HLA 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, time, depth (if applicable), and the collector's initials to be added at the time of collection.

After collection in the field, the samples were stored on ice for transport back to HLA's field office. Samples were temporarily stored in the HLA field office refrigerator. They were checked-in on the field office 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 off-site laboratory, HLA continued to use the sample tracking system to track and record the status of the samples, including the date analyzed (to determine actual holding times), the date a sample results transfer file was established by ESE, and the date the sample results transfer file was sent to IRDMIS (Subsection 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, HLA 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, ESE created chemical files using data codes provided by HLA, 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 HLA (Level 2). HLA 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 this AOC 57 RI report and human health risk assessment.

4.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) IDENTIFICATION

CERCLA was enacted by Congress in 1980, establishing the Superfund program. The regulations implementing this program are found in 40 CFR Part 300, also known as the National Contingency Plan (NCP). CERCLA was amended in 1986 by SARA, which mandated that the level or standard of control specified in a remedial action be "at least that of any ARAR standard, requirement, criteria, or limitation under any federal environmental law, or any more stringent standard, requirement, criteria or limitation promulgated pursuant to a state environmental statute." SARA also established that the requirements of the NCP apply to federal facilities.

The purpose of the RI was to determine the nature and distribution of site-related soil and groundwater contamination at AOC 57 Areas 2 and 3. In order to evaluate whether there is a potential threat to human health and the environment, preliminary ARARs are identified in this section and will then be compared to site-specific data. ARARs are federal and state human health and environmental requirements used to (1) evaluate the distribution of site impacts and the appropriate extent of site cleanup; (2) define and formulate remedial action alternatives; and (3) govern implementation and operation of the final remedy.

Identification and evaluation of ARARs is an iterative task, necessary throughout the remedial response process. Therefore, the preliminary lists of requirements identified for AOC 57 Areas 2 and 3 and their relevance may change as more information is obtained, as the preferred alternative is chosen, and as the design and approach to remediation becomes more refined.

Applicable Requirements - Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance that have jurisdiction at a site. An example of an applicable requirement is the use of the Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) drinking water standards for a site where hazardous substances have caused water in a public water supply distribution system to become contaminated.

Relevant and Appropriate Requirements - Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the particular site. For example, MCLs for drinking water would be relevant and appropriate requirements at a site where hazardous substances are found in or could enter drinking water classified as a current or future drinking water source. When a requirement is found to be relevant and appropriate, it is complied with to the same degree as if it were applicable.

To be Considered (TBC) Material. Non-promulgated advisories or guidance issued by the federal and state government are not legally binding and do not have the status of potential ARARs. However, in many circumstances, TBCs will be considered along with ARARs as part of the site risk assessment, and may be used in determining the level of cleanup for protection of human health or the environment.

ARARs that pertain to the remedial response can be classified into three categories: chemical-, location-, and action-specific. The following subsections provide an overview of these ARARs.

4.1 CHEMICAL-SPECIFIC ARARS

Because of their site-specific nature, the identification of ARARs requires an evaluation of the federal, state, and local environmental regulations with respect to chemicals of concern and site characteristics. Chemical-specific ARARs generally involve health- or risk-based numerical values or methodologies that establish site-specific acceptable chemical concentrations or amounts. These values are used to develop action levels or cleanup concentrations.

4.1.1 Groundwater

Table 4-1 sets forth the federal chemical-specific ARARs and TBC information for groundwater. USEPA SDWA MCLs are legally applicable to contaminants found in public water systems that have at least 15 service connections or serve an average of at least 25 people daily at least 60 days per year. Even when not legally applicable, MCLs may be relevant and appropriate to groundwater remediation. Maximum contaminant level goals (MCLGs) are non-enforceable, health-based goals at which no known or anticipated adverse effects on health will occur and are considered TBCs. Table 4-1 also includes the current version of USEPA Region III risk-based concentrations (RBCs) which are commonly used as TBC information at CERCLA sites. The surface water criteria set forth in Table 4-1 are TBC information and will only be applicable if a discharge to surface water will be part of the groundwater remedial action.

Table 4-2 sets forth the state chemical-specific ARARs and TBC information for groundwater. The Commonwealth of Massachusetts has developed drinking water standard and guidelines, expressed in terms of maximum levels of contaminants allowed in drinking water. Groundwater data from AOC 57 will be applied to Massachusetts Maximum Contaminant Levels (MMCLs), Massachusetts Class I groundwater quality standards, and/or USEPA Region III RBCs for tap water.

4.1.2 Soil

Table 4-3 sets forth the soil screening levels (TBCs) from the current USEPA Region III RBC documents.

4.1.3 Massachusetts Contingency Plan

The NCP provides that CERCLA response actions must comply with environmental and public health laws and regulations to the extent they are substantive (i.e., pertain directly to actions or conditions in the environment), but do not need to comply with those that are administrative (i.e., mechanisms that facilitate the implementation of the substantive requirements).

The provisions of the MCP, 310 CMR 40.0000 (January 13, 1995) are mostly administrative in nature and, therefore do not have to be complied with in connection with the response actions selected for AOC 57 Areas 2 and 3. Further, the MCP contains a specific provision (310 CMR 40.0111) for deferring application of the MCP at CERCLA sites. As stated in the MCP, response actions at CERCLA sites are deemed adequately regulated for purposes of compliance with the MCP, provided the MADEP concurs in the CERCLA Record of Decision (ROD).

However, some provisions of the MCP contain substantive requirements that may be ARARs. Section 310 CMR 40.0940 sets forth three methods of risk characterization. Section 310 CMR 40.0942 provides that any of the three methods may be used, subject to certain specified limitations. MCP Method 1 establishes specific numerical standards for certain listed contaminants (see 310 CMR 40.0974.-0975). Since MCP Method 1 contains promulgated numerical standards, it may be an ARAR if this method is selected.

MCP Method 3 does not contain substantive numerical standards; rather it provides a risk characterization methodology to determine the appropriate cleanup level (see 310 CMR 40.0991.-0996). Because MCP Method 3 is a methodology and does not contain substantive standards, and because it defines protectiveness in a way which is inconsistent with the CERCLA NCP, Method 3 is not an ARAR which has to be met. Therefore, these standards of the MCP do not apply to the remedial response at AOC 57.

4.2 LOCATION-SPECIFIC ARARS

Location-specific ARARs represent restrictions placed on the concentration of hazardous substances or the conduct of activities because of the location or characteristics of a site. These ARARs set restrictions relative to special locations such as wetlands, floodplains, sensitive ecosystems, as well as historic or archeological sites, and provide a basis for assessing existing site conditions. Table 4-4 lists location-specific federal and state requirements.

Some of the location-specific ARARs for areas such as wetlands and floodplains may or may not be applicable, or relevant and appropriate, depending on the remedial action selected because the regulations do not apply unless some activity is conducted in a certain defined area.

4.3 ACTION-SPECIFIC ARARS

Action-specific ARARs involve design, implementation, and performance requirements that are generally technology- or activity-based. Action-specific ARARs, unlike location- and chemical-specific ARARs, are usually technology- or activity-based limitations that direct how remedial actions are conducted. After remedial alternatives are developed, the evaluation of action-specific ARARs is one criterion for assessing the feasibility and effectiveness of compliance with proposed remedial alternatives. The applicability of this set of requirements is directly related to the particular remedial activities selected for the site. Table 4-5 represents an overview of potential action-specific ARARs that may or may not ultimately be applicable to AOC 57.

4.4 BACKGROUND CONCENTRATIONS

As a means to evaluate concentrations of inorganic analytes detected in samples collected as part of each phase of investigation, background concentrations 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 Devens installation, selected as representative of background (non-contaminated) conditions. Although 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 representative of actual background concentrations at 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 Devens specifically to establish background concentrations of inorganic analytes in soil. The background soil samples were collected from locations that were visually undisturbed, at least 50 feet from any road, and 300 feet from any known SA.

The calculations were performed on 22 of the 23 PAL inorganic analytes (no data was available for thallium). For analytes that were not detected in the majority of soil samples, the detection limit for that analyte was selected as the background concentration. Sample location, data ranges, mean values, details of calculations, and calculated background concentrations are summarized in Appendix L.

For groundwater, HLA selected 10 representative groundwater samples collected from the Round One groundwater sampling events, completed in 1992, for Groups 2, 3, 5, 6 and 7 for the purpose of calculating background inorganic analyte concentrations in groundwater.

Representative groundwater samples were selected from specific monitoring wells located upgradient of a SA, exhibiting low TSS and/or low aluminum concentrations. Aware that elevated TSS concentrations artificially elevate inorganic analyte concentrations, HLA selected samples that exhibited TSS concentrations on the same order of magnitude as the South Post Water Point (Well D-1). 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, data ranges, mean values, and details of the calculations are also provided in Appendix L.

5.0 AOC 57 REMEDIAL INVESTIGATION

5.1 BACKGROUND AND CONDITIONS

AOC 57 consists of three areas, Area 1, Area 2, and Area 3 located south of Barnum Road, on the Main Post south of Building 3713 (Figures 5-1 and 5-2). A storm drain outfall which collects rainfall from the paved areas around Building 3713 has been designated Area 1 (Figure 5-3). The runoff from the storm drain flows to the outfall at Area 1, and eventually into Cold Spring Brook.

Area 2 is located 800 feet northeast of Area 1, and adjacent to a vehicle storage yard associated with the former motor repair shops located in Buildings 3757 and 3758. The nearby Building 3756 served as a mess hall and was later converted to a general storehouse. This area formerly consisted of an eroded drainage ditch created by periodic rain runoff. The area has been recently regraded and a permanent drainage swale has been installed. Runoff drains into the swale and discharges east to Cold Spring Brook.

On February 13, 1977, Fort Devens personnel at Building 3713 noticed No. 4 fuel oil flowing from an overfilled UST into a nearby storm drain (Biang et al., 1992; DFAE, 1977). An estimated 50 to 100 gallons of oil entered Cold Spring Brook through the Area 1 outfall. Containment dikes and absorbent booms were set up across Cold Spring Brook adjacent to Area 2, and approximately 3,000 gallons of mixed oil and water were recovered from the swamp (DFAE, 1977).

A portion of this spill reportedly flowed across Barnum Road to Area 2. However, topographic relief in the spill area and Area 2 is such that the oil could not have flowed overland to Cold Spring Brook.

Area 3 is located approximately 600 feet northeast of Area 2 on a strip of land between former fenced in motor pools to the north and the forested Cold Spring Brook floodplain to the south. This area was the site of past disposal of vehicle and maintenance related wastes.

5.2 SUMMARY OF PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS

The following subsections summarize previous investigations and removal actions performed by Devens contractors at AOC 57. The text discussion of previous investigation is provided chronologically. A brief summary of analytical data is presented to demonstrate the need for subsequent investigations at the site. A complete assessment of the analytical data is presented in Section 7.0 of the RI Report. The scope of each investigations' activities is summarized in Table 5-1.

5.2.1 1992 Site Investigations

HLA conducted an SI at Areas 1 and 2 of AOC 57, then SA 57, in September 1992. The objective of the SI was to determine the presence or absence of environmental contaminants in the different environmental media at AOC 57 as a result of the February 1977 fuel oil spill. A detailed description of the results of the SI are presented in the Revised Final Groups 2, 7, and Historic Gas Station SI Report (ABB-ES, 1995b).

Samples of surface soil, surface water, and sediment were collected from Areas 1 and 2 during the SI. Polycyclic aromatic hydrocarbons (PAHs) and TPHC possibly associated with fuel oil were detected in surface soils at Area 1 (57S-92-01X through 57S-92-03) (Figure 5-4). However, the Preliminary Risk Evaluation (PRE), which was conducted to evaluate potential exposure to detected PAH compounds and TPHC, indicated that there was no unacceptable risk for the presumed commercial/industrial site reuse. The Army recommended that Area 1 be further investigated as part of the installation-wide AREE 70 storm sewer study.

At Area 2, naphthalene and TPHC were detected in surface soils during the SI (57S-92-06X through 57S-92-08X) (Figure 5-4). Fingerprint analysis of soil from Area 2 indicated that contaminated soil was most likely derived from lubricating oil, possibly from the release of vehicle crank case oil. Given this finding, the contaminants found at Area 2 are not likely related to the 1977 release of No. 4 fuel oil. Results of the human health and ecological PREs indicated that the chemical hazards at Area 2 were not significant. However, the PREs were performed prior to promulgation of applicable MCP standards. Area 2 surface soil data is presented in Table 5-2.

Surface water and sediment samples were collected during the SA 57 SI (57D-92-01X and 57D-92-02X) as well as during the Group 3 SI (G3D-92-01X through G3D-92-03X) conducted in June of 1992. Analyses of these samples showed similar levels of VOCs, SVOCs, TPHC, and various inorganics in both the upstream and downstream samples. Based on these data it was concluded that SA 57 may have impacted sediment quality in Cold Spring Brook. However, analytical results showed that additional contamination was entering Cold Spring Brook from a source further south (upstream). This was further investigated during the AREE 70 investigation and the Lower Cold Spring Brook SI. Surface water and sediment data from the previous investigations are provided in Appendix E.

5.2.2 AREE 70 Investigation

The AREE 70 investigation (ADL, 1994a) gathered information on 55 storm drain systems and three surface water bodies, and identified potential sources of contamination that were not identified through previous investigations. Included in the AREE 70 evaluation was Storm Drain System 6 (AOC 57 Area 1). Three sediment and two water samples were collected at three locations within the drainage ditch (SSD/SSW-93-06A, SSD/SSW-94-06B, and SSD-94-06C). Of these samples only SSD/SSW-93-06B is located within AOC 57 (Figure 5-4). Analyses of the surface water and sediment samples indicated elevated levels of arsenic, chromium, and lead in sediment and arsenic and lead in water. Seventeen SVOCs were reported in SSD-93-06B. This sample also had the highest concentration of total SVOCs at approximately 59.8 µg/g. Results of the sampling were incorporated into the Lower Cold Spring Brook Study ecological PRE (see Subsection 5.2.4). AREE 70 surface water and sediment analytical data are provided in Appendix E.

5.2.3 Area 2 Soil Removal Activities

The PREs performed in conjunction with the 1992 Groups 2 and 7 SI indicated that chemical hazards at Areas 1 and 2 were not significant. However, the PREs were performed just prior to promulgation of MCP soil standards. In consideration of the new standards, the Army proposed that a limited soil removal (focused on TPHC) be conducted at Area 2.

In October of 1993 eight additional surface soil samples (57S-93-10X through 57S-93-17X) were collected from the drainage ditch area and screened for TPHC to aid in determining the extent of contamination requiring removal (Figure 5-4).

A removal action performed by OHM began on August 26, 1994 and continued until September 12, 1994. Soil was excavated using standard excavating equipment. Soil samples were collected for field analysis of TPHC as each area was excavated. TPHC was detected in these samples up to a maximum concentration of 74,208 mg/kg (Tables 5-4 and 5-5). Black, oily soil was detected at approximately 18 inches below ground surface (bgs) at the base of the slope.

Continued excavation efforts revealed stained soil laterally and at depths in excess of original estimates. A trench was excavated to the water table in the southern-most portion of Area 2 to define the extent of contamination (Figures 5-4 and 5-5). An oily sheen was observed on water in the trench.

The trench was not successful in determining the limits of contamination, so test pits were subsequently excavated outside the previously excavated area. Locations of the test pits are identified in Figure 5-4 and 5-5. Soils collected from the test pits were field-screened to determine the extent of TPHC-contaminated soil. Soon after starting the test pit excavation, it became clear that contamination extended well beyond the limits originally estimated, and the removal action was suspended until Area 2 could be better characterized. A total of approximately 1,300 cubic yards of soil was ultimately excavated from Area 2, before it was lined with 6-mil polyethylene, backfilled with clean soil, and covered with an erosion control blanket. A drainage swale was constructed and lined with 6-inch riprap to channel surface water runoff to the Cold Spring Brook wetland. Subsequently, SA 57 Area 2 was administratively transferred to the RI/FS process and redesignated AOC 57.

5.2.4 Lower Cold Spring Brook Study

In 1994, HLA conducted an SI at Lower Cold Spring Brook to evaluate surface water and sediment quality. Samples were collected from 23 locations in Lower Cold Spring Brook and 11 locations in storm drain ditches and swales. A portion of the SI surface water and sediment samples were collected from Cold Spring Brook at locations both upstream and downstream of AOC 57 Areas 1, 2, and 3 (Figure 5-6). Analytical data from these samples are presented in Appendix E. The findings of this SI were presented in the "Lower Cold Spring Brook SI Report" (ABB-ES, 1995c).

The SI produced no evidence that analytes in surface water pose risks to aquatic receptors. Furthermore, no ecological risks were identified from exposure to contaminated media in several of the storm drain systems including system No. 6 (AOC 57 Area 1). No further study was recommended for Area 1.

Analytical results from the brook in the vicinity of Area 2 indicated that the marsh located upstream of the 1977 containment dike contained sediments with elevated concentrations of VOCs, SVOCs, pesticides, PCBs, and inorganics. TPHC was detected at a maximum concentration of 2,700 mg/kg. SVOCs were detected at concentrations that marginally exceeded screening values, while pesticides, PCBs, and inorganics significantly exceeded screening values. Lead was detected in surface water at a concentration above the Ambient Water Quality Criteria (AWQC). Pesticides and the maximum concentrations of inorganics in sediment were found in the sample from location CSD-94-20X, adjacent to AOC 57 Area 2. The ecological PRE showed no risks to aquatic receptors from surface waters. However, limited ecological risks may be associated with AOC 57 marsh sediments. Relative to the control area, this station contained the poorest habitat. However, macroinvertebrate and aquatic toxicity results did not indicate any increased mortality relative to aquatic receptors.

As a result, it was recommended that Lower Cold Spring Brook in the vicinity of AOC 57 Area 2 be further evaluated during the RI.

5.2.5 Area 1 Contaminated Soil Removal

Although the Lower Cold Spring Brook PRE for Area 1 showed that there were no identifiable ecological risks, it was decided to perform a contaminated soil removal at the outfall to address soil contamination resulting from releases of petroleum oil.

Excavation of outfall soils commenced in February of 1997. Initial removal operations included excavation of a 15-foot by 15-foot area to a maximum depth of 2 feet bgs at the outfall location. Following the initial excavation, four composite samples were collected for on-site TPHC screening. TPHC values in these composite samples ranged between 66 and 271 ppm. Six confirmatory samples (AOC-57, A1-SW1, SW2, SW3, SW4, FL1, DUP) were also collected and submitted for off-site analyses for EPH/VPH and inorganics to verify the on-site screening (Figure 5-7 and Table 5-6).

The EPH $C_{10} - C_{22}$ aromatic fraction in excess of MCP S-1/GW-1 standards was detected in sidewall samples. Based upon these data, an additional three feet of soil was excavated from the sidewalls perpendicular to the outfall pipes and approximately seven feet was excavated from the wall opposite the outfall pipes. The maximum depth of excavation was three feet bgs. Following the second phase of excavation, an additional three confirmatory samples were collected from the sidewalls (AOC 57-A1-SW1/B, SW2/B and SW4/B) (Figure 5-7 and Table 5-6). Confirmatory analytical results for the second round of sampling indicated elevated PAH concentrations in sidewalls AOC 57-A1-SW1/B and SW4/B. A total of 10 PAH contaminants exceeded the applicable MCP S-1/GW-1 standards with the highest concentrations located downstream of the outfall pipes.

A statistical comparison of the arithmetic mean concentration of the PAHs indicated that the types and concentrations of PAHs in sediments at the Area 1 outfall are consistent with concentrations at various outfalls along Cold Spring Brook (Weston, 1998). This analytical data strongly indicates that fuel oil related contamination at the outfall was successfully removed, and what remains in soil and sediment at the outfall are PAHs that are likely related to runoff from paved, trafficked areas along Barnum Road. This type of PAH contamination, which cannot feasibly be eliminated from runoff from asphalt paved areas, is specifically exempted from MCP requirements due to its relative ubiquity at these types of outfalls.

5.3 REMEDIAL INVESTIGATION PROGRAM OBJECTIVES

Based upon the conclusion and recommendations of the previous investigations an RI was planned and performed at AOC 57 Area 2 in 1995. During the 1995 RI field work additional explorations were conducted at a location approximately 600 feet northeast of Area 2 based upon potential soil staining observed in historical photographs. The explorations showed that this was the site of historical disposal of vehicle maintenance waste. The site was designated AOC 57 Area 3 and became the subject of the 1996 field investigation.

The Draft RI Report was issued following the 1996 field investigation. As a result of regulatory comments additional sampling was performed in 1998 at Areas 2 and 3. The purpose of the 1998 supplemental sampling was to further delineate the downgradient extent of contamination.

As a result of the data obtained from the 1998 field investigation, a contaminated soil removal was performed in 1999 at Area 3.

5.3.1 Technical Objectives

The following subsections present the technical objectives of the sampling and analysis programs completed for the RI at AOC 57. The RI included the following activities:

5.3.1.1 Background Historical Research. As a means to further understand and better characterize the contaminant release scenarios at AOC 57, HLA researched historical site use, past and present waste disposal practices, nearby in-use and abandoned underground storage tanks, and other potential sources of contaminants. The results of this research effort were used to guide the selection of sampling locations and laboratory analyses. Information gathered under this research activity on current and future uses of the site were incorporated into the assessment of human health and environmental risk included in Section 9.0 of this report.

5.3.1.2 Geophysical Survey. After conducting the historical research and prior to exploratory work, a geophysical survey was conducted at AOC 57/Area 2 and Area 3 to rapidly gather AOC-wide, non-intrusive data on subsurface features. The survey focused on identifying the location of potential subsurface utilities such as underground storage tanks and pipelines, as well as buried materials that may have contributed to the release of contaminants. The geophysical survey results also provided information on subsurface geology which aided in the placement of test pits, soil borings and monitoring wells.

5.3.1.3 Test Pits. Because of the inherent complexity in the distribution of contaminants as observed during the 1992 SI and subsequent removal action, a test pitting program was conducted to better define the boundaries of contaminant migration and characterize the vertical distribution of contaminants within the overburden. Using the test pits excavated during the soil removal action as a basis, test pits were located inside and outside the presumed limits of contamination for the purpose of evaluating potential contaminant sources and migration pathways, as well as estimating volumes of contaminated soil. Soil samples were collected from each test pit and analyzed for various chemical parameters to characterize the concentration and distribution of individual compounds. Test pits were also used to define the contaminant source area at Area 3.

The results of the test pitting program were used with other RI data to assess risk to potential receptors, to establish clean-up goals, and to evaluate remedial action alternatives.

5.3.1.4 TerraProbe^{SM} Borings. Soil and groundwater samples were collected from TerraProbe^{SM} points to further define the lateral and vertical distribution of contamination in Area 3. Field analytical data obtained from the TerraProbe^{SM} samples were used to aid in placement of soil borings and monitoring wells

5.3.1.5 Soil Borings, Surficial and Subsurface Soil Sampling. Soil borings were advanced at Areas 2 and 3 to allow the collection of additional subsurface soil samples for chemical analysis. Borings were drilled in the area of critical interest based on the test pit excavation findings to further define the limits of contaminant migration. The results were used to support both the contamination assessment and the human health and ecological risk assessments.

5.3.1.6 Groundwater Monitoring Wells and Piezometers. Evidence collected during the suspended 1994 soil removal effort at AOC 57/Area 2 revealed free phase product in soil at the water table suggesting the possibility of groundwater contamination in the form of dissolved and free-phase contaminants. Little information on local groundwater flow and contamination was available. Characterizing the nature of potential groundwater flow and contamination in the area around AOC 57/Areas 2 and 3 was of critical importance to defining potential receptors. The installation of groundwater monitoring wells and piezometers at AOC 57/Areas 2 and 3 provided information on the distribution of contaminants and characterization of aquifer hydraulic properties.

Wells were installed in locations selected to provide representative samples from upgradient and downgradient groundwater. Piezometers were located to evaluate the hydraulic dynamics between groundwater and Cold Spring Brook as part of the assessment of potential downgradient receptors. Soil samples collected during the installation of these monitoring wells and piezometers were used to characterize soil stratigraphy, also useful in developing remedial alternatives.

5.3.1.7 Sediment and Surface Water Sampling. In order to characterize the potential for contaminant migration to Cold Spring Brook, sediment and surface water samples were collected from wetland areas near AOC 57/Area 2 and 3 and in Cold Spring Brook. Whole sediment samples were also collected for toxicity testing.

The results of the sediment and surface water sampling program were used with other RI data to delineate the extent of contamination and to assess risk to potential receptors and establish clean up goals.

5.3.1.8 Sample Analysis. Petroleum hydrocarbons appear to be the predominant contaminants present in soil and sediment collected at AOC 57. Elevated concentrations of VOCs, PCBs, lead, and arsenic possibly associated with the petroleum hydrocarbons, have also been detected. Soil, groundwater, surface water, and sediment samples collected from selected locations within test pits, soil borings, monitoring wells, and Cold Spring Brook were analyzed for these and other analytes. Chemical analyses performed during the RI included various field screening techniques designed to provide a preliminary evaluation of contaminant distribution. Sample analysis also included off-site laboratory analysis designed to provide a higher level of accuracy in evaluating contaminant distribution, as input to the human health and ecological risk assessments, and remedial alternatives development. The field and off-site laboratory analytical program enhanced and built upon efforts begun under previous investigations at these sites.

Toxicity testing was also conducted on selected whole sediment samples collected from the wetland adjacent to AOC 57/Area 2. The test results are used to evaluate adverse effects associated with exposure of selected freshwater invertebrate species to whole sediment. These results will be used to supplement the chemical data used in the ecological risk assessment.

5.3.1.9 Ecological Survey and Wetlands Investigation. A qualitative ecological survey was conducted to identify potential ecological receptors and exposure pathways in Cold Spring Brook and its floodplain at AOC 57 Areas 1, 2, and 3. Information from the qualitative survey was incorporated into the baseline ecological risk assessment. The results of the survey provide information necessary for evaluating and developing cost estimates for remedial alternatives.

5.3.1.10 Baseline Risk Assessment. A baseline risk assessment, in accordance with USEPA risk assessment guidelines, was conducted for AOC 57/Areas 1, 2, and 3 to evaluate both actual and potential human health and ecological risks associated with soil, groundwater, surface water, and sediment contamination. The components of the two risk assessments include the following: data summarization and selection of chemicals of potential concern (CPCs); hazard assessment; ecological characterization; exposure assessments; ecological effects assessment; toxicity assessment; risk characterizations; comparison of analytical data to health standards and guidelines; and qualitative uncertainty analyses. The risk assessments are presented in Section 9.0 of this report.

5.3.1.11 Remedial Alternatives Development/Screening. A range of remedial alternatives are developed in the FS by assembling combinations of technologies to address the response objectives. The range of alternatives include no action, actions that reduce contaminant migration or minimize exposure, and treatment alternatives that address the principal threats and eliminate or minimize the need for long-term management. These alternatives will then be screened using effectiveness, implementability, and cost criteria to limit the number of alternatives to be evaluated in detail, while still preserving the range of options.

5.3.1.12 Detailed Analysis of Alternatives. A limited number of alternatives remaining after the screening process will be evaluated based on seven of the nine CERCLA criteria in the FS. The criteria of state and community acceptance will be evaluated upon receipt of state and public comments. Each alternative is evaluated individually, and then the alternatives are compared against each other to provide decision-makers with information that will assist them in selecting the best alternative for remediation of the site.

5.3.2 Data Quality Objectives

The procedures of the Quality Assurance (QA) Objectives presented in Section 3.0 of Volume I of the Fort Devens POP (ABB-ES, 1995b) were followed during the RI/FS field programs at AOC 57/Areas 2 and 3. This subsection describes a general scope of work, data quality objectives (DQOs) and the QA/QC approach.

Analyses were conducted on samples collected from AOC 57/Areas 2 and 3 to evaluate the nature and distribution of the contaminants detected during previous investigations. On-site field analysis conform with the guidelines presented in Subsection 4.6 of Volume I of the

Fort Devens POP. Off-site laboratory analytical procedures are presented in Section 3.0 and Appendix D of this report and Section 7.0 of Volume I of the POP. The Laboratory QA Plan and the USAEC Performance Demonstrated Analytical Methods procedures are presented in Appendices B and C, respectively, in Volume II of the Fort Devens POP (ABB-ES, 1995b).

The USEPA in 1993 identified two general levels of analytical data quality (USEPA, 1993), to replace the five previously described data quality levels (USEPA, 1987). One of the levels, Screening with Definitive Confirmation, generally comprises field screening and analysis, and encompasses former USEPA 1987 DQO Levels I and II. Activities conducted under the AOC 57 RI which fall into this category include basic field measurements for pH, conductivity, temperature, dissolved oxygen, turbidity, and PID measurements, as well as any on-site analyses. The other general level of data quality, Definitive Data, generally comprises off-site laboratory analysis using CLP RAS or other published USEPA methods, and includes former USEPA 1987 DQO Levels III, IV, and V. Laboratory methods which have been performance-demonstrated under procedures outlined in the USATHAMA QA Plan (USATHAMA, 1990) fall into this level. This level includes off-site water quality parameter and other parameters where USAEC guidelines are not applicable, and off-site laboratory analyses for PAL organics and inorganics.

With the exception of the 1999 Area 3 source area soil removal, data collected during the RI/FS process (both chemical and geotechnical data) was entered and stored in USAEC's IRDMIS. The subcontract analytical laboratory entered all off-site laboratory chemical data as USAEC Level II data, and HLA was responsible for all geotechnical data. The USAEC was responsible for reviewing and qualifying the USAEC Level II data submitted by the subcontract laboratory, and elevating the chemical data to USAEC Level III data. At that point the chemical data is at it's highest data quality and is then available for use in the IRDMIS. USAEC Level III and appropriate USEPA methods data were used in the RI/FS Report.

DQOs were established to support the level of detail required for RI activities. Data generated during the field and laboratory tasks were used to characterize AOC 57 conditions and to perform baseline risk assessments.

DQOs and QC for field measurements and 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 are discussed in Section 3.0 of this report. They focus on the use of laboratory control spikes in associated data lots to measure the performance of the off-site laboratory in the use of USAEC methods. Many of the USAEC methods are identical to standard USEPA methods. The certification process, required by laboratories performing USAEC work, is discussed in Subsection 3.2.1. The data review and evaluation process are described in Subsection 3.2.6.

Laboratory data were 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 QC blanks such as field blanks, trip blanks and equipment rinsates, and through the evaluation of laboratory blanks such as method blanks. The specific purpose of collecting each of these is discussed in Subsection 3.2.5 of this report. 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 Subsection 3.2.5. MS/MSD samples and duplicate samples were also analyzed to meet PARCC data quality objectives. QC sample results are presented in Appendix D. Interpretations on the quality and usability of data are presented in Subsection 7.1.

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 RPD of MS/MSD sample pairs and field duplicate sample pairs. Accuracy measurements identify the performance of a measurement system based on tests with known values. The laboratory, sampling, and media effects on accuracy were assessed by reviewing the percent recoveries of spiked analytes for MS/MSDs, laboratory control samples, and surrogate compounds. Evaluations of the precision and accuracy of the data are found in Appendix D and Subsection 7.1.3.

Representativeness refers to the extent to which a measurement accurately and precisely represents a given population within the accepted variation of 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 QC sample data. By evaluating method blank and field QC samples, potential false positive results were identified. Representativeness was also measured by evaluating field duplicate pair precision. Evaluations of data representativeness are presented in Appendix D and Subsection 7.1.2.

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. Analytical results are considered usable unless otherwise stated in Subsection 7.1.

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.

5.4 SUMMARY OF 1995, 1996, AND 1998 REMEDIAL INVESTIGATION PROGRAMS

RI field investigations were initiated at AOC 57 Area 2 in August of 1995 and continued into November of 1995. In addition to the 23 test pits excavated within Area 2, four test pits were excavated to the east of AOC 57 Area 2. The test pitting was performed based upon apparent soil staining evidenced in historical photographs. Sample analysis results from the four test pits warranted further investigation based upon TPHC and chlorinated VOC concentrations. The area east of AOC 57 Area 2 was designated AOC 57 Area 3 and additional field investigation was performed in August and September of 1996. In an effort to address regulatory concerns, and to better delineate the extent of contamination, additional sampling was performed at Areas 2 and 3 in May of 1998. The RI techniques used at AOC 57 were conducted in conformance with the Revised Final Task Order Work Plans for AOC 57, AOC 63AX, and AOC 69W (ABB-ES, 1996a), The Final RI/FS Task Work Plan Addendum for AOC 57 (ABB-ES, 1996b), the Draft RI/FS Supplemental Work Plan for AOC 57 Areas 2 and 3 (HLA, 1998), and the Fort Devens POP (ABB-ES, 1995b). A summary of investigation activities completed during the RI is presented in Table 5-1. Locations of RI explorations are presented in Figures 5-8 and 5-9.

The RI field investigation programs for AOC 57 Areas 2 and 3 consisted of:

- geophysical survey consisting of EM-31 and magnetometer at Area 2 and EM-31 and EM-61 at Area 3;
- collection of 16 sediment and 11 surface water samples from Cold Spring Brook near Area 2, and five surface water and sediment samples from the Cold Spring Brook Flood plain at Area 3;
- excavation of 23 test pits at Area 2 (57E-95-01X through 57E -95-20X and 57E-95-25X through 57E-95-27X) and eight test pits at Area 3 (57E-95-21X through 57E-95-24X and 57E-96-28X through 57E-96-31X);
- drilling and sampling of six soil borings at Area 2 (57B-95-01X through 57B-95-06X) and six soil borings at Area 3 (57B-96-07X through 57B-96-12X);
- soil and groundwater sampling of 20 TerraProbe^{SM} points installed at Area 3 (57R-95-01X through 57R-95-06X and 57R-96-07X through 57R-96-20X);
- collection of surficial and subsurface soil samples from 10 locations at Area 2 and from six locations at Area 3;
- installation of nine monitoring wells at Area 2 (57M-95-01X, 57M-95-02X, 57M-95-04A, 57M-95-04B, 57M-95-05X, through 57M-95-07X, 57M-95-08A, and 57M-95-08B) and six monitoring wells at Area 3 (57M-95-03X and 57M-96-09X through 57M-96-13X);
- installation of three piezometers at Area 2 (57P-95-01A, 57P-95-01B and 57P-98-02X) and two piezometers at Area 3 (57P-98-03X and 57P-98-04X);
- well development of all newly installed monitoring wells;
- performance of a qualitative ecological survey and wetlands investigation of the Cold Spring Brook wetlands and floodplain;

- two rounds of groundwater sampling from nine new and two existing monitoring wells at Area 2, one round of groundwater sampling from six new and one existing monitoring well at Area 3, and one round of sampling from the piezometers at Areas 2 and 3 and monitoring well 57M-96-11X;

- field analysis of soil and groundwater samples from test pits , TerraProbe^{SM} points, and soil borings from Areas 2 and 3 using a field GC and IR;

- laboratory analysis of environmental samples;

- aquifer conductivity testing of all new monitoring wells; and

- site topographic survey and vertical and horizontal survey of explorations at Areas 2 and 3.

HLA established a project field office in Building 2012 on the former Main Post. The field office was used for equipment storage and maintenance, sample management, shipping and receiving, staff meetings, and communications. A telephone was maintained in the field office and each field crew was issued a hand-held cellular phone. An equipment decontamination pad was constructed near Building 202 also on the former Main Post. HLA and subcontractor staff were briefed about the nature of AOC 57, health and safety information, Devens traffic regulations, and key technical requirements.

HLA began implementation of the AOC 57 field program in August 1995, with equipment mobilization and GPR survey for boring clearance. The next phase of field work began in August of 1996 and the third phase in May of 1998.

The subcontractors assisting HLA in conducting the RI field program were as follows:

- D.L. Maher, Reading, MA - Drilling and monitoring well installation (1995).

- New Hampshire Boring, Londonderry, NH - Drilling and monitoring well installation (1996).

- Enpro Environmental Services, Newburyport, MA - Test pit excavation.

- ESE/QST, Gainesville, FL and Groundwater Analytical of Woods Hole, MA - Chemical analysis of environmental samples.
- Martinage Engineering Assoc., Inc., Reading, MA - Surveying of site explorations.

All field activities were conducted in accordance with the Fort Devens POP (ABB-ES, 1995b) and USAEC's Geotechnical Guidelines (USAEC, 1987). The following subsections describe the RI field activities performed at AOC 57 in 1995, 1996, and 1998.

5.4.1 Surficial Geophysical Survey

A surficial geophysical survey was performed at Area 2 in September of 1995. Magnetometer and terrain conductivity (EM-31) were performed on a 20-foot grid in an area approximately ten acres in size (Figure 5-8) in an attempt to locate subsurface source(s) of the contamination detected in soils. Geophysical anomalies were investigated with ground penetrating radar (GPR).

A second geophysical survey was performed at Area 3 in August of 1996. The Area 3 survey utilized terrain conductivity (EM-31) and EM-61 on a 10 foot grid in an area approximately 1.5 acres in size (Figure 5-9). The survey was conducted in an attempt to delineate potential subsurface source(s) of the contamination detected in soils and to locate subsurface debris. Data obtained from both of the geophysical surveys were also used to aid in placement of subsequent explorations (e.g., test pits, soil borings, and monitoring wells). Geophysical data and interpretations are provided in Appendix C.

The surficial geophysical survey procedures are outlined in Subsection 4.4.3 of Volume I of the Fort Devens POP (ABB-ES, 1995b).

5.4.2 Surface Water and Sediment Sampling

In order to characterize the impact of AOC 57 Area 2 on Cold Spring Brook, 13 sediment and eight surface water samples were collected from eight locations during the 1995 field investigation (57D-95-03X through 57D-95-10X) (Figures 5-6 and 5-8). Samples were collected from areas of deposition within Cold Spring Brook and the associated wetland. At five of the locations (57D-95-03X through 57D-95-07X) two sediment samples were collected, one from the top of the sediment layer and one from between 2 and 5 feet below the top of the sediment layer. Sediment samples were collected using either a stainless steel hand spoon, hand auger, or Ekman dredge and were analyzed for petroleum fingerprinting, PAL VOCs, PAL SVOCs, PAL inorganics, PAL pesticides/PCBs, TPHC, TOC, and grain size distribution. In addition, short-term chronic toxicity testing for *Hyallela axteca* and *Chironomus tentans* was performed on whole sediment samples collected at 57D-95-04X through 57D-95-08X and 57D-95-10X.

Surface water samples were collected by direct immersion of the sample container at each of the sampling locations (57W-95-03X through 57W-95-10X). Off-site analysis of the surface water samples consisted of select PAL VOCs, PAL SVOCs, PAL total inorganics, PAL dissolved inorganics, PAL pesticides/PCBs, PAL water quality parameters, and TPHC. Samples for dissolved inorganic analysis were collected using a peristaltic pump and 0.4 micron filter. HLA sampling personnel also measured and recorded water depth, temperature, specific conductivity, pH, turbidity, and dissolved oxygen at the sampling location at time of collection.

In May of 1998 an additional three surface water and sediment samples were collected from Area 2 (57D/W-98-01X, 57D/W-98-02X, and 57D/W-98-03X) (Figure 5-8) and five surface water and sediment samples were collected from Area 3 (57D/W-98-04X, 57D/W-98-05X, 57D/W-98-06X, 57D/W-98-07X, and 57D/W-98-08X) (Figure 5-9). The samples were collected in order to help define the downgradient distribution of contaminants, assess the potential for contaminants discharging to the wetland and floodplain, and to provide data to support the human health and ecological risk assessments. Locations were selected based upon regulatory input during the site walkover and using field analytical data obtained from soil sampling. An effort was made to place sediment samples downgradient of areas with the highest levels of soil contamination.

Sediment samples were collected with a stainless steel hand spoon and screened for TPHC at an on-site laboratory. All sediment samples collected in 1998 were also submitted for off-site analysis for PAL VOCs, PAL SVOCs, select PAL inorganics, PAL pesticides/PCBs, TPHC, and EPH/VPH.

Surface water samples were collected by direct immersion of the sample container. On-site screening for TPHC was performed on all surface water samples. Off-site analysis consisted of PAL VOCs, PAL SVOCs, select PAL inorganics, select PAL dissolved inorganics, PAL pesticides/PCBs, and EPH/VPH. Samples for dissolved inorganic analysis were collected using a peristaltic pump and 0.4 micron filter.

5.4.3 Test Pitting

In September of 1995, 23 test pits were installed at Area 2 (57E-95-01X through 57E-95-20X and 57E-95-25X through 57E-95-27X) (Figure 5-8) and four test pits were installed at Area 3 (57E-95-21X through 57E-95-24X) (Figure 5-9). Four additional test pits (57E-96-28X through 57E-96-31X) were installed at Area 3 in August of 1996. Track and tire mounted backhoes were used to excavate the test pits which ranged in depth from 5 to 13 ft. Between three and eight soil samples were collected from each test pit for field analytical screening. Samples collected in 1995 were field analyzed for select chlorinated VOCs, TPHC, and GRO/DRO. Samples collected in 1996 were field analyzed for select chlorinated VOCs and TPHC. Based upon 1995 field analytical results, twenty test pit soil samples were selected for off-site analysis. A confirmatory off-site analytical sample was collected from each of the four test pits installed in the fall of 1996. Off-site analysis for test pit soil samples consisted of petroleum fingerprinting, select PAL VOCs, PAL SVOCs, PAL inorganics, PAL pesticides/PCBs, TPHC, and grain size. During the test pitting, an HLA geologist described activities and observations in test pit logs that are presented in Appendix A. Test pit sampling and geologic data are summarized in Table 5-7.

5.4.4 TerraProbe^{SM} Soil and Groundwater Sampling

Twenty TerraProbe^{SM} points were completed at Area 3, 57R-95-01X through 57R-95-06X in 1995 and 57R-96-07X through 57R-96-20X in 1996 (Figure 5-9). Soil and groundwater samples were collected from the TerraProbe^{SM} points to further define the vertical and horizontal distribution of the soil and groundwater contamination detected in test pit 57E-95-24X and monitoring well 57M-95-03X (Figure 5-9). Three soil samples were collected at each point from depths ranging between 0 and 12 feet, except 57R-95-06X where only one soil sample was collected. Soil samples were analyzed in the field for BTEX, select chlorinated VOCs, and TPHC. Analysis of field chromatograms of samples collected at the beginning of the 1996 investigation indicated that soil and groundwater samples may contain dichlorobenzene and naphthalene. As a result the field GC was calibrated for these compounds and select TerraProbe^{SM} locations resampled. TerraProbe^{SM} locations were based upon geophysical survey results and contaminant distribution as determined by field analytical data.

Groundwater samples were collected from 19 of the 20 TerraProbe^{SM} points at depths ranging between 10 and 14 feet bgs and analyzed for BTEX and select chlorinated VOCs. Groundwater was sampled with a peristaltic pump from inside the probe rods. Prior to sampling, the borings were purged using the peristaltic pump. Upon recharge or the removal of two boring volumes a groundwater sample was collected. Sampling procedures are presented in Subsection 4.5.1.3 of Volume I of the Fort Devens POP (ABB-ES, 1995b). Analytical sample results are discussed in detail in Section 7.0 of this report.

5.4.5 Soil Borings and Soil Sampling

A total of 12 soil borings and 15 monitoring well borings were installed during the RI. Soil borings 57B-95-01X through 57B-95-06X and monitoring well borings 57M-95-01X, 57M-95-02X, 57M-95-04A, 57M-95-04B, 57M-95-05X, 57M-95-06X, 57M-95-07X, 57M-95-08A, and 57M-95-08B were installed at Area 2 in September and October of 1995 (Figure 5-8). Soil borings 57B-96-07X through 57B-95-12X and monitoring well borings 57M-95-03X and 57M-96-09X through 57M-96-13X were installed at Area 3 in August of 1996 (Figure 5-9).

The monitoring well borings 57M-95-01X, 57M-95-02X, 57M-95-04A, 57M-95-04B, 57M-95-05X, 57M-95-06X, 57M-95-07X, 57M-95-08A, and 57M-95-08B were drilled with 6¼-inch inside diameter (ID) hollow stem augers (HSAs). The remainder of the borings were installed with 4¼-inch ID HSAs.

Borings 57M-95-01X, 57M-95-03X, 57M-95-07X, and 57M-95-08B were sampled continuously with 3-inch outside diameter (OD) split spoons using the standard penetration test technique to characterize subsurface stratigraphy. The remainder of the borings were sampled at approximately 5-foot intervals except for 57M-96-12X which was intended to be a monitoring well boring but abandoned after 5-feet of drilling. In addition, only one soil sample was collected from monitoring well borings 57M-96-10X, 57M-96-11X, 57M-96-12X, and 57M-96-13X. Refer to Table 5-8 for reference sample and off-site analytical sample intervals. The soil samples collected from each boring were used for soil classification, field analytical samples and/or off-site laboratory analysis. Soil samples were analyzed in the field for BTEX, select chlorinated VOCs, and TPHC and at the off-site laboratory for petroleum fingerprinting, PAL VOCs, PAL SVOCs, PAL inorganics, PAL pesticides/PCBs, TPHC and grain size distribution. Groundwater samples were collected for field analysis by GC from the monitoring well borings 57M-95-01X, 57M-95-02X, 57M-95-03X, 57M-95-06X, 57M-95-07X, 57M-95-08A, 57M-95-08B, 57M-96-09X, 57M-96-10X, 57M-96-11X, 57M-96-12X, and 57M-96-13X. These samples were collected to better define the horizontal distribution of site contaminants for optimum downgradient and crossgradient monitoring well location. Soil boring and sampling procedures are presented in Subsection 4.5.1.3 of Volume I of the Fort Devens POP (ABB-ES, 1995b). Soil boring logs are presented in Appendix A and summarized in Table 5-8. Analytical sample results are discussed in Section 7.0 of this report.

In May of 1998 additional surficial and subsurface soil sampling was performed to better define downgradient contaminant distributions at Areas 2 and 3. Two soil samples, one at the ground surface and one at the water table, were collected from 10 locations at Area 2 (57S-98-01X through 57S-98-10X) (Figure 5-8) and from six locations at Area 3 (57S-98-11X through 57S-98-16X) (Figure 5-9). Samples were collected using a stainless steel hand spoon and stainless steel hand auger. All samples were screened at the on-site laboratory for TPHC. Ten samples from Area 2 and three samples from Area 3 were selected for off-site analysis based upon field observations and the results of the on-site TPHC analysis. Area 2 samples selected for off-site analysis included; 57S-98-01X at 1-foot bgs, 57S-98-02X at ground surface, 57S-98-03X at 2 feet bgs, 57S-98-04X at 1-foot bgs, 57S-98-05X at 3 feet bgs, 57S-98-06X at 1-foot bgs, 57S-98-07X at ground surface and 1-foot bgs, 57S-98-08X at ground surface, and 57S-98-09X at ground surface. Area 3 samples chosen for off-site analysis included; 57S-98-13X at 1-foot bgs, 57S-98-14X at 1-foot bgs, and 57S-98-15X at 3 feet bgs. Off-site analysis of the 1998 soil samples consisted of PAL VOCs, PAL SVOCs, select PAL metals, PAL pesticides/PCBs, TPHC, and EPH/VPH. Sampling procedures are presented in Subsections 4.5.1 and 4.5.1.1 of the Fort Devens POP (ABB-ES, 1995b). Results of the field and off-site analyses are discussed in Section 7.0 of this report.

5.4.6 Monitoring Well/Piezometer Installation

Based on the field analytical results of the test pitting and soil boring programs nine monitoring wells and two piezometers were installed at Area 2 in 1995. In 1998 an additional water table piezometer, 57P-98-02X, was installed (Figure 5-8). All of the monitoring wells were water table wells with the exception of the deeper overburden wells 57M-95-04B and 57M-95-08B. A total of six monitoring wells were installed at Area 3 in

1996; 57M-95-03X in 1995 and 57M-96-09X through 57M-96-13X in 1996. In 1998 two piezometers were installed at Area 3, 57P-98-03X and 57P-98-04X (Figure 5-9). The piezometers were screened 2 feet below the water table. All of the monitoring wells at Area 3 were water table wells.

Monitoring well construction was completed in accordance with USAEC requirements and Subsection 4.4.6.4 of Volume I of the Fort Devens POP (ABB-ES, 1995b). Monitoring well construction diagrams are provided in Appendix B and a summary of each monitoring well installation is presented in Table 5-9.

5.4.7 Monitoring Well Development

Each of the newly installed RI monitoring wells were developed using the pump and surge method, to remove any water added to the boring during drilling and/or well installation, and to remove sediment from the monitoring well screen prior to groundwater sampling and aquifer testing. Dedicated equipment was used to minimize the possibility of cross contamination occurring between wells and water was not added to the wells during development. The procedures for well development are presented in Subsection 4.4.6.5 of Volume I of the Fort Devens POP (ABB-ES, 1995b).

Monitoring well development is documented on Well Development Field Data Records presented in Appendix G.

5.4.8 Groundwater Sampling

Two rounds of groundwater samples were collected from the nine new and two existing monitoring wells at Area 2 and 57M-95-03X at Area 3. Round 1 samples were collected in October and November of 1995 and Round two samples were collected in February of 1996. The groundwater samples for these two rounds were submitted for off-site laboratory analysis consisting of PAL VOCs, SVOCs, inorganics (both filtered and unfiltered), water quality parameters, TPHC, and TSS. Groundwater sampling procedures are presented in Subsection 4.5.2.2 of Volume I of the Fort Devens POP (ABB-ES, 1995b). One round of groundwater sampling, designated Round 3, was performed at Area 3. Area 3 monitoring wells were sampled in September and October of 1996 following USEPA Region I low-flow sampling protocols as described in "Low Flow (minimum stress) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells:

SOP # GW 0001" (USEPA, 1996). An additional round of groundwater samples was collected in 1998 from the Area 2 piezometer 57P-98-02X, the Area 3 piezometers 57P-98-03X and 57P-98-04X, and the monitoring well 57M-96-11X. The groundwater samples were screened for TPHC at the on-site laboratory and submitted for off-site analysis for PAL VOCs, PAL SVOCs, dissolved select PAL metals (As, Se, Sb, Ba, Cu, Pb, Mn, and Zn), total select PAL metals, PAL pesticides/PCBs, and EPH/VPH. These samples were collected to better define the distribution of downgradient contamination. Field data records are presented in Appendix H, and off-site laboratory analytical results are discussed in detail in Section 7.0 of this report.

5.4.9 In-Situ Hydraulic Conductivity Testing

In-situ hydraulic conductivity tests were performed on all of the monitoring wells installed during the RI to obtain estimates of hydraulic conductivity. Appendix F presents data and analysis of the hydraulic conductivity testing. All tests were performed by rising head methodology. The rate of water level recovery back to static conditions within the well casing or screened interval was monitored using a pressure transducer and data logger. The depression of the water level within the well (for rising head tests) was accomplished with a solid, cylindrical PVC slug using the techniques discussed in Subsection 4.8.2 of Volume I of the Fort Devens POP (ABB-ES, 1995b).

The data from all in-situ hydraulic conductivity tests were analyzed using the method of Bouwer and Rice (1976) with the Aqtesolv computer program. In addition, data were analyzed by the Hvorslev (1951) method. Discussion of the results of in-situ hydraulic conductivity testing are presented in Section 6.0 of this RI report. Hydraulic conductivity data and analyses are provided in Appendix F.

5.4.10 Equipment Decontamination

Several different sampling and analytical procedures were used during the AOC 57 RI field programs, which led to a variety of decontamination procedures. Decontamination procedures were conducted in conformance with Subsection 4.3 in the Fort Devens POP (ABB-ES, 1995b). To document the effectiveness of decontamination procedures, periodic equipment rinsate blanks were collected and submitted for chemical analyses. Analytical results for the rinsate blanks are presented in Appendix D.

5.4.11 Investigation-Derived Waste

During the field programs at AOC 57 a variety of investigation-derived waste (IDW) was produced, including purge water, soil cuttings, well development water, decontamination fluids, and personnel protective equipment. The collection, handling, and disposal of IDW was conducted in conformance with Subsection 4.10 of the Fort Devens POP (ABB-ES, 1995b).

5.4.12 Location and Elevation Survey

Upon completion of the 1995 and 1996 RI field programs at AOC 57, a location and elevation survey was conducted to accurately locate the explorations, including new and existing monitoring wells, piezometers, soil borings, test pits, surface water/sediment sampling points, and TerraProbe^{SM} points. A topographic survey was also conducted at Areas 2 and 3 of AOC 57 to better define the topographic features at the site.

The surveys were conducted by Martinage Engineering, Inc. of Reading, MA. Horizontal control was established with a Leitz Sokkia II Total Station Vernier reading to one second accuracy. Vertical control was established using a Topcon Auto Level. Vertical locations were measured to within 0.01 feet and the horizontal control was measured as state planer coordinates to the nearest 0.1 feet.

Monitoring wells and piezometers were surveyed for horizontal control and vertical control of the ground surface, top of the protective casing, and the top of the PVC well riser. Soil borings, test pits, surface water/sediment points, and TerraProbe^{SM} points were surveyed for horizontal control and vertical control of the ground surface. Procedures followed during the survey task are outlined in Subsection 4.9 of Volume I of the Fort Devens POP (ABB-ES, 1995b). Appendix I presents a summary of the survey data.

Following the 1998 field program all explorations were horizontally located using a Trimble Pro-SR global positioning system. Piezometers were vertically surveyed by HLA personnel to within 0.01 feet.

5.5 1999 AREA 3 CONTAMINATED SOIL REMOVAL

A contaminated soil removal was performed at AOC 57 Area 3 in the spring of 1999. Data collected during the RI showed that a historic garage waste disposal site approximately 40 feet square by five feet in depth was acting as a source of soil and groundwater contamination. Advective transport appears to have aided in the southerly migration of soil contamination. Removal activities were conducted in accordance with the Action Memorandum for AOC 57, Area 3 (HLA, 1999).

Soil excavation was performed with an extended-reach, tracked excavator. Prior to excavation a soil berm was constructed and a silt fence was erected on the southern side of the excavation to prevent migration of contaminated soils or siltation of the Cold Spring Brook wetland. The source area removal was conducted in phases based on results of confirmatory samples collected from the excavation floor and sidewalls. Confirmatory samples were analyzed at an off-site laboratory for pesticides/PCBs and EPH/VPH. In addition, while soils were being excavated, samples were collected for PID headspace analysis to aid in directing the excavation. The extent of the excavation and location of confirmatory samples are provided in Figure 5-9.

PHASE I

The initial soil removal action was completed between March 22 and March 25, 1999. Existing landmarks including monitoring wells and historic sample locations were used as reference points to identify the boundaries of the excavation. The excavation began at the southern end of the source area (near soil boring 57B-96-07X) and moved north. The excavation reached a depth of approximately 5 feet in the southern portion and 10 feet in the north. Phase I of the source area removal action yielded approximately 1400 cubic yards of contaminated soil and debris. A total of ten confirmatory samples, eight sidewall (EX57W01X through EX57W08X) and two floor samples (EX57F01X and EX57F02X), were collected for off-site analysis.

Results of confirmatory sampling are discussed in detail in Section 7.0.

PHASE II

Phase I confirmatory sampling indicated that residual PCB contamination was present in two of the samples (EX57W03X and EX57F01X) at levels in excess of MCP S-2/GW-3 standards but below the risk based goal for subsurface soils of 4 µg/g. The PCB detections were located at the southern extent of the excavation. In response to these results a second phase of the soil removal action was conducted on April 15 and 16, 1999. The Phase II excavation was started approximately 50 feet south of the existing excavation and was extended north to the previous excavation. The width of the excavation in this area was approximately 12 feet, the same as the southern tongue of the previous excavation. In addition, the southwestern wall of the previous excavation was expanded approximately three feet to the west. The phase II excavation was approximately three feet deep in the southern end and approximately 5 feet deep at the northern end where it joined the Phase I excavation.

A total of six confirmatory samples were collected from within the excavation including five wall samples (EX57W09X through EX57W13X) and one floor sample (EX57F03X). A total of 320 cubic yards of material was removed during this phase of the soil removal action.

The results of the Phase II confirmatory samples indicated that elevated concentrations of PCBs and EPH were present on the southern wall of the excavation. Therefore, on May 26, 1999 PCB immuno-assays were used to delineate the area of residual PCB contamination. Samples were collected from eleven location using a hand auger. The sample locations were within two to six feet of the excavation and the samples were collected from one to three feet bgs. Some of the locations were sampled at multiple depths.

PHASE III

Based upon the results of the PCB screening and the Phase II confirmatory sampling, additional excavation was performed in the area extending laterally two feet around the southern tongue of the excavation. No additional material was removed from the bottom of the excavation in this area. Four confirmatory samples were collected from the sidewalls. An additional 140 cubic yards of soil was removed during the Phase II excavation.

In total, 1860 cubic yards of soil was removed during the Area 3 soil removal. The contaminated soil was stored adjacent to Barnum Road. The soil was placed on poly-sheeting, and covered with reinforced poly-sheeting. Straw bales were placed around the covered soil pile to prevent runoff to the surrounding area.

6.0 SITE HYDROLOGY, GEOLOGY AND GROUNDWATER CHARACTERIZATION

6.1 SITE HYDROLOGY

AOC 57 is located in the eastern portion of the former Main Post south of Barnum Road. The most significant hydrological feature is Cold Spring Brook, which originates in the central part of the former Main Post at Devens. Its headwaters are formed by runoff and groundwater discharge in the vicinity of the former Ammunition Storage Point and Cold Spring Brook landfill. Further downstream, it flows north through woodlands and wetlands and passes beneath the B&M Railroad right-of-way at Barnum Road. From there the brook is fed by runoff and groundwater discharge from the former Army property south of Barnum Road. It is at this point that the brook passes to the south of AOC 57 (Figures 5-1 and 5-2). The brook continues to flow northeast off Devens property where it ultimately discharges to Grove Pond. The portion of the brook that is located south and southeast of Barnum Road has been designated Lower Cold Spring Brook and was the subject of the Lower Cold Spring Brook Site Investigation (ABB-ES, 1995c).

Lower Cold Spring Brook is characterized by a four to six feet wide meandering stream channel surrounded by 20 to 60 feet of scrub and emergent cattail marsh. Downstream from AOC 57 Area 2 the stream channel becomes poorly defined and dendritic flow paths become more predominant. The 1977 earthen containment dike located immediately south of AOC 57 Area 2 is not believed to have caused ponding of the brook. Observations of flow through the southern portion of the dike indicate that flow is not significantly impeded. In addition, the emergent marshes are of equal width immediately upstream and downstream of the containment dike instead of just upstream as would be expected if ponding were occurring.

Precipitation runoff near Area 1 is primarily controlled by the storm drain No. 6 outfall. The outfall flows into an eroded drainage ditch which becomes dendritic and poorly defined before ultimately discharging to Cold Spring Brook.

Precipitation runoff in the vicinity of AOC 57 Area 2 is controlled primarily by topography and the drainage ditch that runs roughly north to south through Area 2 (Figure 6-1) eventually discharging to the Cold Spring Brook wetlands.

Area 3 precipitation runoff is primarily northwest to southeast as dictated by the topography. Runoff occurs in eroded channels that are 0.5 to 1 foot deep. Runoff discharges and infiltrates in the Cold Spring Brook flood plain and upper portion of the wetlands. There is no direct surface runoff from Area 3 to the Cold Spring Brook stream channel.

6.2 SITE GEOLOGY

This subsection presents descriptions of the geologic formations encountered at AOC 57 Areas 2 and 3. Figures 6-1 and 6-2 show the orientations of the geologic cross sections. Figures 6-3 through 6-6 present geologic cross sections A-A' through D-D', respectively. Bedrock was not encountered at AOC 57.

6.2.1 Overburden Soils

Surficial and subsurface soils at AOC 57 Areas 2 and 3 are classified by the SCS as the Hinckley-Merrimac (Freetown)-Windsor Association (see Figure 2-3). The soil is described as being deep; excessively to moderately well drained; nearly level to very steep (see Subsection 2.2.5). Boring logs are presented in Appendix A and results of grain size analysis are provided in Appendix J.

6.2.1.1 Area 2 Soils. Data from soil borings and test pits indicate that soils at Area 2 are comprised of reworked gravelly sands and silty sands overlying a discontinuous black ashy silt layer which in turn overlies native, poorly to well graded sand and silty sand.

The surficial gravelly sands and silty sands are predominately located on the flat northern portion of the site between the treeline and Barnum Road. These soils are comprised of dark brown to tan well graded to poorly graded fine to medium sand. Gravel and silt contents vary between 5 and 30 percent with generally higher silt fractions near the treeline and floodplain and increased gravel content to the north toward Barnum Road. The surficial soils vary in thickness from 0.5 to 2.0 feet. A layer of black ashy silt, sand, and gravel discontinuously underlies the surficial soil. The ashy layer was observed to be 2 to 6-inches thick in the relatively flat area between Barnum Road and the treeline. The ashy layer increases to a maximum observed thickness of 3 feet at the break in slope just inside the treeline (57E-95-06X). This layer was not observed in test pits excavated within the floodplain; however, gravel sized pieces of charcoal were found in test pits just over the break in slope (57E-95-20X). It is assumed that these two soil layers represent fill from two different periods. The ash layer may be due to disposal of spent coal from the former power plant located on the north side of Barnum Road and/or it may have served as grade material for a motor pool to service Building 3713.

The surficial layer of the Cold Spring Brook 100 year floodplain, starting at approximately the 228 foot topographic contour, is comprised of fluvial deposits of silty sand and silt ranging in observed thickness of 1 to 4 feet. Laterally discontinuous deposits of black silty organic material from 1 inch to 2 feet in thickness underlie the surficial material.

Native subsurface soils encountered at the site are comprised of yellowish brown to gray, fine to medium, loose to medium dense, poorly to well graded sand and silty sand. Rust colored staining was apparent in soil samples from several explorations (57M-95-05X, 57M-95-07X, 57M-95-08B, and 57B-95-05X).

6.2.1.2 Area 3 Soils. The northern portion of Area 3 from the motor pool fence to the break in slope inside the treeline (located between the 230 and 235 foot topographic contours) is comprised of fill material ranging in observed thickness from 1 to 6 feet bgs (Figures 6-5 and 6-6). The fill is comprised of silty sand and gravel which is poorly to well graded. Assorted debris was observed in all of the test pits excavated at Area 3. It appears that Area 3 was used as a disposal area for vehicle maintenance debris presumably generated by the Barnum Road motor pools. Surficial debris (e.g., concrete, barbed wire, cans) was observed within the wooded floodplain. Native soils at the site are comprised of fine to medium, tan to gray, poorly graded sand near the northern portion of the site (57E-95-21X through 57E-96-31X). Floodplain deposits consist of loose to medium dense, gray fine silty sands as observed in monitoring well borings 57M-96-10X through 57M-96-13X.

A dark brown to black sandy organic layer, presumably an accumulation of organic matter, eluviated from the upper horizons overlies the native gray sand. The organic layer was relatively continuous across the undisturbed portions of the site, ranging in depth from three to four feet bgs in the northern portion of the site to 1 foot bgs in the southern flood plain area.

6.2.2 Bedrock Geology

Bedrock was not encountered in any of the borings at either Area 2 or 3. The bedrock in the vicinity of AOC 57 has been classified as the Berwick Formation. The formation is described as 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). Depth to bedrock is assumed to be approximately 100 feet bgs. This is based on the known depth to bedrock of 137.5 feet bgs at the Grove Pond well triplet located in the Massachusetts National Guard property approximately 2,000 feet to the north-northeast.

6.2.3 Site Geology Interpretation Summary

Geology at both Area 2 and Area 3 is comprised of fill materials overlying native sandy soils. The fill materials above the floodplain (228-foot topographic contour) at Area 2 are comprised of reworked gravelly sand and silty sand 0.5 to 2 feet in thickness overlying a 2 to 6-inch thick discontinuous ash and coal layer. The fill layers reach a maximum observed thickness of 3 feet at the break in slope above the floodplain.

Floodplain deposits consist of 1 to 4 feet of silty sand and silt overlying black organic soils which are 1-inch to 1-foot thick and laterally discontinuous.

Fill materials at Area 3 are comprised primarily of reworked sand and silty sand, garage waste, and construction debris. The fill layer reaches a maximum observed thickness of 6 feet at test pit 57E-95-24X. Surficial debris was observed within the floodplain south of the 225 foot topographic contour. The vegetation of the floodplain area is scrub oak, maple and brush while 150 feet to the east the vegetation turns to mature pine. The change in vegetation is also coincident with the eastern extent of the surficial debris. Subsurface soil was observed to be comprised of fine to medium, tan to gray, poorly graded sand near the northern portion of the site (57E-95-21X through 57E-96-31X). Floodplain deposits consist of loose to medium dense, gray, fine silty sands as observed in monitoring well borings 57M-96-10X through 57M-96-13X. Native soils area overlain by a sandy organic layer approximately 1-foot thick.

6.3 HYDROGEOLOGY

This subsection presents data and interpretations of hydrogeologic conditions at AOC 57 Areas 2 and 3. Groundwater levels used in this subsection are provided in Table 6-1 and interpretive water table elevation contours are presented on Figures 6-7 through 6-10. Water level elevations at Area 2 were measured on December 7, 1995, March 26, 1996, July 23, 1996, January 15, 1997, June 2, 1997, and September 23, 1998. Water level elevations at Area 3 were measured on January 15, 1997, June 2, 1997, and September 23, 1998. In-situ hydraulic conductivity results are provided in Table 6-2 and Appendix F.

6.3.1 Area 2 Hydrogeology

As a result of the type of contaminants (primarily fuel related compounds) identified in groundwater at AOC 57 Area 2, the majority of the monitoring wells have been installed as water table wells (i.e., their screened interval, including sandpack, spans the water table)(see Figures 6-3, 6-4 and Table 5-8). A total of 11 monitoring wells, G3M-92-02X, G3M-92-07X, 57M-95-01X, 57M-95-02X, 57M-95-04A, 57M-95-04B, 57M-95-05X, 57M-95-06X, 57M-95-07X, 57M-95-08A, and 57M-95-08B and three piezometers 57P-95-01A, 57P-95-01B, and 57P-98-02X were installed in overburden soils. Of these, all are water table monitoring wells except for 57M-95-04B and 57M-95-08B which are screened from 18 to 28 feet below ground surface and approximately 14 feet below the water table and the piezometer 57P-95-01B which was screened from 10 to 15 feet bgs, approximately eight feet below the water table.

The water table occurs in the overburden across AOC 57 Area 2 (Figure 6-3 and 6-4). Figures 6-7 and 6-8 present interpreted water table elevation contours for Area 2 based on the January 15, 1997 and September 23, 1998 data sets, respectively. Groundwater flow is predominately north-northwest to south-southeast toward Cold Spring Brook. These flow directions are in agreement with the basewide overburden groundwater flow model (Figures 2-6 and 2-7) (ETA, 1995). Local variations in the flow scheme occur in the floodplain from the vicinity of monitoring well 57M-95-05X to the area of flooded emergent marsh west of the containment dike (Figure 6-7 and 6-8). The marsh is a local groundwater discharge area and the effects of this are seen as depressed water levels in the adjacent floodplain and a convergence of flowpaths towards the marsh. The depression adjacent to the marsh, and therefore the convergence of flowpaths, is more pronounced during low water levels. The depressed water levels also indicate that the containment dike is not causing ponding of

Cold Spring Brook.

A review of historical groundwater level data indicates that the brook and associated wetlands act as a mediating influence on water levels. A comparison of data from March of 1996 and January of 1997 shows increases in water levels of over 1 foot near Barnum Road (225.5 to 226.71 feet at G3M-92-02X and 225.33 feet to 226.32 feet at 57M-95-01X) while monitoring wells and piezometers adjacent to the wetland show increases on the order of 0.1 feet (220.65 to 220.71 at 57P-95-01A and 221.11 to 221.25 at 57M-95-04A) for the same time period.

Horizontal hydraulic gradients were calculated from each set of water level measurements. Gradients were calculated using multiple wells that, as much as possible, share a common flow path. In general, horizontal hydraulic gradients are flatter in the northern portion of the site above the break in slope and more steep near the break in slope and floodplain. Multiple wells were selected with respect to this so as to provide representative gradients. Calculations are provided in Appendix F. The geometric mean of horizontal hydraulic gradients calculated for all data sets range between 0.0095 ft/ft (December 7, 1995) and 0.013 ft/ft (July 23, 1996).

Vertical hydraulic gradients were calculated between the piezometer pair 57P-95-01A/57P-95-01B and the monitoring well pairs 57M-95-04A/57M-95-04B and 57M-95-08A/57M-95-08B (Figure 6-7 and 6-8) for each set of water level measurements. The piezometer pair yielded upward gradients ranging between 0.028 and 0.039 ft/ft. The 57M-95-04A/57M-95-04B well pair showed relatively no vertical gradient with calculated values ranging between 0.002 ft/ft upward and 0.0006 ft/ft downward. Downward vertical gradients between 0.001 and 0.019 ft/ft were measured at 57M-95-08A/57M-95-08B. The decrease in magnitude of upward vertical gradients between the piezometer pair 57P-95-01A/57P-95-01B and the monitoring well pair 57M-95-04A/57M-95-04B as well as the change to a small downward vertical gradient at 57M-95-08A/57M-95-08B is in direct correlation with their distances from the brook and wetland.

In-situ Hydraulic Conductivity Results. In-situ hydraulic conductivity test results presented in Table 6-2 indicate that estimates of hydraulic conductivity as calculated by the Bouwer and Rice method range between 1.2 x 10^{-1} cm/sec (2.4 x 10^{-1} ft/min) and 4.2 x 10^{-4} cm/sec (8.3 x 10^{-4} ft/min) at 57M-95-01X and 57M-95-08A, respectively. The geometric mean of the monitoring wells hydraulic conductivities was calculated as 1.7 x

10^{-2} cm/sec (3.3 x 10^{-2} ft/min). Estimates of hydraulic conductivity as calculated by the method of Hvorslev range between 1.3 x 10^{-2} cm/sec (2.3 x 10^{-2} ft/min) at 57M-95-01X and 4.3 x 10^{-5} cm/sec (8.4 x 10^{-5} ft/min) at 57M-95-08A. The geometric mean of the hydraulic conductivities as calculated by the Hvorslev method is 6.0 x 10^{-4} cm/sec (1.2 x 10^{-3} ft/min). The hydraulic conductivity test results are presented in Appendix F.

Groundwater Velocity Analyses. Flow velocities were estimated for AOC 57 Area 2 using maximum, minimum, and mean horizontal hydraulic gradients and hydraulic conductivities as determined by the Bouwer and Rice method (calculations are provided in Appendix F). An overburden porosity of 30 percent was assumed for the predominately sandy soils. The maximum groundwater flow velocity was estimated at 14 feet per day (ft/day) and the minimum flow velocity was calculated as 0.038 ft/day. A flow velocity of 1.56 ft/day was calculated using the geometric mean of observed hydraulic conductivity and horizontal gradients.

6.3.2 Area 3 Hydrogeology

A total of six monitoring wells, 57M-95-03X, 57M-96-09X, 57M-96-10X, 57M-96-11X, 57M-96-12X, and 57M-96-13X and two piezometers, 57P-98-03X and 57P-98-04X were installed in overburden soils. All of the groundwater monitoring points at Area 3 have been installed as water table wells (i.e., their screened interval, including sandpack, spans the water table) with the exception of the piezometers 57P-98-03X and 57P-98-04X which are screened 2 feet below the water table (see Figure 6-6 and Table 5-8).

The water table occurs in the unconsolidated overburden across AOC 57 Area 3 (Figure 6-5 and 6-6). Figures 6-9 and 6-10 present interpreted water table elevation contours for Area 3 based on the January 15, 1997 and September 23, 1998 data sets. Groundwater flow is predominately from the north-northwest to the south-southeast toward Cold Spring Brook. These flow directions are in agreement with the basewide overburden groundwater flow model (Figures 2-6 and 2-7)(ETA, 1995).

Horizontal hydraulic gradients were calculated from the January 15, 1997, June 2, 1997, and September 23, 1998 water level measurements. Gradients were calculated using multiple wells that, as much as possible, share a common flow path. In general, horizontal hydraulic gradients are flatter on the northern portion of the site above the break in slope and steeper near the break in slope and floodplain. Multiple wells were selected with respect to this so as to provide representative gradients. Calculations are provided in Appendix F. The geometric mean of calculated horizontal hydraulic gradients ranged between 0.022 ft/ft on January 15, 1997 and 0.015 ft/ft on September 23, 1998.

Deeper overburden wells were not installed at AOC 57 Area 3, but data from Area 2 suggests that groundwater discharges to Cold Spring Brook and its associated wetlands. The presence of surface water in depressions in the Area 3 floodplain further suggests that groundwater discharge is occurring.

In-situ Hydraulic Conductivity Results. In-situ hydraulic conductivity test results from Area 3 presented in Table 6-2 indicate that estimates of hydraulic conductivity as calculated by the Bouwer and Rice method range between 5.6 x 10^{-3} cm/sec (1.1 x 10^{-2} ft/min) and 6.9 x 10^{-4} cm/sec (1.4 x 10^{-4} ft/min) at 57M-95-03X and 57M-96-10X, respectively. Hydraulic conductivity estimates calculated by the Hvorslev method range between 5.3 x 10^{-4} cm/sec (1.0 x 10^{-3} ft/min) at 57M-95-03X and 2.2 x 10^{-5} cm/sec (4.4 x 10^{-4} ft/min) at 57M-96-10X. The geometric mean of the monitoring wells hydraulic conductivities was calculated as 1.8 x 10^{-3} cm/sec (3.5 x 10^{-3} ft/min) by the Bouwer and Rice Method and 6.0 x 10^{-4} cm/sec (1.2 x 10^{-3} ft/min) by the Hvorslev method. In general, hydraulic conductivities are greater in the northern portion of the site and decrease as the soils grade finer in the floodplain. The hydraulic conductivity test results are presented in Appendix F.

Groundwater Velocity Analyses. Flow velocities were estimated for AOC 57 Area 3 using maximum, minimum, and mean horizontal hydraulic gradients and hydraulic conductivities as determined by the Bouwer and Rice method (calculations are provided in Appendix F). An overburden porosity of 30 percent was assumed for the predominately sandy soils. The maximum groundwater flow velocity was estimated at 1.2 ft/day. A minimum flow velocity of 0.14 ft/day was calculated for the water table. A flow velocity of 0.34 ft/day was calculated using the geometric mean of observed hydraulic conductivity and horizontal gradients.

6.3.3 Site Hydrogeology Interpretation Summary

Groundwater at AOC 57 Areas 2 and 3 occurs in the overburden and bedrock aquifer. Bedrock aquifer characteristics were not monitored at AOC 57. Flow directions are predominately from the north-northwest to the south-southeast with local variations occurring as groundwater discharges to Cold Spring Brook. Upward vertical gradients were observed in the piezometer pair 57P-95-01A/57P-95-01B at Area 2 during each groundwater level measurement round near Cold Spring Brook. Small downward vertical gradients were measured at the monitoring well pair 57M-95-08A / 57M-95-08B which is located at a greater distance from the brook. This same scenario is believed to hold for Area 3. The moderately fast groundwater flow velocities are consistent with the type of soil (sand) observed at this AOC. Water level data at Area 2 indicates that the containment dike is not causing ponding of the water table.

7.0 NATURE AND DISTRIBUTION OF DETECTED SITE CONTAMINANTS

The following subsections address the nature and distribution of analytes detected in surface water, sediment, soil, and groundwater collected from AOC 57 during the 1995, 1996, and 1998 RI field efforts. Additional data is also included from the Area 3 source area soil removal completed during the Spring of 1999. Data obtained from the off-site laboratory and from the on-site field analytical laboratory are presented in this section.

During implementation of the RI field programs, field analytical results were used to direct placement of soil borings, test pits, and monitoring wells, and were used to define the vertical and/or horizontal distribution of contaminants. Field analytical results were also used to select samples for off-site laboratory analysis. Samples were collected from contaminated zones to gather information on the nature and concentration of contaminants as well as from clean areas for off-site confirmation. Field analytical data were used to supplement the off-site laboratory analytical data in the assessment of the nature and distribution of detected analytes.

This assessment of site-related contaminants relies upon tables and figures to present the field and off-site laboratory analytical data. The tables contain only detected analytes and concentrations for samples within a given media. The figures aid in assessing areal distribution of site contaminants. The text provides detail, interpretation, and analysis of the tabulated data. A complete report of the field and off-site analytical data is presented in Appendix M.

7.1 APPROACH TO CONTAMINATION ASSESSMENT

Off-site laboratory analytical results and field analytical data are the primary data used to assess impacts at the site from suspected past disposal and storage practices.

A summary of the analytes detected in RI samples analyzed at the off-site laboratory and during on-site field screening are presented in Tables 7-10 through 7-21. A complete data set of field and off-site analytical data, including non-detect results, is presented in Appendix M. Tentatively identified compounds (TICs) reported for off-site laboratory data are discussed in Subsection 7.1.1 and presented in Table 7-1.

Analytes detected in QC blanks analyzed at the off-site laboratory are presented in Subsection 7.1.2. A blank contamination evaluation was performed with this data to identify probable sampling and off-site laboratory-related contaminants. The contamination assessment included determining uncertainty regarding potential false positive results due to sampling and off-site laboratory contaminants. Data presented in the tables were not qualified or corrected for blank contamination. However, based on the blank contamination assessment performed, a "*" flag has been added to the data when applicable, to indicate probable blank contamination. A detailed review of method blank and field laboratory quality control blank analyses from the RI program is presented in the DQR reports in Appendix D.

An evaluation of analytical data precision and accuracy was conducted using results of field duplicate and MS/MSD analyses. Accuracy of VOC and SVOC results were also evaluated using surrogate recovery data from each sample analysis. The results for some analytes have been identified as estimated based on the field duplicate, surrogate, and/or MS/MSD data. In some cases, possible data biases have been identified. A summary of data usability interpretations is contained in Subsection 7.1.2. Detailed discussions of surrogate, field duplicate, and MS/MSD results are presented in Appendix D.

7.1.1 Tentatively Identified Compounds/Non-Project Analyte List Compounds

During off-site laboratory analysis, non-project analyte list compounds present in VOC and SVOC samples were tentatively identified by comparing the GC/mass spectroscopy (GC/MS) spectra to those contained in the National Bureau of Standards mass spectral library. Once the tentative identification was made based on matching spectra, the appropriate USAEC code name was assigned for that compound.

Reported concentrations of TICs are considered estimated and are not based on calibration standards. If no compound identification was possible, the compound became listed as an unknown with an assigned number. The assigned number which accompanies the prefix "UNK" is determined by the relative retention time to the internal standard. For example, if the relative retention time of the compound compared to 1,4-difluorobenzene is 1.42, the compound would be assigned the number "UNK142" in IRDMIS.

The requirements for making tentative identification of compounds are listed in the Fort Devens POP (ABB-ES, 1995a) as follows:

1. Relative intensities of major ions in the reference spectrum (ions > 10 percent of the most abundant ion) should be present in the sample spectrum.
2. The relative intensities of the major ions must agree within 20 percent.
3. Molecular ions present in the reference spectrum should be present in the sample spectrum.
4. Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.
5. Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting compounds. Data system library reduction programs can sometimes create these discrepancies.
6. If in the technical judgment of the mass spectral interpretation specialist, no valid tentative identification can be made, the compound should be reported as unknown.

7.1.1.1 TICs Detected in Samples from AOC 57. VOC and SVOC TICs and unknown compounds were detected in several samples collected from AOC 57 Areas 2 and 3. These compounds are differentiated from target analytes in the USAEC's IRDMIS with an "S" flag in the flagging code field. All TICs associated with samples from AOC 57 collected during the 1995 and 1996 RI investigations and from the RI groundwater sampling events are summarized below and are presented in Table 7-1.

It is important to note that in addition to the GC/MS method used to identify and report the alkanes and aromatics identified as TICs, USEPA Methods 418.1, 9071 and 8015 were used during the off-site analysis of soil and water samples to quantify and classify hydrocarbons within these chemical classes. Field analysis was conducted on many samples during the RI using a modified version of USEPA Method 418.1. The field analysis method was designed to provide data on the distribution of these fuel hydrocarbons. Field analytical results were used to direct field exploration programs and provide supporting data for the off-site sample results. The off-site laboratory USEPA Method 418.1 results are the primary data used to make quantitative evaluations of these chemicals as TPHC.

1995 RI TICs. The only TICs detected in surface water samples were hexane, a VOC TIC at 5 µg/L, and an unknown SVOC at 8 µg/L.

TICs detected in groundwater, soil and sediment samples collected during the 1995 RI consisted primarily of alkenes, alkanes, alkyl-substituted-alkanes, and alkyl-substituted benzenes, toluenes and naphthalenes. TICs detected in soil, groundwater and sediment samples and are shown in Tables 7-1.

The field samples with the highest concentrations and the most frequent detection of these TICs include soil samples EX570200, EX570704, EX571502, EX572404, EX572500 at concentrations ranging from approximately 0.0077 µg/g to 100 µg/g, groundwater samples MX5703X1, MX5703X2, and MD5703X2 at concentrations ranging from 4 µg/L to 200 µg/L, and sediment sample DD570300 at concentrations ranging from 0.03 µg/g to 50 µg/g. The presence of alkanes and alkyl-substituted compounds in these samples may be indicative of gasoline and/or fuel related contamination.

The freon compound 1,1,2-trichloro-1,2,2-trifluoroethane was detected in AOC 57 samples, however, this compound was also detected in the laboratory method blanks indicating that its presence is not site-related.

Other compounds detected in samples collected from AOC 57 include molecular sulfur, and gamma-sitosterol.

Samples also contained unknown VOCs and SVOCs ranging from 0.007 µg/g to 10,000 µg/g in soil, 5 µg/L to 600 µg/L in groundwater samples, and 0.01 µg/g to 90 µg/g in sediment samples.

1996 RI TICs. TICs detected in field samples collected during the 1996 RI consisted primarily of alkenes, alkanes, alkyl-substituted-alkanes, and alkyl-substituted benzenes, toluenes and naphthalenes.

Alkanes detected include nonane, undecane, decane, dodecane, and tetradecane. Examples of substituted alkane and alkene compounds detected in soil and groundwater samples include: 2,2,6-trimethyloctane; 2,6,10,14-tetramethylpentadecane; 2,6-dimethylundecane; 2,6-dimethyloctane; 3,6-dimethyloctane; 3,7-dimethylnonane; 3-methyldecane; 6-methyldodecane; 6-methyltridecane; 7-trimethyldecane; 3-methylcyclohexene; 1,3,5-trimethylcyclohexane;.as well as hexadecanoic and octadecenoic acid.

The alkyl-substituted benzenes, toluenes and naphthalenes detected in soil and groundwater samples were as follows: sec-butylbenzene; 1,2,3,5-tetramethylbenzene; 1,2,4-trimethylbenzene; 1,2,3-trimethylbenzene; dichlorobenzenes; 1-ethyl-3-methylbenzene; and 1-ethy-4-methylbenzene; n-propylbenzene; 4-(1-methylethyl)toluene; 4-ethyltoluene; decahydro-2-methylnaphthalene and 1-methylnapthalene.

The concentration of the TICs listed above ranged from 5 µg/L to 100 µg/L in five groundwater samples, and from approximately 1 µg/g to 60 µg/g in twelve soil samples. The field samples with the highest concentrations and the most frequent detection of these TICs include groundwater sample MX5703X3 and soil samples EX573006, BX570705, and EX572810. The presence of alkanes and alkyl-substituted compounds may be indicative of gasoline and/or fuel related contamination.

The freon compound 1,1,2-trichloro-1,2,2-trifluoroethane was detected in AOC 57 samples, however, this compound was also detected in the laboratory method blanks indicating that it's presence is not site-related.

Other compounds detected in soil samples collected from AOC 57 include benzo[b]thiophene in soil sample BX571010 at 0.0077 µg/g.

Samples also contained unknown VOC and SVOC TICs ranging from 0.009 µg/g to 10,000 µg/g in soil, and 4 µg/L to 300 µg/L in groundwater samples. Specific samples with detections of unknowns include soil samples BX571105, BX571110, BX570800, BX571005, BX571010, BD571110, EX573006, BX570700, BX570705, EX573810 and groundwater samples MX5703X3, MX5709X1, MX5711X1, and MX5713X1.

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A subset of samples had non-target compounds reported as tentatively identified compounds (TICs) in the VOA and SVOA data. TICs are summarized In Appendix D-4, Table D-11.

The majority of SVOA non-target compounds were reported as unknowns. TICs included alkanes (C16 -C29), ß-sitosterol, and alpha-pinene. Sediment and soil samples contained numerous unknowns ranging in total concentration per sample from <5 µg/g to 171 µg/g. The ß-sitosterol, and alpha-pinene are interpreted to represent natural organics. The alkanes and unknowns may represent fuel related contamination.

No TICs were reported in VOA soils. A number of fuel related hydrocarbons were reported in aqueous samples including light alkanes, alkyl-substituted benzenes, and cyclohexanes which are indicators of possible gasoline contamination.

7.1.2 Potential Laboratory and Sampling Contaminants

An evaluation of results from rinse, trip, and laboratory method blank analyses was conducted to determine possible contaminant contributions originating from non-site-related sources. Potential sources of contamination include materials used during borehole advancement and monitoring well installation, field sampling procedures, field equipment decontamination, sample shipment, laboratory storage, and laboratory analysis.

Because the majority of off-site analytical data were generated using USAEC methods, USEPA data validation guidelines related to the evaluation of blank contamination were not implemented. The following blank contamination assessment approach for organics was used regarding laboratory method blank and field QC sample blank contamination:

1. Non-target VOCs and SVOCs TICs that are common organic laboratory contaminants (USEPA, 1988) are not considered chemicals of concern. These common organic laboratory contaminants identified in this document include:

    - Siloxanes; diethyl ether; 1,1,2-trichloro-1,2,2-trifluoroethane; fluorotrichloromethane; and phthalates at levels less than 100 µg/L or 4 µg/g in samples collected during the 1995 Field Investigation and the Round 2 Groundwater sampling event.

- trifluorochloromethane at levels less than 0.1 µg/g in samples collected during the 1996 Field Investigation.
- Solvent preservatives such as cyclohexane, and related by-products including cyclohexene, cyclohexanone, cyclohexenone, cyclohexanol, cyclohexenol, chlorocyclohexene, and chlorohexanol.
- Aldol condensation products of acetone including 4-hydroxy-4-methyl-2-pentanone, 4-methyl-2-penten-2-one, and 5-dimethyl-2(5H)-furanone.

2. The additional TICs detected in semivolatile organic analysis (SVOA) blanks include heptacosane, nonacosane and dioctyladipate. The VOC TICS detected hexane and ethanol. The investigations during which these TICs were detected are shown in Tables 7-2 and 7-4.

3. For organic target compounds, trends in method and field blanks were evaluated. Several target compounds routinely detected have been identified by USEPA as common laboratory contaminants including:

   - phthalates
   - methylene chloride, acetone, toluene, and methyl ethyl ketone (2-butanone) at concentrations comparable to concentrations observed in blanks.

4. The pesticides malathion detected in method blanks at 0.188 µg/L and alpha- and gamma-chlordane in method blanks at concentrations up to 0.01 µg/g.

Detailed discussions of blank results are presented in Appendix D.

Organic target analytes detected in method blanks and rinse blanks during the 1995 and 1996 field investigations and the 1995 Round 2 Groundwater Sampling Event are summarized in Tables 7-2 and 7-3. VOCs detected in trip blank samples collected during the 1995 Field Investigations and the Round 2 Groundwater Sampling Event are summarized in Table 7-4. Trip blanks analyzed during the 1996 investigation did not have any detections of VOCs reported. Organic compounds detected in samples at similar concentration ranges as those in blanks are identified and discussed qualitatively in the contamination assessment, and carried through the risk assessment calculations.

Inorganic elements were not reported in rinse blanks and water method blanks. Inorganic detections in the soil method blanks are not presented because the source of elements is believed to be the blank soil matrix rather than laboratory contamination (see Appendix D, Section 2.0). Inorganic sample data presented in the data tables and risk assessment tables were not revised based on blank contamination results. All inorganic detections were used for risk assessment calculations.

During the RI, samples were analyzed for a variety of water quality parameters to generate data to support the development of alternatives during the FS process. No rinse blank or method blank contamination was reported for the water quality parameters analyzed.

A more detailed discussion of laboratory QC sample results is presented in the DQRs in Appendix D.

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The following compounds should be evaluated as potential contaminants when using analytical data from the 1998 Supplemental Field Investigation:

1. Based on method blank data evaluations presented in Appendix D4, Section 2.1, low concentrations of bis(2-ethylhexyl)phthalate and manganese in aqueous samples may represent laboratory contamination.

2. Based on method blank data evaluations presented in Appendix D4, Section 2.1, low concentrations of TPHC (at approximately 36.5 µg/g), barium (8.31 µg/g), manganese (21.2 µg/g), alpha-chlordane (.0058 - .0082 µg/g), gamma-chlordane (.0092 - .013 µg/g), and the TIC diacetone alcohol in soil samples may represent laboratory contamination.

7.1.3 Analytical Data Accuracy and Precision

Analytical data accuracy and precision was evaluated using MS and field duplicate analyses for the majority of off-site and on-site laboratory analytical methods. Surrogate recoveries were reviewed to evaluate the accuracy of volatile organic analysis (VOA) and SVOA measurements. This evaluation was conducted to support the AOC 57 1995 and 1996 RI field programs. Detailed discussions and presentation of these results are included in the DQR for the 1995, 1996, and 1998 investigations shown in Appendix D.

1999 Source Area 3 Removal Action

Samples collected during the Source Area 3 removal action included hydrocarbon analyses using Massachusetts VPH/EPH methods (MADEP, 1998), and pesticide and PCB analyses using USEPA SW846 methods (USEPA, 1996). A detailed discussion of data quality evaluations for samples collected during removal is presented in Appendix D-5.

Matrix spike, field duplicate, and surrogate results for the majority of the and target analytes evaluated during the RI indicate the accuracy and precision of results were within project goals outlined in the Fort Devens POP (ABB-ES, 1995a) and USEPA control limits (USEPA, 1988; USEPA, 1989). Trends were reviewed for each set of QC sample data from each field event to determine if qualification of the accuracy of results was needed. The results for some analytes in AOC 57 samples have been identified as invalid or as estimated values with potential biases noted.

The following items summarize data usability considerations for the RI program data collected in 1995 through 1998:

7.1.3.1 Off-Site Laboratory Data.

<u>AOC 57 1995 RI</u>

1. Based on spike recovery data discussed in Appendix D, Subsection D.3.1.1, positive detections of selenium in soil are considered estimated with no particular low or high bias.

2. Results for MS and MSDs, discussed in Subsection D.3.1.1 of Appendix D, indicate lead results for soil analyzed by GFAA are estimated, and results may be biased low.

3. High frequency of MS/MSD recoveries above the upper control limits indicate that there may be some matrix interference for arsenic (Appendix D, Subsection D.3.1.1). Positive results reported for arsenic in soil samples should be considered estimated and potentially biased high.

4. Based on MD/MSD recoveries discussed in Subsection D.3.1.2, Appendix D, positive results for 4,4-DDT in soil samples collected at AOC 57 should be considered estimated and potentially biased high.

5. Based on spike recoveries for hardness (Appendix D, Subsection 3.3.3), all hardness results for groundwater samples should be considered invalid, with the exception of groundwater sample MXG302X1 in which acceptable hardness recoveries were reported.

6. Low TPHC MS spike recoveries were reported in sediment sample DX570500 from AOC 57. All positive sediment sample results for TPHC for AOC 57 sediments should be considered estimated and biased low, and all non-detect results should be considered invalid.

7. SVOC surrogate recovery evaluations are presented in Appendix D, Subsection D.3.2.1:

   - Surrogate standard 2,4,6-tribromophenol in AOC 57 soil sample EX571602 was less than 10 percent. All non-detect results in the acid fraction of this sample are rejected and considered unusable.

8. VOC surrogate recovery evaluations are presented in Appendix D, Subsection D.3.2.1:

   - Groundwater sample MX5703X1, had high surrogate recoveries for 1,2-dichlorobenzene-D4. Positive results for ethylbenzene, tetrachloroethene, toluene, xylenes, and chloromethane reported in MX5703X1 are considered estimated and potentially biased high.

   - The recovery of surrogate standard 1,2-Dichloroethane-D4 in surface water sample WX5704XX from AOC 57 was high. Positive results reported for 1,2-dichloroethene, tetrachloroethene, and trichloroethene in surface water sample WX5705XX are considered estimated and potentially biased high.

9. Outlier duplicate RPDs for sediment sample DX570300 from AOC 57 were reported (Subsection D.4.1.1, Appendix D). Based on these results, concentrations of mercury, manganese, sodium, and zinc in sediment samples from AOC 57 should be considered estimated.

10. Based on field duplicate RPDs (Subsection D.4.1.4, Appendix D), positive results in surface water samples from AOC 57 for nitrogen determined by the kjeldahl method, hardness, and total phosphate should be considered estimated.

11. Positive detections of endosulfan II in AOC 57 groundwater sample EX5706X1 are considered estimated based on RPD exceedances between spiked sample results (Subsection D.4.2.2 in Appendix D).

Groundwater, Round 2 (February 1996).

1. Based on low spike recoveries for lead and selenium (Subsection D.3.3.3, Appendix D), results reported at the CRLs for these elements in AOC 57 groundwater samples should be considered estimated and potentially biased low. Lead and selenium were not detected groundwater samples.

2. Based on low spike recoveries discussed in Subsection D.3.3.3, Appendix D, antimony CRLs for groundwater samples are considered estimated and potentially biased low. Antimony was not detected in any groundwater samples.

3. Phosphate results from AOC 57 groundwater samples are considered estimated values based on outlier RPDs between field duplicate results.

4. The concentration of 1,3,5-trimethylbenzene in groundwater sample MX5703X2 and the duplicate MD5703X2 are considered estimated based on duplicate RPDs results.

AOC 57 Fall 1996 RI

1. Based on MS recoveries discussed in Appendix D, Subsection D.3.1.1, positive detections and results reported at the CRL for mercury, arsenic, and manganese in soil are considered estimated values and potentially biased low based.

2. Based on MS recoveries discussed in Appendix D, Subsection D.3.1.2, lindane CRLs in AOC 57 groundwater samples may be biased low and should be considered estimated. Lindane was not detected in groundwater samples.

3. Based on MS and MSD recoveries for TPHC (Method 9071) discussed in Appendix D, Subsection D.3.1.3, positive results in AOC 57 soil sample EX573106 are considered estimated and potentially biased low.

4. VOA surrogate recovery evaluations are presented in Appendix D, Subsection D.3.2.2:

   - Soil sample EX572810 from AOC 57 had surrogate recoveries for 4-bromoflourobenzene above the control limits. Concentrations of 2-hexanone, ethylbenzene, tetrachloroethene, and xylenes in this sample are considered estimated and potentially biased high.

   - The concentrations of 2-hexanone and xylenes reported in AOC 57 soil sample EX573006 are considered estimated and potentially biased high.

5. Pesticide/PCB surrogate recovery evaluations are presented in Appendix D, Subsection D.3.2.3:

   - Low recoveries of surrogate standard decachlorobiphenyl in AOC 57 groundwater samples MD5711X1, MX5711X1, MX5712X1 for PCBs were reported. PCBs were not detected in these samples and CRLs are considered estimated and potentially biased low.

- Low recoveries of surrogate standard decachlorobiphenyl in AOC 57 groundwater samples MX5713X1, MX5703X3 for pesticides were reported. Pesticides were not detected in these samples and CRLs are considered estimated and potentially biased low.

- The result for Aroclor-1260 in AOC 57 soil sample EX572810 is considered estimated and potentially biased-low. Low surrogate recoveries for surrogate standards tetrachlorometaxylene and decachlorobiphenyl were reported.

6. Based on duplicate precision evaluations presented in Appendix D, Subsection D.4.1.5, TPHC soil results are considered estimated.

7. Concentrations of 1,2,3-trimethylbenzene in soil sample MX5711X1 are considered estimated based on duplicate evaluations presented in Appendix D, Subsection D.4.1.3.

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1. Based on VOA surrogate data presented in Appendix D-4, Subsection 2.4, Results for benzene, chlorobenzene, and toluene in samples DX570600 are potentially biased high.

2. Based on SVOA surrogate data presented in Appendix D-4, Subsection 2.4, results for WX570300 (57W-98-03X) and WX570400 (57W-98-04X) indicate a low bias for base/neutral compounds in these samples. Base/neutral compounds include all non-phenolic compounds.

3. Based on pesticide surrogate data presented in Appendix D-4, Subsection 2.4, all results for pesticides in water sample MX570200 (57W-98-02X), sediment sample DX570500 (57D-98-05X), and soil samples SX570302 (57S-98-03X) and SX570701 (57S-98-07X) are considered estimated and

potentially biased low.

4. Based on PCB surrogate data presented in Appendix D-4, Subsection 2.4, results for water sample WX570400 (57W-98-04X) are considered estimated and potentially biased low.

5. Based on matrix spike results presented in Appendix D-4, Subsection 2.5, antimony soil results are for method JS16 are considered to be estimated and potentially biased low.

6. Based on field duplicate data presented in Appendix D-4, Subsection 2.6, results for barium in all water samples should be considered estimated values, and all TSS data should be considered estimated.

7.1.3.2 On-site Laboratory Data Use Considerations. A detailed review of quality control sample measurements from the on-site laboratory program is presented in Appendix D. Data use considerations are summarized below:

1. Chloroform was detected in a laboratory method blank (390 µg/g) indicating this compound may be reported in samples as a result of laboratory contamination.

2. Based on field duplicate results for the TPHC modified 418.1 method discussed in Appendix D, Subsection D.4.2, reporting limits and low concentration (<100 µg/g) detected results are considered estimated values.

3. Based on field duplicate results for VOCs discussed in Appendix D, Subsection D.4.2, VOC results for soils should be considered estimated values.

1998 Supplemental Field Investigation

1. Based on discussions in Appendix D-4, Subsection 3.1.1, TPHC field screening results for sediments may be biased high.

7.2 AOC 57 INVESTIGATIONS

7.2.1 Previous Investigations

The following subsection details the analytical findings of the previous investigations conducted at AOC 57. AOC 57 has been divided into three sub-areas, Area 1, Area 2, and Area 3 (Figure 5-2). Area 1 has been the subject of previous investigations and was not included in the investigative phase of this RI. Results of investigations at Area 1 are included, however, in this RI report for completeness.

7.2.1.1 1992 Site Investigations. HLA conducted an SI at Areas 1 and 2 of AOC 57 (then SA 57) in September 1992. The objective of the SI was to investigate the presence or absence of environmental contaminants in the different environmental media found at AOC 57, reportedly as a result of a February, 1977 fuel oil spill. A detailed description of the results of the SI are presented in the Revised Final Groups 2, 7, and Historic Gas Station SI Report (ABB-ES, 1995a).

Samples of surface soil, surface water, and sediment were collected from Areas 1 and 2 during the SI. PAHs and TPHC possibly associated with the fuel oil were detected in surface soils at Area 1 (57S-92-01X through 57S-92-03X) (Figure 5-4). The human health PRE, which was conducted to evaluate potential exposure to the detected PAH compounds and TPHC, indicated that there was no unacceptable health risk for the presumed commercial/industrial future site use. Because Area 1 is part of the storm water drainage network which discharges into Cold Spring Brook, the Army recommended that this area be further investigated as part of the installation-wide AREE 70 storm water study.

At Area 2, naphthalene and TPHC were detected in surface soils during the SI (57S-92-06X through 57S-92-08X). Fingerprint analysis of soil from Area 2 indicated that contaminated soil was most likely derived from lubricating oil, possibly from the release of vehicle crank case oil. Given this finding, the contaminants found at Area 2 were not likely related to the 1977 release of No. 4 fuel oil. Results of the human health and ecological PREs indicated that the chemical hazards at Area 2 were not significant. However, the PREs were performed just prior to promulgation of MCP soil standards. In consideration of the new standards, the Army proposed that a removal action (focused on TPHC) be conducted.

The following subsections present a detailed summary of analytical results by medium, at Area 2. A discussion of subsequent soil removal activities at Area 2 is also presented.

Surface Soil

Three surface soil samples (57S-92-01X, 57S-92-02X, and 57S-92-03X) were collected from the Area 1 storm drain outfall and drainage ditch (Figure 5-4). Several PAHs were detected in samples 57S-92-02X and 57S-92-03X. The total PAH detected ranged from 35.5 µg/g in 57S-92-02X to 36 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 7-5).

Three surface soil samples were collected from stained areas within the drainage ditch at Area 2 (57S-92-06X through 57S-92-08X). These samples were collected to assess the distribution of contaminants along the ditch (Figure 5-4). Each sample was submitted for analysis of Project Analyte List (PAL) SVOCs, TPHC, Total Organic Carbon (TOC), petroleum fingerprinting, and grain size.

Analysis of surface soil samples detected naphthalene at a concentration of 0.3 µg/g at 57S-92-07X. TPHC were detected at each surface soil sample location, at concentrations ranging from 606 µg/g at 57S-92-08X to 4,910 µg/g in the duplicate sample at 57S-92-07X. Fingerprint analysis of soil from Area 2 indicated that contaminated soil was most likely derived from a release of vehicle crank case oil. Table 7-5 presents the SI surface soil analytical results.

The PRE conducted to evaluate potential exposure to the detected PAH compounds, and for TPHC, indicated that there was no unacceptable health risk for commercial/industrial site use at either Areas 1 or 2. The concentrations of naphthalene and TPHC were determined to be well below their respective ecological benchmark values. However, in consideration of the source of contaminants, the ecological PRE established that it was unknown whether or not concentrations of analytes other than SVOCs may be contributing to ecological risk at the site. It should be noted that the 1992 PREs were performed prior to promulgation of MCP soil standards.

Surface Water and Sediment

Two surface water and sediment samples were collected from Cold Spring Brook during the SI. One surface water and sediment sample location was located approximately 1,000 feet upstream (57D-92-01X), and one was located approximately 3,000 feet downstream (57D-92-02X) of AOC 57/Area 2, to assess if contaminants from AOC 57/Area 2 were impacting the surface water and sediment quality in the Brook (Figure 5-4). In addition, surface water and sediment samples were collected from Cold Spring Brook during the Group 3 site investigations conducted in June 1992. One location (G3D-92-01X) was located immediately upstream from AOC 57/Area 2, while one (G3D-92-02X) was located just downstream of Area 2 (Figure 5-4). Historical surface water and sediment analytical data are presented in Appendix E.

Two rounds of surface water and sediment sampling were conducted during the SI. The first round of surface water samples from these two locations was analyzed for PAL SVOCs, TPHC, and PAL water quality parameters. The first round of sediment samples was analyzed for PAL SVOCs, TPHC, TOC, and grain size. The second round of sampling involved resampling surface water and sediment from 57D-92-01X, and surface water only at 57D-92-02X. The second round of surface water samples was analyzed for PAL VOCs, PAL SVOCs, PAL inorganics, and TPHC. The additional sediment sample was analyzed for PAL VOCs, PAL SVOCs, PAL inorganics, TPHC, and TOC.

Surface water analytical results indicated the presence of chloroform at a concentration of 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. Cation/anion concentrations remained relatively constant in each surface water sample collected from Cold Spring Brook. Results of the Group 3 upstream surface water sample (G3D-92-01X) were consistent with 57D-92-01X, the SI upstream sample. The Group 3 downstream sample (G3D-92-02X) results were very similar to the upstream sample (G3D-92-01X).

Sediment sampling results indicated the presence of PAHs and TPHC at sampling locations 57D-92-01X and 57D-92-02X. PAHs increased in number and in concentration at the downstream location (57D-92-02X), and were not detected at all at the upstream location (57D-92-01X) during the second sediment sampling event. TPHC concentrations were higher at the upstream location (57D-92-01X). The TPHC concentration of the sole sediment sample collected at 57D-92-02X was 92.6 µg/g. The TPHC concentrations at

57D-92-01X were 497 and 466 µg/g from Round 1 and Round 2 respectively. Several inorganic analyte concentrations appeared to be consistent in the upstream and downstream sediment samples collected from Cold Spring Brook.

The Group 3 sediment results indicated the presence of VOCs, SVOCs, TPHC, and various inorganics in both the upstream and downstream samples. The concentrations of detected analytes were similar in both the upstream and downstream samples. From these data, it was unclear as to whether AOC 57 Areas 1 and 2 were impacting sediment quality. The analytical results did show that additional contamination was entering Cold Spring Brook from a source(s) further upstream.

A human health and ecological risk PRE of surface water and sediment samples collected from Cold Spring Brook was not conducted during the SI. Results from sampling of this medium were evaluated during the AREE 70 study (ADL, 1994) and Lower Cold Spring Brook Study (ABB-ES, 1995c).

7.2.1.2 AREE 70 Investigation. The AREE 70 investigation gathered information on 55 storm drain systems and three surface water bodies, and identified potential sources of contamination that were not identified through previous investigations. Included in the AREE 70 evaluation was Storm Drain System 6 (AOC 57 Area 1). Three sediment and two water samples were collected at three locations within the drainage ditch (SSD/SSW-93-06A, SSD/SSW-93-06B, and SSD-93-06C) (Figure 5-4). Of these samples only SSD/SSW-93-06B is located within AOC 57. Analyses of the surface water and sediment samples indicated elevated levels of arsenic, chromium, and lead in sediment and arsenic and lead in water. SSD-93-06B, located at the Area 1 storm system outfall adjacent to Barnum Road, also had the highest concentration of total PAHs (59.8 µg/g) and a higher TPHC concentration than the upgradient system samples SSD/SSW-93-06A and SSD-93-06C. Results of the sampling were incorporated into the Lower Cold Spring Brook Study ecological PRE. Historical surface water and sediment analytical data are presented in Appendix E.

7.2.1.3 Area 2 Soil Removal Activities. The results of the human health and ecological PREs performed in conjunction with the Groups 2 and 7 SI indicated that the chemical hazards at Areas 1 and 2 were not significant. However, the PREs were performed prior to promulgation of MCP soil standards. In consideration of the new soil standards, the Army proposed that a soil removal action (focused on TPHC) be conducted at Area 2.

In October of 1993 eight additional surface soil samples (57S-93-10X through 57S-93-17X) were collected from the drainage ditch area and screened for TPHC to aid in determining the extent of contamination requiring removal (Figure 5-4 and Table 7-6).

Subsequently, HLA prepared a document entitled "Final Action Memorandum, SA 57 Barnum Road Oil Spill Area 2, Fort Devens, Massachusetts" in June 1994. The Action Memorandum documented the decision to perform a removal action to address petroleum-contaminated soil in the drainage ditch at Area 2. The proposed clean-up objective outlined in the Action Memorandum was to remove surface soil within areas of petroleum staining, and historically high TPHC concentrations, to a TPHC concentration less than 500 milligrams per kilogram (mg/kg). The Action Memorandum estimated that a limited amount of soil needed to be excavated.

A removal action began on August 26, 1994 and continued until September 12, 1994. Soil was excavated using standard excavating equipment. Erosion control measures were taken during the excavation to prevent erosion and sedimentation of soil into the Cold Spring Brook wetland. Soil samples were collected for field analysis of TPHC as each area was excavated (Figure 5-5 and Table 7-7). TPHC was detected in these samples up to a maximum concentration of 74,208 mg/kg. Black, oily soil was detected at approximately 18 inches bgs in an excavation, at the base of the slope. This soil was sampled for laboratory analysis for metals, SVOCs, TPHC, and VOCs (Table 7-8). TPHC was detected at concentrations ranging from 29,300 to 50,100 mg/kg, and lead was detected at concentrations ranging from 137 to 464 mg/kg. The VOCs ethylbenzene, toluene, and xylenes were detected in the soil samples. SVOCs were not detected; however, detection limits were elevated due to dilution of the samples.

Continued excavation efforts revealed stained soil laterally and at depths in excess of original estimates. A trench was excavated to the water table in the southern-most portion of Area 2 to define the extent of contamination. An oily sheen was observed on water in the trench. The water in this trench was analyzed for TPHC, PCBs, metals, SVOCs and VOCs. This sample contained elevated TPHC (754,000 mg/L) and PCBs (140 mg/L). Petroleum fingerprinting indicated that the oil was most likely a mixture of kerosene and lubricating oil.

The trench was not successful in determining the limits of contamination so test pits were subsequently excavated outside the previously excavated area (Figure 5-4). Soils collected from the test pits were field screened to determine the extent of TPHC-contaminated soil (Table 7-7). Soon after starting the test pit excavation, it became clear that contamination extended well beyond the limits originally estimated, and the removal action was suspended until Area 2 could be better characterized. A total of approximately 1,300 cubic yards of soil was ultimately excavated from Area 2, before it was lined with 6-mil polyethylene, backfilled with clean soil, and covered with an erosion control blanket. A drainage swale was constructed and lined with 6-inch riprap to channel runoff to the Cold Spring Brook wetland.

7.2.1.4 Lower Cold Spring Brook Study. In 1994, HLA conducted an SI at Lower Cold Spring Brook to evaluate surface water and sediment quality. Samples were collected from 23 locations in Lower Cold Spring Brook and 11 locations in storm drain ditches and swales. Of these six surface water and sediment pairs (CSD-94-13X, -14X, -17X, -19X, -20X, and -35X) were collected from Lower Cold Spring Brook in the vicinity of AOC 57/Area 2 and four surface water and sediment pairs (CSD-94-16X, CSD-94-18X, CSD-94-26X, and CSD-94-22X were collected from the area of Cold Spring Brook that is hydrogeologically downgradient of the area that would become Area 3 (Figure 5-6). The surface water samples were analyzed for PAL SVOCs, total and dissolved inorganics, and water quality parameters, TSS, chloride, sulfate, total hardness, and alkalinity. These surface water samples were also analyzed in the field for pH, dissolved oxygen, conductivity, and temperature. The sediment samples were analyzed for PAL VOCs, PAL SVOCs, PAL inorganics, TOC, TPHC, grain size distribution, and percent solids. At four of the locations, CSD-94-13X, CSD-94-18X, CSD-94-20X, and CSD-94-27X, the macroinvertebrate community was characterized, and sediment samples were subjected to toxicity testing. At these four locations, surface water and sediment samples were also analyzed for pesticides and PCBs. The data was subjected to an ecological PRE. The findings of this SI were presented in the "Lower Cold Spring Brook Site Investigation Report", submitted in December 1995. Analytical data are presented in Appendix E.

Analytical results from the brook in the vicinity of Area 2 indicated that the marsh located upstream of the 1977 containment dike contained sediments with elevated concentrations of VOCs, SVOCs, pesticides, PCBs, and inorganics. TPHC was detected at a maximum concentration of 2,700 mg/kg. SVOCs were detected at concentrations that marginally exceeded screening values, while pesticides, PCBs, and inorganics significantly exceeded screening values. Lead was detected in surface water at a concentration above the Ambient Water Quality Criteria (AWQC). Pesticides and the maximum concentrations of inorganics in sediment were found in the sample from location CSD-94-20X located on the upstream side of the containment dike adjacent to AOC 57 Area 2. The ecological PRE showed no risks to aquatic receptors from surface waters at that location.

Macroinvertebrate and aquatic toxicity results did not indicate any increased mortality relative to aquatic receptors, although this station contained the poorest habitat relative to the control area. Despite the demonstrated lack of increased mortality, the ecological PRE indicated that there may be limited ecological risks associated with Area 2 marsh sediments.

Results of samples collected from the portion of Cold Spring Brook hydrogeologically downgradient of Area 3 showed decreased concentrations of SVOCs, TPHC, and inorganics as compared to the samples collected upstream (e.g., Area 2 samples and G3D-92-02X). Further discussion of these sample results is provided in Subsection 7.2.4, RI Sediment.

7.2.1.5 Area 1 Contaminated Soil Removal. Although the Lower Cold Spring Brook PRE for Area 1 showed that there were no identifiable ecological risks, it was decided to perform a contaminated soil removal at the outfall to address soil contamination resulting from releases of petroleum oil.

Excavation of outfall soils commenced in February of 1997. Initial removal operations included excavation of a 15-foot by 15-foot area to a maximum depth of 2 feet bgs at the outfall location. Following the initial excavation, four composite samples were collected for on-site TPHC screening. TPHC values in these composite samples ranged between 66 and 271 ppm. Six confirmatory samples (AOC-57, A1-SW1, SW2, SW3, SW4, FL1, DUP) were also collected and submitted for off-site analyses for EPH/VPH and metals to verify the on-site screening (Figure 5-7).

EPH $C_{10} - C_{22}$ aromatic fraction in excess of MCP S-1/GW-1 standards were detected in sidewall samples (Table 7-9). Based upon these data, an additional three feet of soil was excavated from the sidewalls perpendicular to the outfall pipes and approximately seven feet was excavated from the wall opposite the outfall pipes. The maximum depth of excavation was three feet bgs. Following the second phase of excavation, an additional three confirmatory samples were collected from the sidewalls (AOC 57-A1-SW1/B, SW2/B and SW4/B) (Figure 5-7 and Table 7-9). Confirmatory analytical results for the second round of sampling indicated elevated PAH concentrations in sidewalls AOC 57-A1-SW1/B and SW4/B. A total of 10 PAH contaminants exceeded the applicable MCP S-1/GW-1 standards with the highest concentrations located downstream of the outfall pipes.

A statistical comparison of the arithmetic mean concentration of the PAHs indicated that the types and concentrations of PAHs in sediments at the Area 1 outfall are consistent with concentrations at various outfalls along Cold Spring Brook (Weston, 1998). This analytical data strongly indicates that fuel oil related contamination at the outfall was successfully removed, and what remains in soil and sediment at the outfall are PAHs that are likely related to runoff from paved, trafficked along Barnum Road. This type of PAH contamination, which cannot feasibly be eliminated from runoff from asphalt paved areas, is specifically exempted from MCP requirements due to its relative ubiquity at these types of outfalls.

7.2.2 AOC 57 RI and Removal Action Soils Results

The following subsections present field and off-site laboratory analytical soil results for samples collected at AOC 57 Areas 2 and 3 during the RI. Field analytical soil data are presented in Tables 7-10, 7-11 and 7-13. Off-site laboratory analytical soil data are presented in a hits-only format in Tables 7-12 and 7-13. Complete field analytical and off-site laboratory analytical soil data are presented in Appendix M.

7.2.2.1 Field Analytical Soil Results. Soil samples were collected for field analysis from TerraProbe^{SM} points, soil borings, test pits, and surface soil sampling points. The field analytical samples were collected in an attempt to define the nature and distribution of the site-related contaminants as well as to delineate potential contaminant source areas. A discussion of the results for Areas 2 and 3 is presented below.

Area 2

RI Test Pit Soil Sampling Field Analytical Results. A total of 23 test pits, 57E-95-01X through 57E-95-20X and 57E-95-25X through 57E-95-27X, were excavated at Area 2 in 1995. Sixty-nine soil samples were collected from the test pits for on-site analysis of BTEX, select VOCs, GRO, and TPHC. Soil samples were collected based upon visual evidence or PID screening. In the absence of overt contamination, samples were generally collected at the surface, midpoint and bottom of the excavation. On-site analytical results for the test pit soils are provided in Table 7-10.

Toluene, ethylbenzene, chlorobenzene, m/p xylene, or o-xylene were detected in seven samples from the Area 2 test pits 57E-95-01X, 57E-95-06X, 57E-95-07X, 57E-95-12X, 57E-95-15X, 57E-95-16X, and 57E-95-17X. Total detected concentrations ranged between 3.2 µg/kg (toluene) at 2 feet bgs from 57E-95-01X to 109,400 µg/kg (combined toluene, ethylbenzene, m/p-xylene, and o-xylene) in the 4 foot bgs sample from 57E-95-07X. In general, the TEX detections were concentrated around the southern portion of the soil removal excavation.

Chlorinated hydrocarbons were detected in three samples. 1,1-DCE exceeded the detection limit of 6100 in the 4 foot bgs sample from 57E-95-07X. PCE was found in the 2 foot bgs sample from 57E-95-15X and at 3 feet bgs in 57E-95-20X at concentrations of 4.8 and 2.5 µg/kg, respectively. The 5 foot bgs sample from 57E-95-17X contained 21 µg/kg of TCE. As with the TEX distributions, the TCE and PCE detects were located around the southern portion of the soil removal excavation.

Soil samples from AOC 57 Area 2 were also analyzed for TPHC by IR (Method 418.1) and GRO. TPHC was detected in 25 of the soil samples with a maximum observed concentration of 65,000 mg/kg at 4 feet bgs in 57E-95-07X. This sample also corresponded to the maximum GRO detection of 8,600,000 µg/kg. GRO was detected in seven of the 69 total samples. Figure 7-1 shows TPHC detections in subsurface soils as determined by on-site analysis. The highest concentrations were observed along the southern portion of the soil removal excavation, 1,400 mg/kg at 0 feet in 57E-95-08X, 3,400 and 2,000 mg/kg at 0 and 2 feet respectively in 57E-95-17X, 8,000 mg/kg at 3 feet in 57E-95-16X, 9,700 mg/kg at 0 feet in 57E-95-12X, 28,000 mg/kg at 2 feet in 57E-95-15X, and 65,000 mg/kg at 4 feet in 57E-95-07X. TPHC was also found in the northern portion of the site in surficial soils with a maximum concentration of 480 mg/kg in the 2 feet bgs sample from 57E-95-25X. The surficial TPHC concentrations in the northern portion of the site are attributed to the observed coal ash layer.

RI Soil Boring Field Analytical Results. Soil samples were collected for field analysis from four soil borings (57B-95-03X, 57B-95-04X, 57B-95-05X, and 57B-95-06X,) three monitoring well borings (57M-95-07X, 57M-95-08A, and 57M-95-08B) and a piezometer boring (57M-95-01A) to provide data on contaminant distribution, aid in the selection of samples for off-site analysis, and confirm monitoring well location. Soil boring and

TerraProbe^{SM} field analytical results are provided in Table 7-11. Soil samples were collected from the soil borings 57B-95-03X at 0 and 5 feet bgs; 57B-95-04X at 15 feet bgs; 57B-95-05X at 15 feet bgs; and 57B-95-06X at 12 feet bgs. The monitoring well and piezometer borings 57M-95-07X, 57M-95-08A, 57M-95-08B, and 57P-95-01A were sampled at 4, 7, 4, and 5 feet bgs, respectively. All samples were analyzed in the field laboratory for BTEX, select VOCs, and TPHC by NDIR and GC. BTEX and chlorinated solvents were below detection limits for all of the samples. TPHC was detected by NDIR at 480 mg/kg at 0 feet bgs in 57B-95-03X and at 65 mg/kg at 4 feet bgs in 57M-95-08B.

1998 Surface and Subsurface Soil Sampling Field Analytical Results

In May of 1998, additional surficial and subsurface soil sampling was performed to better define downgradient soil contamination. Two soil samples, one at the ground surface and one at the water table, were collected from 10 locations at Area 2 (57S-98-01X through 57S-98-10X). Sample locations were selected to best characterize the soils south (downgradient) of the removal excavation and the explorations showing the highest historical levels of petroleum and chlorinated VOC contamination (i.e., test pits 57E-95-15X, 57E-95-16X, and 57E-95-07X). Sample depths ranged between 0 and 3 feet bgs. All 20 samples were screened at the on-site laboratory for TPHC by NDIR.

TPHC concentrations ranged between 32,000 μg/g at 1-foot bgs from 57S-98-07X to less than 210 μg/g at the ground surface from 57S-98-05X (Figure 7-2 and Table 7-13). The distribution of TPHC detections was consistent with the earlier RI findings in that the highest concentrations were found adjacent to the southern extent of the Area 2 Removal Action excavation. Screening results south of test pits 57E-95-15X and 57E-95-16X, 570 μg/g at 0 feet and 680 μg/g at 1-foot bgs from 57S-98-04X; 920 μg/g at 0 feet and 2500 μg/g at 1-foot bgs from 57S-98-06X; and <800 μg/g at 0 feet and <270 μg/g at 1-foot bgs from 57S-98-08X, indicate that the elevated TPHC concentrations have not migrated further toward the wetland on the south and southeast side of the excavation. However, elevated TPHC was detected in the 2-foot bgs sample collected from 57S-98-03X suggesting that contamination detected in 57E-95-07X has migrated toward the wetland. Impacts to Area 2 wetlands are further discussed in Subsection 7.2.4, RI Sediment.

Area 3

RI Test Pit Soil Sampling Field Analytical Results. A total of eight test pits were excavated at Area 3, 57E-95-21X through 57E-95-24X in 1995 and 57E-96-28X through 57E-96-31X in 1996. Forty soil samples were collected from the test pits for on-site analysis of BTEX, select VOCs, and TPHC. Soil samples were collected based upon visual evidence or PID screening. On-site analytical results for the test pit soils are provided in Table 7-10.

Detected VOCs include chlorobenzene, ethylbenzene, m/p-xylene, o-xylene, chloroform, and naphthalene. The VOCs were detected mainly in the vicinity of test pit 57E-95-24X and 57E-96-28X through 57E-96-31X. It should be noted that naphthalene and the dichlorobenzene suite were not calibrated for until near the end of the test pitting program; therefore, only soil samples from test pit 57E-96-31X were analyzed for these compounds. The maximum observed VOC concentrations were found in the 10 feet bgs sample from 57E-96-31X with ethylbenzene reported at 8,800 µg/kg, m/p-xylene at 26,000 µg/kg, o-xylene at 9,900 µg/kg, and naphthalene at an estimated ("J" qualified) concentration of 12,000 µg/kg.

Soil samples from AOC 57 Area 3 were also analyzed for TPHC by IR (Method 418.1) and GRO (1995 samples only). TPHC was detected in 26 of the soil samples with a maximum concentration that exceeded the detection limit 63,000 mg/kg at 4 feet bgs in 57E-96-31X. Figure 7-3 shows contours of TPHC detections in surface and subsurface soils as determined by on-site analysis.

RI TerraProbe^{SM} and Soil Boring Field Analytical Soil Sample Results. A total of 87 soil samples were collected from 20 TerraProbe^{SM} points, six soil borings and one monitoring well boring to aid in the delineation of horizontal and vertical contaminant distribution, determine the source of the contamination, and confirm monitoring well placement. Soil samples were analyzed in the field laboratory for BTEX, select VOCs, TPHC, and GRO (1995 only). Field analytical soil data are presented in Table 7-11.

Detected VOCs included ethylbenzene, toluene, chlorobenzene, m/p-xylene, o-xylene, naphthalene, 1,1-DCE, 1,2-DCB, and 1,4-DCB. Chloroform was also detected in three of the samples but was linked to blank contamination. Naphthalene and the dichlorobenzene suite were not calibrated for until after commencement of the 1996 sampling program;

therefore, soil samples from TerraProbe^{SM} points 57R-96-07X through 57R-96-12X at 6 feet bgs were not analyzed in the field for these compounds.

Naphthalene was detected in the soil borings 57B-96-07X (0, 5 and 10 feet bgs) and 57B-96-12X at 5 feet bgs as well as the TerraProbe^{SM} points 57R-96-13X (3 and 5 feet bgs), 57R-96-14X (3 feet bgs), 57R-96-15X (3, 5, and 9 feet bgs), 57R-96-16X (3 feet bgs), and 57R-96-19X (9 feet bgs). Estimated naphthalene concentrations ranged between 440 µg/kg and 27,000 µg/kg in the 10 and 5 foot bgs samples from 57B-96-07X. 1,2-DCB and 1,4-DCB were detected in four samples; 57B-96-07X (5 feet bgs), 57R-96-15X (5 and 9 feet bgs), and 57R-96-19X (1,2-DCB only at 9 feet bgs). The maximum observed concentrations of 1,2-DCB and 1,4-DCB were 46,000 and 14,000 µg/kg in the 5 foot bgs sample from 57B-95-07X. DCB hits were found coincident with the higher concentrations of naphthalene, ethylbenzene and xylenes.

Other detected VOCs included 1,1-DCE at 370 µg/kg in the 10 foot bgs sample from 57B-96-09X and an estimated concentration of 5.4 µg/kg in the surficial sample from 57R-95-01X. Chlorobenzene was detected in 57B-96-12X at 5 feet bgs at a concentration of 4,700 µg/kg, in 57R-95-04X at 10 feet at a concentration of 49 µg/kg, and the 10 feet bgs duplicate sample from 57R-96-10X at a concentration of 300 µg/kg.

TPHC were detected in 37 of the soil samples collected from Area 3 soil borings and TerraProbe^{SM} points. The maximum observed concentration was 39,000 mg/kg in the 5 feet bgs sample from 57R-96-13X. Other significant detections (e.g., in excess of 500 mg/kg) include the 0 and 5 feet bgs samples from 57B-96-07X at 12,000 and 14,000 mg/kg, respectively, the 5 feet bgs sample from 57B-96-11X at 7,400 mg/kg, the 5 feet bgs sample from 57B-96-12X at 13,000 mg/kg, the 4 feet bgs sample from 57R-95-05X at 4,500 mg/kg, the 3 and 5 feet bgs samples from 57R-96-13X at 9,400 mg/kg, the 3, 5, and 9 feet bgs samples from 57R-96-15X at 12,000, 12,000, and 14,000 mg/kg, respectively, and the 9 feet bgs sample from 57R-96-19X at 700 mg/kg. TPHC contamination is approximately coincident with the VOC contamination and is located from the vicinity of test pit 57E-95-24X to the soil boring 57B-96-12X. Pre-removal action distribution of Area 3 TPHC contamination as determined by field analytical results is provided in Figure 7-3.

1998 Surface and Subsurface Soil Sampling Field Analytical Results.

In May of 1998, additional surficial and subsurface soil sampling was performed to better define downgradient soil contamination at Area 3. Two soil samples, one at the ground surface and one at the water table, were collected from six locations at Area 3 (57S-98-11X through 57S-98-16X). Sample depths ranged between 0 and 3 feet bgs. All 12 samples were screened at the on-site laboratory for TPHC by NDIR.

TPHC concentrations ranged between 2,900 μg/g at 0 feet from 57S-98-14X to less than 260 μg/g at 2 feet bgs from 57S-98-16X (Table 7-13). The highest concentrations of TPHC were found adjacent to monitoring well 57M-96-11X were 57S-98-13X at 1-foot bgs contained 1,600 μg/g and 57S-98-14X at 0 feet contained 2,900 μg/g. The 1998 TPHC field analysis is combined with the earlier RI data and contoured in Figure 7-3. The 1998 TPHC data is provided along with 1998 off-site TPHC and EPH/VPH data in Figure 7-4.

7.2.2.2 Off-Site Laboratory Soil Analytical Results.

Area 2

RI Test Pit Soil Sampling Off-Site Analytical Results. A total of 19 soil samples were collected for off-site laboratory analysis from the 23 test pits excavated at AOC 57 Area 2 in 1995. Samples were collected from depths ranging from the ground surface to 6 feet bgs and analyzed at the off-site laboratory for PAL VOCs, SVOCs, inorganics, pesticides/PCBs, and TPHC. Off-site laboratory analytical results for the subsurface soils are provided in Table 7-12.

Inorganics analysis indicated that arsenic, barium, calcium, cadmium, chromium, cobalt, copper, nickel, lead, selenium, silver, sodium, and zinc were present in concentrations that exceeded established background concentrations for Devens soils. The majority of exceedances were located around the southern portion of the soil removal excavation at depths coincident with the observed TPHC and VOC contamination. The surficial sample from 57E-95-25X, located on the northern portion of the site towards Barnum Road, also showed limited exceedances of background concentrations.

Detected VOCs are comprised of TEX, PCE, TCE, and 1,2-DCE. The common laboratory contaminants 2-hexanone, acetone, dichloromethane (methylene chloride) and trichlorofluoromethane (freon) were detected in a number of AOC 57 Area 2 soil samples. These compounds, as well as toluene, were identified in soil blanks or rinsate blanks (see Subsection 7-1 and Tables 7-2 and 7-3).

VOC detections in soil are concentrated around the soil removal excavation in test pits 57E-95-07X, 57E-95-10X, 57E-95-12X, 57E-95-15X, 57E-95-16X, and 57E-95-17X. TEX were also detected in the surficial sample from 57E-95-02X. The highest levels of VOCs were observed in 57E-95-07X in 4 feet bgs with total TEX of 0.344 µg/g, 0.0039 µg/g of 1,2-DCE, 0.011µg/g of TCE, and 0.0059 µg/g of PCE.

SVOC detections were limited to six of the test pit soil samples and consisted of 2-methylnaphthalene, fluoranthene, naphthalene, phenanthrene, pyrene, bis(2-ethylhexyl) phthalate, and di-n-butyl phthalate. Although only two SVOC analytes were detected, 2-methylnaphthalene and naphthalene, the 4 feet bgs sample from 57E-95-07X contained the highest concentration of total SVOCs at 12 µg/g.

The pesticides 4,4-DDE and 4,4-DDT, 0.0199 and 0.0257 µg/g respectively, were detected in the surficial sample from 57E-95-02X located adjacent to the drainage swale in the northern portion of the site. Pesticides and PCBs were detected in the southern portion of the site in explorations adjacent to the soil removal excavation. They included the pesticides dieldrin at a maximum observed concentration of 0.032 µg/g in the surficial sample from 57E-95-17X, 4,4 DDE at 0.00928 µg/g in the same sample, and Endosulfan I at 0.081 µg/g in the 2 foot bgs sample from 57E-95-16X. PCBs were only detected in test pits 57E-95-012X, 57E-95-15X, 57E-95-16X, and 57E-95-17X, all located around the southern perimeter of the soil removal excavation. Maximum observed concentrations were 3.2 µg/g of Aroclor-1248 and 12 µg/g of Aroclor-1260 both from the 2 foot bgs sample from 57E-95-16X.

TPHC was identified in 15 of the test pit soil samples. Significant detections (e.g., >100 µg/g) were limited to the perimeter of the soil removal excavation. Notable detections include 31,800 µg/g in the 4 feet bgs sample from 57E-95-07X, 5,110 µg/g in the surficial sample from 57E-95-12X, 26,100 µg/g in the 2 feet bgs sample from 57E-95-15X, 30,000 µg/g in the 2 feet bgs sample from 57E-95-16X, and 2,390 µg/g in the surficial sample from 57E-95-17X.

RI Soil Boring Off-Site Analytical Results. A total of 11 soil samples were collected from the six Area 2 soil borings, 57B-95-01X through 57B-95-06X. The soil borings were located on the mid- to northern portion of the site above the break in slope and treeline. Samples were collected from soil borings to allow for characterization of soils from greater depths than allowed by test pitting. Samples were collected from depths ranging from the ground surface to 21 feet bgs and analyzed at the off-site laboratory for PAL VOCs, SVOCs, inorganics, pesticides/PCBs, and TPHC. Off-site laboratory analytical results for the subsurface soils are provided in Table 7-12.

Inorganics analysis indicated that cobalt, nickel, and sodium were present in concentrations that exceeded established background concentrations for Devens soils. Sodium was in exceedance of background in every soil boring sample. Exceedances of all other inorganics were limited to the surficial soil samples from 57B-95-01X and 57B-95-02X, both located on the northern portion of the site.

Acetone, dichloromethane (methylene chloride), toluene, and trichlorofluoromethane (freon) were the only VOCs detected. All of these compounds have been defined as possible sampling or laboratory contaminants. Observed toluene concentrations did not exceed 0.0045 µg/g.

The SVOC compounds 2-methylnaphthalene, dibenzofuran, fluoranthene, naphthalene, phenanthrene, pyrene, and bis(2-ethylhexyl) phthalate were detected in the surficial samples from 57B-95-01X and 57B-95-02X. Total SVOC concentrations in 57B-95-01X was 4.174 µg/g which includes 2.7 µg/g of the probable laboratory contaminant bis(2-ethylhexyl) phthalate.

No pesticides or PCBs were detected in the soil boring samples.

TPHC was detected in seven of the soil boring off-site analytical samples. The only significant detections (e.g., in excess of 100 µg/g) occurred in the surficial sample from 57B-95-02X, 7,970 µg/g, and the duplicate sample collected at 5 feet bgs from 57B-95-02X, 138 µg/g.

1998 Surface and Subsurface Soil Sampling Off-Site Analytical Results.

Ten samples from the 1998 soil sampling activities were selected for off-site analysis. Samples were collected from depths ranging between 0 and 3 feet bgs and analyzed at the off-site laboratory for EPH/VPH, TPHC, PAL VOCs, PAL SVOCs, PAL pesticides/PCBs, and select PAL inorganics. Samples were selected for off-site analysis based upon visual evidence, PID screening, and field analytical results. Off-site and on-site analytical results for the 1998 soil sampling are provided in Table 7-13.

The following inorganic analytes were detected at levels in excess of established Devens background concentrations; barium, copper, manganese, lead, zinc and arsenic. The highest concentrations of most of the individual analytes were found in the 0-foot sample from 57S-98-02X. Arsenic was found at a higher level in the 0-foot sample from 57S-98-07X. The bulk of the inorganic background exceedances were found in the surficial samples as opposed to the samples collected between 1 and 3 feet bgs.

Three VOC compounds were detected in the 1998 Area 2 soil samples; 1,2-DCE, ethylbenzene, and acetone. The 1-foot bgs sample from 57S-98-06X contained 0.01 µg/g of 1,2-DCE and 0.003 µg/g of ethylbenzene, 57S-98-07X at 0 feet had 0.33 µg/g of acetone, and the 1-foot bgs sample contained 0.01 µg/g of 1,2-DCE.

SVOC compounds were detected in several of the surficial soil samples. The highest total SVOC concentration, 8.4 µg/g, was found in the 0-foot sample from 57S-98-02X (2-methylnaphthalene, acenaphtylene, benzo[k]flouranthene, chrysene, flouranthene, naphthalene, phenanthrene, and pyrene). The only other significant concentration of SVOCs was found in the 0-foot sample from 57S-98-08X which contained 5 µg/g of total SVOCs (flouranthene, phenanthrene, and pyrene).

Pesticides were detected in seven of the 10 soil samples. The four compounds detected were dieldrin, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. The highest concentrations of total and individual pesticides were found in 57S-98-03X at 2 feet bgs, dieldrin at 0.043 µg/g and 4,4'-DDD at 0.044 µg/g, and 57S-98-09X at 0 feet, 4,4'-DDE at 0.0524 µg/g and 4,4'-DDT at 0.018 µg/g. The PCB congener Aroclor-1260 was detected in eight of the 10 samples collected. The highest concentration was found in the 2-foot bgs sample from 57S-98-03X which contained 5.2 µg/g. All other detections were below 1 µg/g.

TPHC concentrations in the 1998 Area 2 soil samples ranged between 17,000 µg/g and 393 µg/g. Detections in excess of 5,000 µg/g include 17,000 µg/g in 57S-98-07X at 1-foot bgs, 14,800 µg/g in 57S-98-03X at 2 feet bgs, and 6,170 µg/g in 57S-98-07X at 0 feet. TPHC detections were consistent with the contaminant distributions determined by the previous RI work. The highest concentrations were found in the area immediately south of the removal action excavation and test pits 57E-95-15X and 57E-95-16X.

The soil samples were also analyzed by EPH/VPH which is generally recognized as a more reliable means of determining concentrations of petroleum hydrocarbons. TPHC and EPH/VPH values are presented in Table 7-13 and Figure 7-2.

VPH fractions were detected at low levels in nine of the 10 samples analyzed. The highest concentrations were found in 57S-98-07X where the 0-foot and 1-foot samples each contained 15 µg/g of the C9 to C12 aliphatic range (duplicate) and 21 µg/g of the C9 to C10 aromatic range (duplicate). These were also the highest detected concentrations of these fractions. Other detections include 6.4 µg/g of the C9 to C12 aliphatic range and 13 µg/g of the C9 to C10 aromatic range in the 0-foot sample from 57S-98-08X. All other detections were below 5 µg/g for the C9 to C12 aliphatic range. The C9 and C10 aromatic and C5 to C8 aliphatic ranges were not detected in any of the other samples.

Nine of the 10 samples analyzed were shown to contain detectable levels of EPH fractions. The 2-foot bgs sample from 57S-98-03X contained the highest levels of the C19 to C36 aliphatic and C11 to C22 aromatic ranges, 3,300 µg/g and 990 µg/g, respectively. The C9 to C18 aliphatic range was also detected in this sample at 110 µg/g. Sample location 57S-98-07X contained 2,100 µg/g of C19 to C36 aliphatics and 590 µg/g (duplicate) of the C11 to C22 aromatics in the 0-foot sample. The C9 to C18 aliphatic range was below detectable levels in this sample. The 1-foot bgs sample from 57S-98-07X contained 1,600 µg/g of the C19 to C36 aliphatics, 270 µg/g of the C9 to C18 aliphatics, and 450 µg/g of the C11 to C22 aromatic range. Other locations containing elevated levels of EPH fractions include 57S-98-02X at 0 feet, 57S-98-04X at 1-foot bgs, 57S-98-05X at 3 feet bgs, and 57S-98-06X at 1-foot bgs. The EPH analysis yielded far fewer exceedances of MCP standards than did the TPHC values. Furthermore, the exceedances that were observed for the EPH fractions were of a much smaller magnitude than the TPHC exceedances at the same locations.

Area 3

RI Test Pit Soil Sampling Off-Site Analytical Results. A total of five soil samples were collected from the Area 3 test pits 57E-95-24X, 57E-96-28X, 57E-96-29X, 57E-96-30X and 57E-96-31X. Soil samples were selected for off-site analysis based upon visual evidence, PID screening, and on-site analytical results. Samples were collected from depths ranging from 4 to 11 feet bgs and analyzed at the off-site laboratory for PAL VOCs, SVOCs, inorganics, pesticides/PCBs, and TPHC as well as petroleum fingerprinting in 1996. Off-site laboratory analytical results for the subsurface soils are provided in Table 7-12.

Inorganic analytes detected in exceedance of established background concentrations consist of antimony, cadmium, calcium, copper, lead, sodium and zinc. Sodium was in excess of background in all of the samples. The majority of the remaining exceedances occurred in the 4 feet bgs sample from 57E-95-24X.

Ethylbenzene, xylenes, and / or PCE were detected in three of the soil samples from Area 3 test pits. The identified laboratory contaminants 2-hexanone and trichlorofluoromethane (freon) were also detected in the soil samples. PCE was observed at 0.0094 µg/g in the 10 feet bgs sample from 57E-96-28X and 0.0018 µg/g in the 4 feet bgs sample from 57E-95-24X. Ethylbenzene and xylenes were detected in the 10 feet bgs sample from 57E-96-28X at 0.0042 µg/g and 0.066 µg/g respectively. The 6 feet bgs sample from 57E-96-30X was shown to contain 0.13 µg/g of xylenes.

SVOC compounds were detected in all four of the soil samples collected from the test pits excavated in 1996 (57E-96-28X through 57E-96-31X). The bulk of the detections occurred in the 10 feet bgs sample from 57E-96-28X. Detected SVOC analytes consist of 1,2,4-trichlorobenzene at 0.5 µg/g, 1,2-DCB at 6 µg/g, 1,4-DCB at 4 µg/g, 2-methylnaphthalene at 0.4 µg/g, fluoranthene at 1 µg/g, fluorene at 0.3 µg/g, chrysene at 1 µg/g, naphthalene at 2 µg/g, phenanthrene at 0.4 µg/g, and pyrene at 3 µg/g.

The pesticide Aldrin was detected in the 4 feet bgs sample from 57E-95-24X at 0.0255 µg/g. Chlordane-alpha was found in 57E-96-28X at 0.0103 µg/g. In addition, chlordane-alpha and heptachlor epoxide were detected in 57E-96-31X at 0.068 and 0.00691 µg/g respectively.

PCBs were detected in three of the test pit soil samples. The highest observed concentration of PCBs, 3.6 µg/g of Aroclor-1248 and 10 µg/g of Aroclor-1260, was found in 57E-95-24X at 4 feet bgs. 1.7 µg/g of Aroclor-1260 was also found in the 10 feet bgs sample from 57E-96-28X.

TPHC was detected in all of the Area 3 test pit soil samples at concentrations ranging between 64,900 µg/g at 57E-95-24X and 262 µg/g at 57E-96-29X. Petroleum fingerprinting performed on samples collected in 1996 showed that all samples were below detection limit for the gasoline, diesel, and aviation gas patterns. Field analytical results for TPHC are contoured and provided in Figure 7-3.

RI Soil Boring Off-Site Analytical Results. Eleven soil samples were collected for off-site analysis from five soil borings at AOC 57 Area 3 (57B-96-07X through 57B-96-11X). Soil samples were collected from the soil borings to confirm field analytical results and delineate horizontal and vertical distribution of contaminants. Samples were collected from depths ranging from the 0 to 10 feet bgs and analyzed at the off-site laboratory for PAL VOCs, SVOCs, inorganics, pesticides/PCBs, and TPHC as well as petroleum fingerprinting in 1996. Off-site laboratory analytical results for the subsurface soils are provided in Table 7-12.

Inorganics analyses indicated that arsenic, barium, calcium, cadmium, copper, lead, manganese, silver, sodium, and zinc were present in concentrations that exceeded established background concentrations for Devens soils. Sodium was detected in excess of background concentrations in every sample. Inorganic concentrations in soils do not appear to be related to sample depth. The greatest number of reported exceedances were found in the surficial sample from 57B-96-07X.

Analysis for VOCs indicated that six of the samples contained toluene. The majority of the toluene concentrations are consistent with it being reported as a potential laboratory or sampling contaminant. However, the highest detected concentration, 0.31 µg/g at 5 feet bgs in 57B-96-07X, is substantiated by a detection of ethylbenzene at 1.2 µg/g and xylenes at 22 µg/g. PCE was detected in one sample, the surficial sample from 57B-96-07X at a concentration of 0.0057 µg/g.

SVOC compounds were detected in two soil boring samples from Area 3. The 5-foot bgs sample from 57B-96-07X contained 31.3 µg/g of total SVOCs including 8 µg/g of 1,2-

DCB, 2 µg/g of 1,4-DCB, 9 µg/g of 2-methylnaphthalene, and 9 µg/g of naphthalene. The surficial sample from 57B-96-09X contained 0.448 µg/g of total SVOCs.

Pesticides were detected in two of the soil boring samples. The surficial sample from 57B-96-09X was shown to contain 4,4'-DDE and 4,4'-DDT at concentrations of 0.0081 and 0.0121 µg/g respectively. The five feet bgs sample from 57B-96-11X contained 0.017 µg/g of 4,4'-DDE.

Three of the samples contained PCBs. The surficial sample from 57B-96-07X had detections of Aroclor-1240 and Aroclor-1260 at 3.4 and 8 µg/g respectively. The 5-foot bgs sample from the same boring contained 2.6 µg/g of Aroclor-1242 and 6.1 µg/g of Aroclor-1260. Aroclor-1260 was also detected at a concentration of 7.4 µg/g at 5 feet bgs in boring 57B-96-11X.

Five samples were shown to contain measurable levels of TPHC. Three of these samples contained levels in excess of 100 µg/g; the surficial sample from 57B-96-07X contained 41,400 µg/g, the 5 feet bgs sample from the same boring contained 31,600 µg/g, and the 5 feet bgs sample from 57B-96-11X was found to contain 4,250 µg/g. Petroleum fingerprinting of the soil samples indicated that the TPHC contamination was consistent with a motor oil pattern.

1998 Surface and Subsurface Soil Sampling Off-Site Analytical Results.

Three samples from the 1998 soil sampling activities were selected for off-site analysis, 57S-98-13X at 1-foot bgs, 57S-98-14X at 1-foot bgs, and 57S-98-15X at 3 feet bgs (Figure 7-3). Samples were analyzed at the off-site laboratory for EPH/VPH, TPHC, PAL VOCs, PAL SVOCs, PAL pesticides/PCBs, and select PAL inorganics. Samples were selected for off-site analysis based upon visual evidence, PID screening, and field analytical results. Off-site and on-site analytical results for the 1998 soil sampling are provided in Table 7-13.

Arsenic was the only inorganic analyte detected at levels in excess of established Devens background concentrations. The highest detected concentration was 28.2 µg/g in the 3-foot bgs sample from 57S-98-15X.

Five VOC compounds were detected in the 1998 Area 3 soil samples. The 1-foot bgs sample from 57S-98-13X contained 0.012 μg/g of chlorobenzene and 0.0042 μg/g of TCE. 57S-98-15X at 3 feet bgs contained 0.013 μg/g of 1,1,1-TCA, 0.0013 μg/g of toluene, and 0.0041 μg/g of xylenes. There were no VOC detections in 57S-98-14X.

SVOC compounds were detected in two soil samples. The majority of the detections were found in 57S-98-13X at 1-foot bgs which contained 1,2-DCB at 0.35 μg/g, 1,4-DCB at 0.48 μg/g, flouranthene at 0.13 μg/g, phenanthrene at 0.067 μg/g, and pyrene at 0.096 μg/g. The common laboratory contaminant bis(2-ethylhexyl)phthalate was the only SVOC detected in 57S-98-15X 14 μg/g.

Low levels of pesticides were detected in two of the three soil samples. 57S-98-13X at 1-foot bgs contained 0.0028 μg/g of chlordane alpha, 0.0028 μg/g of chlordane gamma, and 0.0234 μg/g of 4,4'-DDD. The only pesticide detected in 57S-98-14X was 4,4'-DDT at 0.0248 μg/g. No pesticides were detected in 57S-98-15X.

57S-98-14X at 1-foot bgs contained the only detection of PCBs, 0.474 μg/g of Aroclor-1260 at 1-foot bgs.

Two of the three soil samples submitted for off-site analysis contained detectable levels of TPHC. 57S-98-13X had 951 μg/g at 1-foot bgs and 57S-98-14X contained 895 μg/g at 1-foot bgs. These results were slightly lower than the on-site TPHC analysis but were consistent with TPHC distributions determined by earlier investigations.

The soil samples were also analyzed by EPH/VPH, which is generally recognized as a more reliable means of determining concentrations of petroleum hydrocarbons. TPHC and EPH/VPH values for Area 3 are presented in Table 7-13 and Figure 7-4.

The only detection of a VPH carbon range was 3.7 μg/g of C9 to C12 aliphatics.

Two of the three soil samples analyzed were shown to contain detectable levels of EPH fractions. The 1-foot bgs sample from 57S-98-13X contained the C19 to C36 aliphatic and C11 to C22 aromatic ranges, 180 μg/g and 60 μg/g respectively. The 1-foot bgs sample from 57S-98-14X also contained the C19 to C36 and C11 to C22 ranges at 150 μg/g and 75 μg/g, respectively. There were no EPH detections in 57S-98-15X. EPH concentrations for these samples were much lower than the respective TPHC concentrations with respect to

MCP standards suggesting that the TPHC analysis was artificially high due to organic content in the soil or potential biogenic TPHC sources.

7.2.2.3 Summary of Soil Impacts.

Area 2

Soil contamination at Area 2 can be divided into two types, surficial contaminants, primarily petroleum hydrocarbons, in the northern portion of the site and higher levels of VOCs, SVOCs, PCBs, and petroleum hydrocarbons in surface and subsurface soils along the southern portion of the soil removal excavation.

Elevated levels of TPHC were observed in the surficial sample from soil boring 57B-95-02X located in the flat, northern portion of the site above the treeline. Other detected contaminants included low levels of SVOCs, pesticides, and PCBs.

The most significant contamination encountered during the 1995 RI efforts was located around the southern portion of the soil removal excavation from the test pit 57E-95-07X to 57E-95-12X at depths ranging from the ground surface to the water table at 4 to 5 feet bgs. Detected VOCs include TEX, 1,2-DCE (cis and trans), TCE, and PCE. The primary SVOCs encountered were naphthalene and methylnaphthalene. Elevated levels of pesticides and PCBs were also observed. High levels of TPHC were coincident with the VOC detections.

The 1998 soil sampling aided in defining the southern extent of the petroleum hydrocarbon contamination south of the Removal Action Excavation. TPHC and/or EPH results from 57S-98-04X, 57S-98-08X, 57S-98-09X, and 57S-9810X all showed decreased concentrations compared to upgradient explorations. Elevated EPH concentrations were observed in the area to the southwest of the Removal Action and at 57S-98-06X.

A comparison of 1998 EPH results and TPHC results showed that EPH results were much lower than TPHC results from the same sample with respect to the MCP screening values. This suggests that the TPHC data may be artificially high due to interference with organic material in the soils or potential biogenic sources.

Elevated levels of arsenic were detected in surficial samples coincident with the petroleum hydrocarbon contamination.

Data gathered during the RI as well as previous investigations suggests that the contaminated soils are due to the historical disposal of vehicle maintenance related wastes. Contaminant distributions indicate that the disposal occurred along the break in slope above the floodplain. Contaminants in surficial soils then percolated/leached into subsurface soils and groundwater where they were transported hydrogeologically downgradient and resorbed to subsurface soils. Contaminants to the south and southeast of the removal action excavation do not appear to be migrating toward the wetland. Contaminant distributions do show that petroleum hydrocarbons and chlorinated VOCs do appear to have migrated toward the wetland southwest of the excavation.

Area 3

Soil sampling of test pits, TerraProbes^{SM}, and soil borings at Area 3 indicated that concentrations of soil contaminants were highest in the area bounded by test pit 57E-95-24X to the north and the soil boring 57B-96-07X to the south. A historic disposal site located from the surface to approximately 5 feet bgs was defined by test pits 57E-96-28X through 57E-96-31X. Advective transport and sorption appears to have aided in the southerly migration of soil contamination.

The most significant observed soil contaminants included the SVOCs naphthalene, 1,2-DCB, and 1,4-DCB. Elevated levels of PCBs in soil were encountered in proximity to the source area.

Elevated levels of TPHCs were observed coincident with the SVOC contamination.

Soil sampling performed in 1998 further defined the downgradient extent of the soil contamination. Downgradient soils showed decreasing levels of petroleum hydrocarbons, VOCs, SVOCs, and arsenic.

A comparison of EPH and TPHC results showed that EPH values were significantly lower than TPHC results from the same sample. This suggests that the TPHC data may be artificially high due to interference with organic material in the soils or potential biogenic sources.

7.2.3 AOC 57 RI Groundwater

The following discussion of groundwater sampling includes field analytical results of water samples collected from TerraProbe^{SM} borings and monitoring well borings as well as the off-site laboratory analytical results for the three rounds of RI groundwater sampling (two rounds at Area 2 and one round at Area 3). Groundwater quality will be discussed separately for Area 2 and Area 3.

7.2.3.1 RI Field Analytical Groundwater Results.

Area 2

During the 1995 investigation, a total of eleven groundwater samples were collected from six monitoring well borings and 5 soil borings at Area 2 and analyzed in the field for BTEX, select VOCs, and GRO (Table 5-1). Data from the monitoring well and soil boring groundwater samples were used to delineate horizontal contaminant distribution and confirm placement of monitoring well locations. In addition, one groundwater sample was collected in 1998 from the piezometer 57P-98-02X. Field analytical results are provided in Tables 7-14 and 7-16.

The only detection was PCE at a concentration of 2.5 µg/L at the water table in the monitoring well boring 57M-95-07X.

Area 3

As part of the 1995 and 1996 investigations, thirty-three groundwater samples were collected from TerraProbe^{SM} points, monitoring well borings, and soil borings. All of the groundwater samples were analyzed in the field for BTEX, select VOCs, and GRO (1995 samples only). In addition, three groundwater samples were collected from the Area 3 piezometers and 57M-96-11X in 1998 and field analyzed for TPHC. Groundwater field screening analyses results are provided in Tables 7-14 and 7-16.

BTEX, chlorobenzene, PCE, and GRO were detected in groundwater samples collected from six TerraProbe^{SM} points in 1995, 57R-95-01X through 57R-95-06X (Figure 5-9). The highest concentrations of BTEX compounds were found in the groundwater sample from

57R-95-05X including 110 µg/L of benzene, 240 µg/L of toluene, 410 µg/L of ethylbenzene, and 1,650 µg/L of xylenes. This sample also contained 43,000 µg/L of GRO, which was in excess of the detection limit. PCE was detected in two samples, 2.1 µg/L in 57R-95-02X and 2.5 µg/L in 57R-95-04X. Based on these results, monitoring well 57M-95-03X was installed at the location of 57R-95-03X.

Field analysis of groundwater samples collected in 1996 showed concentrations of TEX, 1,2-DCB, 1,4-DCB, 1,1-DCE, PCE, and naphthalene. Figure 7-5 shows groundwater contaminant detections for the 1996 sampling event. Notable detections include 3.2 µg/L of PCE at 57B-96-08X, 110 µg/L of 1,2-DCB and 130 µg/L of naphthalene in 57R-96-19X, and 95 µg/L of 1,1-DCE in 57B-96-09X.

TPHC was not detected in the 1998 samples.

7.2.3.2 RI Groundwater Off-Site Laboratory Analytical Sample Results.

Area 2

As part of the RI field investigation HLA installed nine monitoring wells at Area 2 in 1995 (57M-95-01X, 57M-95-02X, 57M-95-04A, 57M-95-04B, 57M-95-05X, 57M-95-06X, 57M-95-07X, 57M-95-08A, and 57M-96-08B) to supplement the two existing Group 3 monitoring wells (G3M-92-02X and G3M-92-07X) (Figure 5-8). Two rounds of groundwater sampling were conducted on all of the monitoring wells. Groundwater samples were analyzed for PAL VOCs, SVOCs, total and filtered PAL inorganics, pesticides/PCBs, TPHC, TDS, and water quality parameters. Analytical results for the Round 1 and Round 2 sampling events are provided in Table 7-15.

Several inorganic analytes were detected above the calculated Devens background concentrations in groundwater. Arsenic, barium, calcium, copper, lead, manganese, potassium, sodium, and zinc were detected above background in the unfiltered samples. The filtered samples contained barium, lead, manganese, potassium, and sodium at levels in excess of the established background concentrations. The greatest numbers of background exceedances were observed in the Round 1 unfiltered samples from 57M-95-01X and 57M-95-04A. The Round 2 samples from these wells showed only one exceedance, sodium in 57M-95-01X. The Round 2 unfiltered samples also showed a dramatic decrease in total suspended solids from Round 1.

Several VOCs were detected in Round 1 and Round 2 groundwater samples. 1,1,1-TCA at 0.5 µg/L, toluene at 0.63 µg/L, 0.56 µg/L of TCE, and 356 µg/L of TPHC were detected in the Round 1 sample from 57M-95-01X. The Round 2 sample contained only toluene at 1.2 µg/L. The Round 2 sample from the other upgradient wells, 57M-95-02X and G3M-92-07X, contained 1.6 µg/L and 0.89 µg/L, respectively, of toluene.

Groundwater contamination in the vicinity of the soil removal excavation contained lower concentrations of toluene than the upgradient samples. However, Round 1 and Round 2 samples from the monitoring wells 57M-95-04A, 57M-95-07X, and 57M-95-08B contained quantities of chlorinated solvents. 1,2-DCE (cis and trans), TCE, and PCE were detected in Round 1 and Round 2 samples from 57M-95-04A. This well also contained the highest observed concentrations of these compounds; 3.6 µg/L of 1,2-DCE (cis and trans) in the Round 1 sample, 1.9 µg/L of TCE in the Round 2 sample, and 16 µg/L of PCE in the Round 2 sample. Round 1 and Round 2 VOC detection data are shown in Figure 7-6.

Diethyl phthalate and bis(2-ethylhexyl) phthalate were the only SVOCs detected in the Round 1 and 2 groundwater samples from Area 2. Both of these compounds have been identified as common laboratory and / or sampling contaminants. Diethyl phthalate was detected in both Round 1 and Round 2 samples , at 2.3 µg/L and 3.2 µg/L respectively, in only one well, 57M-95-02X. Bis(2-ethylhexyl) phthalate was detected in Round 1 and Round 2 samples from both 57M-95-04B and 57M-95-08B. In both of these wells the Round 2 samples were orders of magnitude greater than the Round 1 samples, 5 µg/L for the Round 1 sample and 400 µg/L for the Round 2 in 57M-95-04B and 6.9 µg/L and 300 µg/L in 57M-95-08B.

Endosulfan I was the only pesticide detected in Area 2 groundwater. The Round 1 sample from 57M-95-06X contained 0.0271 µg/L.

No PCBs were detected in Area 2 groundwater.

TPHC was detected in one sample, 57M-95-01X during Round 1 was reported to contain 356 µg/L. TPHC concentrations in this well for Round 2 were below detection limits. As was noted in the inorganics discussion the total suspended solids in this well decreased from 23,200 µg/L in Round 1 to 5,000 µg/L in Round 2.

One groundwater sample was collected in 1998 from the piezometer 57P-98-02X and submitted for off-site analysis for VOCs, SVOCs, select inorganics, pesticides/PCBs, and EPH/VPH.

The inorganics, arsenic, lead, and manganese were detected at levels in excess of established Devens background concentrations. The manganese data was flagged as rejected for QC reasons. Arsenic was detected at 54.5 µg/g and lead at 16 µg/L in the unfiltered samples. The filtered sample contained 73 µg/L of arsenic and 4.4 µg/L of manganese.

Three VOCs were detected in the sample, 1,2-DCE at 13 µg/L; TCE at 0.71 µg/L; and toluene at 0.54 µg/L.

The lone SVOC detected was bis(2-ethylhexyl)phthalate at 6.4 µg/L.

No pesticides or PCBs were detected.

No EPH or VPH ranges were detected.

Area 3

Groundwater samples were collected using low-flow sampling protocols in November of 1996 from seven monitoring wells at AOC 57 Area 3 (G3M-92-07X, 57M-95-03X, 57M-96-09X, 57M-96-10X, 57M-96-11X, 57M-96-12X, and 57M-96-13X). Two rounds of samples were collected from G3M-92-07X and 57M-95-03X in conjunction with the Area 2 groundwater sampling which was performed using conventional purge and bail sampling in the fall of 1995 and winter of 1996. Only the low flow sample data from G3M-92-07X and 57M-95-03X will be incorporated into the Area 3 assessment although all data is provided in Table 7-15. Figure 7-7 shows all analyte detections.

Arsenic, barium, cadmium, calcium, iron, manganese, potassium, sodium, sodium, and zinc were identified at concentrations in excess of established Devens background concentrations. Two of these compounds were detected at levels in excess of MCLs, cadmium at 8.67 µg/L in 57M-95-03X and arsenic at 170 µg/L in the normal and duplicate samples from 57M-96-11X.

VOCs were detected in 57M-95-03X, 57M-96-11X, 57M-96-12X, and 57M-96-13X. Toluene was found in all of these samples with a maximum concentration of 19 µg/L in 57M-95-03X. Toluene, at 1.1 µg/L, was the only VOC detected in 57M-96-12X. 57M-96-13X contained toluene at 2.9 µg/L, ethylbenzene at 2.8 µg/L, and the only detection of styrene with 8 µg/L. Chlorinated solvents comprised the majority of the detections in 57M-95-03X and 57M-96-11X. 57M-95-03X contained 4.5 µg/L of carbon tetrachloride, 10 µg/L of chloroform, 2.9 µg/L of dichloromethane, 0.59 µg/L of TCE, 2.6 µg/L of PCE, as well as 46 µg/L of ethylbenzene and 200 µg/L of xylenes. 57M-96-11X contained 0.89 µg/L of 1,2-DCE (cis and trans), 1.1 µg/L of TCE, and 4.8 µg/L of PCE. This sample also contained 0.86 µg/L of toluene, 4.6 µg/L of ethylbenzene, and 6.8 µg/L of xylenes.

The majority of SVOC detections occurred at 57M-95-03X and 57M-96-11X. 57M-95-03X, located immediately downgradient of the identified source area contained 9.8 µg/L of 1,2-DCB, 5.6 µg/L of 1,4-DCB, 4.4 µg/L of 2-methylnaphthalene, 1.5 µg/L of 4-methylphenol, and 20 µg/L of naphthalene. The duplicate sample from 57M-96-11X, the furthestmost downgradient well contained 3.4 µg/L of 1,2-DCB, 3.3 µg/L of naphthalene, and 6.7 µg/L of bis(2-ethylhexyl) phthalate. Other SVOC detections include 5 µg/L of methylphenol in 57M-96-13X and 12 µg/L of bis(2-ethylhexyl) phthalate in the sample from the upgradient well G3M-92-07X.

No pesticides, PCBs, or TPHC were detected in Area 3 groundwater.

Additional groundwater sampling was performed at Area 3 in May of 1998. Samples were collected from the piezometers 57P-98-03X and 57P-98-04X, as well as the monitoring well 57M-96-11X. The groundwater samples were submitted for off-site analysis for VOCs, SVOCs, select inorganics, pesticides/PCBs, and TPHC.

The inorganic analytes arsenic, barium, copper, lead, and manganese were detected in the unfiltered samples at levels in excess of established Devens background concentrations. Arsenic was the only analyte to exceed background concentrations in the filtered sample. The highest concentration of arsenic detected in an unfiltered sample was 84.4 in a duplicate sample collected from 57M-96-11X. The filtered samples collected from 57M-96-11X contained higher levels of arsenic, 138 µg/L in the duplicate sample. The normal sample from 57M-96-11X contained comparable arsenic concentrations, 84.4 µg/L in the unfiltered sample and 133 µg/L in the filtered sample. Total suspended solids in this sample were 2,120,000 µg/L. Arsenic levels in the piezometers were significantly lower, 13.4 µg/L and 20.9 µg/L in the unfiltered and filtered samples collected from 57P-98-03X and 7.7 µg/L and 12.7 µg/L in the unfiltered and filtered samples collected from 57P-98-04X. There is no known explanation for the uniform increase in arsenic concentrations from the unfiltered to the filtered samples. All other inorganic analyte concentrations decreased from the unfiltered to the filtered samples.

The majority of VOC detections occurred in 57M-96-11X. PCE was detected at 5.5 µg/L, TCE at 3.8 µg/L, ethylbenzene at 20 µg/L, and xylenes at 5.8 µg/L. Two VOCs were detected in 57P-98-03X, ethylbenzene at 3.2 µg/L, and xylenes at 5.7 µg/L. Chlorobenzene at 0.88 µg/L was the only VOC detected in 57P-98-04X.

Five SVOCs were detected in the 1998 Area 3 groundwater samples. The most detections occurred in 57P-98-03X which contained bis(2-ethylhexyl)phthalate at 52 µg/L, 1,2-DCB at 4.9 µg/L, 2-methylnaphthalene at 2 µg/L, and naphthalene at 13 µg/L. 57M-96-11X contained detectable levels of three SVOC compounds, 1,2-DCB at 6.4 µg/L, 1,4-DCB at 2.7 µg/L, and naphthalene at 6.2 µg/L.

No pesticides or PCBs were detected in the 1998 Area 3 groundwater samples.

No EPH fractions were detected.

All three VPH carbon ranges were detected in the sample collected from 57M-96-11X. The C5 and C8 aliphatic range was detected at 91 µg/L, the C9 to C12 aliphatic range at 75 µg/L, and the C9 to C10 aromatic range at 250 µg/L (duplicate sample). The highest concentration of aromatics, 310 µg/L, was detected in 57P-98-03X. This was the only VPH fraction detected in this sample.

7.2.3.3 Summary of Groundwater Impacts

Area 2

Identified Area 2 groundwater contaminants include 1,2-DCE, TCE, PCE, and toluene. As with the soil contamination, the contamination is localized around the southern perimeter of the soil removal excavation. In addition, PCE was detected in both Rounds 1 and 2 at 57M-95-07X located approximately 140 feet west of the excavation.

No SVOCs, other than probable laboratory contaminants, were identified in Area 2 groundwater.

Endosulfan in the Round 1 sample from 57M-95-06X was the only pesticide detected in groundwater.

No PCBs were detected in Area 2 groundwater.

The only Area 2 TPHC detection, 356 µg/L, occurred in the Round 1 sample from the upgradient well 57M-95-01X.

Area 3

Area 3 groundwater contamination occurs primarily from the source area located immediately north of 57M-95-03X to the furthestmost downgradient monitoring well 57M-96-11X. Contaminants observed in this area include inorganics, VOCs and SVOCs.

Elevated levels of cadmium and arsenic were observed in 57M-95-03X and 57M-96-11X, respectively. Arsenic concentrations decreased dramatically in the piezometers located downgradient of 57P-96-11X.

Detected VOCs include TEX, TCE, and PCE. Additional VOCs detected in the source area well 57M-95-03X include carbon tetrachloride and chloroform. Additional VOCs detected at the downgradient well 57M-95-11X consist of the chlorinated organic degradation product 1,2-DCE. The downgradient piezometers 57P-98-03X and 57P-98-04X contain only low levels of ethylbenzene and chlorobenzene.

SVOCs are significant groundwater contaminants at Area 3. SVOCs detected consist of 1,2-DCB, 1,4-DCB, and naphthalene. These SVOCs were detected at both the source area well 57M-95-03X and the downgradient well 57M-96-11X and piezometer 57P-98-03X.

No pesticides, PCBs, or TPHC were detected in Area 3 off-site groundwater samples.

7.2.4 RI Sediment

RI sediment sampling was conducted at Area 2 in 1995 and 1998 and at Area 3 in 1998.

The 1995 sampling consisted of the collection of fourteen sediment samples, including a duplicate sample, from eight sample locations (57D-95-03X through 57D-95-10X) in Cold Spring Brook and its associated wetlands in the vicinity of AOC 57 Area 2 (Figure 5-8). Two sediment samples, a surficial and one from 2 feet bgs, were collected from 57D-95-03X through 57D-95-07X. Surficial sediment only was collected at 57D-95-08X through 57D-95-10X. Sediment samples were analyzed for select PAL VOCs, SVOCs, inorganics, pesticides, PCBs, TOC, TPHC, and petroleum fingerprinting. Results of the off-site sediment sample analyses are presented in Table 7-17. In 1998 three additional surface water and sediment pairs were collected at Area 2 (57D/W-98-01X through 57D/W-98-03X). Also in 1998 five surface water and sediment pairs were collected from the Area 3 wetlands (57D/W-98-04X through 57D/W-98-08X, Figure 5-9). The 1998 samples were analyzed for PAL VOCs, SVOCs, select inorganics, pesticides, PCBs, EPH/VPH, and TPHC (sediment only).

Area 2 Sediment. Background concentrations for inorganics in sediment have not been established for the Devens area; therefore, inorganic concentrations in 1995 sediment samples 57D-95-03X through 57D-95-10X were compared against established background concentrations for Devens soils. Exceedances of background concentrations were noted for arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, sodium, vanadium, and zinc. The surficial sediment samples had far more exceedances of background concentrations than the deeper sediment samples. There were no apparent correlations between sample locations and the number of background exceedances. However, the greatest number of maximum observed concentrations occurred at the upstream sample 57D-95-03X. Maximum concentrations and their respective sample locations are as follows: arsenic, 180 µg/g at 57D-95-03X; barium, 159 µg/g at 57D-95-07X; beryllium, 2.8 µg/g at 57D-95-04X (2 feet below surface); cadmium, 2.33 µg/g at 57D-95-05X; calcium, 18,400 µg/g at 57D-95-07X; chromium, 98.8 µg/g at 57D-5-05X (2 feet below surface); cobalt, 29.9 µg/g at 57D-95-03X; copper, 201 µg/g at 57D -95-04X (1 foot below surface); iron, 31,500 µg/g at 57D-95-03X; lead, 410 µg/g at 57D-95-04X (1 foot below surface); manganese, 3,940 µg/g at 57D-95-07X; mercury, 0.36 µg/g at 57D-95-06X; nickel, 46.8 µg/g at 57D-95-03X; selenium, 3.24 µg/g at 57D-95-03X; sodium, 3,610 µg/g at 57D-95-04X (1 foot below surface); vanadium, 46.4 µg/g at 57D-95-03X; and zinc, 468 µg/g at 57D-95-09X.

The 1998 samples contained three compounds that exceeded background concentrations. The sediment sample CSD-98-01X, located on the edge of the marsh on the upstream side of the containment dike, contained 14.3 μg/g of copper and 220 μg/g of arsenic. This was the highest concentration of arsenic detected in Cold Spring Brook sediments. The other background exceedance occurred in 57D-98-02X, located on the edge of the marsh on the downstream side of the containment dike. This sample contained lead at 88.9 μg/g. There were no background exceedances in the furthestmost downgradient sample 57D-98-03X.

The 1995 and 1998 sediment data are consistent with the results of the Lower Cold Spring Brook SI (ABB-ES, 1995) which concludes that inorganic concentrations tend to be highest in the upstream sample CSD-98-13X and Area 2 marsh samples CSD-98-14X, CSD-94-20X, and CSD-94-35X. The downstream samples CSD-94-17X, SSD-93-92G, and CSD-94-19X generally contained lower inorganic concentrations than the upstream samples. The lowest concentrations were in CSD-94-19X, the most downstream of the Lower Cold Spring Brook SI samples collected for AOC 57.

The inorganic results show that elevated levels of arsenic are present at the edge of the Area 2 marsh on the upstream side of the containment dike. However, arsenic concentrations in sediment collected from the marsh between Area 2 and the stream channel (e.g., CSD-94-14X, CSD-94-20X, CSD-94-35X, 57D-95-04X, and 57D-95-05X, Figure 5-6) showed much lower arsenic concentrations, all below the MCP S-1/GW-1 standard. This indicates that arsenic contamination in sediment within the stream channel is attributed to upstream sources or conditions as evidenced in the upgradient samples G3D-92-01X and 57D-95-03X. Results of the Lower Cold Spring Brook SI and RI sampling showed that arsenic concentrations in sediment decrease in the downstream direction (Figure 7-8). Historical photographs show that between 1920 and 1960, apple orchards were located adjacent to the south side of Cold Spring Brook southwest (upstream) of Area 2. The orchards and railroad tracks, which cross Barnum Road, are a potential source of the observed upstream arsenic contamination.

The common laboratory contaminants acetone, dichloromethane (methylene chloride), toluene, and trichlorofluoromethane (freon) were detected in several of the 1995 sediment samples. Toluene was detected in six of the sediment samples and is consistent with soil and groundwater contamination at AOC 57 Area 2. One of the toluene detections occurred at an upstream sampling location, 0.0028 μg/g in the 2 feet below surface sample from 57D-95-03X. The maximum concentration observed in sediments of 0.02 μg/g in the 1 foot below surface sample from 57D-95-04X, located in the marsh area upstream of the containment dike. PCE and chlorobenzene were detected in only one of the 1995 RI sediment samples. The 2 feet below surface sample from the upstream location 57D-95-03X contained 0.0046 µg/g of PCE and 0.0016 µg/g of chlorobenzene.

The 1998 sediment samples from Area 2 contained two VOC compounds, PCE and TCE. 57D-98-01X, located on the upstream side of the containment dike contained 0.078 µg/g of PCE. 57D-98-02X, located on the downstream side of the containment dike contained 0.01 µg/g of PCE and 0.027 µg/g of TCE. There were no VOC detections in 57D-98-03X. The 1995 and 1998 data show that AOC 57 Area 2 is contributing small amounts of chlorinated VOCs (PCE and TCE) to near shore sediments. PCE and TCE were not detected in stream channel sediments. The data also suggests that Area 2 may be a source of toluene contamination in sediments although toluene was detected in upstream sediments.

The SVOCs benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene were detected in 1995 RI sediment samples. Chrysene was found in only one of the samples, the 2 feet below surface sample from the downstream location 57D-95-07X at 0.46 µg/g, while the rest of the compounds were found in both upstream and downstream samples. The highest concentrations of total SVOCs were observed in the duplicate surficial sample from the upstream location 57D-95-03X and the surficial sample from 57D-95-07X, located downstream from the containment dike. Respective SVOC concentrations were 19 µg/g at 57D-95-03X and 18 µg/g in 57D-95-07X.

Benzo(k)flouranthene, chrysene, flouranthene, phenanthrene, and pyrene were detected in the 1998 sediment samples. The highest total concentration of SVOCs as well as the highest individual concentrations were found in 57D-98-02X which contained 6.65 µg/g of total SVOCs. 57D-98-01X had 3.05 µg/g of total SVOCs and 57D-98-03X contained 2.20 µg/g. These data suggests that Area 2 is contributing small amounts of SVOCs to the wetland. However, the 1995 RI sampling and the Lower Cold Spring Brook SI showed that much higher concentrations were detected in the upstream samples 57D-95-03X and CSD-94-13X indicating an upstream source.

Ten of the 1995 RI sediment samples were found to contain pesticides. The surficial sediment samples contained higher concentrations than the deeper sediment samples. The highest concentrations of total pesticides as well as the maximum observed concentrations of individual analytes were observed in the upstream samples. The upstream surficial samples from locations 57D-95-08X and 57D-95-03X both contained 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT at total concentrations of 0.79 µg/g and 1.165 µg/g, respectively. The deeper sample (2 feet below surface) at 57D-95-03X contained 4,4'-DDD and 4,4'-DDE at a total concentration of 0.0719 µg/g. Surficial samples from the area immediately upstream of the containment dike had concentrations of total pesticides of 0.7081 (57D-95-05X) and 0.678 µg/g (57D-95-06X). The only detection of the pesticide dieldrin, at 0.0183 µg/g, was found in the surficial sample from 57D-95-05X. Sample locations downstream of the containment dike contained the smallest concentrations of total pesticides.

Pesticides were detected in two of the three 1998 sediment samples. 57D-98-02X contained 0.091 µg/g of 4,4'-DDD and 57D-98-03X contained 0.0418 µg/g of 4,4'-DDD and 0.046 µg/g of dieldrin. No pesticides were detected on the upstream side of the containment dike at 57D-98-01X. As with many of the previous analytes the highest concentrations have been found at the upstream locations and not adjacent to AOC 57 Area 2.

PCBs were found in only one 1995 RI sediment sample. The surficial sediment sample from 57D-95-05X was found to contain 0.301 µg/g of Aroclor-1260.

None of the 1998 sediment samples contained PCBs.

TPHC concentrations in 1995 RI sediment samples from Cold Spring Brook ranged between 106 µg/g in the deep sediment sample from 57D-95-07X and 3170 µg/g in the surficial sample from 57D-95-05X. The highest observed TPHC concentrations were observed in the surficial samples located immediately upstream of the containment dike adjacent to AOC 57 Area 2. Petroleum fingerprinting of the sediment samples indicated that the upstream and downstream samples were comprised of both the diesel and gasoline patterns while the samples collected adjacent to Area 2 were predominately of the diesel pattern.

TPHC concentrations in the samples collected in 1998 ranged between 103 µg/g in 57D-98-01X and 452 µg/g in 57D-98-02X. EPH/VPH carbon ranges for these samples were all below detection levels (Figure 7-2).

Area 3 Sediment. Five sediment samples were collected from the wetlands immediately south of AOC 57 Area 3 in 1998 (Figure 5-9 and 7-4). 1998 sediment sample locations are approximately 350 feet northwest of the Cold Spring Brook Stream channel. Inorganics analysis of these samples showed that arsenic, barium, lead, manganese, and zinc were present at levels in excess of established Devens soil background levels. The greatest number of exceedances were found in 57D-98-05X which contained arsenic at 37.1 µg/g, lead at 64.6 µg/g, and zinc at 90.8 µg/g. Barium at 59.8 µg/g and copper at 459 µg/g were above background levels in 57D-98-04X. Arsenic at 37 µg/g was the only background exceedance in 57D-98-06X.

Several sediment samples were collected from the portion of Cold Spring Brook located hydrogeologically downgradient from Area 3 as part of the Lower Cold Spring Brook SI. These samples include CSD-94-16X and CSD-94-18X. CSD-94-26X represents conditions downstream of this area and G3D-92-02X, CSD-94-19X, and the 1995 RI samples 57D-95-07X and 57D-95-10X represent conditions upstream. A review of inorganic data from these locations indicates that Area 3 is not impacting sediment quality in Cold Spring Brook which is located approximately 350 feet to the southeast. The Lower Cold Spring Brook SI stated that inorganics concentrations were generally higher in upstream samples than in the downstream samples. Arsenic concentrations in this area follow a general trend of decreasing from the upstream locations (e.g., G3D-92-02X, CSD-94-19X, 57D-95-07X and 57D-95-10X) to the downstream locations (CSD-94-26X and CSD-94-27X) (Figure 7-8). One of the further downstream samples, G3D-92-03X, did exhibit an elevated arsenic concentration of 95.2 µg/g. This result is not corroborated by any sample results either immediately upstream or downstream.

The VOCs acetone, benzene, chlorobenzene, toluene, and xylene were detected in Area 3 sediment samples. Acetone was found in every sample at concentrations ranging between 0.21 and 0.057 µg/g. 57D-98-08X had the most detections, 0.037 µg/g of benzene, 0.0031 µg/g of chlorobenzene, 0.0048 µg/g of toluene, and 0.011 of xylenes. 57D-98-06X was found to contain 0.007 µg/g of benzene, 0.013 µg/g of chlorobenzene, and 0.0047 of toluene. 57D-98-05X contained low levels of chlorobenzene and toluene, 0.019 µg/g and 0.0018 µg/g respectively. There is no evidence that Area 3 VOCs are adversely impacting the wetlands or Cold Spring Brook sediments.

The SVOCs 1,2-DCB, 1,4-DCB, benzo(b)flouranthene, benzo(k)flouranthene, chrysene, flouranthene, naphthalene, phenanthrene, and pyrene were detected in Area 3 sediment samples. The highest concentration of total SVOCs was found in 57D-98-05X, 3.27 µg/g. The SVOCs detected in sediment are consistent with those detected in source area and downgradient soils and groundwater. The SVOC concentrations decrease farther into the wetland, 57D-98-07X contained 1.86 µg/g and 57D-98-08X contained 0.415 µg/g.

The Lower Cold Spring Brook SI samples (Appendix E) collected from the portion of the brook downgradient of Area 3 (Bowers Brook area) showed that SVOCs decreased from the upstream samples to the downstream samples. Pyrene at 1 µg/g was the only SVOC detected at CSD-94-18X and no SVOCs were detected in the downstream sample CSD-94-26X.

One pesticide was detected in Area 3 sediments. 4,4'-DDD was detected in 57D-98-05X at 0.048 µg/g and in 57D-98-06X at 0.15 µg/g. Pesticides were not detected in any other 1998 Area 3 sediment samples.

Of the samples included in the Lower Cold Spring Brook SI, only CSD-94-18X was analyzed for pesticides. 4,4'-DDD was found in this sample at 0.0498 µg/g. This pesticide was also found in upstream samples near Area 2.

PCBs were detected in one of the Area 3 sediment samples. 57D-98-05X contained 0.84 µg/g of aroclor 1260. PCBs were not detected in Lower Cold Spring Brook SI samples.

TPHC concentrations ranged between 3,540 µg/g at 57D-98-05X and 109 µg/g at 57D-98-08X. Besides 57D-98-05X, all other samples contained less than 250 µg/g of TPHCs. VPH analysis of these samples showed that 57D-98-06X contained small concentrations of all carbon fractions; 3.3 µg/g of C5-C8 aliphatics, 5.6 µg/g of C9-C12 aliphatics, and 4.3 µg/g of C9-C10 aromatics. The only other VPH detection occurred in 57D-98-05X which contained 4.2 µg/g of C9-C12 aliphatics. EPH fractions were detected in only one sample, 57D-98-05X 57D-98-05X contained 630 µg/g of the C19-C36 aliphatics and 280 µg/g of the C11-C22 aromatics. The TPHC and EPH detections at 57D-98-05X correspond with the observed distribution of soil contamination at Area 3.

7.2.5 Surface Water

Area 2. During the 1995 RI field phase nine surface water samples, including a duplicate sample, were collected at the eight sediment sample locations (57D-95-03X through 57D-95-10X) in Cold Spring Brook and its associated wetlands in the vicinity of AOC 57 Area 2 (Figure 5-6 and 5-8). Filtered surface water samples were also collected at the toxicity testing locations 57D-95-04X, 57D-95-05X, 57D-95-06X, 57D-95-08X, and 57D-95-10X. Surface water samples were analyzed for select PAL VOCs, SVOCs, inorganics, pesticides, PCBs, TPHC, and water quality parameters. Results of the off-site surface water sample analyses are presented in Table 7-19.

Background concentrations for inorganics in surface water have not been established for the Devens area; therefore, inorganic concentrations in the 1995 surface water samples 57D-95-03X through 57D-95-10X were compared against established background concentrations for Devens groundwater. Calcium, iron, manganese, sodium, and zinc were shown to be in excess of background concentrations in the filtered surface water samples. The unfiltered surface water samples also showed exceedances of these compounds as well as aluminum, arsenic, barium, cadmium, chromium, copper, lead, magnesium, mercury, potassium, and vanadium. The bulk of the exceedances occurred in the unfiltered sample from 57D-95-04X. The filtered sample showed exceedances of only calcium and sodium. The large number of background exceedances are attributed to an elevated TSS concentration of 504,000 µg/g in the unfiltered sample. The greatest number of background exceedances in a filtered sample was observed at 57D-95-05X, located adjacent to Area 2. This sample contained calcium, iron, manganese, sodium and zinc all in excess of background concentrations.

Three additional surface water samples, 57W-98-01X through 57W-98-03X, were collected in 1998 to further characterize the impact of Area 2 on Cold Spring Brook and the associated wetlands. The samples were collected from the same locations as the 1998 sediment samples. The samples were submitted for off-site analysis for PAL VOCs, SVOCs, select inorganics, select dissolved inorganics, pesticides, PCBs, and EPH/VPH. Water quality parameters were also measured at the time of sample collection.

All three of the unfiltered samples contained arsenic, barium, copper, lead, and zinc in excess of background levels. The highest concentrations of all inorganic analytes were observed in 57W-98-02X. None of the filtered samples contained inorganic analytes in excess of background.

In contrast to the sediments, toluene was found in only one of the 1995 Area 2 surface water samples, the upstream sample 57D-95-08X at 0.58 µg/L. The common laboratory contaminant dichloromethane (methylene chloride) was found in five of the surface water samples. The only other VOCs detections in the 1995 RI surface water samples occurred at 57D-95-05X. This sample was shown to contain 1.8 µg/L of PCE, 3.5 µg/L of TCE, and 26 µg/L of DCE (cis and trans). This sample location is located in the groundwater discharge area southwest of the Area 2 soil removal excavation.

Similar results were found during the 1998 surface water sampling. 57W-98-01X, collected from a flowing seep on the upstream side of the containment dike, contained 2.6 µg/L of PCE and 0.6 µg/L of TCE. This data along with 57D-95-05X indicate that Area 2 is contributing chlorinated organic compounds to surface water. Two VOCs, chloroform at 0.72 µg/L and carbon disulfide at 1.1 µg/L were detected in 57W-98-02X. Toluene at 1.1 µg/L was the only VOC detected in 57W-98-03X.

SVOCs were detected in one of the 1995 RI surface water samples. 57D-95-04X, located upstream of AOC 57 Area 2 contained 0.52 µg/L of phenanthrene and 24 µg/L of bis(2ethylhexyl) phthalate. This was also the sample exhibiting the highest TSS.

No SVOCs were detected in the 1998 Area 2 surface water samples.

No pesticides or PCBs were detected in either the 1995 or 1998 surface water samples.

TPHCs were found in two of the 1995 RI surface water samples. 57D-95-04X contained 924 µg/L and 57D-95-05X contained 247 µg/L. The detection at 57D-95-04X may be partially attributed to the elevated TSS concentrations observed in the sample.

No VPH carbon fractions were detected in the 1998 Area 2 surface water samples.

The C19 to C36 aliphatic and C11 to C22 aromatic EPH ranges were detected in all of the 1998 surface water samples. The highest concentrations were found in 57W-98-02X which contained 1,700 µg/L of the C19 to C36 aliphatic range and 1,400 µg/L of the C11 to C22 aromatic range.

Area 3. Five surface water samples were collected in 1998 from the wetlands immediately south of Area 3. Samples were submitted for off-site analysis for EPH/VPH, PAL VOCs, SVOCs, select inorganics, select dissolved inorganics, pesticides, and PCBs. Surface water sample locations are provided in Figures 5-6 and 5-9. Analytical data are provided in 7-20.

Arsenic, antimony, barium, copper, lead, and zinc were all found in excess of established Devens background groundwater concentrations. 57W-98-05X contained exceedances of all of the above analytes and 57W-98-07X had the fewest exceedances with only barium and lead in excess of background. The filtered samples from 57W-98-04X (24 µg/L), 57W-98-05X (53.4 µg/L), and 57W-98-08X (12.5 µg/L) contained arsenic in excess of background levels. These were the only background exceedances in the filtered samples.

Two of the Area 3 surface water samples contained detectable levels of VOCs. 57W-98-05X contained 4.6 µg/L of chlorobenzene, 0.58 µg/L of carbon disulfide, and 1.6 µg/L of toluene. Toluene at 0.59 µg/L was the only VOC detected in 57W-98-08X.

Benzo[k]flouranthene at 0.94 µg/L in 57W-98-08X was the only SVOC detected in Area 3 surface water samples.

No pesticides or PCBs were detected in Area 3 surface soil samples.

The C9 to C10 aromatic range was the only VPH fraction detected at Area 3. The surface water sample 57W-98-05X contained 25 µg/L of the aromatic range.

The EPH C11 to C22 aromatic ranges were detected in every surface water sample. The highest concentration was 650 µg/L in 57W-98-08X. The 57W-98-08X sample and 57W-98-04X were also found to contain the C19 to C36 aliphatic fraction at 1,100 µg/L and 1,000 µg/L, respectively.

7.3 AREA 3 SOIL REMOVAL ACTION

Confirmatory soil samples were collected from the excavation walls and floor following each of the three phases of excavations. The soil samples were submitted for off-site analysis for EPH/VPH, pesticides, and PCBs. The following section summarizes the results of the confirmatory sampling and discusses the residual soil contamination at Area 3. Confirmatory sampling results are provided in Table 7-21 and sampling locations are shown in Figure 5-9.

VPH carbon ranges were detected along the eastern and western walls of the southern tongue of the excavation. The highest concentrations were detected along the western wall approximately 40 feet north of the southern terminus of the excavation where EX57W16X at 2 feet bgs was shown to contain 890 µg/g of C9 to C12 aliphatics and 600 µg/g of C9 to C10 aromatics. Elevated VPH levels were also found in EX57W14X which contained 52 μg/g of the C9 to C12 aliphatics and 55 μg/g of the C9 to C10 aromatics.

Elevated levels of EPH were found at 1 to 2 feet bgs along the southern extent of the excavation. The highest concentrations were found in EX57W14X which contained 920 μg/g of C9 to C18 aliphatics, 20,000 μg/g of C19 to C36 aliphatics, and 3,100 μg/g of C11 to C22 aromatics. EX57W15X and EX57W16X also contained high levels of EPH aliphatic and aromatic ranges.

The pesticides dieldrin, endrin, and 4,4'-DDD were found coincident with the EPH detections in the southern portion of the excavation. Dieldrin was found at 2 feet bgs in EX57W14X and EX57W16X at 0.14 μg/g and 0.086 μg/g, respectively. EX57W16X was the only sample to contain endrin 0.07 μg/g. Low levels of 4,4'-DDD, 0.24 to 0.29 μg/g, were detected at 1 to 2 feet bgs in EX57W15X, EX57W16X, and EX57F01X.

Residual PCB contamination was detected at 2 feet bgs in EX57W14X at 4.3 μg/g. PCBs were also detected in the floor sample EX57F01X at 2.6 μg/g. PCB detections consisted of the congener Aroclor 1260.

Residual contamination is located at 1 to 2 feet bgs in the southern portion of the excavation in the vicinity of EX57W14X, EX57W15X, and EX57W16X. The Removal Action showed that the soil contamination was primarily confined to a subsurface zone of eluviated organic silty sand varying in thickness from 2-inches to 1-foot. This layer varied in depth from three to five feet in the northern source area to 1-foot in the southern extent of the excavation.

8.0 CONTAMINANT FATE AND TRANSPORT

This subsection discusses the migration potential and probable environmental fate of general contaminant groups identified at AOC 57 Areas 2 and 3. Compounds and analytes detected include VOCs, SVOCs, inorganics, and TPHC. The observed distribution of these contaminants in different environmental media (soil, groundwater, sediment, and surface water) is the result both of the release pattern and of their physical and chemical properties. For organic chemicals, these properties include specific gravity, solubility, volatility, and organic carbon partition coefficient (K_{oc}). For inorganic constituents, the physical and chemical properties include oxidation state of the analyte, pH, and specific solute species. Site-specific conditions governing fate and transport (e.g., persistence and migration) of analytes include contaminant concentration, topography, meteorological conditions, and in the case of groundwater, hydrogeology.

8.1 COMPOUND PROPERTIES AND TRANSPORT PROCESSES

The primary contaminants detected in soil at AOC 57 are fuel, waste oil, and solvent-related VOCs, SVOCs, TPHC and PCBs. In addition, some VOCs and SVOCs may have been introduced in samples as laboratory contamination.

The persistence of compounds in soil is determined by chemical properties, source configurations and releases, geochemical and biochemical reactions, and soil and meteorological conditions. Factors and processes that control the persistence of chemicals in water-bearing units, in addition to the aforementioned factors, are water-bearing unit characteristics, advection, and hydrodynamic dispersion. Compounds may exist in the surface and subsurface in gaseous, aqueous, or solid phases. The fate of these compounds is controlled by a combination of all of these factors.

The following subsections discuss general physical and chemical properties, and how these properties affect transport and general attenuation processes.

8.1.1 Physical and Chemical Properties Significant to Fate and Transport

This subsection discusses the physical and chemical properties that affect the fate and transport of contaminants in the environment. Physical and chemical properties of organic contaminants of concern detected at AOC 57 are presented in Table 8-1. Table 8-2 summarizes the relative mobilities of selected inorganic elements in different chemical environments.

Most physical and chemical properties of Target Compound List (TCL) analytes, including specific gravities, K_{oc}, relative solubility, and relative volatility, are described in "Basics of Pump-and-Treat Groundwater Remediation Technology" (USEPA, 1990b). This reference document does not include inorganics, because analyses conducted measure the total amount of a particular constituent in the sample rather than the actual chemical form or metal oxidation state. The distribution of specific solute species, pH, and oxidation are important factors in establishing the total solubility or mobility of a given inorganic element.

Specific gravity is the ratio of the mass of a given volume of a liquid substance to the mass of an equal volume of water. Liquids with specific gravities greater than 1 are termed "heavier" than water.

Solubility measures the partitioning between the aqueous phase and solid form of a chemical, and the tendency of a material to dissolve in water. Substances with lower solubilities are more likely to remain in a separate phase when in contact with water; substances with higher solubilities will dissolve into, and move with, water.

Volatility measures the tendency of a chemical to partition into the gaseous phase. Volatility can be predicted by an analyte's vapor pressure and Henry's Law Constant value (H). Volatility of a compound increases with increasing vapor pressure. Compounds with H values less than $1.0x10^{-5}$ (e.g., dimethyl phthalate pyrene) have a low degree of volatility, and those with H values below $3.0x10^{-7}$ are considered non-volatile (PCBs). H values between $1.0x10^{-5}$ and $1.0x10^{-3}$ (e.g., naphthalene and phenanthrene) are moderately volatile, while those with values exceeding $1.0x10^{-3}$ (e.g., VOCs) are considered highly volatile.

K_{oc} measures the extent that an organic chemical partitions between a solid phase and a liquid phase, and is used to predict to what extent a chemical could be adsorbed to soil organic carbon. Chemicals with a K_{oc} greater than 10,000 will adsorb strongly to soil organic carbon (e.g., fluoranthene, phenanthrene, and pyrene) Chemicals with a K_{oc} ranging from 1,000 to 10,000 will moderately adsorb, and move slowly in the soil profile (e.g., naphthalene). Chemicals with a K_{oc} of less than 1,000 weakly adsorb to soil organic carbon and tend to be more mobile. Examples of weakly adsorbed compounds include many VOCs such as benzene and xylene.

8.1.2 General Transport and Attenuation Processes

Migration and persistence are controlled by various transport and attenuation processes. Processes that tend to disperse contaminants include surface water and groundwater movement (which includes the movement of dissolved and suspended contaminants), facilitated transport, leaching by dissolution or desorption, and surface erosion.

The solubility of a compound in water is considered to be the most important transport factor, because it determines the maximum concentration dissolved in water. Knowledge of the solubility of a chemical provides considerable insight into the fate and transport of that chemical. In general, highly soluble compounds are less likely to partition into soil or sediment, or to volatilize from water, and are more likely to biodegrade (Montgomery, 1991).

Dissolved phase transport can occur via two processes: advection or dispersion. Advection involves transport with flowing groundwater and migrating with the mean velocity of the solvent (groundwater plus dissolved compounds). When compounds move through the ground by advection, they are subject to spreading within the ground, which allows compounds with little or no affinity for soils to migrate faster than the mean groundwater velocity. This spreading is the result of a process known as dispersion. Hydrodynamic dispersion has two components: molecular diffusion and mechanical dispersion (USEPA, 1989a). Diffusion is the process by which ionic or molecular constituents move under the influence of concentration gradients. Mechanical dispersion occurs as the groundwater flows through the media, and compounds spread out through the tortuous pathways of the soil matrix, and mix with clean water. The result is a dilution of the compound by a process known as dispersion (Fetter, 1988). At very low groundwater velocities, diffusion is the dominant process; at higher velocities, mechanical dispersion is the dominant process. Dispersivity is dependent on vertical and horizontal permeability variations, increasing with the degree of heterogeneity and anisotropy, and is dependent on whether flow is principally through porous media or nonporous media (e.g., fractured bedrock) (Walton, 1988).

The rate a compound migrates can be influenced by facilitated transport, which is the combined effects of physical, chemical, and/or biological phenomena that act to increase mobility. Examples of facilitated transport include particle transport, cosolvation, and phase shifting (Keely, 1989).

Particle transport involves the movement of small, solid-phase particles (such as inorganic and organic colloids), macromolecules, or emulsions to which compounds have adhered by sorption, ion exchange, or other means. High molecular weight organic compounds such as polynuclear aromatic hydrocarbons (PAHs), pesticides, PCBs, and heavy metals, have a high affinity for mobile subsurface particles, and this affinity increases their mobility (Huling, 1989). Small particles, especially mobile organic carbon phase particles such as biocolloids and macromolecules (e.g., humic substances) are transported in the aqueous phase and may act as mobile sorbents.

Cosolvation is the process by which the solubility and mobility of one compound is increased by the presence of another (Keely, 1989). Naturally occurring organic compounds (e.g., humic acids) can undergo complexation reactions with metals and pesticides. Complexation reactions can increase the solubility of metals (including iron, aluminum, copper, nickel, and lead) and pesticides (e.g., dichlorodiphenyl trichloroethane [DDT]). In a cosolvent system, as the fraction of a water-miscible cosolvent increases, the solubilities of the metals or pesticides increase. However, the cosolvent concentration normally needs to be high to ensure a substantial increase in solute velocity. Therefore, cosolvation is important primarily near sources of groundwater impact (USEPA, 1989a). High concentrations of water-miscible phases (e.g., ketones) were not detected at AOC 57.

Chemical phase shifts involve changes in pH and/or the redox potential of the groundwater. These shifts can increase solubilities and mobilities by ionizing neutral organics, solubilizing precipitated metals, forming complexes, or limiting biological activity (Keely, 1989). These processes are particularly important in determining the mobility of heavy metals. Inorganics and heavy metals may be related to historic disposal practices at AOC 57.

Processes that tend to attenuate migration of impacted groundwater include retardation resulting from sorption, volatilization, degradation, and precipitation. The sorption properties of individual solutes are dependent on soil and groundwater characteristics. In general, the relative amount of sorption by soil or sediment materials that do not contain organic matter is as follows: clay > silt > sand > gravel (Walton, 1988). The soil beneath AOC 57 is a silty sand to sand. Sorption would be expected to exert a moderate to minimal influence in retarding the migration of fuel-related VOCs and SVOCs in the soil and a strong influence on retarding PCB migration in soil.

The tendency of organic chemicals to be sorbed is also dependent on the organic content of the soil and the degree of hydrophobicity (lack of affinity for water) of the solute (contaminant). The rate of travel for each chemical depends on the groundwater seepage velocity and the degree of sorption. If an organic chemical is extensively adsorbed by particles, it will be rendered relatively immobile. The rates and degree of volatilization, photolysis, hydrolysis, and biodegradation are directly dependent on the extent of adsorption (Montgomery, 1991). The vadose zone typically contains greater amounts of organic material and metal oxides (which may also act as sorbents) than the saturated zone, which may make the rate of movement in the vadose zone substantially less than that in the saturated zone (USEPA, 1989a).

The soil partition or sorption coefficient (K_{oc}) is defined as the ratio of adsorbed chemical per unit weight of organic carbon to the aqueous solute concentration. The coefficient indicates the tendency of a compound to adsorb to organic carbon (degree of retardation) and, therefore, provides a means for estimation of the relative mobility of solutes (Montgomery, 1991). Mobility is a function of the relative rate of transport of a chemical versus the rate of groundwater flow. Chemicals that have relatively low mobilities (i.e., high retardation or sorption) move slowly compared to the velocity of the groundwater. Chemicals that have relatively high mobilities (i.e., low retardation or sorption) move at a rate closer to groundwater velocity. VOCs detected at AOC 57 have relatively high mobility potential, while SVOCs have moderate to high mobility potential (Table 8-1).

Volatilization is the transport of a compound from the liquid to the vapor phase and, ultimately, into the atmosphere. Volatilization rates are affected by soil properties, vapor pressure, temperature, and sorption. VOCs partition between the aqueous and gaseous phase in unsaturated soils. This process will occur most readily for compounds with a high vapor pressure and a high H. These compounds tend to partition off into the gas phase and occupy the available soil pore space. In addition, VOCs in the saturated zone or in surface water will partition to the gaseous phase, particularly those with lower solubility (e.g., xylenes). VOCs with greater aqueous solubility (e.g., benzene) tend to remain in solution.

Volatilization is an important process in shallow soils and surface water. In recharge areas composed of sandy or gravelly soil, volatilization may be an important process, especially for compounds with moderate to high volatility (Montgomery, 1991). The effectiveness of volatilization normally decreases with depth in the soil column.

Chemicals released to the environment are susceptible to several degradation pathways, including chemical degradation (e.g., oxidation and reduction); photolysis or photochemical degradation; and biodegradation. Compounds formed by these processes may be more or less toxic and/or more or less mobile than the parent compound.

Oxidation typically involves the loss of electrons during a chemical reaction. In general, substituted aromatic compounds such as ethylbenzene and naphthalene can be oxidized. Oxidation rates for aromatic compounds are typically an order of magnitude faster than for chlorinated aliphatic compounds (e.g., 1,2-dichloroethane [1,2-DCA]). Overall, abiotic (without biological life) oxidation of organic compounds in groundwater systems is limited.

Photochemical breakdown processes involve structural changes in a molecule induced by radiation in the ultraviolet-visible light range. This process may occur in surficial soils at AOC 57 but would not affect contamination in the subsurface soils.

Biodegradation may be defined as the breakdown of organic compounds by microorganisms through metabolic processes. Variables affecting the rate of biodegradation include:

- number of microorganisms
- chemical properties, concentrations, and distribution
- presence of food and nutrients
- temperature
- pH

- moisture and oxygen content

The rate of biodegradation tends to be higher for low molecular weight compounds. Naturally occurring soil and aquatic microorganisms capable of degrading aromatic hydrocarbons (e.g., BTEX) have been studied, and a relationship between dissolved oxygen and biodegradation has been documented (Jamison, et al., 1975; and Bailey, et al., 1973). As the aromatic hydrocarbons are mobilized by dissolution from soil or sediment, they are likely to be rapidly degraded as long as microorganisms and dissolved oxygen are available. Degradation rates for aromatic hydrocarbons are much slower under anaerobic conditions.

8.2 FATE AND TRANSPORT OF CONTAMINANTS DETECTED AT AOC 57

This subsection discusses the potential fate and transport of contaminants, by chemical class, detected at AOC 57.

VOCs. Soil samples collected at or below the water table at AOC 57 contained the fuel-related VOCs TEX as well as the chlorinated aliphatics PCE, TCE, 1,1,1-TCA, 1,2-DCE (cis and trans), chloroform, and carbon tetrachloride (see Tables 7-12 and 7-13). Fuel-related VOC TICs such as 1-ethyl-2-methylbenzene, 4-(1-methylethyl) toluene, 1,2,4-trimethylbenzene, and octane were also present in the soil samples (see Table 7-1). TEX and chlorinated aliphatics are the primary VOCs detected in groundwater samples from AOC 57 (see Table 7-12 and 7-13). Chloroform and dichloromethane were also detected in downgradient monitoring wells. No fuel related TICs were identified in groundwater.

VOCs detected at AOC 57 can be classified as aromatic hydrocarbons (e.g., BTEX) and chlorinated aliphatics (e.g., PCE). Processes and forces that will control the fate of these VOCs include volatilization, advection/dispersion, and biodegradation.

Factors affecting VOC percolation to groundwater are density and volatility. Compounds with higher density and low volatility are most likely to be transported to groundwater.

Dissolution of VOCs from unsaturated zone soil via infiltrating precipitation may be a transport mechanism at AOC 57 due to the sandy nature of the soils and the relatively shallow water table.

Volatilization is believed to be the most significant transport mechanism for VOCs in the unsaturated soils at AOC 57. The fuel-related VOCs at AOC 57 are likely partitioning between the aqueous and gaseous phases in the source area unsaturated soils. This process occurs most readily for compounds with a high vapor pressure and a high H (e.g., benzene and toluene). In addition, VOCs in the saturated zone will partition to the gaseous phase, particularly those with lower solubility (e.g., TEX). As groundwater transports the fuel-related VOCs away from the source areas, the VOCs with lower solubility will partition to some extent into the gas phase and occupy the available soil pore space above the water table in the unsaturated zone. VOCs with greater aqueous solubility (e.g., benzene) tend to partition more strongly to the aqueous phase.

Dissolved phase transport of VOCs in groundwater is a significant transport mechanism at AOC 57. Factors affecting partitioning of VOCs from soil to groundwater include solubility and K_{oc}. VOCs with high solubilities and low K_{oc}s, such as benzene, will partition to groundwater from the saturated zone soils. Toluene, ethylbenzene, and xylene were detected in saturated zone soils and groundwater, which is probably a result of the moderate K_{oc}s and solubilities (see Table 8-1). Processes that tend to attenuate migration of impacted groundwater at AOC 57 include retardation resulting from sorption, volatilization, and degradation.

Biodegradation reactions act to reduce the total mass of VOCs. Naturally occurring soil microorganisms capable of degrading aromatic hydrocarbons have been studied, and a relationship between dissolved oxygen and biodegradation has been documented (Jamison, et al., 1975; and Bailey, et al., 1973). As the aromatic hydrocarbons are mobilized by dissolution from the soil or sediment, they are likely to be rapidly degraded as long as dissolved oxygen and sufficient microorganisms are available.

Fuel-related VOC contaminants at AOC 57 are expected to be reduced through volatilization, biodegradation, and/or dilution and dispersion.

SVOCs. Soil samples collected at or below the water table at AOC 57 contained fuel-related SVOCs (see Tables 7-12 and 7-13). Fuel-related SVOC TICs such as trimethylbenzene, 1,1,2,2-tetrachloroethane, 1-ethyl-2-methylbenzene, and nonacosane were also present in the soil samples (see Table 7-1). 1,2-DCB, 1,4-DCB, naphthalene, 2-methylnaphthalene and phthalates are the primary SVOCs detected in groundwater samples from AOC 57. Fuel-related SVOC TICs in groundwater include indan and hexadecanoic acid (see Table 7-1).

Dissolution of SVOCs from unsaturated zone soil via infiltrating precipitation may be a probable transport mechanism at AOC 57 due to the sandy nature of the overburden soils.

Volatilization is a minor transport mechanism for SVOCs in the soils and groundwater at AOC 57. The fuel-related SVOCs at AOC 57, such as naphthalene and phenanthrene, are considered moderately volatile, and therefore volatilization is not as significant a transport mechanism as it is for VOCs.

Dissolved phase transport of SVOCs in groundwater is a significant transport mechanism at AOC 57. Factors affecting partitioning of SVOCs from soil to groundwater include solubility and K_{oc}. SVOCs are generally regarded as immobile because of strong adsorption to the organic carbon fraction of soil predicted through higher K_{oc}s and low solubilities (Tinsley, 1979; Kenaga and Goring, 1978). SVOCs with moderate solubilities and moderate to high K_{oc}s, such as pyrene and phenanthrene, will partition slightly to groundwater from the saturated zone soils (see Table 8-1). Results of saturated zone soil samples and groundwater samples indicate this to be the case, as the SVOCs were not detected in groundwater. Processes that tend to attenuate migration of impacted groundwater at AOC 57 include retardation resulting from sorption, volatilization, and degradation.

Biodegradation reactions act to reduce the total mass of lower molecular weight PAHs (e.g., naphthalene). Naturally occurring soil microorganisms capable of degrading aromatic hydrocarbons have been studied, and a relationship between dissolved oxygen and biodegradation has been documented (Jamison, et al., 1975; and Bailey, et al., 1973). As the aromatic hydrocarbons are mobilized from the soil by groundwater movement, they are likely to be degraded as long as dissolved oxygen and sufficient microorganisms are available.

The fate of fuel-related SVOC contaminants at AOC 57 is expected to be reduction through volatilization, biodegradation, and/or dilution and dispersion. The slow rate of migration (due to partitioning to soil) for the PAHs allows for significant degradation, even if degradation rates are small, before they can travel significant distances. The fuel-related PAHs also tend to be more persistent with increasing molecular weight.

PCBs. Soil samples collected at AOC 57 during the RI contained the individual PCB compounds (congeners) Aroclor 1242, Aroclor 1248, and Aroclor 1260. The different congeners are described by the percent of chlorine; for example Aroclor 1260 contains 60% chlorine by weight.

PCBs are characterized as being relatively insoluble and having low volatility and tend to sorb strongly to soils. Solubility and volatility have in inverse relationship to the degree of chlorination of the individual congeners. Dissolution and volatilization are not significant transport mechanisms for PCBs at AOC 57.

PCBs are also persistent in the environment as a result of their general resistance to degradation.

Inorganics. Inorganics detected at AOC 57 include metals (aluminum and lead), transition metals (iron, manganese, vanadium, chromium, cobalt, nickel, zinc, and copper), alkaline earth metals (calcium, magnesium, and barium), alkali metals (sodium and potassium), and nonmetallic elements (arsenic). The detection of these inorganics, it should be noted, could not be correlated with the presence of fuel-related organic compounds (see Section 7.0 of this report). Discussion of the fate and transport of inorganics, presented below, is therefore limited.

The mobility of inorganics in soil-water systems is strongly affected by compound solubility, pH, soil cation exchange capacity, soil type, oxidation-reduction potential, adsorption processes, major ion concentrations, and salinity. The distribution of inorganics would most likely be controlled by adsorption processes. Once adsorbed to soil, the inorganics may migrate with the soil by mechanical transport of particles. The migration of dissolved inorganics is dependent upon their individual adsorption characteristics (Oak Ridge National Laboratories, 1989). Mobilities of inorganic elements relative to the redox state of the environment are presented in Table 8-2.

8.3 SITE CONCEPTUAL MODEL

Figure 8-1 presents a simplified site conceptual model flow chart encompassing the essential features of AOC 57 Areas 2 and 3 and showing the potential source and transport mechanisms for the contaminants detected at AOC 57. The model reflects the current understanding of the site with respect to sources of contamination, the distribution of contamination, and the potential migration pathways.

Based on the results of the RI, the primary site-related contaminants at AOC 57 are solvent and fuel-related contaminants in soil and groundwater. VOCs, SVOCs, pesticides, PCBs, and TPHC were detected during the investigation.

Based on the results of the field investigation, it appears that the Area 2 contaminant source was contaminated surface and near surface soils located in the vicinity of the soil removal excavation. The soil contamination is believed to be due to disposal of vehicle maintenance wastes. The Area 3 contaminant source is the historic disposal site identified by test pitting at 57E-95-24X.

The primary release mechanism at both areas appears to infiltration into groundwater from source area contaminants above the water table. Potential secondary release mechanism is the contaminated soil downgradient of the source areas. The contaminated soil downgradient of the source areas is believed to be due to sorption of dissolved phase contaminants.

The migration pathways/transport mechanisms appear to be groundwater flow of dissolved contaminants.

9.0 RISK ASSESSMENT

9.1 BASELINE HUMAN HEALTH RISK ASSESSMENT

Overview

A human health risk assessment has been conducted to evaluate potential health risks to individuals under current and foreseeable future site conditions at AOC 57. The methods used to perform the risk assessment are consistent with relevant national and regional USEPA risk assessment guidance (e.g., Risk Assessment Guidance for Superfund (USEPA, 1989a); USEPA New England Risk Updates (USEPA, 1992a; 1994a; 1995; 1996) and incorporate data from the various remedial investigation and removal action sampling activities at AOC 57.

The assessment for AOC 57 consists of the following components:

- Selection of Chemicals of Potential Concern (CPCs)
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Evaluation
- Summary and Conclusions

Summary of Site History

AOC 57 is located approximately 3,800 feet southwest of the Barnum Road Gate, between Barnum Road and Cold Spring Brook (Figure 9-1). AOC 57 is in an area of Devens that has been used primarily for the storage and maintenance of military vehicles. AOC 57 consists of three subsites (Area 1, Area 2, and Area 3) which received storm water runoff and wastes from vehicle repair at the adjacent former vehicle storage yard associated with Buildings 3757 and 3758. The vehicle storage yard was abandoned in 1998, and the pavement and fencing were removed. The former storage yard is now a soil and grass-covered area.

Areas 1, 2, and 3 are located between Barnum Road and Cold Spring Brook (Figure 5-2). This area includes an upland area (elevations between 228 and 240 ft mean sea level

[msl]) that slopes downward to a delineated wetland area (elevations lower than 228 ft msl). At Area 2 the wetland boundary is located approximately 250 feet from Cold Spring Brook, and at Area 3 the wetland boundary is located approximately 500 feet from Cold Spring Brook. The upland area is forested with trees and scrub brush. The wetland area is densely vegetated with brush and contains small areas of standing water.

Area 1 was investigated and addressed as part of the AREE 70 investigation (ADL, 1995). This area underwent a soil removal action to address TPHC and PAH contamination from parking lot runoff. Although some residual TPHC and PAH concentrations remained in Area 1 soils after the removal action, the contamination was determined to be consistent with soil and sediment at stormwater outfalls throughout Devens. Therefore, Area 1 was recommended for no further action (Weston, 1998); the decision is to be formalized in the AOC 57 ROD. However, in accordance with recent USEPA requirements for site closure, a no further action decision must be supported by the demonstration that a site does not pose an unacceptable risk for future unrestricted land use. Area 1 was not investigated as part of this RI, but is included here for completeness. An assessment of risks associated with unrestricted future land use at Area 1 indicates that residual contamination at Area 1 does not pose an unacceptable risk for future unrestricted land use (Appendix N-1).

Area 2, formerly an eroded drainage ditch created by periodic rain runoff, was investigated following detection of naphthalene and TPHC in surface soils during a 1993 site investigation. Subsequent sampling confirmed the presence of TPHC and PAHs in surface soil. In addition, these classes of compounds were also detected in sediment samples from Cold Spring Brook, although the distribution of these contaminants did not indicate that AOC 57 was the source. Based on the results of these investigations, the Army performed a soil removal action at Area 2 in 1994. Approximately 1,300 cubic yards of soil were excavated during the removal action. At the completion of the removal action, the area was regraded and a permanent drainage swale was installed. Results of sampling conducted during and at the completion of the removal action in 1994 indicated the presence of TPHC, PCBs, lead, and VOCs in soil and/or groundwater at the site. Additional sampling conducted in 1998 focussed on delineating the extent of contamination in soil and groundwater at Area 2, and surface water and sediment in the floodplain between Area 2 and Cold Spring Brook. These data indicate that contamination associated with Area 2 is located primarily near the southern portion of the removal action excavation.

Area 3 is located approximately 600 feet northeast of Area 2. This area was investigated in 1995 and 1996 to address soil staining observed in historical photos. Results of the soil and groundwater sampling indicated elevated concentrations of TPHC, as well as PCBs and PAHs in soils. Additional sampling conducted in 1998 focussed on delineating the extent of contamination in soil and groundwater at Area 3, and surface water and sediment in the floodplain area between Area 3 and Cold Spring Brook. These data indicate that contamination associated with Area 3 extends from the upland area at the top of the slope adjacent to the former motor pool area, approximately 70 feet into the delineated wetland (Figure 9-1). Based on the findings from these field investigations, the Army performed a soil removal action in 1999. Approximately 1,860 cubic yards of soil were removed from Area 3. Confirmatory soil sampling indicated that the majority of the PCB and TPHC contaminated soil were removed from Area 3.

Site Conceptual Model

The RI identified soils contaminated with petroleum in two areas adjacent to the former motor pool yard (Area 2 and Area 3). Figure 9-2 graphically presents the site conceptual model, which relates sources of petroleum-related contamination to migration pathways and the environmental media which human and ecological receptors may potentially be exposed to. The conceptual model applies to Area 2 and Area 3, and is based on the findings of the RI and supplemental sampling.

As indicated in Figure 9-2, petroleum was released to the surface and subsurface soils (as motor oil, hydraulic fluid, and other heavy oils; no fuel oil is believed to have been released to the soils). The petroleum contamination, which was quantified in this RI by measuring TPHC, EPH and VPH fractions along with their associated target analytes (i.e., BTEX and PAHs), primarily contained EPH; VPH, VOCs, and PAHs were detected sporadically and at low concentrations. Petroleum contamination in the source area (on the upland slope and wetland area nearest to the slope) extended from the surface to approximately 10 feet bgs, whereas contamination was limited to the top two to three feet of soil in the more distant wetland areas. PCBs, principally comprised of Aroclor-1260, were also detected in petroleum-contaminated soils. Inorganic analytes, particularly arsenic, iron, and manganese, were detected in site soil and groundwater, as well as surface water and sediment in the wetland area.

EPH and PCBs tend to adsorb to soils and do not readily leach to groundwater or migrate in groundwater. The RI did not identify substantial petroleum-related contamination in groundwater at AOC 57. EPH was detected at a low frequency and concentration. This indicates that petroleum contamination has not leached from soils to groundwater. Groundwater at AOC 57 is approximately 10 feet bgs at the top of the slope near the former motor pool lot, and approximately 1 to 2 feet bgs in the wetland area. Groundwater flows toward Cold Spring Brook, and discharges to the wetland soils as seeps and small ponded areas when the groundwater level is high. Since petroleum-related compounds were not detected in Area 2 and Area 3 groundwater, it appears that these constituents have not migrated to wetland soils or Cold Spring Brook via groundwater discharge. Similarly, petroleum-contaminated soils do not appear to have migrated to Cold Spring Brook via overland flow and erosion. Based on this information, the principal exposure pathways to site-related petroleum contamination include ingestion and dermal contact with surface soil and subsurface soil in the upland and wetland areas, as well as inhalation of soil-derived particulates. Vapor migration to ambient air or to air within buildings that could be constructed at the site does not appear to be a substantial exposure pathway because EPH, PCBs, and inorganics are not volatile, and VPH and VOCs were detected at relatively low concentrations in soil and groundwater.

VPH chains, as well as VOCs and soluble inorganics, can leach from the soil and migrate in groundwater. Although VPH and VOCs were detected only at low concentrations in groundwater, arsenic, iron and manganese were detected in groundwater at concentrations above Devens background. These constituents are mobile in groundwater, and could potentially discharge to wetland soils in groundwater seeps, or to surface water. Once in surface water the inorganics may adsorb to sediment. Arsenic, iron, and manganese, as wells as additional inorganics, were detected in wetland soils, sediments, and surface water.

There has been no documented disposal of inorganic constituents at AOC 57, and no apparent disposal areas or source areas of inorganic contamination were identified during the RI. The detection of inorganic constituents in groundwater and wetland soils is more likely caused by leaching of naturally-occurring inorganics from the petroleum-contaminated soils. Reducing conditions, created by the biodegradation of petroleum compounds in soils, would enhance leaching of inorganic constituents from soil to groundwater. In the reduced state, the inorganic constituents would more easily migrate in groundwater. However, upon discharge to surface water, these inorganics would tend to oxidize and then adsorb to soil or sediment and become less mobile. This cycle of reduction/migration/discharge/oxidation could account for the detections of inorganic constituents in groundwater and wetland soils. As discussed in Section 8.0, inorganics that are interpreted to be related to AOC 57 are located in groundwater and wetland soils at Areas 2 and 3. Inorganics detected in Cold Spring Brook are not interpreted to be related to AOC 57 based on two primary lines of evidence: 1) arsenic concentrations in wetland sediments decrease with distance from AOC 57; 2) arsenic concentrations in the reach of Cold Spring Brook adjacent to AOC 57 are consistent with or lower than arsenic concentrations detected upstream of AOC 57. Therefore, contamination associated with AOC 57 has not migrated to the Cold Spring Brook stream channel. Nonetheless, to reduce petroleum contamination in soils and to mitigate possible continued leaching of naturally-occurring inorganics, the Army conducted soil removal actions at Area 2 (1994) and Area 3 (1999).

Based on this information, the principal exposure pathways to inorganic constituents are associated with incidental ingestion and dermal contact with surface soil and subsurface soil, as well as ingestion and dermal contact with surface water and sediment in the wetland. Potable use of groundwater could also provide an exposure pathway to inorganic constituents, although groundwater at AOC 57 is not within a potentially productive aquifer and is therefore not considered a drinking water resource by the State of Massachusetts.

According to the Devens Reuse Plan (Vanasse Hangen Brustlin, Inc., 1994), the land in the vicinity of AOC 57 is designated for reuse as "Rail, Industrial, Trade-Related" in the upland area, and as “Open Space” in the delineated wetlands. Under the present and anticipated future land use conditions, people who may occupy the site include trespassers, recreational visitors, maintenance workers, commercial workers, and excavation workers.

9.1.1 Selection of Chemicals of Potential Concern

The first step in the risk assessment involves compiling and evaluating the analytical site data to identify those chemicals present in environmental media as a result of potential sources at AOC 57. Site-related chemicals that were selected for risk evaluation are referred to as CPCs.

9.1.1.1 Identification and Selection of Analytical Data. Samples were collected at AOC 57 from surface and subsurface soil, sediment, surface water, and groundwater. The sampling and analytical programs are discussed in Section 5.0.

Soil

Surface and subsurface soil samples were collected throughout the source areas during the RI (Figure 9-1). For the human health risk assessment, surface soil was defined as extending from 0-2 feet bgs, and subsurface soil was defined as extending from 2 to 10 feet bgs (there were no samples collected from depths greater than 10 feet bgs). Although USEPA Region I defines surface soil as 0-1 foot bgs (USEPA, 1995), "surface soil" samples collected in 1995/1996 represented soil 0-2 ft bgs. To ensure data comparability, samples collected 0-1 foot bgs and 1-2 foot bgs in the 1998 field program and 1999 removal action at Area 3 were considered surface soils in the risk assessment.

Soil data used in the risk assessment are from field programs performed in 1995/1996 and 1998, and the Area 3 soil removal action performed in 1999. Due to the differences in proposed future land uses between the wetland and upland areas of the site, soil data for each subsite were segregated by upland and wetland areas, based on the sample locations relative to the wetland boundary. In the human health risk assessment, upland areas are referred to as industrial use areas, and wetland areas are referred to as recreational use areas. Table 9-1 presents a summary of the sample locations and analytical parameters associated with each data set evaluated in the risk assessment.

As shown in Table 9-1, samples collected in the 1995/1996 field programs were analyzed for inorganics, pesticides/PCBs, SVOCs, VOCs, and TPHC. Samples collected in the 1998 field program were analyzed for the same parameters, as well as EPH and VPH and associated target analytes. Confirmatory soil samples collected during the Area 3 soil removal were analyzed for EPH, VPH, and pesticides/PCBs, since the removal actions were performed to address petroleum and PCB contamination. All data used in the risk assessment are from off-site laboratory analyses. Although field screening analyses for TPHC and VOCs were performed during the 1995/1996 field programs, the data generated by those analyses is considered unsuitable for use in risk assessment. A review of the off-site laboratory data and field screening data indicate that samples which only received field screening analyses had low or non-detectable petroleum (i.e., TPHC) concentrations; samples which had elevated petroleum concentrations were submitted for off-site laboratory analyses. Therefore, excluding the field screening data from the risk assessment does not lend to underestimation of risk.

Samples collected during the 1995/1996 and 1998 field programs that were associated with soil that was removed during the Area 3 soil removal action were not included in the risk assessment (Table 9-2).

As explained in Subsection 9.1.3, the risk assessment evaluates possible exposures to petroleum using EPH and VPH data. This is a preferable approach because it allows for a site-specific assessment of the petroleum-related constituents, and is consistent with the MADEP petroleum policy (MADEP, 1997). TPHC data for samples collected during the 1995/1996 field programs (for which EPH/VPH analyses were not performed) was converted to EPH and VPH equivalent fractions for use in the risk assessment. This procedure is documented in Appendix N-2.

Groundwater

Groundwater data were collected from monitoring wells at AOC 57 during the 1995/1996 and 1998 field programs (Figure 9-1). Due to the differences in proposed future land uses between the wetland and upland areas of the site, groundwater data for each subsite were segregated by upland and wetland areas. In addition, groundwater data from wells located upgradient of Area 2 were grouped separately. Table 9-3 presents a summary of the sample locations and analytical parameters associated with each data set evaluated in the risk assessment.

As shown in Table 9-3, samples collected in the 1995/1996 field programs were analyzed for inorganics, pesticides/PCBs, SVOCs, VOCs, and TPHC. Samples collected in the 1998 field program were analyzed for the same parameters, as wells as EPH and VPH and associated target analytes. Inorganics were analyzed in both unfiltered and filtered samples. All data used in the risk assessment are from off-site laboratory analyses.

The most recent groundwater data from each monitoring well was evaluated in the risk assessment so that risks reflect the most current groundwater conditions (e.g., post-soil removal action). For most wells, the data collected in the 1995/1996 field programs represent the most recent data. The majority of 1998 groundwater data represent samples collected from piezometers or monitoring wells that were installed during the 1998 field program. The remainder of the 1998 data is for EPH/VPH analyses from re-sampling some previously existing monitoring wells.

Surface Water and Sediment

Surface water and sediment samples were collected from small ponded areas of standing water in the wetland (Figure 9-1). The sediment and surface water sampling and associated data are described in detail in Sections 5.0 and 7.0. In summary, surface water and sediment samples collected during the 1995/1996 RI were analyzed for VOCs, SVOCs, pesticides/PCBs, inorganics, and TPH. Surface water and sediment samples collected in 1998 were analyzed for EPH/VPH and inorganics to better define the nature and extent of these analytes.

The procedures used to evaluate and summarize data and to screen data for the selection of CPCs are discussed below.

9.1.1.2 Data Summary Procedures. Prior to selecting CPCs, the analytical data were grouped into data sets for each area and medium. The following steps, which are in accordance with USEPA (1989a; 1992c) guidance, were used to summarize the analytical data for this risk assessment:

Data quality was evaluated by validating the data in accordance with USEPA data quality assessment procedures (USEPA, 1989c). Data suitable for use in risk assessment (i.e., those not rejected) were used in the risk assessment. Data qualified as estimated and blank-contaminated were used in the risk assessment; uncertainties that may affect the risk assessment results are discussed in Subsection 9.1.5. Several TICs were detected in surface and subsurface soil, groundwater, and sediment, but they are not included in this evaluation because they were few in number and low in concentration compared to identified analytes. A summary of TICs is provided in Table 7-1. The data quality assessment is provided in Appendix D.

Data were summarized by environmental medium (for example, surface soil, groundwater). All chemicals detected in at least one sample in each data set were identified.

The arithmetic mean concentration was calculated for each chemical using the detected concentration(s), and one-half the sample quantitation limit (SQL) for nondetect(s). Duplicate samples for a given sampling point were also averaged in this manner if a chemical was detected in only one sample of a duplicate pair

Frequency of detection was calculated as the number of samples in which the chemical was detected over the total number of samples analyzed. Duplicate pairs were counted as a single result for calculation of the frequency of detection.

The minimum and maximum sample quantitation limits were identified for each analyte in each data set.

95 percent upper confidence levels on the arithmetic mean concentration were calculated in accordance with "Supplemental Guidance to RAGS: Calculating the Concentration Term" (USEPA, 1992b), assuming a log-normal distribution. This guidance states that data sets with fewer than ten samples provide poor estimates of the true mean, with the upper confidence limit (UCL) frequently being greater than the highest measured concentration. Therefore, the 95 percent UCLs on the arithmetic means were not calculated for data sets with fewer than 10 samples. The 95 percent UCL is used for evaluating exposures, as described in Subsection 9.1.3.

Summary sampling data for the surface soil, subsurface soil, groundwater, and sediment data sets for AOC 57 are presented in Tables 9-4 through 9-19. The table lists frequency of detection, range of SQLs, minimum and maximum detected concentrations, arithmetic mean concentration, and 95 percent UCL for each chemical detected.

9.1.1.3 Data Screening Procedures The procedures used for selection of CPCs, based on USEPA (1989a; 1995) guidance, are described below. The results, including reasons for selection or exclusion of CPCs, are presented in Tables 9-4 through 9-19.

The summary data for soil and groundwater were compared to concentrations of site-specific naturally occurring inorganic analytes. The development of the background data sets for soil and groundwater are described in Appendix L. In accordance with USEPA Region I guidance, the comparison was not used to eliminate any analytes; however, maximum concentrations of analytes that were below background levels were noted on the CPC selection tables. Risks attributable to background concentrations are discussed in the uncertainty section for inorganic analytes that are determined to be risk drivers.

A screening process was conducted as described by USEPA Region I (USEPA, 1995) to focus the quantitative assessment on the most likely risk drivers. As specified by the guidance, maximum concentrations of chemicals detected in a medium were compared to RBCs derived from USEPA Region III's Risk-Based Concentration Table (USEPA, 1999). Soil and sediment concentrations were compared to residential soil RBCs, and groundwater and surface water concentrations were compared to tap water RBCs. The RBCs published by USEPA Region III are derived for a 1×10^{-6} cancer risk level or a noncancer hazard quotient (HQ) of 1. Per USEPA Region I guidance (USEPA, 1995), the RBCs based on noncarcinogenic effects have been adjusted for a HQ of 0.1 for the purposes of CPC selection. If the maximum concentration of an analyte exceeded the appropriate RBC, the analyte was retained as a CPC.

Analytes were also compared to ARARs. No contaminant was eliminated as a CPC if it exceeded an ARAR. In this case, the ARARs used included the USEPA screening level for lead in soil (USEPA, 1994b), and USEPA MCLs, secondary MCLs, and action limits for groundwater (USEPA, 1998).

Essential nutrients were eliminated from the risk assessment because they are unlikely to result in adverse effects at low concentrations. Chemicals considered to be essential human nutrients are calcium, magnesium, potassium, and sodium. Iron is also considered a human essential nutrient, but a USEPA Region III RBC is available for it.

RBCs and ARARs were not available for TPHC, EPH, or VPH. These contaminants were therefore considered CPCs.

The CPCs selected for surface soil, subsurface soil, groundwater, surface water, and sediment are discussed below.

SURFACE SOIL

Area 2 Industrial

CPCs selected in Area 2 industrial surface soils included arsenic, chromium, iron, manganese, and TPHC (Table 9-4). Among these CPCs, the maximum detected concentrations of chromium and iron did not exceed the background concentrations, suggesting that their presence in Area 2 industrial surface soils is not attributable to releases at the Site.

Area 2 Recreational

CPCs selected in Area 2 recreational surface soils included arsenic, iron, manganese, Aroclor-1260, TPHC, C9-C12 aliphatics and C9-C10 aromatics VPH fractions, and C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics EPH fractions (Table 9-5). The maximum detected concentration of iron did not exceed the background concentration, suggesting that its presence in Area 2 recreational surface soils is not attributable to releases at the Site.

Area 3 Industrial

CPCs selected in Area 3 industrial surface soils included arsenic, iron, manganese, TPHC, C9-C12 aliphatics and C9-C10 aromatics VPH fractions, and C19-C36 aliphatics EPH fraction were also selected as CPCs (Table 9-6). The maximum detected concentration of iron did not exceed the background concentration, suggesting that its presence in Area 3 industrial surface soils is not attributable to releases at the Site.

Area 3 Recreational

CPCs selected in Area 3 recreational surface soils included arsenic, manganese, dieldrin, TPHC, C9-C12 aliphatics and C9-C10 aromatics VPH fractions, and C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics EPH fractions (Table 9-7). The maximum detected concentration of manganese did not exceed the background concentration, suggesting that its presence in Area 3 recreational surface soils is not attributable to releases at the Site.

SUBSURFACE SOIL

Area 2 Industrial

CPCs selected in Area 2 industrial subsurface soils included arsenic, iron, manganese, and TPHC (Table 9-8). The maximum detected concentrations of arsenic, iron, and manganese did not exceed the background concentrations, suggesting that their presence in Area 2 industrial subsurface soils is not attributable to releases at the Site.

Area 2 Recreational

CPCs selected in Area 2 recreational subsurface soils included aluminum, arsenic, chromium, iron, lead, manganese, dieldrin, Aroclor-1248, Aroclor-1260, and TPHC (Table 9-9). In addition C9-C12 aliphatics VPH, and C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics EPH were selected as CPCs. The maximum detected concentrations of aluminum, iron, and manganese did not exceed the background concentrations, suggesting that their presence in Area 2 recreational subsurface soils is not attributable to releases at the Site.

Area 3 Industrial

CPCs selected in Area 3 industrial subsurface soils included arsenic, iron, TPHC, and C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics EPH fractions (Table 9-10). The maximum detected concentration of iron did not exceed the background concentration, suggesting that its presence in Area 3 industrial subsurface soils is not attributable to releases at the Site.

Area 3 Recreational

Arsenic is the only CPC selected in Area 3 recreational subsurface soils (Table 9-11).

GROUNDWATER

Area 2 Industrial

CPCs selected in Area 2 industrial unfiltered groundwater included aluminum and manganese (Table 9-12). The same CPCs were selected in filtered groundwater.

Area 2 Recreational

CPCs selected in Area 2 recreational unfiltered groundwater included arsenic, iron, manganese, Aroclor-1260, bis(2-ethylhexyl)phthalate, 1,2-dichloroethylene (total), tetrachloroethylene, trichloroethylene, nitrogen, and phosphate (Table 9-13). The same inorganic CPCs were selected in filtered groundwater.

Area 3 Industrial

CPCs selected in Area 3 industrial unfiltered groundwater included aluminum, arsenic, cadmium, iron, manganese, 1,2-dichlorobenzene, 1,4-dichlorobenzene, naphthalene, carbon tetrachloride, chloroform, tetrachloroethene, nitrogen, phosphate, and C9-C10 aromatics VPH (Table 9-14). Arsenic, iron, and manganese were selected as CPCs in filtered groundwater.

Area 3 Recreational

CPCs selected in Area 3 recreational unfiltered groundwater included aluminum, arsenic, iron, manganese, 1,4-dichlorobenzene, bis(2-ethylhexyl)phthalate, naphthalene, tetrachloroethene, trichloroethylene, phosphate, and C5-C8 aliphatics, C9-C12 aliphatics, and C9-C10 aromatics VPH fractions (Table 9-15). Arsenic was the only CPC selected in filtered groundwater.

Sediment

Area 2 Recreational

The CPCs selected in Area 2 sediment included aluminum, arsenic, chromium, iron, lead, manganese, dieldrin, and TPHC (Table 9-16).

Area 3 Recreational

The CPCs selected in Area 3 sediment included arsenic, manganese, Aroclor-1260, C11-C22 aromatic and C19-C36 aliphatic EPH fractions, as well as C9-C10 aromatic, C9-C12 aliphatic, and C5-C8 aliphatic VPH fractions (Table 9-17). Arsenic and manganese were detected at concentrations below background.

Surface Water

Area 2 Recreational

The CPCs selected in Area 2 surface water included ten inorganics, bis(2-ethylhexylphthalate), five chlorinated VOCs, TPHC, C11-C22 aromatic EPH, and C19-C36 aliphatic EPH (Table 9-18). Of the inorganics detected, arsenic, iron, and manganese were detected at concentrations below background.

Area 3 Recreational

The CPCs selected in Area 3 surface water included antimony, arsenic, barium, manganese, C11-C22 aromatic EPH, and C19-C36 aliphatic EPH, and C9-C10 aromatic VPH (Table 9-19). Arsenic and manganese were detected at concentrations below background.

9.1.2 Exposure Assessment

The purpose of the exposure assessment is to identify the potential pathways by which human populations may be exposed to CPCs at AOC 57, and to make quantitative estimations of those exposures. The following subsections describe the exposure assessment for the human health risk assessment at AOC 57.

9.1.2.1 Exposure Pathways. An exposure pathway generally consists of four elements:

(1) A source and mechanism of chemical release to the environment;

(2) A retention or transport medium for the released chemical;

(3) A point of potential human contact with the impacted medium (i.e., the exposure point); and

(4) A route of exposure (ingestion or dermal contact, for example) for a potential receptor.

When all four of these elements are present, an exposure pathway is considered "complete." In the risk assessment, only exposure pathways that are complete under present land use, or potentially complete under the anticipated future land use, are evaluated. The exposure pathway assessment for AOC 57 draws on information regarding the source of CPCs, fate and transport of CPCs, and information on human populations potentially exposed to CPCs in environmental media. The conceptual site model presented in Subsection 9.1 provides an overview of the potentially complete migration pathways at AOC 57. These migration pathways are evaluated in the context of current and anticipated future land use to identify potentially exposed populations, exposure media, and exposure routes to those exposure media.

Current and Anticipated Future Site Use

In evaluating potential human exposure pathways, exposures under both current and potential future site uses and surrounding land use conditions were evaluated. Current land use conditions were evaluated to consider possible exposures under the existing land use. Future land use conditions were considered to address exposures that may occur as a result of possible reuse of the site.

The current land use at AOC 57 may best be described as idle. The are no active military operations or land-redevelopment near AOC 57. The majority of the AOC is forested and densely vegetated, and access is difficult. There is no specific reason to visit the AOC, and there are no nuisance or curiosity attractions. The wetland area is muddy; any standing surface water is not deep enough nor aesthetically pleasing. Therefore, it is unlikely that any people would be present at, or access AOC 57 under the existing land use conditions.

The future site and surrounding land use conditions at AOC 57 were assumed to be commercial/industrial in the upland areas, and open space, recreational in the wetland areas. AOC 57 is located within an area designated for "Rail, Industrial, Trade-Related, and Open Recreational" in the Devens Reuse Plan (Vanasse Hangen Brustlin, 1994). Under commercial/industrial use, buildings could be constructed at the site, and occupational workers could be present on a full-time basis. Construction of buildings in the delineated wetland area or use of this area for anything other than open space is not realistic. However, the future use of this area could include constructing designated trails for passive recreational use (e.g., bird watching). Therefore, under the future land use, it is possible that recreational visitors and construction workers could access the wetland areas.

Future residential use of the land at AOC 57 is not a likely future land use; the Devens Reuse Plan does not include residential development of the land in the vicinity of AOC 57, and construction of residential properties in the wetland is not realistic. Nonetheless, to aid in risk management decision-making and to evaluate the need for additional actions at AOC 57, future unrestricted (i.e., residential) land use was evaluated.

Exposure Pathways and Scenarios

Possible exposure pathways encompassing both current and future conditions are summarized in Table 9-20 and discussed below.

Soil Pathway

Industrial Use Areas. Under current and possible future land use, it is assumed that a maintenance worker could be exposed to surface soils. Although it is not likely that this receptor would occur at the site frequently under the existing land use, re-development of a nearby property could result in exposures during landscaping activities. Under possible future land use as a commercial/industrial property, occupational workers could occupy the property daily and be exposed to surface soils. In addition, an excavation worker may be exposed to surface and subsurface soils during site re-development. Unrestricted land use is evaluated by assuming that child and adult residents could be exposed to surface soil and subsurface soil. Soil exposure pathways for all receptors include incidental soil ingestion, dermal contact, and dust inhalation.

Recreational Use Areas. Although exposures at the wetland area are not expected under the current land use, exposures could occur in the future during passive recreational use. Therefore, it is assumed that an older child (ages 6 through 16) might be exposed at the wetland areas. Evaluation of possible exposures to this receptor provides a conservative assessment of risks for possible current land uses. Possible exposure pathways for this receptor include incidental ingestion and dermal contact with surface soil. Inhalation exposures to dust would be insignificant because the wetland soils are too moist and too heavily vegetated to liberate dust when agitated. It is unlikely that occupational workers who may be employed at future commercial/industrial facilities in the industrial areas would access the wetland. However, if walking pathways are constructed in the wetland areas, it is possible that an excavation worker could be exposed to soils. Unrestricted land use is evaluated by assuming that child and adult residents could be exposed to surface soil and subsurface soil. Under this assumption, excavation workers could also be exposed to surface and subsurface soils during construction of residential properties. Soil exposure pathways for residential and excavation worker receptors include incidental soil ingestion, dermal contact, and dust inhalation.

Groundwater Pathway

Industrial Use Areas. Under current land use there is no use or exposure to groundwater associated with AOC 57. AOC 57 is not within the Zone II of a potentially productive aquifer and, therefore, is not considered a drinking water resource by the State of Massachusetts. Because Devens has a municipal water supply, any commercial/industrial properties that are constructed at AOC 57 would be supplied with municipal water. It is possible, however, that industries which require water for process operations would install a groundwater well to supply water. Workers could potentially contact the groundwater if it was used in open systems. Under this scenario, dermal contact and volatile inhalation exposures could occur. However, any volatile inhalation exposures would be insignificant (see discussion in "Air Pathway" below), and dermal contact exposures would likely be minimal as well due to the use of worker protective equipment (e.g., gloves). To provide a very conservative evaluation of possible risks associated with commercial/industrial use of groundwater, exposures associated with potable use of the groundwater (i.e., ingestion exposures) by commercial/industrial workers is evaluated.

Unrestricted land use is evaluated by assuming that residents could be exposed to groundwater via potable use. Groundwater exposure pathways for residential receptors include ingestion, dermal contact, and volatile inhalation.

Recreational Use Areas. Under current land use there is no use or exposure to groundwater associated with AOC 57. AOC 57 is not within the Zone II of a potentially productive aquifer and, therefore, is not considered a drinking water resource by the State of Massachusetts. Under possible future land use, the wetland areas would not be developed and, therefore, groundwater use and exposures would not occur. Unrestricted land use is evaluated by assuming that residents could be exposed to groundwater via potable use. Groundwater exposure pathways for residential receptors include ingestion, dermal contact, and volatile inhalation

Surface Water and Sediment Pathways

The wetland areas contain small areas of standing surface water. These surface water bodies are not suitable for swimming, and are generally not deep enough for wading in. In addition, due to the heavy vegetation and stagnancy of the water, the surface water bodies are not aesthetically pleasing. However, older children who may visit the wetland areas may be drawn to areas of standing water. Therefore, these receptors could contact the surface water and sediment in the wetland areas. Exposure routes to these media would include incidental ingestion and dermal contact. Construction workers would not be exposed to the surface water and sediment because they would wear protective clothing (e.g., boots and gloves) in anticipation of such exposures.

Air Pathway

Industrial and Recreational Use Areas. There are five possible exposure pathways by which current and future land use receptors could be exposed to CPCs in air: 1) soil-derived dust inhalation; 2) vapor migration from soil to ambient air; 3) vapor migration from groundwater to ambient air; 4) vapor migration from soil to indoor air; and 5) vapor migration from groundwater to indoor air.

VOCs and VPH compounds may volatilize from soil or groundwater to ambient air. Volatile migration from soil or groundwater to buildings that are constructed over the volatile contamination can result in exposures to occupants of the buildings. Due to the dilution of vapor concentrations that occurs when vapors migrate from below ground surface to open air, exposures to volatiles in ambient air are normally only a concern when volatile CPCs are detected at high concentrations in soil or groundwater. Volatile migration from groundwater is only a potential concern when the depth to groundwater is fifteen feet or less.

Groundwater at AOC 57 is located within 15 feet of the ground surface, indicating that groundwater could be a source of vapor emissions. However, a comparison of maximum detected groundwater VOC concentrations to MADEP GW-2 groundwater standards, which are protective for volatile migration from groundwater to indoor air which are protective for vapor migration to indoor air at a cancer risk level of $1x10^{-6}$ and a non-cancer HI of 0.2, indicates that VOCs were not detected in groundwater at concentrations that could pose a volatile migration concern (Table 9-21). As shown in Table 9-21, the maximum groundwater concentrations are generally several orders of magnitude below the GW-2 standards, indicating that risks for vapor migration to indoor air would be below $1x10^{-6}$ and a HQ of 0.1. Similarly, VOCs were detected in soil at low frequencies (generally only one or two samples per data set), and at low concentrations (generally less than 0.1 mg/kg). This indicates that volatile migration from soil to ambient air or air within buildings that could be constructed in the future would be insignificant. Therefore, inhalation exposures associated with volatile migration from soil and groundwater were not quantitatively evaluated.

9.1.2.2 Estimation of Exposure. To quantitatively estimate the magnitude of exposures and the risks that may be experienced by an individual, the representative concentration of the CPC in the contact medium at each exposure point must be known or estimated. This concentration is referred to as an exposure point concentration (EPC). To develop quantitative estimates of exposure, the EPC is combined with receptor-specific variables which describe the magnitude with which the receptor comes into contact with the exposure medium.

Exposure Points

For soil and groundwater at Area 2 and Area 3, there are two exposure points for each medium: industrial use exposure points for surface soil, subsurface soil, and groundwater, and recreational use exposure points for surface soil, subsurface soil, and groundwater. The surface water and sediment have one exposure point at each area. The boundaries of each exposure point are defined by the locations of the samples included in each of the media, as listed in Tables 9-4 through 9-19 and shown in Figure 9-1.

Exposure Point Concentrations

The EPCs for surface soil, subsurface soil, surface water, and sediment are the lesser of the 95 percent UCL on the arithmetic mean concentration or the maximum detected concentration (USEPA, 1992b; 1994a). Because there were less than ten samples included in the data sets for some exposure points, 95 percent UCLs were not calculated; the EPCs for these exposure points are the maximum detected concentrations. The same EPC was used for the reasonable maximum exposure (RME) and central tendency (CT) exposure scenarios (USEPA, 1995).

Exposures to petroleum contamination in soil were evaluated using EPH and VPH data, as opposed to TPHC data. Use of EPH and VPH data permits a site-specific assessment of the petroleum-related constituents, and is consistent with the MADEP petroleum policy (MADEP, 1997). Because some soil samples collected near source areas during the 1995/1996 field program were analyzed for TPHC (the EPH/VPH methodology had not been promulgated at the time), it was necessary to convert the TPHC concentrations to EPH/VPH concentrations for development of EPCs. The TPHC data were converted to EPH/VPH by calculating the average composition of EPH/VPH in site soils (based on measured EPH/VPH concentrations), and then applying the compositional information to the measured TPHC concentrations. Statistical parameters for deriving EPCs were then calculated using data sets composed of the measured and estimated EPH/VPH concentrations. Appendix N-2 provides documentation of the EPH/VPH EPC calculations.

In surface water, Area 3 sediment, and groundwater, petroleum was evaluated as EPH and VPH fractions. In Area 2 sediment, petroleum contamination was evaluated as TPH using several different analytical methods. To provide a conservative assessment of potential exposures, the highest TPH concentration among the various analytical methods was used as the exposure point concentration.

For groundwater potable use, USEPA Region I guidance states that the groundwater EPC for RME conditions is the maximum concentration (USEPA, 1995).

Exposure point concentrations for soil, groundwater, surface water, and sediment are provided in Tables 9-22 through 9-37.

Exposure Estimates

Quantitative exposure estimates were derived by combining the EPCs with information describing the extent, frequency, and duration of exposure for the specific receptor. An overview of the approaches used to quantify exposures is given below, along with specific details for potential exposure pathways. The approaches to quantify exposures described in the following paragraphs are consistent with guidance provided by USEPA (1989a; 1989b; 1991; 1992d; 1994a; 1995).

The term "reasonable maximum exposure" (RME) is defined as the maximum exposure that is reasonably expected to occur at a site (USEPA, 1989). The RME is intended to place a conservative upper-bound on the potential risks, meaning that the risk estimate is unlikely to be underestimated but it may very well be overestimated. The likelihood that this RME scenario may actually occur is small, due to the combination of conservative assumptions incorporated into the scenario. The RME estimate for a given pathway is derived by combining the EPC of each chemical with reasonable maximum values describing the extent, frequency, and duration of exposure (USEPA, 1994a). The CT estimate combines the EPC with CT exposure parameters. Many of the exposure parameter values used in this assessment have been defined by USEPA (1989a; 1989b; 1991; 1994a). Both CT and RME exposures were estimated for each current and future land use receptor exposure scenario evaluated. CT exposures were not evaluated for the unrestricted land use scenario, since decisions regarding the possible need for land use restrictions or other actions will be based on the RME risks.

The general equation for calculating chemical intake is as follows:

$$Intake = \frac{C \times CR \times RAF \times EF \times ED}{BW \times AT \times CF}$$

where:

Intake = daily intake averaged over the exposure period (mg/k/day)
C = concentration of the chemical in the exposure medium (mass/volume)
CR = contact rate for the medium of concern (mass/day)
RAF = relative absorption factor (unitless)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight of the hypothetically exposed individual (kg)
AT = averaging time (for carcinogens, AT = 70 years; for noncarcinogens, AT = ED)
CF = units conversion factor (365 days/yr)

Specific equations for each exposure scenario are provided in the risk calculation spreadsheets in Appendix N-5. For dermal uptake of soil CPCs, USEPA Region I uses USEPA draft dermal exposure guidance (USEPA, 1998), which provides quantitative dermal absorption factors for several chemicals. Dermal exposures to those chemicals (when detected) were quantitatively evaluated; dermal exposures to chemicals for which dermal absorption values are not published were not quantitatively evaluated.

Standard exposure parameters from USEPA guidance were used, where appropriate, to estimate CPC intake. Tables 9-38 presents the parameters used in current/future use, possible future use, and unrestricted future use scenarios, respectively. The parameters are discussed briefly below.

Contact Rate. The contact rate reflects the amount of the medium contacted per unit of time or event. For incidental ingestion of soil, the RME contact rate is 100 mg soil per day (mg/day) for the site maintenance worker, commercial/industrial worker, recreational child, and adult resident (USEPA, 1994a). The CT value for these receptors is 50 mg/day (USEPA, 1994a). The RME ingestion rate for the child resident is 200 mg/day, and the CT value is 100 mg/day (USEPA, 1994a). For the excavation worker, the RME and CT contact rates are 480 mg/day (USEPA, 1994a). A fraction-ingested variable can be used to account for the amount of soil ingested daily that is assumed to come from the area of concern. It is conservatively assumed that all soil ingested daily would originate at AOC 57.

For ingestion of groundwater used as residential drinking water, the ingestion rate for the RME is 2 liters per day (USEPA, 1994a). The RME ingestion of groundwater used as commercial/industrial drinking water is 1 liter per day (USEPA, 1994a).

The inhalation rate for maintenance and commercial/industrial workers is based on the short-term inhalation rate for moderate activities (1.6 m^3/hour; USEPA, 1997). The inhalation rate for the excavation worker is based on the upper percentile rate outdoor activities (3.3 m^3/hour; USEPA, 1997). The inhalation rate for residential receptors is based on the mean long-term inhalation rate for children (0.31 m^3/hour; USEPA, 1997) or adults (0.63 m^3/hour; USEPA, 1997).

The contact rate for ingestion of sediment was assumed to be ¼ the ingestion rate for soil. This value was used because the soil ingestion rate is based on the total amount of soil that is consumed in a given day from all sources (i.e., outdoor soil, indoor dust, etc). Therefore using the same soil ingestion rate to account for surface soil and sediment exposures would overestimate "soil" ingestion by two-fold. Adjustment of the sediment ingestion rate reflects the fact that more of the wetland areas are covered with soil than sediment (i.e., more wetland area is represented by soil data than by sediment data), indicating that the majority of potential exposures would be to soil than to sediment. The surface water ingestion rate was assumed to be ¼ the surface water ingestion rate for swimming (USEPA, 1997). This value reflects that fact that ingestion exposures to the small, shallow areas of surface water would only be incidental.

The contact rate for dermal exposures is calculated using the skin surface area exposed to soil and the soil adherence factor. The skin surface area for the older child trespasser is calculated as the age-averaged body surface area for hands, arms, and lower legs (surface soil and sediment) and lower legs and feet (surface water) (USEPA, 1997). The soil adherence factor for this receptor, as well as the child resident, is assumed to be 1.0 mg/cm^2 (USEPA, 1998). As recommended in recent USEPA guidance (USEPA, 1997;

USEPA, 1998), the soil adherence factors for adult receptors are calculated using body part-specific dermal loading factors and skin surface areas that are selected for activities that conservatively represent the type of exposures that receptors at the site may have. Appendix N-3 provides documentation of the soil adherence factor and body surface area calculations for the receptors evaluated in this risk assessment.

Relative Absorption Factor. The relative oral absorption factor represents the ratio of a chemical's bioavailability (i.e., ability to be absorbed and potentially exert an effect) in an environmental matrix to its bioavailability when administered in the experimental dose-response study from which the toxicity criterion for that chemical was derived. The relative oral bioavailability factor is applied to account for the potentially reduced bioavailability of a chemical when ingested in a soil matrix, compared to when experimentally administered in a food mash, water, or a solvent medium. In keeping with the conservative nature of this assessment, a relative oral bioavailability of 100 percent (or 1.0) is assumed for all CPCs.

Dermal exposures to soil and sediment CPCs were evaluated using dermal absorption efficiency values published by USEPA (USEPA, 1998). Dermal exposures to CPCs in surface water were evaluated using permeability coefficients published by USEPA (USEPA, 1998).

Exposure Frequency and Duration. An exposure frequency of two times per week for 26 weeks (May-October), equal to 52 days per year for 25 years, is assumed for the site maintenance worker. It is assumed that the maintenance worker spends 8 hours per day on the days working at the Site. Contact with the soil is negligible when the ground is frozen or snow-covered. An exposure rate of less than five days per week accounts for work performed in other areas of the facility..

Commercial/industrial workers are assumed to work 5 days per week, 50 weeks per year for 25 years, but be exposed to soils for only 30 weeks per year (equal to 150 days per year) when the ground is not frozen (USEPA, 1994a). The CT exposure frequency and duration are assumed to be one-half the RME values.

Since AOC 57 is not located near any active facilities at Devens (e.g., schools, houses), it is unlikely that trespassing occurs at the site frequently. However, future recreational visitors may access the site more regularly. Therefore, an RME exposure frequency of two days per week for 26 weeks (May-October), equal to 52 days per year, is assumed for the recreational child exposure to surface soil. The CT value is assumed to be one-half the RME value. A recreational child ages 6 through 16 is assumed to occur at the site for 11 years (equivalent to the duration of age 6 through 16) for the RME and CT scenarios.

The excavation worker is assumed to work five days per week (equivalent to a frequency of 250 days per year) over a 26 week period (one-half a year).

Body Weight. The body weight used for adult receptors is 70 kilograms (kg), which represents the standard default value for adult body weight (USEPA, 1994a). The age-adjusted body weight for the child trespasser, assumed to be 6 through 16 years of age, is 61 kg (USEPA, 1997).

Averaging Time. The averaging time for lifetime exposure, used for developing intake to evaluate carcinogenic risk, is 70 years. Averaging time for noncarcinogenic risk is equal to the exposure duration (USEPA, 1989).

9.1.3 Toxicity Assessment

The objective of the toxicity assessment is to define the relationship between the dose of a substance and the likelihood that a toxic effect, either carcinogenic or noncarcinogenic, will result from exposure to that substance. This is performed by identifying the potential adverse health effects associated with exposure to a substance, and then quantifying those dose-response relationships. Potential adverse health effects associated with each CPC evaluated in this risk assessment are summarized in short toxicity profiles provided in Appendix N-4. Dose-response information for the CPCs, which is used in the risk assessment to estimate the likelihood of adverse effects as a function of human exposure to the CPCs, is presented in Tables 9-39 through 9-43.

There are two types of dose-response values used in this risk assessment: cancer slope factors (CSFs) and reference doses (RfDs). USEPA has derived CSFs and RfDs to evaluate carcinogenic risks and noncarcinogenic (systemic) effects, respectively. The definitions of CSFs and RfDs, as stated in USEPA guidance are:

- Cancer Slope Factor - a plausible upper bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The CSF is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime exposure to a particular concentration of a potential carcinogen (USEPA Class A or B carcinogens) (USEPA, 1989a).

- Chronic Reference Dose - an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (e.g., as a Superfund program guideline, seven years to a lifetime) (USEPA, 1989a). The chronic RfD is used to estimate toxicity to all receptors occurring at a site for more than seven years.

- Subchronic Reference Dose - an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a portion of a lifetime (e.g., as a Superfund program guideline, two weeks to seven years) (USEPA, 1989a). The subchronic RfD is used to estimate toxicity to all receptors occurring at a site for between two-weeks and seven years (e.g., excavation worker).

In addition, because the toxicity and/or carcinogenicity of a compound can depend on the route of exposure (e.g., oral or inhalation), unique dose-response values (e.g., CSFs and RfDs) have been developed for the oral and inhalation exposure routes. Oral and inhalation CSFs for the CPCs associated with AOC 57 are presented in Tables 9-39 and 9-40, respectively. Oral and inhalation RfDs for the CPCs associated with AOC 57 are presented in Tables 9-41 and 9-42, respectively.

Inhalation RfDs are not available for many CPCs. HEAST and IRIS do, however, list reference concentrations for a number of the CPCs. Inhalation reference concentrations were converted to inhalation reference doses as needed (Table 9-42).

The methodology used to develop dermal toxicity values is obtained from Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance Dermal Risk Assessment Interim Guidance (USEPA, 1998). The oral toxicity value is adjusted from administered dose to absorbed dose, if necessary. The absorption efficiency of a particular compound is used to calculate an RfD based on absorbed dose. For example, if the RfD based on administered dose was 20 mg/kg/day, and the absorption efficiency in the study that is the basis of the RfD was 10 percent, then: 20 mg/kg/day x 0.10 = 2 mg/kg/day. Therefore, the adjusted RfD is 2 mg/kg/day. This adjusted value is the dermal reference dose (RfD_{derm}). Similarly, the dermal cancer slope factor (CSF_{derm}) is obtained by adjusting the oral CSF. For example: if the CSF based on administered dose was 1.6 $(mg/kg/day)^{-1}$, and the absorption efficiency in the study that is the basis of the CSF is 20 percent, then: 1.6 $(mg/kg/day)^{-1}/0.20$ = 8 $(mg/kg/day)^{-1}$. This adjusted value is the CSF_{derm}.

The oral absorption efficiencies used to derive dermal dose response values for specific compounds were obtained from USEPA guidance (USEPA, 1998). If the absorption efficiency for a compound was not listed, then a dermal dose-response value was not calculated. If there was more than one value listed for an individual compound, the value for oral absorption from the diet was chosen; if there was not a value listed for absorption from the diet, then the most conservative published value was used. Dermal dose-response values are presented in Table 9-43.

Source of Dose-Response Values

The primary source for dose-response values is the USEPA Integrated Risk Information System (IRIS) (USEPA, 1998). If no information is found in IRIS, the USEPA Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997c) are used. If appropriate dose-response values are not available from either of these two sources, other USEPA sources are consulted (e.g., the USEPA National Center for Environmental Assessment).

No USEPA-approved toxicity values are available for TPHC, EPH, or VPH. However, the "Characterizing Risks posed by Petroleum Contaminated Sites: Implementation of MADEP VPH/EPH Approach" (MADEP, 1997) recommends the application of Reference Doses for indicator compounds to various fractions of petroleum products analyzed for by the EPH and VPH methods as a means of assessing risks associated with media that contain petroleum. These RfDs were used to estimate the risks associated with each EPH/VPH fraction.

Because no chemical speciation analyses were performed for chromium in environmental media at AOC 57, chromium was evaluated using dose-response values for hexavalent chromium. This provides a conservative assessment of potential toxicity and risks because hexavalent chromium is considered to be the more toxic (and potentially carcinogenic) form of inorganic chromium.

USEPA has published cancer slope factors for PCBs that are based on a tiered approach that considers risks and persistence by various exposure pathways (USEPA, 1999). The three tiers identified by USEPA are: high risk and persistence, low risk and persistence, and lowest risk and persistence. Within each of these tiers, upper bound and central-estimate slope factors have been published. The slope factors are to be used for oral, dermal, and inhalation exposures. The high risk/high persistence slope factors are used for soil and sediment because exposures to these media are evaluated for ingestion, particulate inhalation (soil only), and dermal contact with the application of an absorption factor. These slope factors are also chosen for groundwater and surface water because PCBs detected in these media are unlikely to be dissolved in the water, but are more likely to be relatively insoluble and adsorbed to suspended solids or particulates in the water sample. The upper bound slope factors are chosen in order to provide an evaluation that is unlikely to underestimate risks for potential exposures to PCBs.

9.1.4 Risk Characterization

In this final step of the risk assessment process, the exposure and toxicity information are integrated to develop both quantitative and qualitative evaluations of risk. To quantitatively assess risks associated with CPCs in an environmental medium, the average daily intakes calculated in the Exposure Assessment are combined with the dose-response criteria presented in the Toxicity Assessment. The methodology used to quantitatively assess risks is described below.

9.1.4.1 Risk Characterization Methods. The potential risks to individuals from exposure to carcinogenic and noncarcinogenic CPCs is evaluated in accordance with USEPA (1989) guidance.

Cancer Risks

For exposures to a chemical associated with carcinogenic effects, an individual upper bound excess lifetime cancer risk (ELCR) is calculated by multiplying the estimated daily CPC intake by the relevant CSF:

$$\text{ELCR} = \text{Intake (mg/kg/day)} \times \text{CSF (mg/kg/day)}^{-1}$$

The resulting risk estimate is an upper-bound estimate of the probability of developing cancer as a result of exposure to the potential carcinogen over a 70-year lifetime under the specified exposure conditions. A risk level of $1\text{x}10^{-6}$, for example, represents an upper bound probability of one in one million that an individual will develop cancer. The upper bound cancer risk estimates provide estimates of the upper limits of risk, and the risk estimates produced are likely to be greater than the 99th percentile of risks faced by actual receptors (USEPA 1989a). This incremental lifetime risk is over and above what is considered an individual's background chances of developing cancer. In the U.S., approximately one in three people develop cancer during their lifetime (American Cancer Society, 1997). To assess the upper bound individual ELCRs associated with simultaneous exposure to all carcinogenic chemicals of concern, the risks derived from the individual chemicals are summed within each exposure pathway. This approach is consistent with the USEPA's guidelines for evaluating the toxic effects of chemical mixtures (USEPA 1989b). In addition, to evaluate total cancer risk to a receptor population, cancer risks are summed for each medium to which a receptor may be exposed.

The relative significance of carcinogenic risk estimates is evaluated by comparison to a range of 10^{-6} to 10^{-4} established in the National Contingency Plan (USEPA, 1990). USEPA's guidelines state that when the total incremental carcinogenic risk for an individual resulting from exposure at a hazardous waste site is within the range of 10^{-6} to 10^{-4}, the decision about whether a response action is required is based on site-specific factors.

Non-Cancer Risks

Unlike carcinogenic effects, noncarcinogenic effects are not expressed as incidence probabilities. Rather, potential noncarcinogenic effects are evaluated by means of calculating hazard quotients (HQs) and hazard indexes (HIs). To assess effects associated with noncarcinogenic exposures, the ratio of the daily intake to the RfD is calculated by dividing the intake for each noncarcinogenic CPC by the RfD for that CPC to derive an HQ:

$$HQ = \text{Intake (mg/kg/day)} / \text{RfD (mg/kg/day)}$$

In general, HQs that are less than 1 indicate that the associated exposure is not likely to result in any adverse health effects, whereas HQs greater than 1 indicate a greater likelihood of adverse health effects. The effects from simultaneous exposures to all CPCs were calculated by summing the individual HQs within each exposure pathway. This sum, the screening HI, serves the same function for exposures to multiple CPCs as the HQ does for exposure to an individual compound. In addition, to evaluate total non-cancer risk to a receptor population, screening HIs are summed for each medium to which a receptor may be exposed.

Screening HIs for both RME and CT exposures are compared to a target level of 1 established by USEPA. HIs greater than 1 indicate the potential for the occurrence of adverse health effects. However, a conclusion should not be categorically drawn that all screening HIs greater than 1 are unacceptable. If the individual CPCs effect different target organs or work through different toxicological mechanisms of action, then an HI of greater than 1 does not indicate that threshold effect levels have been reached. In cases where a screening HI is greater than 1, the CPCs are segregated by target organ/critical effect (e.g., liver, skin, etc.) and the HQs for each group of CPCs may be summed to determine if the target organ-specific HI is greater than 1 (USEPA, 1989a).

Consistent with USEPA guidance (USEPA, 1989), a determination of whether the risks for exposures to COCs in site media are additive was performed by segregating the HI according to the target organs or organ systems that each COC effects. A determination of whether risks for multiple COCs are additive was made by examining the target organs that each COC potentially exerts adverse effects on. The risks for COCs that affect the same target organ(s) are considered to be additive. For receptor scenarios in which the screening HI values exceeded the USEPA threshold HI of 1, the target organ-specific HIs were used to evaluate the potential for the occurrence of adverse health effects. The HI segregation is documented in Appendix N-6.

9.1.4.2 Risk Characterization Results. The risk calculations are presented in Appendix N-5. The risk estimates are summarized in Table 9-44, and are discussed below. Target organ-specific HIs are presented in Appendix N-6.

Area 2 - Industrial Area

Current Land Use

Risks associated with the current site use were evaluated for a maintenance worker potentially exposed to surface soil via incidental soil ingestion, dermal contact, and particulate inhalation. The RME cancer risk for the maintenance worker is 2×10^{-6}, which is within the USEPA cancer risk range of 1×10^{-6} to 1×10^{-4}. The cancer risk is attributable to arsenic. The RME non-cancer risk is a screening HI of 0.04, which is below the USEPA threshold HI of 1. The CT cancer and non-cancer risks are 2×10^{-7} and 0.01, respectively.

Possible Future Land Use

Future land use was assumed to be commercial/industrial, based on the Devens Reuse Plan. Therefore, risks associated with future site use were evaluated for a commercial industrial worker potentially exposed to surface soil via incidental soil ingestion, dermal contact, and particulate inhalation, and groundwater via potable use (i.e,. ingestion). A construction worker potentially exposed to surface and subsurface soil via incidental ingestion, dermal contact, and particulate inhalation was also evaluated.

There were no cancer risks associated with ingestion of groundwater because there were no carcinogenic CPCs detected in Area 2 industrial groundwater. The non-cancer RME risk for commercial/industrial potable use of groundwater is a screening HI of 0.07, which is below the USEPA threshold HI of 1. The RME cancer risk for commercial/industrial worker exposure to surface soil is $7\text{x}10^{-6}$ which is within the USEPA cancer risk range of $1\text{x}10^{-6}$ and $1\text{x}10^{-4}$. The non-cancer RME risk for surface soil is a screening HI of 0.1, which is below the USEPA threshold limit of 1. The total non-cancer RME risk for exposure to surface soil and groundwater is a screening HI of 0.2, which is below the USEPA threshold of 1. The CT cancer and non-cancer combined risks for surface soil and groundwater for the commercial/industrial worker are $1\text{x}10^{-6}$ and 0.1, respectively.

For the construction worker, the total RME cancer risks for surface soil ($1\text{x}10^{-6}$) and subsurface soil ($6\text{x}10^{-7}$) are within the USEPA acceptable cancer risk range of $1\text{x}10^{-6}$ to $1\text{x}10^{-4}$. The cancer risk is attributable to arsenic. The total non-cancer RME screening HIs for surface soil (0.5) and subsurface soil (0.2) are below the USEPA threshold of 1. The CT cancer risk is below the USEPA cancer risk range, and the CT non-cancer screening HI is below the threshold HI of 1.

Unrestricted Future Land Use

To aid in risk management decision-making and to evaluate the need for additional actions in the industrial (upland) portion of Area 2, unrestricted future land use was evaluated. Risks associated with unrestricted land use were evaluated for residential exposures to surface soil, subsurface soil, and groundwater.

RME adult resident and child resident cancer risks for surface soil and subsurface soil are within the USEPA cancer risk range. The total receptor RME cancer risk for exposure to surface soil and subsurface soil is $4\text{x}10^{-5}$, which is within the USEPA risk range of $1\text{x}10^{-6}$ to $1\text{x}10^{-4}$. Cancer risks are attributable to arsenic. Cancer risks associated with ingestion of groundwater were not evaluated because there were no carcinogenic CPCs detected in Area 2 industrial groundwater.

The total RME adult resident non-cancer screening HI for exposure to surface soil (0.1) and groundwater (0.2) is 0.3, which is below the threshold HI of 1 set forth by the USEPA. The RME child resident non-cancer screening HI for surface soil and subsurface soil is 2; the risk is primarily associated with surface soil, which has a screening HI of 2. However, as shown in Appendix N-6, Table 5, no target organ-specific HI values exceed 1. The highest target organ HI values are for effects to the kidney (HI = 1) and to the skin (HI = 0.7). Based on this evaluation, non-cancer risks to the child resident do not exceed the USEPA threshold HI of 1.

This evaluation indicates that risks associated with the current, foreseeable future, and future unrestricted land uses at AOC 57 Area 2 – Industrial (upland) do not exceed USEPA risk limits.

Area 2 – Recreational Area

Current/Future Land Use

Risks associated with the current and future site use were evaluated for an older child (ages 6 through 16) potentially exposed to surface soil, surface water, and sediment via incidental ingestion and dermal contact. The RME cancer risk is $5x10^{-5}$, which is within the USEPA cancer risk range of $1x10^{-6}$ and $1x10^{-4}$. The RME non-cancer risk is a screening HI of 1, which does not exceed allowable USEPA HI threshold of 1. The CT cancer and non-cancer risks are $2x10^{-5}$ and a screening HI of 0.7, respectively. Cancer and non-cancer risks are primarily associated with arsenic and Aroclor-1260 in surface soil and sediment (Appendix N-6, Table 6).

Possible Future Land Use

Possible future land use may include construction of walkways in the wetland areas. Therefore, risks for the future land use are evaluated for a construction worker, as well as being represented by the risks for the current/future recreational child.

The RME cancer risks for the construction worker are within the USEPA acceptable cancer risk range for both surface soil ($3x10^{-6}$) and subsurface soil ($3x10^{-6}$); the total cancer risk for exposure to both media is $6x10^{-6}$. The CT cancer risk for exposures to both surface soil and subsurface soil is $2x10^{-6}$. The cancer risks for this receptor are primarily attributable to arsenic.

The RME and CT non-cancer screening HIs for subsurface soil exceed a HI of one (HI of 3), and the RME and CT screening HIs for surface soil are equal to 1. In addition, the EPC for lead (5,060 mg/kg) exceeds the USEPA residential screening value for lead of 400 mg/kg. As shown in Appendix N-6, Table 7, HIs based on target organ effects are at or below 1 for all organs/systems except the immune system. The HI for effects to the immune system is a HI of 2, and is primarily attributable to Aroclor-1260 in subsurface soil (HQ=2).

Unrestricted Future Land Use

To aid in risk management decision-making and to evaluate the need for additional actions in the recreational (wetland) portion of Area 2 (e.g., placement of land-use restrictions on the site), unrestricted future land use was evaluated. Risks associated with unrestricted land use were evaluated for residential exposures to surface soil, subsurface soil, and groundwater.

RME adult resident cancer risk for combined exposures to surface soil and subsurface soil is $4x10^{-5}$ and the RME child resident cancer risk for combined exposures to surface soil and subsurface soil is $1x10^{-4}$. The total resident cancer risk for exposure to soil is $1x10^{-4}$, which does not exceed the USEPA risk range of $1x10^{-6}$ to $1x10^{-4}$. Cancer risks are contributed equally by arsenic and Aroclor-1260 in surface soil and subsurface soil (Appendix N-6, Tables 8 and 9). The RME cancer risk for ingestion of groundwater is $1x10^{-3}$, which is above the USEPA cancer range of $1x10^{-6}$ to $1x10^{-4}$. This risk is attributable to arsenic; cancer risks for other CPCs do not exceed $1x10^{-4}$ (Appendix N-6, Table 8).

The RME adult resident non-cancer risk for surface soil and subsurface soil (combined) is a screening HI of 1. However, the child resident non-cancer risk for surface soil is a screening HI of 4, and the screening HI for subsurface soil is 19. In addition, the EPC for lead (5,060 mg/kg) exceeds the USEPA residential screening value for lead of 400 mg/kg. Target organ-specific HIs for the skin, GI tract, immune system, an kidney exceed one, indicating an increased risk of possible adverse health effects to these organs and organ systems. The CPCs associated with these non-cancer risks include arsenic, chromium, aroclor-1260, and C11-C22 aromatic EPH (Appendix N-6, Table 9). The RME adult resident non-cancer screening HI for groundwater (7) exceeds the USEPA threshold HI of 1. The only target organ-specific HI that exceeds 1 is for the skin, and is attributable to arsenic in groundwater (Appendix N-6, Table 8).

This evaluation indicates that risks associated with current and possible future recreational uses of the Area 2 wetland are within USEPA acceptable limits. However, risks associated with possible future subsurface soil excavation in the Area 2 wetland are above a HI of 1, due to risks from Aroclor-1260. Risks associated with future unrestricted use of the Area 2 wetland exceed the USEPA acceptable cancer risk range for groundwater, and non-cancer risks exceed a HI of 1 for exposures to arsenic, aroclor-1260, chromium, and C11-C22 aromatic EPH. In addition, the EPC for lead (5,060 mg/kg) exceeds the USEPA residential screening value for lead of 400 mg/kg.

Area 3 – Industrial Area

Current Land Use

Risks associated with the current site use were evaluated for a maintenance worker potentially exposed to surface soil via incidental soil ingestion, dermal contact, and particulate inhalation. The RME cancer risk for the maintenance worker is $4x10^{-6}$, which is within the USEPA cancer risk range of $1x10^{-6}$ to $1x10^{-4}$. The RME non-cancer risk is a HI of 0.03, which is below the USEPA threshold HI of 1. The CT cancer and non-cancer risks are $3x10^{-7}$ and 0.008, respectively.

Possible Future Land Use

Future land use was assumed to be commercial/industrial, based on the Devens Site Redevelopment Plan. Therefore, risks associated with future site use were evaluated for a commercial industrial worker potentially exposed to groundwater via potable use, and to surface soil via incidental soil ingestion, dermal contact, and particulate inhalation. Risks were also evaluated for a construction worker potentially exposed to surface and subsurface soil via incidental ingestion, dermal contact, and particulate inhalation.

The RME cancer risk for the commercial/industrial worker is $1x10^{-5}$ for surface soil exposures, which is within the USEPA cancer risk range of $1x10^{-6}$ and $1x10^{-4}$. The RME cancer risk for groundwater is $2x10^{-4}$, which exceeds the USEPA cancer risk range. Cancer risks for soil and groundwater are attributable to arsenic; other potentially carcinogenic CPCs are associated with cancer risks below $1x10^{-5}$ (Appendix N-6, Table 11). The RME non-cancer screening HI is 0.1 for surface soil and 2 for groundwater. Although the RME non-cancer screening HI for groundwater exceeds the USEPA threshold HI of 1, HIs based on target organ effects do not exceed a HI of 1 (Appendix N-

6, Table 11). The CT cancer and non-cancer risks for combined exposure to surface soil and groundwater is $5x10^{-5}$ and a screening HI of 2, respectively; the target organ-specific HI does not exceed 1.

For the construction worker, the total RME cancer risks to surface soil ($2x10^{-6}$) and subsurface soil ($6x10^{-7}$) are within the USEPA cancer risk range of $1x10^{-6}$ to $1x10^{-4}$. The total RME screening HI of 1 for combined exposure to surface soil (HI=0.8) and subsurface soil (HI=0.2) does not exceed the USEPA threshold of 1. The CT cancer risk for combined exposure to surface and subsurface soil is $1x10^{-6}$ and the screening HI is 1.

Unrestricted Future Land Use

To aid in risk management decision-making and to evaluate the need for additional actions in the industrial (upland) portion of Area 3, unrestricted future land use was evaluated. Risks associated with unrestricted land use were evaluated for residential exposures to surface soil, subsurface soil, and groundwater.

RME adult resident and child resident cancer risks for combined exposures to surface soil and subsurface soil are $1x10^{-5}$ and $5x10^{-5}$, respectively, and the total resident cancer risk for exposure to soil is $6x10^{-5}$, which is within the USEPA range of $1x10^{-6}$ to $1x10^{-4}$. Arsenic is the principal contributor to cancer risk associated with soil. The resident cancer risk associated with ingestion of groundwater is $6x10^{-4}$, which exceeds the USEPA cancer risk range. The principal risk contributor is arsenic; other potentially carcinogenic CPCs in groundwater are associated with cancer risks below $1x10^{-5}$.

The RME adult resident and child resident non-cancer screening HIs for combined exposure to surface soil and subsurface soil are 0.1 and 1, respectively, which do not exceed the USEPA threshold HI of 1. The HI for ingestion of groundwater is 5; the HI for effects to the skin (due to arsenic) is 3 (Appendix N-6, Table 13).

This evaluation indicates that risks associated with current, possible future, and future unrestricted land use exposures to the Area 3 upland (industrial) soils are within the USEPA acceptable risk limits. Cancer and non-cancer risks associated with potable use of groundwater in the upland portion of Area 3 exceed the USEPA risk limits due to arsenic.

Area 3 – Recreational Area

Current/Future Land Use

Risks associated with the current and future site use were evaluated for an older child (ages 6 through 16) potentially exposed to surface soil, surface water, and sediment via incidental ingestion and dermal contact. The RME cancer risk for exposure to all media is $2x10^{-5}$, which is within the USEPA cancer risk range of $1x10^{-6}$ and $1x10^{-4}$. The RME non-cancer screening HI is 0.7, which is below the USEPA threshold HI threshold of 1. Cancer risks are primarily contributed by arsenic in all media. Non-cancer risks are primarily contributed by arsenic in soil, C11-C22 aromatic EPH in soil, and aroclor-1260 in sediment (Appendix N-6, Table 15). The CT cancer and non-cancer risks are $8x10^{-6}$ and 0.3, respectively.

The sediment EPC for lead (410 mg/kg) exceeds the USEPA residential screening value for lead of 400 mg/kg. However, exposures to sediment are not analogous to exposures to surface soil in a residential yard. Therefore, given the low lead concentration with respect to the screening value, and the lower exposure potential associated with sediment in the wetland, this lead concentration is not interpreted to pose a risk to the recreational child.

Possible Future Land Use

Possible future land use may include construction of walkways in the wetland areas. Therefore, risks for the future land use are evaluated for a construction worker, as well as being represented by the risks for the current/future recreational child.

The RME cancer risks for the construction worker are within the USEPA acceptable cancer risk range for both surface soil ($1x10^{-6}$) and subsurface soil ($1x10^{-6}$). The RME non-cancer risks for combined exposures to surface soil (screening HI=0.6) and subsurface soil (screening HI=0.4) is below a the USEPA threshold HI of 1. The CT cancer and non-cancer risks are approximately the same as the RME cancer and non-cancer risks.

Unrestricted Future Land Use

To aid in risk management decision-making and to evaluate the need for additional actions in the recreational (wetland) portion of Area 3, unrestricted future land use was evaluated. Risks associated with unrestricted land use were evaluated for residential exposures to surface soil, subsurface soil, and groundwater.

RME adult resident and child resident cancer risks for combined exposures to surface soil and subsurface soil are $2x10^{-5}$ and $6x10^{-5}$, respectively, and the total resident cancer risk for exposure to soil is $8x10^{-5}$, which is within the USEPA range of $1x10^{-6}$ to $1x10^{-4}$. Risks are primarily associated with arsenic. The RME cancer risk for ingestion of groundwater is $1x10^{-3}$, which is above the USEPA cancer range of $1x10^{-6}$ to $1x10^{-4}$. The principal risk contributor is arsenic; cancer risks calculated for other potentially carcinogenic CPCs are below $1x10^{-5}$.

The RME adult resident non-cancer HI for combined exposure to surface soil and subsurface soil is 0.3. (0.2). The adult resident screening HI for groundwater is 8, which exceeds the USEPA threshold HI of 1. The target organ-specific HI for effects to the skin (due to arsenic) is 8; HIs for other CPCs and target organs are below 1 (Appendix N-6, Table 17).

The RME child resident non-cancer screening HI for combined exposures to surface soil (HI=3) and subsurface soil (HI=0.7) is 4, which exceeds the USEPA threshold HI of 1. The target organ HI for effects to the kidney is 2 (due to C11-C22 aromatic EPH in subsurface soil), indicating an increased potential for adverse health effects (Appendix N-6, Table 18).

This evaluation indicates that risks associated with current and possible future recreational uses of the Area 3 recreational reuse area (wetland) are within USEPA acceptable limits. Risks associated with possible future excavation in the Area 3 recreational area are also within USEPA acceptable limits. Risks associated with future unrestricted use of the Area 3 recreational area (wetland) exceed the USEPA acceptable cancer risk range for groundwater (due to arsenic) and exceed a target organ-specific HI of 1 for soils (due to C11-C22 aromatic EPH) and groundwater (due to arsenic).

9.1.5 Evaluation of Uncertainty

The interpretation of risk estimates is subject to a number of uncertainties as a result of assumptions inherent in risk assessment. All quantitative estimates of risk are based on numerous assumptions, most intended to be protective of human health (i.e., conservative). As such, risk estimates are not truly probabilistic estimates of risk, but rather conditional estimates given a series of conservative assumptions about exposure and toxicity.

In general, sources of uncertainty are categorized into site-specific factors (e.g., variability in analytical data, modeling results, and exposure parameter assumptions) and general factors that affect most risk assessments equally, such as toxicity information. Toxicity information for many chemicals is very limited, leading to varying degrees of uncertainty associated with calculated toxicity values. Sources of uncertainty for calculating toxicity factors include extrapolation from short-term to long-term exposures, amount of data (e.g., number of studies) supporting the toxicity factors, consistency of different studies for the same chemical, and responses of various species to equivalent doses. The general uncertainties that affect most risk assessments, and the direction of their potential effects on the risk assessment results (e.g., to over- or under-estimate risks) for AOC 57 are summarized in Table 9-45. Site-specific uncertainties that have the greatest potential effect on the results of this risk assessment are discussed below.

Background Conditions

Arsenic was a substantial contributor to cancer risk in soil and groundwater, and non-cancer risk in groundwater. The presence of arsenic in environmental media at AOC 57 is due to its natural occurrence; arsenic is a naturally occurring element in soil and groundwater throughout New England, and there is no evidence indicating that arsenic-containing materials were disposed of at AOC 57. The levels of arsenic in groundwater at AOC 57 are generally elevated with respect to local background conditions because the anoxic conditions in soils at AOC 57 (created in part by the biotic degradation of petroleum) may have liberated naturally-occurring arsenic from the soil, whereupon it has leached to the groundwater.

The Devens background values for arsenic in groundwater and soil are 10.5 ug/L and 19 mg/kg, respectively. These concentrations are associated with residential land use cancer risks of $2x10^{-4}$ in groundwater and $3x10^{-5}$ in soil, and residential land use non-cancer risks of an HQ of 1 in groundwater and 0.3 in soil. The Federal drinking water maximum contaminant limit (MCL) for arsenic is 50 ug/L, a concentration that is associated with a cancer risk of $9x10^{-4}$ and HI of 5. Therefore, both the Devens groundwater background value and Federal MCL are associated with cancer risks that exceed the USEPA Superfund risk range. For comparison, the cancer risks associated with potential exposures to arsenic in groundwater at AOC 57 ranged from $7x10^{-4}$ (Area 3 industrial portion) to $1x10^{-3}$ (Area 2 and Area 3 wetland portions), and the HIs ranged from 3 to 8. The cancer risks associated with potential exposures to arsenic in soil at AOC 57 were generally approximately $5x10^{-5}$. The soil and groundwater risk values for AOC 57 compare closely to the risks associated with the Devens background concentrations and/or the Federal MCL; this information should be considered when making risk management decisions about the site.

Exposure Assessment

The most substantial uncertainty affecting the results of this risk assessment is associated with the basis of the exposure point concentrations. Although a large number of samples have been collected in the various media at AOC 57, and the boundaries of the site-related contamination have been appropriately established, the segregation of the site by upland (industrial) and wetland (recreational) portions, and surface and subsurface soils, has resulted in many of the exposure points having fewer than 10 samples. Consequently, the EPCs for those exposure points are the maximum detected concentrations (USEPA indicates that the 95 percent UCL should not be used when there are fewer than 10 samples in the data set). In other areas, the EPCs are strongly influenced by the concentrations in one or two samples. Although USEPA considers the maximum concentration to be the best estimate of the EPC when there are fewer than 10 samples, it is likely that risks based on the maximum concentration are overestimated.

At the Area 2 recreational area, risks associated with exposures to subsurface soils were above an HI of 1 for the construction worker, and the HI for surface soil was equal to an HI of 1 for the construction worker and recreational child. The principal risk contributor in these media is Aroclor-1260. Aroclor-1260 was detected in 4 out of 12 subsurface soils, and 8 out of 11 surface soils. However, the concentrations associated with three of the samples (57E-95-15X, 16X, and 12X) were approximately one order of magnitude higher than concentrations in other samples. These three samples are located at the base of Area 2 soil removal excavation and together represent only a small portion of the site. PCB concentrations throughout the remainder of the site would not pose a non-cancer risk above an HI of 1 for the construction worker.

Another substantial uncertainty associated with this risk assessment is associated with the assumed use of groundwater as a potable water source. As discussed previously, groundwater beneath AOC 57 is not considered a potable water resource by the State of Massachusetts. Given that there is an existing potable water distribution system at Devens, any future development at AOC 57 would likely use the municipal water at Devens as the potable water source. Therefore, evaluation of exposures to groundwater as potable water represents a theoretical scenario that is most useful for evaluating the possible need for land use restrictions at the site.

If AOC 57 groundwater was used as a source of industrial process water, workers would not be ingesting the water. Any contact that occurred with the water would be incidental, and most likely only involve dermal contact. Since arsenic, which is the primary risk-contributing CPC in groundwater, does not readily absorb through the skin from water, it is unlikely that workers would be at risk from using AOC 57 groundwater as process water.

Toxicity Assessment

In accordance with USEPA Region I risk assessment guidance, dose-response values were obtained from USEPA-approved sources, including IRIS, HEAST, and NCEA. CPCs for which dose-response values were not published in these sources and for which potentially complete exposure pathways exist include arsenic, aroclor-1260, and dieldrin (inhalation RfDs), and benzo(k)flouranthene (oral RfD). Although an RfD is not published for lead, lead was evaluated using the Office of Solid Waste and Emergency Response (OSWER) residential soil screening value. In addition, NCEA publishes RfDs for iron and copper; however, those RfDs are not based on risk of adverse health effects and, therefore, are not appropriate for use in this risk assessment.

In accordance with risk characterization methodology published by the MADEP in "Guidance for Disposal Site Risk Characterization" (MADEP, 1995), inhalation RfDs may be derived for arsenic (7E-07 mg/kg/day) and aroclor-1260 (2E-05 mg/kg/day), and an oral RfD may be derived for benzo(b)flouranthene (0.03 mg/kg/day). However, incorporation of these dose-response values presented in this risk assessment does not change the conclusions of the risk assessment. If these dose response values were included in the risk characterization for the construction worker at Area 2 – recreational (wetland) subsurface soil (the exposure point and scenario with the highest inhalation non-cancer risks), the inhalation HQ for arsenic would be 0.006, and the inhalation HQ for aroclor-1260 would be 0.0001, which would not measurably add to the inhalation HI for this receptor of 0.02. If the oral RfD for benzo(b)flouranthene was used to characterize risk to the child trespasser exposed to the Area 3 wetland surface water (the only medium where benzo(b)flouranthene was detected), the HQ would be 0.0007, which does not appreciably add to the surface water HI of 0.1.

USEPA sources do not publish dose-response values for petroleum compounds. However, because the contaminants detected at AOC 57 are primarily attributable to releases of petroleum-containing wastes, risks for potential exposures to petroleum compounds were characterized using RfDs developed by the MADEP (MADEP, 1997). This represents a conservative approach to Superfund risk characterization, because through use of these dose-response values, petroleum hydrocarbons were identified as primary (but not the only) risk contributors in Area 2 and Area 3 wetland soils. The risk management decision-making for this site should consider that risks for petroleum hydrocarbons are not based on USEPA-approved dose-response values.

Arsenic was selected as a CPC detected in all media at AOC 57. Use of the CSF for arsenic to estimate ELCRs is thought to overestimate the true risk by perhaps an order of magnitude or more (USEPA, 1998). The oral CSF for inorganic arsenic is based on dose/response data for skin cancer incidence obtained by Tseng et al. (1968). Individuals in this study were exposed to high levels of inorganic arsenic in drinking water (170 μg/mL). Arsenic exposure was approximated based on estimates of water intake. Other exposure pathways contributing to total exposure, such as ingestion of fish, livestock, and plants, were not assessed, potentially resulting in an underestimate of arsenic exposure. The oral slope factor was calculated using a model that assumes the dose/response curve is linear at low doses. Recent evidence suggests that arsenic, at low doses, may be largely detoxified by methylation, producing a non-linear dose/response curve. In the study of Tseng et al. (1968), the overwhelming of the normal detoxification pathways, coupled with an underestimate of exposure, may have resulted in an overestimate of cancer risk. These uncertainties have caused the USEPA to report that, "the uncertainties associated with ingested inorganic arsenic are such that estimates could be modified downwards as much as an order of magnitude, relative to risk estimates associated with most other carcinogens" (USEPA, 1998). Hence, for all groundwater exposure points at AOC 57, risks would not exceed the USEPA acceptable cancer risk range if this modification factor was applied to the risk estimates.

Risk Characterization

Given the uncertainties discussed in this section, it appears that the risk estimates reported in this risk assessment overestimate risks rather than underestimate risks. The primary sources of uncertainty that lend to a general overestimation of risks include:

- Influence of a small number of samples on the EPC; risks associated with

PCBs at the Area 2 wetland (recreational reuse) are elevated due to the PCB concentrations associated with three samples at the southern end of the former soil excavation.

- Likelihood of groundwater use as drinking water
- Conservativeness of the arsenic CSF; risks for exposures to arsenic in groundwater at the Devens background concentration or Federal MCL are similar to the risks associated with groundwater at AOC 57.

9.1.6 Summary and Conclusions

Possible health risks were evaluated for the current land uses, anticipated future land uses, and unrestricted future land uses at AOC 57. Although the site is presently not used for any specific purposes, and is not located near any properties with active land uses, exposures and risks for current site use were evaluated for a site maintenance worker (possible exposure to surface soil), and a trespasser ages 6 through 16 (possible exposure to surface soil, surface water, and sediment). The possible health risks associated with the anticipated future site use were evaluated assuming that the upland portion of the site will be redeveloped for commercial/industrial use, and included evaluation of a commercial industrial worker (possible exposure to surface soil and groundwater) and an excavation worker (possible exposure to surface soil and subsurface soil). Possible health risks for the future use of the wetland areas were evaluated assuming that the areas could be used for passive recreational/open space use. Therefore, the possible health risks associated with future use of the wetland area of the site were evaluated for a recreational child ages 6 through 16 (possible exposure to surface soil, surface water, and sediment), as well as a construction worker (possible exposure to surface soil and subsurface soil). In addition, to aid in risk management decision-making and to determine if additional response actions may be required at AOC 57, future unrestricted land use was evaluated by assuming that child and adult residents would live at the site (possible exposures to surface soil, subsurface soil, and groundwater). Since groundwater at and beneath AOC 57 is not used as a source of drinking or industrial water, and is not considered a groundwater resource by the State of Massachusetts, evaluation of potable groundwater use represents a hypothetical worst-case evaluation of potential exposures and risks.

Soil removal actions performed by the Army at Area 2 in 1994 and Area 3 in 1999 have removed the major source areas of contamination at AOC 57. The risk assessment evaluated post-removal action conditions for surface soil and subsurface soil. Chemicals of potential concern identified in surface soil and subsurface soil primarily included arsenic, iron, manganese, Aroclor-1260, and petroleum compounds such as EPH and VPH hydrocarbon fractions. CPCs identified in groundwater, surface water, and sediment were similar to those identified in soil, but also included chlorinated VOCs, which were detected at low concentrations. Petroleum compounds and PCBs are interpreted to be directly associated with the release of oils and vehicle wastes to soils at the site. Inorganic constituents selected as CPCs are interpreted to be indirectly associated with the petroleum release via enhanced leaching of naturally-occurring inorganics from petroleum source area soils.

Possible health risks were quantified for carcinogenic and non-carcinogenic effects, for both reasonable maximum and central tendency exposure assumptions. Tables 9-44 and Table 10-1 present a summary of the risk estimates. The following points summarize the results of the risk assessment:

Current Land Use

- Estimated cancer and non-cancer risks for maintenance worker and child trespasser exposures at industrial (upland) and recreational (wetland) portions of Area 2 and Area 3 do not exceed the USEPA Superfund cancer risk range or a hazard index of 1.

Future Land Use

- Estimated cancer and non-cancer risks for commercial worker exposures to soil at industrial (upland) portions of Area 2 and Area 3, and commercial worker potable consumption of groundwater at Area 2, do not exceed the USEPA Superfund cancer risk range or a hazard index of 1.
- Estimated cancer risks for commercial worker potable consumption of groundwater at Area 3 exceed the USEPA Superfund cancer risk range. However, due to the fact that groundwater at AOC 57 is not considered a groundwater resource by the State of Massachusetts, and the availability of public water supply at Devens, it is unlikely that groundwater beneath AOC 57 will be used as a source of potable water in the future.
- Estimated cancer and non-cancer risks for construction worker exposures to soil at industrial (upland) portions of Area 2 and Area 3, and the recreational (wetland) portion of Area 3 do not exceed the USEPA Superfund cancer risk range or a hazard index of 1.
- The estimated non-cancer hazard index for potential effects to the immune system exceed a HI of 1 for construction worker exposures to Area 2 wetland soil. The risks are primarily attributable to Aroclor-1260 in subsurface soil. In addition, the EPC for

lead in Area 2 wetland soil exceeds the OSWER residential screening value for soil lead.

Unrestricted Future Land Use

- Estimated cancer and non-cancer risks for child and adult resident exposures to soil and groundwater at the industrial (upland) portion of Area 2 do not exceed the USEPA Superfund cancer risk range or a hazard index of 1.
- Estimated cancer and non-cancer risks for child and adult resident exposures to soil at the industrial (upland) portion of Area 3 do not exceed the USEPA Superfund cancer risk range or a hazard index of 1.
- Estimated cancer risks for child and adult resident exposures to soil at the recreational (wetland) portions of Areas 2 and 3 do not exceed the USEPA Superfund cancer risk range. However, non-cancer risks to a child resident potentially exposed to soils at these areas exceed target organ-based hazard index values of 1. At the Area 2 wetland soils, the principal risk contributors are arsenic, aroclor-1260, chromium, and C11-C22 aromatic EPH. In addition, the EPC for lead in Area 2 wetland soil exceeds the OSWER residential screening value for soil lead. At the Area 3 wetland soils, the principal risk contributor is C11-C22 aromatic EPH.
- With the exception of the industrial (upland) portion of Area 2, estimated cancer and non-cancer risks for potable consumption of the groundwater at AOC 57 exceed the USEPA Superfund cancer risk range and a hazard index of 1. However, due to the fact that groundwater at AOC 57 is not considered a groundwater resource by the State of Massachusetts, and the availability of public water supply at Devens, it is unlikely that groundwater beneath AOC 57 will be used as a source of potable water in the future.

9.2 BASELINE ECOLOGICAL RISK ASSESSMENT

This Baseline Ecological Risk Assessment (BERA) evaluates actual and potential adverse effects to ecological receptors associated with exposure to contamination from AOC 57 at Devens, Massachusetts. The BERA for AOC 57 was completed in accordance with current guidance materials for BERAs at Superfund sites including the following:

- Risk Assessment Guidance for Superfund, Environmental Evaluation Manual (USEPA, 1989a);

- Ecological Assessment of Hazardous Waste Sites, A Field and Laboratory Reference (USEPA, 1989b);
- Ecological Assessment of Superfund Sites, An Overview (USEPA, 1991a);
- Framework for Ecological Risk Assessment (USEPA, 1992a);
- USEPA Region I, New England "Risk Updates" (issued since 1992);
- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (USEPA, 1997c);
- Tri-Service Procedural Guidelines for Ecological Risk Assessments, Volumes I and II (Wentsel et. al., 1996); and
- USEPA Guidelines for Ecological Risk Assessment (USEPA, 1998).

Recent risk assessment guidance including the USEPA "Eco Update" bulletins (issued since 1991) and recent publications (e.g., Maughan, 1993; Suter, 1993) were also consulted.

Historical spill or disposal activities at AOC 57 have resulted in the release of various fuel- and oil-related chemicals into site media. This BERA utilizes surface soil, surface water, sediment, groundwater, biological tissue, and toxicity test data to evaluate potential risks to ecological receptors.

Discussions of the general site history and layout are provided in Section 5.0, and are briefly summarized at the beginning of Section 9.0. A discussion of historical and current analytical data is provided in the contaminant assessment (Section 7.0). The AOC 57 BERA includes a Site Characterization (Subsection 9.2.1), Problem Formulation (Subsection 9.2.2), Hazard Assessment and Selection of CPCs (Subsection 9.2.3), Exposure Assessment (Subsection 9.2.4), Ecological Effects Assessment (Subsection 9.2.5), Risk Characterization (Subsection 9.2.6), Uncertainty Analysis (Subsection 9.2.7), and Summary (Subsection 9.2.8).

9.2.1 Site Characterization

AOC 57 is located between Barnum Road and Cold Spring Brook (a perennial stream) along the eastern boundary of the Main Post at Devens (see Figure 9-1). The area northwest of Barnum Road is primarily industrial, whereas the area southeast of Barnum Road varies from primarily forested to industrial areas bordered by forest.

Upstream portions of Cold Spring Brook (i.e., southwest of AOC 57 Area 2) are characterized by the USFWS as palustrine forested wetlands with a combination of broad-leaved deciduous and needle-leaved evergreen trees dominating the forest composition (USFWS, 1977). Northeast and downstream of AOC 57 Area 2 the brook transitions into a scrub/shrub swamp with emergent marsh characteristics (USFWS, 1977). Southeast of Cold Spring Brook, land is primarily used for agricultural purposes. The brook is a warm-water, lentic (i.e., slow-moving) stream with few channelized lotic (i.e., fast-moving) areas.

AOC 57 is divided into three primary areas of contamination: Area 1, Area 2, and Area 3 (Figures 9-1 and 5-2). Area 1 consists of a storm water outfall and eroded drainage ditch. This area does not provide adequate habitat for ecological receptors and, therefore, is not evaluated in the AOC 57 BERA. Area 2 extends along the southwestern edge of a fenced army vehicle storage yard, down a forested slope, and onto a man-made berm that extends into a floodplain swamp. Area 2 spans a lateral distance of approximately 680 feet, and differs 25 feet in elevation; for the purposes of the BERA, the upland and floodplain portions of Area 2 will be evaluated separately because of the different habitats available to ecological receptors. An erosion mat (approximately 9,400 feet^2 in size) covers an area of the steep slope where contaminated soils were removed in 1994.

Area 3, located approximately 650 feet northeast of Area 2, is situated between the southeastern edge of the former vehicle storage yard and the Cold Spring Brook floodplain. The slope down into the floodplain from Area 3 is gradual as this portion of Cold Spring Brook broadens out into an unchannelized scrub-shrub swamp. The distance from Area 3 to open water contiguous with Cold Spring Brook is approximately 600 feet.

In October of 1995, HLA ecologists visited AOC 57 to characterize the wetland habitats that exist at the site and to determine appropriate receptors in support of the BERA. HLA ecologists used a modified line transect method (Environmental Laboratories, 1987) to identify characteristic habitats, flora, and fauna at the site. The transects, which are shown in Figure 9-1, are approximately 160, 240, and 400 feet long from upstream (where the Cold Spring Brook channel is narrow) to downstream (where the channel broadens before the junction with Bower's Brook). Based on a review of aerial photographs and site map, the area of wetland habitat present at Area 2 and Area 3 were estimated to be approximately 2 and 3 acres, respectively. The following paragraphs summarize the results of the qualitative survey. More information regarding the ecological survey is provided in Appendix P.

9.2.1.1 Vegetative Cover. The wetland vegetative cover types at AOC 57 are fairly well defined by topographic changes, as seen by the four zones of similar habitats encountered during the habitat characterization.

Upstream of AOC 57 Area 2 and at the AOC 57 Area 2 berm, the topographic changes are distinct and the Cold Spring Brook channel is fairly well defined. The habitats identified in this area include: floodplain forest and berm (adjacent to AOC 57), emergent marsh, scrub/shrub marsh, and upland forest (on the opposite bank from AOC 57).

The floodplain forest and berm habitats are located on the northwestern side of the Cold Spring Brook channel, and range from 0 to 2 feet above water. The canopy of the floodplain forest is dominated by white pine inter-mixed with oaks (*Quercus* sp.) and maples (*Acer* sp.). Various shrubs, including arrow-wood (*Viburnum recognitum*), highbush blueberry (*Vaccinium corymbosum*), sheep laurel (*Kalmia angustifolium*), red-osier dogwood (*Cornus stolonifera*), and winterberry (*Ilex verticillata*) were also observed in the floodplain forest. Herbaceous species observed along the edge of the stream include tussock sedge (*Carex stricta*) and various ferns (*Dryopteris* and *Osmunda* spp.). The berm is primarily vegetated with speckled alder (*Alnus rugosa*) and other shrubs also found in the floodplain forest; additional species include fetterbush (*Leucothoe racemosa*), silverberry (*Elaeagnus commutata*), and swamp rose (*Rosa palustris*).

The emergent marsh habitat, located on the southeastern side of the stream channel and in a hollowed area just upstream of the berm on the northwestern side, is dominated by broad-leaved cattails (*Typha latifolia*). The mound and pool microtopography of the emergent marsh suggest that the water table is at or near the surface throughout the year. Scattered saplings and shrubs observed in this habitat include speckled alder, common alder (*Sambucus canadensis*), swamp rose, arrow-wood, sweet gale (*Myrica gale*), winterberry, red-osier dogwood, and swamp birch *(Betula pumila*). Herbaceous species also noted in the emergent marsh include tussock sedge, meadow rue (*Thalictrum polygamum*), marsh bedstraw (*Galium palustre*), aster, purple-leaved willow herb (*Epilobium coloratum*), joe-pye weed (*Eupatorium dubium*), umbrella sedge (*Cyperus* sp.), arrow-leaved tearthumb (*Polygonum sagittatum)*, jewelweed (*Impatiens capensis*), cinnamon fern (*Osmunda cinnamomea*), sphagnum moss (*Sphagnum palustre*), and sensitive fern (*Onoclea* *sensibilis*).

Just upgradient of the emergent marsh on the southeastern edge of Cold Spring Brook is a scrub/shrub marsh dominated with a fairly open canopy of red maple and white pine. Mound and pool topography, and a few snags and windthrows were observed in this habitat suggesting seasonal or year-round saturation. Shrubs found in the scrub/shrub marsh include arrow-wood, highbush blueberry, sweet gale, winterberry, sheep laurel, speckled alder, red choke cherry (*Prunus virginiana*), maleberry *(Lyonia ligustrina*), and paper birch (*Betula papyrifera*). Herbaceous species observed in this habitat include tussock sedge, interrupted fern (*Osmunda claytoniana*), water-smartweed (*Polygonum* sp.), turtle head (*Chelone glabra*), aster (*Aster novi-belgii*), New York aster (*Aster novi-belhii*), cinnamon fern, bedstraw (*Galium asprellum*), and sphagnum.

The last habitat observed on the southeastern side of Cold Spring Brook is an upland forest co-dominated by mature white pine, white oak (*Quercus alba*), and red oak (*Q. rubra*). Few beech (*Fagus grandifolia*) and several oak and pine saplings were also observed, and the open shrub canopy consisted of highbush blueberry, arrow-wood, and lowbush blueberry (*Vaccinium angustifolium*). Herbaceous species found amongst a mat of pine needles and semi-decomposed oak leaves include gold thread (*Coptis groenlandica*), partridge berry (*Mitchella repens*), interrupted fern, cinnamon fern, and lady fern (*Athyrium filix-femina*). This habitat extends up a steep slope and does not support any wetland characteristics.

Downstream of the AOC 57 (Area 2) berm, the elevational changes are more gradual and the Cold Spring Brook channel is dendritic in nature. The habitats identified downstream of the AOC 57 berm include (from northwest to southeast): Forested wetland (dominated by white pine [*Pinus strobus*]), scrub/shrub swamp, forested wetland (with sparse red maple [*Acer rubrum*]), and upland forest.

The white pine-dominated forested wetland to the northwest of Cold Spring Brook has a canopy cover of approximately 50 percent, and contains other species such as red maple, bigtooth aspen (*Populus grandidentata*), and oak. The shrub layer contains nannyberry (*Viburnum lentago*), choke cherry, arrow-wood, white oak, highbush blueberry, red-osier dogwood, and sheep laurel. The herbaceous layer in this habitat is co-dominated by tussock sedge, clubmoss (*Lycopodium* sp.), and gold thread.

Just downstream of the berm, the scrub/shrub swamp broadens and the channel of Cold

Spring Brook becomes somewhat indistinguishable. Many of the same species observed in the upstream scrub/shrub swamp were also found in this habitat; additional shrubs observed in the downstream swamp include swamp rose, nannyberry, alder, and red-osier dogwood. The herbaceous layer in the downstream swamp is co-dominated by reed canary grass (*Phalaris arundinacea*) and tussock sedge; additional species observed include arrowhead (*Sagitaria latifolia*), yellow pond lily (*Nuphar variegatum*), pickerelweed (*Peltandra virginica*), duckweed (*Lemna minor*), and bur-reed (*Sparganium* sp.).

The forested wetland to the southeast of Cold Spring Brook has a sparse canopy cover of red maple saplings. The shrub layer is dominated by winterberry, but also contains maleberry, paper birch, highbush blueberry, and speckled alder. The herbaceous layer contains tussock sedge, interrupted fern, water-smartweed, turtle head, aster, and sphagnum. The ground surface displays some mound and pool microtopography, indicating seasonally flooded and saturated conditions.

The upland forest habitat on the southeastern side of Cold Spring Brook is an extension of the same habitat observed near to and upstream of the berm. Additional shrub and herbaceous species observed in the downstream portion of this habitat include sheep laurel, witch hazel (*Hamamelis virginiana*), nannyberry, choke cherry, clubmoss (*Lycopodium carolinianum*), and ferns (*Thelipteris* sp.).

The habitat in the upland portions of AOC 57 can best be described as disturbed uplands. This relatively flat portion of the site contains sandy, well-drained soils that have been disturbed by army activities and off-road vehicle use. The vegetation is comprised primarily of graminoids (i.e., grasses and sedges). Few trees and shrubs exist in the flatter upland portions of AOC 57; however, the portion of the site that slopes steeply down to Cold Spring Brook is forested, and eventually grades into the floodplain forest, berm, and forested wetland habitats.

9.2.1.2 Wildlife Habitat Characterization. The various wetland cover types in the vicinity of lower Cold Spring Brook are expected to provide diverse wildlife habitat. Mammals typically occurring in floodplain wetland systems in New England include mink (*Mustela vison*), river otter (*Lutra canadensis*), raccoon (*Procyon lotor*), and muskrat (*Ondatra zibethicus*). Birds common to floodplain marshes and forests include dabbling ducks (e.g., wood duck [*Aix sponsa*] and mallard [*Anas platyrhynchos*]), swamp sparrow (*Melospiza georgiana*), great blue heron (*Ardea herodias*), Virginia rail (*Rallus limicola*), and red-winged blackbird (*Agelaius phoeniceus*). Green frogs (*Rana clamitans*) have been observed in the lower Cold Spring Brook watershed, and it is likely that the eastern painted turtle (*Chrysemys picta*) may find habitat in this area. The brook also provides suitable habitat for a wide variety of benthic and winged invertebrates; two odonates were observed during the ecological survey. The deeper portions of the brook may provide habitat for fish species such as golden shiner (*Notemigonus crysoleucas*), pumpkinseed (*Lepomis gibbossus*), and chain pickerel (*Esox niger*).

9.2.1.3 Rare, Threatened, and Endangered Species. The presence or absence of rare and endangered flora and fauna at the site is reviewed in this subsection. Under contract to the USACE, HLA developed a database of all flora and fauna known to seasonally or permanently occur at Devens (ABB-ES, 1993). Particular emphasis has been paid to rare and endangered biota. The Devens Biological and Endangered Species Baseline Study (BESBS) contains information from the Massachusetts Natural Heritage Program (MNHP, 1997), and the USFWS regarding all rare and endangered species known to occur at Devens. Additional information was also requested for more recently documented occurrences.

The BESBS has been checked for known occurrences of rare and endangered biota in the vicinity of AOC 57 and Cold Spring Brook. According to the BESBS (ABB-ES, 1993), no state or federally listed rare and endangered species occur at AOC 57 or in Cold Spring Brook. However, AOC 57 may provide suitable habitat for species that are listed by the state as species of special concern or are on the state watch list, including the wood turtle (*Clemmys insculpta*), water shrew (*Sorex palustris*), Cooper's hawk (*Accipiter cooperii*), Mystic valley amphipod (*Crangonyx aberrans*), northern leopard frog (*Rana pipiens*), great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), northern saw-whet owl (*Aegolius acadicus*), olive-sided flycatcher (*Contopus borealis*), and marsh wren (*Cistothorus palustris*).

According to the MNHP , several species have been documented as occurring within 1 mile of AOC 57. The actual occurrence of these species at the site is unknown. The following species listed by the MNHP may be found in the wooded portions of AOC 57, or in Cold Spring Brook and its floodplain: Blanding's turtle (*Emydoidea blandingii*) (threatened), eastern box turtle (*Terrapene carolina*) (special concern), wood turtle (special concern), and ovate spike-sedge (*Eleocharis obtusa* var. *ovata*) (endangered). The following species listed by the MNHP may be found in the upland sandy soils or disturbed portions of AOC 57: Houghton's flatsedge (*Cyperus houghtonii*) (endangered), New England blazing star (*Liatris scariosa* var. *novae-angliae*) (special concern), and wild senna (*Senna* *hebecarpa*) (endangered). The upland sandpiper (*Bartramia longicauda*), listed by the MNHP as endangered, is not likely to be found in the vicinity of AOC 57 as this species requires large, open grassy areas for nesting and foraging, and is generally restricted in Massachusetts to flightline areas (MNHP, 1997).

9.2.2 Problem Formulation

Problem formulation is the initial step of the BERA process whereby receptors, exposure pathways, and the assessment and measurement endpoints are selected for evaluation.

9.2.2.1 Identification of Receptors. Mammals, birds, reptiles, adult amphibians, terrestrial plants, and terrestrial invertebrates are expected to be found in the terrestrial habitats of AOC 57, including the upland portion of Area 2 and Area 3. Semi-aquatic wildlife (including wading birds, dabbling ducks, and various mammals) and aquatic receptors (including small fish, aquatic plants, benthic and pelagic macroinvertebrates, and juvenile amphibians) are expected to inhabit the scrub-shrub swamp and emergent marshes in Cold Spring Brook.

9.2.2.2 Identification of Exposure Pathways. Exposure pathways are identified for four groups of ecological receptors (wildlife, terrestrial plants, terrestrial invertebrates, and aquatic receptors). The exposure pathway includes a source of contamination, potentially contaminated media, and an exposure route. The exposure pathways from the AOC 57 contaminant source to ecological receptors are depicted in the contaminant pathway model in Figure 9-3. Dots in the model show all potential exposure pathways; those pathways that are quantitatively evaluated in the AOC 57 BERA are indicated by shading. This limitation is necessary to focus the BERA on the pathways for which: (1) contaminant exposures are the highest and most likely to occur, and (2) there are adequate data pertaining to the receptors, contaminant exposures, and toxicity for completion of risk analyses. Exposure pathways evaluated include portions of food chains (e.g., surface soil → primary consumer → secondary consumer → tertiary consumer), as well as other direct and indirect exposures.

<u>Wildlife</u>. The wildlife exposure routes that are believed to contribute the highest potential contaminant exposures include incidental ingestion of site media, and ingestion of food items that have bioaccumulated and bioconcentrated contaminants from site media. Limited site-specific crayfish and fish tissue data were collected from Cold Spring Brook, and were used to evaluate exposures to wildlife that may forage in the brook. In addition, a bioaccumulation study was conducted by exposing an oligochaete (*Lumbriculus variegatus*)

to Cold Spring Brook sediment; due to uncertainties associated with the results, they were only used qualitatively to evaluate wildlife exposures to pesticides and PCBs that may have bioaccumulated in invertebrate tissue.

Dermal exposures to wildlife are not evaluated in the AOC 57 BERA because there are few data relating dermal exposures to toxic responses in wildlife. Dermal exposure to contaminants in surface soil may be an ecologically significant exposure pathway for adult amphibians and for young, hairless mammals in subterranean dens (e.g., juvenile muskrats); however, in general, an assumption is made that fur, feathers, or chitinous exoskeleton limit the transfer of contamination across the dermis. Furthermore, dermal exposures for amphibians are likely to be greatest during developmental aquatic life stages (i.e., free-swimming). Dermal exposures for juvenile amphibians in surface water are evaluated in the AOC 57 ERA.

Inhalation of VOCs is also not evaluated because this does not represent a complete exposure pathway for ecological receptors. The sandy soils at AOC 57 are less likely to retain VOCs from historic spills because VOCs either leached or were rapidly volatilized. Disposal activities occurred long ago, and VOC concentrations in surface soil are low enough (i.e., < 0.030 µg/g) that toxic effects are unlikely to occur. In addition, toxicity data relating adverse effects in wildlife with inhalation exposures are limited.

Potential food chain exposures for reptiles and adult amphibians exist at AOC 57, but are not evaluated due to a lack of data relating contaminant exposures to adverse responses for these taxa.

Terrestrial Plants and Invertebrates. Terrestrial plants and soil invertebrates may be exposed to contamination in surface soil by direct contact, root uptake (plants), or ingestion (invertebrates) of soil.

Aquatic Receptors. Exposure pathways for aquatic receptors (e.g., small fish, aquatic plants, benthic and pelagic macroinvertebrates, and juvenile amphibians) at AOC 57 include direct contact with and ingestion of surface water and sediment in Cold Spring Brook. Aquatic receptors may be indirectly exposed to contaminants in groundwater as it discharges to the surface; consequently, potential risks to aquatic receptors were qualitatively evaluated by comparing groundwater concentrations with surface water concentrations.

9.2.2.3 Identification of Endpoints. The assessment and measurement endpoints selected for the AOC 57 BERA are listed in Table 9-46. Assessment endpoints represent the ecological component to be protected, whereas the measurement endpoints approximate or provide a measure of the achievement of the assessment endpoint. The assessment endpoint selected for the AOC 57 BERA is the survival and propagation of receptor populations at AOC 57. To ensure that the AOC 57 ERA is sufficiently conservative, the lowest dose for lethal (i.e., mortality) or sublethal (i.e., growth, development, or reproduction) effects were used in the ERA as the measurement endpoint. The specific objectives of the AOC 57 BERA are to determine whether the chemical concentrations detected in surface soil, surface water, and sediment are likely to result in population decline of ecological species.

Measurements of actual toxicity and adverse effects to survival and growth were completed for two benthic invertebrates exposed to sediment, the midge (*Chironomus tentans*) and amphipod (*Hyalella azteca*), to decrease uncertainties and to measure the combined effects associated with exposure to the actual mixture of contamination present in sediment. Site-specific toxicological data are not available for surface soil or surface water; therefore, the measurement endpoints used to gauge the likelihood of population-level effects are toxicological benchmark values based on laboratory-measured survival, growth, and reproductive effects.

9.2.3 Hazard Assessment and Selection of CPCs

The Hazard Assessment includes a review of analytical data and selection of CPCs. CPCs are the analytes detected in environmental media that are considered in the AOC 57 BERA and could present a potential risk for ecological receptors. The process for selecting CPCs is depicted in Figure 9-4.

Historical surface soil, surface water, sediment, and groundwater data (i.e., data collected before 1995) were not included in the AOC 57 BERA as they do not represent current conditions at the site. Only more current analytical data (i.e., those data collected since 1995) were utilized in the AOC 57 BERA. All of the analytical data are provided in Section 7.0 of the RI, and in Appendix M. All samples collected in 1995, 1996, and 1998 were analyzed for PAL Metals (only a subset in 1998), pesticides, PCBs, PAL SVOCs, PAL VOCs, and TPHC (except groundwater). In addition, several soil, sediment, and surface water samples in 1998 were analyzed for EPH/VPH parameters. Wet chemistry data and general chemistry data are available for surface water, groundwater, and sediment from 1995, 1996, and 1998. Samples collected in 1999 at Area 3 were analyzed primarily for pesticides, PCBs, TPHC, EPH/VPH, and EPH/VPH target analytes.

Analytical data for AOC 57 were evaluated to determine their validity for use in the BERA. The data review process was conducted according to the methodologies described in Subsection 3.2.6.

The following data sets are evaluated in the AOC 57 BERA:

- Area 2 upland surface soil;
- Area 2 floodplain surface soil;
- Area 3 surface soil;
- Area 2 surface water (collected in Cold Spring Brook and the emergent marshes adjacent to Area 2);
- Area 2 sediment (collocated with Area 2 surface water);
- Area 3 surface water (collected from seeps in the Cold Spring Brook floodplain downgradient of Area 3);
- Area 3 sediment (collocated with Area 2 surface water);
- Area 2 groundwater, and
- Area 3 groundwater.

It should be noted that the surface water and sediment at Area 2 are hydrologically connected with Cold Spring Brook at the surface and via groundwater, whereas the surface water and sediment at Area 3 are only hydrologically connected with Cold Spring Brook via groundwater.

To select CPCs, data were screened against background data (surface soil and groundwater) or upgradient reference data (surface water and sediment) to eliminate analytes from evaluation in the AOC 57 BERA. The background surface soil and groundwater data sets consist of chemical data gathered from locations designed to establish background concentrations of inorganic analytes for Group 1A sites. The values approximately represent the 68th percentile upper bound limits (the mean values plus one standard deviation) of these chemicals (ABB-ES, 1993b). No background surface water or sediment data are available for Devens; therefore, upgradient surface water and sediment data (consisting of data collected in 1995 at sampling stations 57D-95-03X and 57D-95-08X) were used to screen CPCs instead. Sample location 57D-95-08X was collected as an upstream reference sample for the toxicity test evaluation, and sample 57D-95-03X was determined to be outside of the area of impact from AOC 57. Analytes were eliminated from the BERA if the maximum detected concentration was less than the background or upgradient screening value.

Because Cold Spring Brook receives effluent from various contaminant sources upstream of AOC 57, and since there were only two upgradient sample locations collected in 1995, a second "criterion" was used to select CPCs for sediment. A Master's Thesis from Northeastern University entitled "Heavy Metals in the Sediments of Massachusetts Lakes and Ponds" (Rojko, 1990) provided useful information regarding concentrations of inorganics in sediments in 100 regional lakes and ponds. Data in this study include summaries of sediment chemistry collected by MADEP for baseline and long-term surveys of ponds and lakes, as well as data collected for the MADEP Clean Lakes Programs. Rojko calculated "normal" concentrations of inorganics by averaging inorganic concentrations detected in ponds that do not have a history of anthropogenic inputs. Analytes that fall within the normal range of sediment concentrations (i.e., below the range of "elevated" sediment concentrations listed in the CPC selection tables) were excluded from the BERA. Although Cold Spring Brook does not qualify as a lake or pond, the portion of the brook in the vicinity of AOC 57 (i.e., the scrub/shrub swamp and emergent marsh) is similar to a lake or pond in that it is a depositional environment.

The essential nutrients (e.g., calcium, magnesium, potassium, and sodium) were excluded as CPCs for all media, and iron was excluded as a wildlife CPC for food-chain exposures of surface soils and sediment. Evidence suggests that there is little potential for toxic effects resulting from over-exposure to these essential nutrients. The highly controlled physiological regulatory mechanisms of these inorganics suggest that there is little, if any, potential for bioaccumulation, and available toxicity data demonstrate that high dietary intakes of these nutrients are well-tolerated (NAS, 1977; National Research Council [NRC], 1982; 1984).

All analytes detected in surface soil, surface water, sediment, and groundwater are presented in tables that include the following summary statistics: frequency of detection, range of detection limits, range of detected concentrations, and screening values. For those analytes that were retained as CPCs for the BERA, the following information is also provided: average of all concentrations, and RME and average exposure point concentrations. 95th percent UCLs were not calculated for most data sets as there are fewer than 10 samples in the data sets. A discussion of how exposure point concentrations are determined is provided in Subsection 9.2.4.1.

The frequency of detected concentrations often shows a varying total number of samples evaluated in any one data set. This reflects the varied analytical programs that have been adopted for each of the sampling efforts that have occurred since 1995. In addition, the average of all concentrations identified for Areas 2 and 3 groundwater reflect a temporal average of monitoring well data for wells that were sampled more than once since 1995. The minimum and maximum detected concentrations reflect the true minimum and maximum detected concentrations during any one sampling event.

While TPHC and EPH/VPH were detected in most media and were retained as CPCs in the BERA, these analytes could not be evaluated directly in the BERA because there are no relevant toxicity data for ecological receptors. Instead, the individual VOCs and PAHs detected by Methods 8260 (LM 19) and 8270 (LM 18), for which there generally are toxicity data, were evaluated instead. VOCs and PAHs are generally considered to be the fractions most likely to adversely affect ecological receptors, and Methods 8260 and 8270 provide more accurate measurements of the levels of VOCs and PAHs that are often associated with fuel-related compounds.

9.2.3.1 Area 2 Upland Surface Soil. Summary statistics for five surface soil samples (57B-95-01X, 57B-95-02X, 57E-95-02X, 57E-95-10X, and 57E-95-25X) collected in the upland portion of Area 2 (shown in Figure 5-8) are presented in Table 9-47. All organic analytes including six VOCs (three chlorinated solvents and three aromatic hydrocarbons), seven SVOCs (including five PAHs), 4,4'-DDE, 4,4'-DDT, and TPHC were retained as CPCs in the BERA. Six of the 18 inorganic analytes detected in soil (arsenic, cobalt, copper, manganese, nickel, and selenium) were retained as CPCs because their maximum detected concentrations exceed background.

9.2.3.2 Area 2 Floodplain Surface Soil. Summary statistics for eleven surface soil samples (57E-95-12X, 57E-95-16X, 57E-95-17X, 57S-98-01X, 57S-98-02X, 57S-98-04X, 57S-98-06X, 57S-98-07X [0-1 and 1-2 ft. bgs], 57S-98-08X, and 57S-98-09X) (shown in Figure 5-8) collected in the floodplain portion of Area 2 are presented in Table 9-48. All organic analytes including seven VOCs (including four chlorinated solvents and two aromatic hydrocarbons), nine SVOCs (including eight PAHs), 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Aroclor-1260, dieldrin, and TPHC were retained as CPCs in the BERA. Eight of the 19 inorganic analytes detected in soil (antimony, arsenic, barium, copper, lead, manganese, selenium, and zinc) were retained as CPCs because their maximum detected concentrations exceed background.

9.2.3.3 Area 3 Surface Soil. Summary statistics for twelve surface soil samples (57B-95-08X, 57B-95-09X, 57S-98-11X through 57S-98-16X [collected 0-1 ft. bgs], 57S-98-12X through 57S-98-14X [collected 1-2 ft. bgs], and EX57W15X) collected from Area 3 are presented in Table 9-49 (shown in Figure 5-9). All organic analytes including chlorobenzene, tetrachloroethylene, toluene, four PAHs, two dichlorobenzenes, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Aroclor-1260, alpha-chlordane, gamma-chlordane, TPHC, and EPH/VPH were retained as CPCs in the BERA. Four of the eighteen inorganic analytes detected in soil (arsenic, cadmium, manganese, and selenium) were retained as CPCs because their maximum detected concentrations exceed background.

9.2.3.4 Area 2 Surface Water. Summary statistic for nine surface water samples (57D-95-04X through 57D-95-07X, 57D-95-09X, 57D-95-10X, and 57W-98-01X through 57W-98-03X) collected from the emergent marshes in the vicinity of AOC 57 and in the scrub/shrub swamp and Cold Spring Brook channel downstream of AOC 57 (shown in Figure 5-6 and 5-8) are presented in Table 9-50. All organic analytes including five chlorinated solvents, carbon disulfide, toluene, phenanthrene, bis(2-ethylhexyl)phthalate, TPHC, and EPH were retained as CPCs in the BERA. All of the inorganic analytes (except for the essential nutrients) detected in filtered and unfiltered surface water samples were retained as CPCs because their maximum detected concentrations exceed upgradient concentrations. In addition, the water quality parameters alkalinity, chloride, and total suspended solids were retained for consideration in the BERA.

Seven of the unfiltered inorganic CPCs (aluminum, cadmium, chromium, copper, mercury, selenium, and vanadium) were not detected in filtered surface water, suggesting that these analytes may be sorbed to suspended solids within the water column and, therefore, may not be bioavailable. In addition, most of these analytes (cadmium, chromium, mercury, and vanadium) were only detected in sample 57D-95-04X located in the emergent marsh upgradient of the AOC 57 berm, where the total suspended solids were measured at 504,000 µg/g. None of these analytes were detected at 57D-95-05X, which is located at the edge of the floodplain adjacent to the berm, where contaminants from AOC 57 Area 2 would expect to be the highest. Maximum concentrations of other inorganics in Area 2 surface water (aluminum, calcium, copper, iron, magnesium, potassium, sodium, vanadium, and zinc) were also detected at 57D-95-04X. Maximum concentrations of manganese, barium, arsenic, and lead were detected at 57W-98-02X, where the total suspended solids were measured at 10,500,000 µg/g. It is believed that the elevated concentrations of these metals at 57W-98-02X, and those detected at 57D-95-04X, are artifacts of the total suspended solids

9.2.3.5 Area 3 Surface Water. Summary statistic for five surface water samples (57W-98-04X through 57W-95-08X) collected in the floodplain swamp downgradient of Area 3 (shown in Figure 5-9) are presented in Table 9-51. All organic analytes including chlorobenzene, carbon disulfide, toluene, benzo(k)fluoranthene, and EPH/VPH were retained as CPCs in the BERA. With the exception of manganese, all of the inorganic analytes detected in filtered and unfiltered surface water samples were retained as CPCs because their maximum detected concentrations exceed upgradient concentrations. In addition, the total suspended solids measured in Area 3 surface water was considered in the BERA.

As with Area 2, several of the unfiltered inorganic CPCs (antimony, copper, lead, selenium, and zinc) were not detected in filtered surface water, suggesting that these analytes may not be bioavailable. The total suspended solids measured at Area 3 were very high (3,240,000 to 15,800,000 µg/L) due to the sampling conditions (shallow areas of pooled water in groundwater seep locations). The elevated concentrations of nearly all unfiltered inorganics are believed to be an artifact of the high total suspended solids.

9.2.3.6 Area 2 Sediment. Summary statistics for nine sediment samples (57D-95-04X through 57D-95-07X, 57D-95-09X, 57D-95-10X, and 57D-98-01X through 57D-98-03X) which are collocated with the Area 2 surface water samples (shown in Figures 5-6 and 5-8), are presented in Table 9-52. All organic analytes including four chlorinated VOCs, acetone, toluene, five PAHs, the DDT_R family (i.e., 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT), Aroclor-1260, dieldrin, TPHC, and diesel fuel were retained as CPCs in the BERA. All nineteen of the inorganic analytes (except for the essential nutrients, cadmium, and vanadium) detected in sediment were retained as CPCs because their maximum detected concentrations either exceed upgradient concentrations or are greater than "normal" concentrations for lakes and ponds as classified by Rojko (1990). TOC was measured at concentrations ranging from 84,900 to 602,000 µg/g.

9.2.3.7 Area 3 Sediment. Summary statistics for five sediment samples (57D-98-04X through 57D-95-08X) which are collocated with the Area 3 surface water samples (shown in Figures 5-6 and 5-9), are presented in Table 9-53. All organic analytes including four aromatic VOCs, acetone, seven PAHs, two dichlorobenzenes, 4,4'-DDD, Aroclor-1260, TPHC, and EPH/VPH were retained as CPCs in the BERA. None of the inorganic analytes detected in sediment was retained as CPCs because their maximum detected concentrations either exceeded the upgradient concentration or the "normal" concentration for lakes and ponds as classified by Rojko (1990). TOC was measured at concentrations ranging from 38,400 to 210,000 µg/g.

9.2.3.8 Area 2 Groundwater. Summary statistic for eight groundwater samples (57M-95-04A, 57M-95-04B, 57M-95-05X through 57M-95-07X, 57M-95-08A, 57M-95-08B, and 57P-98-02X) collected from the upland and floodplain portions of Area 2 (shown in Figures 5-6 and 5-8) are presented in Table 9-54. All organic analytes including three chlorinated solvents, toluene, acetone, two phthalates, and Endosulfan II were retained as CPCs. Six of the inorganic analytes detected in filtered and unfiltered groundwater samples were retained as CPCs because their maximum detected concentrations are greater than background concentrations.

9.2.3.9 Area 3 Groundwater. Summary statistics for seven groundwater samples (57M-95-03X, 57M-96-10X through 57M-96-13X, 57P-98-03X, and 57P-98-04X) collected from Area 3 (shown in Figure 5-9) are presented in Table 9-55. All organic analytes including six chlorinated solvents, five aromatic hydrocarbons, two dichlorobenzenes, two PAHs, bis(2-ethylhexyl)phthalate, and 4-methylphenol were retained as CPCs. Eight of the inorganic analytes detected in groundwater samples were retained as CPCs because their maximum detected concentrations exceed background concentrations. Two of the unfiltered inorganic CPCs (cadmium and copper) were not detected in filtered groundwater, suggesting that these analytes would not be released to surface water or be bioavailable.

9.2.4 Exposure Assessment

Exposure assessment is the process of estimating or measuring the amount of a CPC to which an ecological receptor may be exposed. The following sections briefly describe how contaminant exposures were estimated or measured for wildlife, terrestrial plants, soil invertebrates, and aquatic receptors at AOC 57. The contaminant pathway model (Figure 9-3) provides a summary of the potential exposure pathways that exist at AOC 57 for each group of receptors.

9.2.4.1 Calculation of EPCs. RME and average EPCs were chosen for all CPCs in surface soil, surface water, sediment, and groundwater to evaluate exposures to receptors. RME concentrations represent the highest concentration of an analyte that ecological receptors could potentially encounter at the site, whereas average EPCs represent typical site concentrations. For most of the data sets in this BERA, the RME concentration is equal to the maximum detected concentration because the 95th percent UCL is not calculated when there are fewer than 10 samples in the data set. For Area 2 floodplain surface soil, the RME concentration is equal to the lower of the maximum detected concentration or the 95th percent UCL. The average of all samples is used to represent the average EPC unless it exceeds the maximum EPC, in which case the maximum EPC is used for both scenarios. The average of all concentrations may exceed the maximum detected concentrations in situations where there were few detects because a value of one-half of the SQL is assigned to all samples in which the analyte is not detected; this may, in some cases, artificially elevate the average.

RME and average EPCs are presented in Tables 9-47 through 9-55 for surface soil, surface water, sediment, and groundwater. A tiered approach was used to efficiently evaluate exposure and risk at AOC 57; if no risk was calculated from exposure to the RME concentrations, then average exposure scenarios were not evaluated. Likewise, if there are no risks for unfiltered surface water, then risks were not estimated for filtered surface water because filtered surface water results, which represent the bioavailable form of an analyte in water, are generally lower.

9.2.4.2 Wildlife. Exposure routes for wildlife receptors include direct or indirect ingestion of AOC 57 soil, surface water, sediment, and ingestion of contaminated food. To evaluate exposures at AOC 57, representative wildlife species were selected for evaluation in food chain models that estimate contaminant exposures to wildlife species respective to their position in the food chain. Ecological exposures for the AOC 57 BERA are assumed to occur within the top two feet of soil, and the top 6 inches of sediment. Contaminant exposures for wildlife are related to the foraging characteristics of the species; therefore, terrestrial and semi-aquatic receptors were chosen to represent the trophic levels typically found in disturbed uplands, forested floodplain, scrub/shrub, and emergent marsh communities. The following representative wildlife species (summarized in Table 9-56) were selected for evaluating food-chain exposures in the AOC 57 BERA:

- **White footed mouse** (*Peromyscus leucopus*). The white-footed mouse represents a small granivorous mammal (i.e. feeding primarily on seeds and young grass shoots) that inhabits wooded or scrub/shrub habitats. Invertebrates also make up a small portion of this receptor's diet. The white-footed mouse represents granivorous mammals found in terrestrial areas at AOC 57.

- **Short-tailed shrew** (*Blarina brevicauda*). The short-tailed shrew finds suitable habitat in forests, fields, marshes, and brush. It primarily feeds on earthworms, snails, centipedes, insects, small vertebrates, and slugs (DeGraaf and Rudis, 1986). Relative to other small mammals, insectivorous species such as the shrew may receive high doses of contamination as a result of their voracious appetite relative to their small body size and the ability of their prey items to accumulate constituents. The shrew represents small mammalian omnivores found in the floodplain forest at AOC 57.

- **Muskrat** (*Ondatra zibethicus*). This herbivorous mammal is widespread throughout North America (Burt and Grossenheider, 1976). Its preferred habitat includes marshes, portions of lakes, ponds, swamps, sluggish streams, and drainage ditches; it is most abundant in regions with cattails (*Typha* sp.) (DeGraaf and Rudis, 1983). Muskrats feed on a variety of aquatic and emergent plant species, including cattails, common reed (*Phragmites australis*), bulrushes (*Scirpus* sp.), and a variety of grasses; this rodent will also occasionally feed on mollusks, crayfish, frogs, and fish (DeGraaf and Rudis, 1983; Baker, 1983; Burt and Grossenheider, 1976). The muskrat represents lower trophic level herbivorous mammals found in Cold Spring Brook at AOC 57.

- **American robin** (*Turdus migratorius*). The robin is often seen perched in open woodlands and foraging in developed areas such as maintained grassy lawns. The robin represents avian receptors that consume earthworms, insects, and plants, and was selected to represent avian omnivores in terrestrial areas at AOC 57.

- **Mallard** (*Anas platyrhynchos*). The mallard is a herbivorous bird (i.e. feeding primarily on submergent vegetation and seeds of herbaceous emergent vegetation) that inhabits wetlands. This widely distributed duck is found throughout temperate regions of the world and is the most abundant duck species throughout much of the northern hemisphere. The mallard represents herbivorous birds found in Cold Spring Brook at AOC 57.

- **Red fox** (*Vulpes vulpes*). This omnivorous mammal prefers open woodlands and grassy fields, and is most active at dawn, dusk, and night. It is an opportunistic forager, feeding on small mammals, birds, amphibians, reptiles, and invertebrates, as well as berries and other fruits (Burt and Grossenheider, 1976). The red fox represents predatory mammals in terrestrial portions of AOC 57.

- **Raccoon** (*Procyon lotor*). The raccoon represents an opportunistic species that is commonly found in virtually every aquatic habitat and developed areas. Although raccoons are primarily active from sunset to sunrise, raccoons will change their activity period to accommodate food and water (USEPA, 1993a). Raccoons will consume a variety of food items, but optimally feed on fleshy fruits, nuts, acorns, grains, insects, frogs, crayfish, and eggs (USEPA, 1993d). The raccoon represents higher trophic level omnivorous mammals found in the floodplain and Cold Spring Brook at AOC 57.

- **Barred owl** (*Strix varia*). The barred owl is primarily a nocturnal hunter. Its habitat includes low, wet woods and heavily wooded swamps. The barred owl prefers hunting for its primary prey items (consisting of small mammals, birds, and frogs [Audubon, 1994]) in open fields surrounded by woodland. The owl represents predatory avian receptors found in terrestrial portion of AOC 57.

- **Great blue heron** (*Ardea herodias*). This species represents a higher trophic level wading avian receptor that feeds primarily on aquatic life including fish, frogs, and invertebrates. Great blue herons inhabit freshwater and marine lakes, rivers, brackish marshes, and lagoons where small fish can be found in shallow water (USEPA, 1993a). The heron has been selected to represent wading-bird receptors potentially found in Cold Spring Brook at AOC 57.

Exposure assumptions (body weights, food ingestion rates, site foraging frequency [SFF], exposure duration [ED], relative consumption of food items, etc.) for each of the representative wildlife species for AOC 57 are provided in Appendix O-1, Table O-1.1.

The SFF considers the frequency a receptor feeds within the site area by estimating the acreage of the site relative to the receptor's home range. By definition, the SFF cannot exceed 1. All three surface soil areas (Area 2 uplands, Area 2 floodplain, and Area 3), calculated to be approximately 0.5, 0.3, and 0.2 acres (respectively) are larger than the home range for the white-footed mouse. In addition, the Area 2 uplands are larger than the home range for the robin, and the Area 2 surface water and sediment (calculated to be approximately 0.7 acres) is greater than the home range of the muskrat. Accordingly, it is assumed that the SFF for these receptors in these areas is 1 (i.e., these receptors forage exclusively within the site area). The available floodplain habitat for ecological receptors at Area 3 is somewhat limited in that the forested floodplain generally lacks standing water, except for a few small pools where seeps occur. The raccoon was, therefore, the only semi-aquatic wildlife receptor evaluated for exposures since suitable habitat does not exist for muskrats, mallards, or herons.

To estimate receptor exposures to contaminants in site media and contaminated food items, a Potential Dietary Exposure (PDE) (or body dose) is estimated for all representative wildlife species for each CPC in all media according to the equations in Table 9-50. Tissue concentrations of CPCs in prey items were either measured directly or estimated using bioaccumulation factors (BAFs) for surface soil and sediment and bioconcentration factors (BCFs) for surface water. The general approach for evaluating bioaccumulation exposures to wildlife at AOC 57 is summarized in Table 9-58. Literature-derived BAFs and BCFs are presented in Appendix O-1, Table O-1.2.

Bioaccumulation is defined as "a process by which chemicals are taken up by aquatic organisms from water directly or through consumption of food containing the chemicals" whereas bioconcentration is "the process by which there is a net accumulation of a chemical directly from water into aquatic organisms resulting from simultaneous uptake (e.g., by gill and epithelial tissue) and elimination" (Rand and Petrocelli, 1985).

Studies have indicated that the magnitude of fish tissue contaminant burden may not be directly related to the magnitude of sediment contamination (Weiner, 1993). It is likely that other factors, including fish lipid content, variations in exposure parameters, trophic level of the fish evaluated, and trophic status of the aquatic resource evaluated may explain ecological partitioning of analytes in aquatic systems (Rowen and Rasmussen, 1992). Therefore, average CPC concentrations detected in crayfish and small fish tissue were used directly in food web models for evaluating semi-aquatic wildlife exposures to CPCs detected in Cold Spring Brook surface water and sediment. Site-specific tissue data for crayfish and small fish are presented in Appendix O-1, Table O-1.3.

When tissue concentrations were not available, BAFs and BCFs that provide estimates of direct uptake from sediments and surface water (respectively) were used instead. BAFs and BCFs were extrapolated from literature values or estimated using regression equations. BCFs calculated from data derived from the AQUIRE database and from AWQC documents are presented in Appendix O-1, Table O-1.4. BAF values were converted to a wet weight tissue value. Based on the lack of scientific data for VOC bioaccumulation and evidence provided in several reference materials (Suter, 1993; Maughan, 1993), an assumption was made that VOCs do not bioaccumulate in prey tissue.

BAFs for terrestrial invertebrate and plant prey items are the ratio of the CPC concentration in plant or invertebrate tissue (mg contaminant/kg tissue wet weight) to the CPC concentration in soil (mg contaminant/kg dry weight). BAFs reported in the scientific literature for avian and mammalian receptors are the ratio of CPC concentrations in the tissues of these receptors (mg contaminant/kg tissue wet weight) to the concentrations of CPCs in their food items (mg contaminant/kg tissue wet weight).

Dietary exposures for semi-aquatic receptors were estimated by multiplying the sediment CPC concentration by the aquatic invertebrate BAFs, or by multiplying surface water CPC concentrations by BCFs (based primarily on fish uptake of contaminants by gill epithelial). If a given analyte was detected in both media, semi-aquatic prey concentrations were estimated as the higher of these two calculations.

The PDEs calculated from exposure to AOC 57 surface soil, surface water, and sediment CPCs for each receptor are presented in Appendix O-2, Tables O-2.1 through O-2.11.

9.2.4.3 Terrestrial Plants and Invertebrates. Terrestrial plants and soil invertebrates may be exposed to CPCs via direct contact with, root uptake (plants), or ingestion (invertebrates) of CPCs measured in AOC 57 surface soil. For the purposes of the AOC 57 BERA, exposures to terrestrial plants and invertebrates are assumed to occur within the top 2 feet of surface soil.

9.2.4.4 Aquatic Receptors. Aquatic organisms may be exposed to CPCs via direct contact with surface water and sediment. Benthic aquatic organisms in Cold Spring Brook may also be exposed to groundwater CPCs in the future as they discharge to the surface. Aquatic organism exposures to the full concentrations of analytes in groundwater are considered in the AOC 57 BERA; however, this exposure assumption may be overly conservative because concentrations of analytes may attenuate before reaching a discharge area.

As previously mentioned, a bioaccumulation study using the freshwater oligochaete (*Lumbriculus variegatus*) was performed in 1995 to evaluate the potential for Area 2 sediment-related contaminants to bioaccumulate in benthic invertebrate tissue. The results of this study are presented in Appendix Q. All test methods were performed in accordance with *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates* (USEPA, 1994). Three replicate oligochaete cultures maintained by the toxicity test laboratory were exposed to each of four Cold Spring Brook sediments (from sample locations 57D-95-05X, 57D-95-06X, 57D-95-08X [reference location], and the laboratory control) for 28 days. Following the 28-day period, oligochaetes were purged of their stomach contents for 24 hours, frozen, and shipped to the analytical laboratory for chemical analysis. Due to problems encountered during shipping, the oligochaete samples arrived at the analytical laboratory 48 hours after shipment, rather than the 24 hours recommended in the test methods. Samples were received at the laboratory at 20° C. Oligochaete tissue was analyzed for PAL pesticides and PCBs; due to limited sample sizes (3 grams wet weight), the detection limits that were achievable by the analytical laboratory were slightly elevated.

Aquatic invertebrate BAFs were calculated for pesticides and PCBs using the paired oligochaete tissue and Cold Spring Brook Area 2 sediment concentrations (presented in Appendix O-1, Table O-1.3). However, due to uncertainties surrounding the oligochaete tissue results, these data were not used in the AOC 57 BERA to evaluate exposures to wildlife foraging for freshwater invertebrates in Cold Spring Brook. Specifically, several analytes were detected in Cold Spring Brook sediments but were not detected in oligochaete tissue; conversely, aldrin was detected in oligochaete tissue but was not detected in Cold Spring Brook Area 2 sediments. The concentrations of aldrin and the two other detected contaminants, tetra-chloro-m-xylene and decachlorobiphenyl, were actually highest in control oligochaete tissue. Based on inquiries made with the analytical laboratory, the analytes detected in oligochaete tissue may be attributable to laboratory contamination and/or unreliable quantitation limits.

In addition to the bioaccumulation study, subchronic toxicity tests were also performed in 1995 using the midge (*Chironomus tentans*) and the amphipod (*Hyalella azteca*). These benthic and epibenthic (respectively) invertebrates were exposed to sediment samples collected from 6 sample locations in Area 2 Cold Spring Brook (57D-95-04X through 57D-95-08X, and 57D-95-10X), shown in Figure 5-6 and 5-8. Sediment toxicity studies were conducted in accordance with the guidelines *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates* (USEPA, 1994). Eight replicates of laboratory-raised midges and vendor-supplied amphipods were exposed to whole sediment in 10-day static renewal toxicity tests. The results of these tests were used to evaluate the potential toxicity to these receptors from exposure to sediment contamination. Results of the AOC 57 sediment toxicity testing are presented in Table 9-59, Appendix Q. Because no toxicity testing was performed in Area 3, the results from Area 2 are used to represent conditions for both areas. This is conservative as the aquatic habitat at Area 2 (Cold Spring Brook and associated marshes) supports more sensitive aquatic organisms than at Area 3 (forested floodplain with little standing water).

9.2.5 Ecological Effects Assessment

As stated in the problem formulation, the assessment endpoints of the BERA are the survival and propagation of ecological receptor populations at AOC 57. The ecological effects assessment discusses what measurement endpoints were used to represent the assessment endpoints evaluated in this BERA. Terrestrial and semi-aquatic wildlife receptors, terrestrial plants, terrestrial invertebrates, and aquatic organisms are potentially exposed to CPCs detected in AOC 57 site media; the measures of adverse ecological effects for these receptors are discussed separately.

9.2.5.1 Terrestrial and Semi-aquatic Wildlife. Because no long-term wildlife population data are available at Devens, a direct measurement of the survival and propagation of wildlife populations at AOC 57 is not possible. The literature-derived results of laboratory toxicity studies that relate the dose of a contaminant in an oral exposure with an adverse response to growth, reproduction, or survival of a test population (avian or mammalian species) were used in food-web models as a measure of the assessment endpoint. Lethal and sublethal wildlife ingestion toxicity data (which are used to derive reference toxicity values [RTVs] for evaluating risk) are presented in Appendix O-1, Table O-1.5. Wildlife effects from exposure to CPCs in Area 2 upland surface soil, Area 2 floodplain surface soil, Area 3 surface soil, and Cold Spring Brook surface water and sediment were evaluated in the AOC 57 BERA.

For each CPC identified and each representative wildlife species selected, two RTVs are identified. A lethal RTV represents the threshold for lethal effects and is based on oral LD_{50} data (oral dose [in mg/kg body weight-day] lethal to 50 percent of a test population). The lethal RTV is equal to one-fifth of the lowest reported LD_{50} for the most closely related test species; this is considered to be protective against lethal effects for 99.9 percent of individuals in a test population (USEPA, 1986). When LD_{50} data were not available, a LOAEL for lethal effects was selected. A sublethal RTV is selected to represent a threshold body weight-normalized dose for adverse effects related to reproduction or growth. A summary of RTVs selected from the ingestion toxicity data are provided in Appendix O-1, Table O-1.6

The RTV used for evaluating adverse effects to wildlife is conservatively selected as the lesser of the lethal or sublethal RTVs derived from the literature. If neither lethal nor sublethal toxicity information were available for a taxonomic group, RTVs from another taxonomic group were used as surrogates. The uncertainties associated with using inter-taxonomic surrogates are discussed in Subsection 9.2.7.

9.2.5.2 Terrestrial Plants and Invertebrates. Site-specific toxicity data for terrestrial plants and invertebrates are not available for AOC 57. Therefore, the results of toxicity studies from the literature that relate the soil or groundwater concentrations of a contaminant with adverse growth, reproduction, or survival effects of a test population are used as a measure of the assessment endpoint. These study results are summarized in Appendix O-1, Tables O-1.7 (plants) and O-1.8 (invertebrates). Terrestrial plant and invertebrate effects from exposure to Area 2 upland surface soil, Area 2 floodplain surface soil, and Area 3 surface soil are evaluated in the AOC 57 BERA.

For plants, the effects primarily considered were measures of growth or yield as these response parameters are most common in phytotoxicity studies. For invertebrates, the effects primarily considered were measures of reproduction or mortality; when LC_{50} data were used, one-fifth of the LC_{50} was used to be protective of 99.9 percent of the population (USEPA, 1986).

9.2.5.3 Aquatic Receptors. Aquatic organism effects from exposure to surface water and sediment are evaluated in the AOC 57 BERA. Potential adverse ecological effects associated with CPCs in sediment were evaluated based on the results of the Area 2 sediment toxicity study using the midge and amphipod. A summary of the results of the sediment toxicity test for the amphipod and midge are presented in Table 9-59 and in Appendix Q. In addition, adverse effects to aquatic receptors from direct contact with CPCs in Area 2 and 3 surface water and sediment were evaluated by comparing the CPC concentrations with literature-derived benchmarks.

Midge growth was significantly lower in sediment sample 57D-95-04X (1.36 ±0.30 grams) than was observed in the upstream reference sample (57D-95-08X) (1.81 ±0.30 grams); however, midge growth in 57D-95-04X was not significantly lower than in the control sample (1.70 ±0.32 grams). Midge survival results showed no statistical differences from the control or reference samples.

Survival and growth results for amphipods reared in Area 2 Cold Spring Brook sediment samples showed no statistically significant differences from the control or reference samples. However, there is uncertainty associated with the amphipod control results because the control sample did not meet the 80 percent acceptance criteria for survival.

Based on inquiries with the toxicity test laboratory, these results may be attributable to several factors: the vendor-supplied amphipod stock may have been stressed from shipment to the toxicity test laboratory and, therefore, more susceptible to other stressors; or the control sediment used for this study (which was collected at Strobs Folly Brook in Wareham, Massachusetts) may have been contaminated. Regardless, amphipod survival in the Cold Spring Brook sediment samples ranged from 70 to 84 percent; these results are not statistically significantly different from the results observed in the reference sample collected upstream of AOC 57, which achieved an average 80 percent survival rate.

In addition to the sediment toxicity test results, literature values that relate the concentration of a contaminant with an effect level (derived from data for adverse growth, reproduction, or survival effects of test populations) are used as a measure of the assessment endpoint.

Surface water RTVs selected for comparison to surface water exposure concentrations include Federal chronic AWQC (USEPA, 1991b; USEPA, 1988a) and aquatic toxicity information from the USEPA AQUIRE database (AQUIRE, 1996). Effects concentration data obtained from AQUIRE are included in Appendix O-1, Table O-1.8. Chronic AWQC are concentrations that, if not exceeded by the four-day average chemical concentration more than once every three years, are protective of most species of aquatic life and its uses (USEPA, 1983). Lowest observed effects concentrations measuring survival, growth, reproduction, and biodiversity endpoints were derived from the AQUIRE database as a supplement to the AWQC (AQUIRE, 1996).

Sediment benchmarks selected for comparison to detected sediment concentrations include the following: National Oceanic and Atmospheric Administration (NOAA) Effects Range-Low (ER-L) and Effects Range-Median (ER-M) sediment guidelines (Long et al., 1995) based on the National Status and Trends Program approach; USEPA Sediment Quality Guidelines (SQG) based on equilibrium partitioning (USEPA, 1988b; USEPA, 1993b,c,d); Ontario Ministry of the Environment (OME) Lowest Effect Level (LEL) provincial sediment quality guidelines (Persaud et al., 1996) based on the Apparent Effects Threshold (AET) approach; and New York State Department of Environmental Conservation sediment quality criteria (NYSDEC, 1994).

The sediment benchmarks selected for evaluating risk to benthic organisms represent chemical concentrations below which biological effects are improbable (by the Apparent Effects Threshold method [USEPA, 1992b]), or that may rarely (i.e., 10th percentile) or sometimes (i.e., 50th percentile) be associated with toxicity to benthic organisms (by the

National Status and Trends Program Approach [USEPA, 1992b]). A third sediment benchmark uses bulk sediment concentrations and the organic carbon content in sediment to predict interstitial water concentrations that are equal to the chronic AWQC. Since the AWQC are protective of 95 percent of aquatic species, these bulk sediment concentrations (generated using the Equilibrium Partitioning Approach) are expected to be equally conservative in evaluating adverse effects to benthic organisms (USEPA, 1992b).

9.2.6 Risk Characterization

This subsection discusses how risks are characterized for ecological receptors exposed to contaminated media at AOC 57. A comparison of exposure information with the appropriate concentration-response toxicity data is the basis for risk characterization. In addition, a qualitative comparison between groundwater CPCs and concentrations of chemicals detected in Cold Spring Brook was performed to evaluate potential future impacts to the stream and other downgradient waterbodies.

9.2.6.1 Terrestrial and Semi-aquatic Wildlife. Risks for the representative wildlife species associated with ingestion and bioaccumulation of CPCs in surface soil and prey items are quantitatively evaluated using HQs, which are calculated for each CPC by dividing the PDE based on RME concentrations by the selected lethal or sublethal RTV. HIs are determined for each receptor by summing the HQs for all CPCs. When the estimated PDE is less than the RTV (i.e., the HQ < 1), it is assumed that chemical exposures are not associated with adverse effects on survival, growth, or reproduction for receptors and no risks to wildlife populations exist. When an HI is greater than 1, a discussion of the ecological significance of the HQs comprising the HI is completed, and risks from exposure to average concentrations of CPCs are evaluated. Often, when an HI is greater than 1, it has been calculated from the HQs of contaminants with mechanistically distinct modes of action, and possibly distinct target organs of toxicity. Summation of such HQs therefore provides an overly conservative estimate of the contaminant stressor on the receptor.

This hazard ranking scheme evaluates potential ecological effects to individual organisms and does not evaluate potential population-wide effects. Contaminants may cause population reductions by affecting birth and mortality rates, immigration, and emigration (USEPA, 1989a). In many circumstances, lethal or sublethal effects may occur to individual organisms with little population or community level impacts; however, as the number of individual organisms experiencing toxic effects increases, the probability that population effects will occur also increases. The number of affected individuals in a population presumably increases with increasing HQ or HI values; therefore, the likelihood of population level effects occurring is generally expected to increase with higher HQ or HI values.

The HQs and HIs calculated based on RME and average EPCs for each representative wildlife species are provided in Appendix O-2, Tables O-2.12 through O-2.22. A summary of risks to representative wildlife receptors is provided in Table 9-60, and in the following paragraphs. There are no toxicity data available relating wildlife exposures to TPHC with adverse responses; therefore, TPHC exposures were not included in the food-web model, and potential adverse effects from TPHC exposure remain an uncertainty.

Area 2 Upland Surface Soil. The HQs and HIs calculated for each representative wildlife species are provided in Appendix O-2, Tables O-2.12 and O-2.13; a summary of risks is provided in Table 9-60. The summary HI for the white-footed mouse exposed to RME concentrations in Area 2 upland soil is 1.5. The primary risk contributor to the mouse is arsenic, which was detected at a maximum concentration (21 μg/g) that only slightly exceeds the background concentration for arsenic (19 μg/g). The summary HI for the mouse based on average EPCs in Area 2 upland soil (which are more representative of site conditions) is 0.98. Summary HIs for all other wildlife receptors exposed to RME and average EPCs in Area 2 upland soil are less than 1. These results suggest that adverse effects to wildlife receptors from exposure to Area 2 upland surface soil are not likely to occur. Furthermore, the selected RTV for arsenic may be overly conservative as the HI estimated at background concentrations would also exceed 1.

Area 2 Floodplain Surface Soil. The HQs and HIs calculated for each representative wildlife species are provided in Appendix O-2, Tables O-2.14 and O-2.15; a summary of risks is provided in Table 9-60. The summary HI for the white-footed mouse, short-tailed shrew, and American robin exposed to RME concentrations in Area 2 floodplain soil are 4.0, 2.4, and 1.8, respectively. Arsenic, with an RME concentration of 47.9 μg/g, contributes to 76 and 49 percent of the overall risk to the mouse and robin. Aroclor-1260 is a secondary risk contributor for the robin. Arsenic, selenium, and lead are primary risk contributors for the shrew, accounting for 21, 28, and 39 percent of the overall risk. The individual HQs for all analytes are less than 1 for the robin and shrew, suggesting that adverse effects from each analyte are minimal. The summary HIs for the mouse, shrew, and robin based on average EPCs in Area 2 floodplain soil (which are more representative of typical site conditions) are 1.9, 1.0, and 0.71, suggesting that risks to these receptors under typical exposures are minimal. Summary HIs for other wildlife receptors exposed to RME and average EPCs in Area 2 floodplain soil are less than 1.

Area 3 Surface Soil. The HQs and HIs calculated for each representative wildlife species are provided in Appendix O-2, Tables O-2.16 and O-2.17; a summary of risks is provided in Table 9-60. The summary HI for the white-footed mouse exposed to RME concentrations in Area 3 soil is 3.0. Arsenic, with an RME concentration of 41 μg/g, contributes to 83 percent of the overall risk to the mouse. The summary HI for the mouse based on average EPCs in Area 3 soil (which are more representative of typical site conditions) is 1.7, suggesting that risk to the mouse under typical exposures is minimal. Summary HIs for other wildlife receptors exposed to RME and average EPCs in Area 3 soil are less than 1.

Area 2 Surface Water and Sediment. HQs and HIs were calculated for each representative wildlife species using both filtered and unfiltered surface water and sediment data. Risk calculations are provided in Appendix O-2, Tables O-2.18 through O-2.21, and a summary of risks is provided in Table 9-60. The RME and average summary HIs for the muskrat and great blue heron exposed to Area 2 Cold Spring Brook unfiltered surface water and sediment exceed 1. Arsenic, lead, and manganese are the primary contributors to HIs of 13 (RME) and 4.6 (average) for the muskrat. Mercury is the primary risk contributors for the heron, with HIs of 12 (RME) and 6.8 (average), respectively.

As mentioned in subsection 9.2.3.4, concentrations of metals in unfiltered surface water were all elevated at sample locations 57D-95-04X and 57W-98-02X, which is probably related to the total suspended solids measured in those samples (504,000 and 10,500,000 μg/L). Using unfiltered samples may over-estimate the bioavailable fraction of metals in surface water. To reduce this potential bias, risks were re-evaluated by using filtered surface water data. All four metals were detected at very low concentrations (i.e., close to or below the AWQC) or not at all (e.g., mercury) in unfiltered surface water. The estimated risks using filtered surface water data were virtually the same for the muskrat (the RME HI = 13, and the average HI = 4.5), and were greatly reduced for the heron (the RME HI = 6.1, and the average HI = 1.8). These results suggest that arsenic, lead, and manganese in sediment may cause risk to herbivorous mammals, and mercury in sediment may cause risk to wading piscivorous birds. The bioconcentration potential of unfiltered mercury in surface water had a dramatic effect on risk estimates for the heron; however, mercury was not detected in the unfiltered sample, suggesting limited or no bioavailability.

All four metals (arsenic, lead, manganese, and mercury) were detected at maximum concentrations in Area 2 sediment that are only two (or less) times higher than upgradient concentrations of these metals.

Arsenic and lead risk estimates for the muskrat are based on reproductive endpoints for rats, and the manganese risk estimate is based on an endpoint for survival. Therefore, it is possible that small herbivorous mammals may potentially experience adverse effects on reproduction or survival. However, the arsenic RTV (0.58 mg/kgBW/day) may be overly conservative for estimating risks for wildlife receptors. As discussed for Area 2 Upland surface soil, risks to wildlife receptors at background levels of arsenic in soil exceed 1. A three-generation study measuring the reproductive effects that arsenic had on rats resulted in a NOAEL of 1 mg/kgBW/day (ATSDR, 1999); if risks to wildlife receptors were calculated using this NOAEL as the arsenic RTV, arsenic risk estimates would be nearly one-half current estimates. In this example, the muskrat HI would drop to 9.4, with the arsenic HQ equal to 5.0. A search for more arsenic toxicity data may reveal higher effect doses. Given how conservative the selected arsenic RTV is, and the relatively low levels of risk contributed by lead and manganese (approximately 12 percent and 9 percent [respectively] of the overall risk, with maximum HQs of 1.7 and 1.3 [respectively]), adverse effects on small mammals from exposure to these analytes are unlikely.

The mercury risk estimate for the heron is based on a three generation reproductive behavior study on mallards; therefore, it is possible that wading piscivorous birds may experience adverse reproductive effects from exposure to RME concentrations of mercury in Area 2 Cold Spring Brook sediment. However, mercury was detected in only one sediment sample (57D-95-06X) at a concentration of 0.36 µg/g. This concentration only slightly exceeds the range of "normal" sediment concentrations (0.35 µg/g) as defined by Rojko (1990). 57D-95-06X is located in the stream channel across from the berm, where site-related concentrations are *not* expected to be highest due to distance from the site and the low depositional nature of that area. It is more likely that mercury concentrations at 57D-95-06X are consistent with regional levels associated with atmospheric deposition, rather than site-related releases. Furthermore, the selected RTV is based on a study for methyl mercury, which may be overly conservative for estimating risks to wildlife receptors. There is no association of methyl mercury with AOC 57.

Area 3 Surface Water and Sediment. HQs and HIs were calculated for the raccoon using unfiltered surface water and sediment data from Area 3. Risk calculations are provided in Appendix O-2, Table O-2.22 and a summary of risks is provided in Table 9-60. The RME summary HI for the raccoon exposed to Area 3 floodplain unfiltered surface water and sediment is less than 1, suggesting that risks to omnivorous semi-aquatic mammals are unlikely. Given that no risks were estimated, risks to the raccoon were not estimated for filtered surface water or average exposure concentrations.

9.2.6.2 Terrestrial Plants. Risks for terrestrial plants were evaluated by comparing the selected phytotoxicity benchmarks (Appendix O-1, Table O-1.7) to RME and average EPCs. The results of the surface soil evaluations for AOC 57 are presented in Tables 9-61 through 9-63, and are discussed in the following paragraphs. There are no toxicity data available relating plant exposures to trichlorofluoromethane or TPHC with adverse responses; therefore, plant exposures to these analytes were not evaluated and potential adverse effects remain an uncertainty.

Area 2 Upland Surface Soil. RME and average EPCs of arsenic and the RME concentration for nickel in Area 2 upland surface soil exceed phytotoxicity benchmarks (Table 9-61). All other CPC exposure concentrations are less than phytotoxicity benchmarks, suggesting that plants are not at risk from exposure to VOCs, SVOCs, pesticides, cobalt, copper, manganese, or selenium in Area 2 upland surface soil.

As discussed in Subsection 9.2.6.1, the RME concentration for arsenic is consistent with background values for arsenic at Devens, and the average concentration is less than background. Therefore, the phytotoxicity benchmark for arsenic most likely over-estimates risk to plants. The RME concentration for nickel (30.7 µg/g) only slightly exceeds its benchmark value (30 µg/g), and only exceeds background values observed at Devens by a factor of 2. Furthermore, given the disturbed nature (i.e., off-road vehicular traffic) of the upland portion of Area 2, it is unlikely that arsenic and nickel concentrations in Area 2 upland surface soil would cause phytotoxic effects in plants; rather, other disturbances are more likely to act as stressors on plant growth and survival.

Area 2 Floodplain Surface Soil. RME and average EPCs of arsenic, lead, selenium, and zinc in Area 2 floodplain surface soil exceed phytotoxicity benchmarks (Table 9-62). All other CPC exposure concentrations are less than phytotoxicity benchmarks, suggesting that plants are not at risk from exposure to VOCs, SVOCs, pesticides, Aroclor-1260, antimony, barium, copper, or manganese in Area 2 floodplain surface soil.

Lead was detected in all eleven floodplain soil samples at concentrations ranging from 18.7 µg/g to 320 µg/g. The RME (320 µg/g) and average (143 µg/g) concentrations of lead exceed the phytotoxicity benchmark by factors of approximately 5 and 3. Elevated concentrations of lead (i.e., >100 µg/g) were observed in surface soil in two distinct areas at Area 2, located southeast and southwest of the erosion mat (including sample locations 57E-95-12X, 57E-95-15X, 57E-95-17X, 57S-98-02X, and 57S-98-07X through 57S-98-10X. It is possible that plants in these areas may exhibit phytotoxic effects from exposure to lead.

The RME (47.9 µg/g) and average (24.1 µg/g) concentrations of arsenic exceed the phytotoxicity benchmark for arsenic (10 µg/g) by factors of approximately 5 and 2.4, respectively. However, this benchmark is less than the observed background concentration of arsenic in soil at Devens (19 µg/g). It is possible that this phytotoxicity benchmark may overestimate risk to terrestrial plants.

The RME and average concentrations of selenium and zinc in Area 2 floodplain soil only slightly exceed their phytotoxicity benchmarks (all by less than 4.5). These slight exceedances suggest that potential risks to terrestrial plants from exposure to selenium and zinc are likely to be minimal.

It should be noted that all surface soil samples evaluated in the AOC 57 BERA were collected in areas characterized by dense floodplain forest growth; no signs of phytotoxicity have been observed at the site.

Area 3 Surface Soil. RME and average EPCs of arsenic, manganese (RME only), and selenium (RME only) in Area 3 surface soil exceed phytotoxicity benchmarks (Table 9-63). All other CPC exposure concentrations are less than phytotoxicity benchmarks, suggesting that plants are not at risk from exposure to VOCs, SVOCs, pesticides, PCBs, and cadmium in Area 3 surface soil.

RME concentrations of arsenic (41 µg/g) and manganese (548 µg/g) (both detected at 57B-98-08X) only exceed background values by a factor of 2 or less; the concentrations of these analytes detected at the other sample locations are less than background and the phytotoxicity benchmarks values. In addition, the maximum manganese and selenium concentrations only slightly exceeds their phytotoxicity benchmarks (500 and 1 µg/g, respectively), and as previously stated, the arsenic phytotoxicity benchmark may overestimate risk as it is less than the background value for arsenic in Devens surface soil. This evidence suggests these analytes are not likely to cause phytotoxic effects for plants exposed to Area 3 surface soil.

9.2.6.3 Terrestrial Invertebrates. Risks for terrestrial invertebrates were evaluated by comparing the selected invertebrate benchmarks (Appendix O-1, Table O-1.8) to RME and average EPCs. The results of the surface soil evaluations for AOC 57 are presented in Tables 9-61 through 9-63, and are discussed in the following paragraphs. There are no toxicity data available relating invertebrate exposures to antimony, barium, cobalt, manganese, selenium, PCBs, dibenzofuran, trichlorofluoromethane, or TPHC with adverse responses; therefore, invertebrate exposures to these analytes were not evaluated and potential adverse effects remain an uncertainty.

Area 2 Upland Surface Soil. RME and average EPCs for all analytes detected in Area 2 upland surface soil are less than soil invertebrate benchmarks, suggesting that invertebrates are not at risk from exposure to analytes in Area 2 upland soil (Table 9-61).

Area 2 Floodplain Surface Soil. The RME concentrations of copper (39.3 µg/g) and zinc (150 µg/g) slightly exceed the soil invertebrate benchmarks (30 and 130 µg/g, respectively) (Table 9-62); however, these slight exceedances are not indicative of substantial risks to these receptors. All other RME and average EPCs are less than soil invertebrate benchmarks, suggesting that invertebrates are not at risk from exposure to Area 2 floodplain soil.

Area 3 Surface Soil. All RME and average exposure concentrations are less than invertebrate benchmark values (Table 9-63), suggesting that invertebrates are not at risk from exposure to analytes detected in Area 3 surface soil.

9.2.6.4 Aquatic Organisms. Risks for aquatic receptors from exposure to Area 2 and 3 surface water and sediment were characterized based on the toxicity test evaluation performed for the midge and amphipod, and a comparison of surface water and sediment EPCs with the toxicity benchmarks discussed in Subsection 9.2.5.

Area 2 Surface Water - Benchmark Comparison. The comparison of Area 2 filtered and unfiltered surface water EPCs with toxicity benchmarks is provided in Table 9-64. This comparison indicates that surface water concentrations of bis(2-ethylhexyl)phthalate and most metals exceed aquatic benchmark values. As discussed in Subsections 9.2.3.4 and 9.2.6.1, concentrations of metals in unfiltered surface water were elevated at sample locations 57D-95-04X and 57W-98-02X, which may possibly be related to the total suspended solids measured at those locations (504,000 and 10,500,000 µg/L). These analytes were either not detected in any other surface water sample, or were detected at concentrations that are consistent with benchmark values.

Using unfiltered samples may over-estimate the bioavailable fraction of metals in surface water. Several metals that were only detected in unfiltered surface water (including cadmium, chromium, copper, mercury, selenium, and vanadium) were not detected in filtered samples, suggesting that these analytes are not bioavailable to aquatic organisms. Of the metals detected in filtered surface water, only iron, manganese, and zinc exceeded benchmarks. The RME and average EPCs for filtered manganese and zinc only slightly exceed their benchmark values. It is unlikely that exposure to these analytes would result in adverse effects.

Bis(2-ethylhexyl)phthalate was detected in only one of nine surface water samples, also at 57D-95-04X. This single detect exceeds the lowest adverse effect concentration in the AQUIRE database (0.89 µg/L for moorfrog hatchability) by slightly less than two orders of magnitude. The maximum concentration does not exceed the proposed federal AWQC of 160 µg/L. A review of the AQUIRE database for bis(2-ethylhexyl)phthalate (Appendix O-1, Table O-1.9) indicates that the maximum concentration exceeds adverse growth, reproduction, or survival effects concentrations for the water flea, rainbow trout, and brook trout. Trout, which are coldwater species of fish, do not inhabit the surface waters at AOC 57. It is possible that some species of freshwater invertebrates and amphibians may be at risk from exposure to bis(2-ethylhexyl)phthalate detected at 57D-95-04X. However, given that bis(2-ethylhexyl)phthalate was only detected once in a relatively dynamic medium (i.e., these results may not be reproducible), and that it is not related to past site disposal activities, it is unlikely that unacceptable risks to water column populations are present.

Iron was detected in all surface water samples at concentrations ranging from 194 to 17,200 µg/L in filtered samples, and from 592 to 17,600 µg/L in unfiltered samples. The RME and average exposure concentrations exceed both the AWQC (1,000 µg/L) and the lowest adverse effect concentration in the AQUIRE database (3,700 µg/L for duckweed growth). The maximum iron concentration detected in unfiltered surface water was detected at 57D-95-04X, which, for the reasons previously mentioned, may not truly represent actual exposures to aquatic organisms. The maximum concentration of iron detected in filtered surface water was detected at 57D-95-05X at the edge of the wetland next to the berm. Surface water at this location is stagnant and is in closest proximity to where contamination from AOC 57 may enter Cold Spring Brook. In addition, an organic sheen has been observed at this location in the past, suggesting that microbial activity at this location may be elevated. Concentrations of iron at all other Cold Spring Brook surface water samples are consistent with the benchmark values, indicating that adverse effects to aquatic organisms are unlikely to occur in other portions of the brook.

Based on the results of the surface water analysis, it is possible that concentrations of iron at 57D-95-05X may cause adverse effects to some aquatic organisms. Potential risks to aquatic organisms from exposure to bis(2-ethylhexyl)phthalate at 57D-95-04X, and filtered zinc and manganese at 57D-95-04X were also identified. The highest unfiltered metals concentrations and TPHC concentrations (924 µg/L) in surface water were detected at 57D-94-04X, suggesting that the emergent marsh may be acting as a sink for metals and petroleum-related compounds that migrate from upgradient sources.

Area 3 Surface Water - Benchmark Comparison. The comparison of Area 3 filtered and unfiltered surface water EPCs with toxicity benchmarks is provided in Table 9-65. This comparison indicates that unfiltered surface water concentrations of copper, lead, and zinc exceed aquatic benchmark values. As discussed in Subsections 9.2.3.5 and 9.2.6.1, concentrations of metals in unfiltered surface water were elevated at sample locations, possibly related to the total suspended solids measured in Area 3 surface water (3,240,000 to 15,800,000 µg/L). These analytes were not detected in unfiltered surface water sample, suggesting that they are not bioavailable to aquatic organisms. Therefore, exposures to these analytes are not likely to result in adverse effects.

Sediment - Toxicity Test Results. Risks for aquatic macroinvertebrates in AOC 57 sediment are characterized based on the results of sediment toxicity tests from samples collected in Cold Spring Brook. The sediment analytical and toxicity test samples were collected concurrently; therefore, the analytical results for the sediment samples can be used to help interpret the contaminant exposures and responses of the test species (midges and amphipods) in the toxicity tests. The results from these tests are used to interpret potential risks to aquatic organisms in both Areas 2 and 3 sediment.

As previously discussed in Subsection 9.2.5.3, midge growth was significantly lower in sediment sample 57D-95-04X than in the reference sample (57D-95-08X). No other statistically significant differences in midge or amphipod survival and growth were observed between the reference or control sediment samples and sediment collected from Cold Spring Brook. The maximum concentrations of copper (201 µg/g), lead (410 µg/g), and TPHC-diesel fraction (150 µg/g) were detected in 57D-95-04X; concentrations of all other metals, pesticides, PCBs, and SVOCs were negligible at this sample location.

Appendix O-3, Tables O-3.1 through O-3.3 present a series of simple linear regression analyses evaluating statistical relationships between biological effects observed in the midge toxicity test and concentration of copper, lead, and TPHC (diesel fraction) detected in AOC 57 sediment. Other sediment CPCs were not included in the regression analyses because there was no apparent relationship between concentrations and adverse biological response.

The results of the regressions indicate that midge growth is somewhat correlated with concentrations of copper and lead in sediment, but poorly correlated with concentrations of TPHC in AOC 57 sediment. The square of the correlation coefficient (r^2) values for copper, lead, and TPHC were 0.59, 0.67, and 0.078 (respectively). These results indicate that there may be a correlation between toxicity testing results and lead and copper concentrations in sediment. This evaluation does not consider the effects on the midge from a combined group of analytes.

Area 2 Sediment - Benchmark Comparison. The comparison of Area 2 sediment concentrations with benchmarks is provided in Table 9-66. This comparison indicates that sediment concentrations of most metals, pesticides, Aroclor-1260, PAHs, and acetone exceed aquatic benchmark values.

Maximum concentrations of metals do not appear to be spatially related (i.e., there is no pattern to where maximum concentrations are distributed), and concentrations generally exceed benchmark values at several sample locations. Metals concentrations generally exceed the NOAA ER-L's (which correspond to the 10th percentile of effects concentrations for aquatic organisms) and the OME LELs (which are designed to be protective of the majority of aquatic organisms). Maximum concentrations of PAHs (except chrysene) are co-located at 57D-95-07X, and maximum concentrations of DDT_R compounds are co-located at 57D-95-06X; however, as with metals, these analytes were detected at several sample locations that exceed sediment benchmarks. As with metals, concentrations of organic analytes generally tend to exceed the NOAA ER-Ls and the OME LELs.

Based on the toxicity test results for *C. tentans* and *H. azteca* (and the fact that copper and lead are not CPCs in Area 3 sediment), it is likely that this benchmark comparison method of evaluation may have over-estimated risk to aquatic organisms. Furthermore, the benchmark comparison with the bulk sediment inorganics concentrations may not be a good predictors of toxicity to aquatic organisms because of the affinity for certain metals to bind to sulfides. Elevated TOC levels in sediment may further limit metals bioavailability similar to organics, as seen by the fact that concentrations of organics are consistent with or less than the USEPA sediment quality guidelines that are adjusted to account for the TOC of sediment (e.g., most pesticides, Aroclor-1260, and the PAHs).

Area 3 Sediment - Benchmark Comparison. The comparison of Area 3 sediment concentrations with benchmarks is provided in Table 9-67. This comparison indicates that sediment concentrations of 4,4'-DDD, Aroclor-1260, PAHs, dichlorobenzenes, and acetone exceed aquatic benchmark values. Concentrations of chemicals detected in Area 3 sediment are generally an order of magnitude lower than those detected in Area 2 sediment.

Maximum concentrations of metals do not appear to be spatially related (i.e., there is no pattern to where maximum concentrations are distributed), and concentrations generally exceed benchmark values at several sample locations. Several of the maximum PAH concentrations are collocated at 57D-98-07X, and maximum concentrations of dichlorobenzenes, Aroclor-1260, and 4,4'-DDD are generally found at 57D-98-05X and 57D-98-06X. Concentrations of organic analytes generally tend to exceed the NOAA ER-Ls and the OME LELs, which are not corrected for the TOC content of sediment. Those USEPA toxicity benchmarks that are corrected for TOC are generally higher than RME concentrations of these analytes (except the RME concentration of 4,4'-DDD, which is less than two times higher than the TOC-adjusted guideline).

Given the generally lower concentration of chemicals in Area 3 sediment (as compared to Area 2), and based on the toxicity test results for *C. tentans* or for *H. azteca*, it is likely that this benchmark comparison method of evaluation may have over-estimated risk to aquatic organisms.

Groundwater Concentrations. Potential impacts to Cold Spring Brook surface water from groundwater discharge are evaluated by qualitatively comparing groundwater exposure concentrations to surface water exposure concentrations. The concentrations for these media are presented in Tables 9-50 (Area 2 surface water), 9-51 (Area 3 surface water), 9-54 (Area 2 groundwater), and 9-55 (Area 3 groundwater).

The results of this evaluation indicate that Area 2 groundwater may be influencing Area 2 surface water in Cold Spring Brook. Most of the same chlorinated solvents and metals were detected in these media; however, more metals were detected in surface water. Nearly all of the concentrations of analytes detected in unfiltered groundwater are less than in unfiltered surface water, but the opposite is true for filtered groundwater and surface water. Concentrations of tetrachloroethylene and bis(2-ethylhexyl)phthalate are also greater in groundwater than in surface water. While the chemicals detected in Area 2 surface water reflect many of those detected in groundwater, they do not seem to be a risk to aquatic organisms.

The chemicals detected in Area 3 groundwater differ substantially from those detected in surface water. Many chlorinated solvents (including carbon tetrachloride, chloroform, methylene chloride, tetrachloroethylene, and trichloroethylene) were detected in groundwater, but were not detected in surface water. In addition, Area 3 groundwater contains many fuel-related VOCs and other SVOCs or PAHs (including ethylbenzene, styrene, xylenes, 2-methylnaphthalene, naphthalene, 1,2- and 1,4-dichlorobenzene, bis[2-ethylhexyl]phthalate, and 4-methylphenol) that were not detected in surface water. Several metals (including barium, copper, lead, and zinc) were detected at higher concentrations in unfiltered Area 3 surface water than in unfiltered Area 3 groundwater. Surface water concentrations in the Area 3 floodplain are likely an expression of groundwater, but do not seem to reflect impacts from Area 3 groundwater.

9.2.7 Uncertainty Analysis

The objective of the uncertainty analysis is to discuss the assumptions of the BERA process that may influence the risk assessment results and conclusions. General uncertainties inherent in the risk assessment process and in the AOC 57 BERA are included in Table 9-68.

Additional uncertainties associated with the risk assessment at AOC 57 include the following.

- There is uncertainty associated with potential risks to rare, threatened, or endangered species. Although none of the species listed in Subsection 9.2.1.3 are confirmed residents at AOC 57, the MNHP identified several rare, threatened, or endangered species as occurring within one mile of AOC 57. Although risks for these specific receptors cannot be quantified, the following risk extrapolations can be made based on risk estimates for other receptors:

1. based on risk estimates for plants, the ovate spike-sedge (endangered) may be at risk if exposed to lead in floodplain surface soil;
2. based on risk estimates for plants, the Houghton's flatsedge (endangered), New England blazing star (special concern), and wild senna (endangered) may be at risk if exposed to lead in Area 3 upland soils at location (57B-95-09X);
3. based on risk estimates for the short-tailed shrew (an omnivorous mammal, whose diet of worms, slugs, and some plants most closely resembles that of turtles), the Blanding's turtle (threatened), eastern box turtle (special concern), and wood turtle (special concern) may be at risk if exposed to selenium and lead in floodplain surface soil;

- As noted in the BERA, there were no signs of stressed vegetation at AOC 57. Furthermore, risk extrapolations for threatened and endangered species may be overly conservative as these species may not reside at AOC 57. Additional uncertainties associated with the potential dietary exposures and risks to the reptiles listed in Subsection 9.2.1.3 are discussed in Table 9-68.

- There is uncertainty associated with the food chain risk evaluations for wildlife, specifically associated with the selection of RTVs. Current Army guidance for conducting BERAs (Wentsel et al., 1997) suggests using NOAEL data for evaluating risks to wildlife. When NOAELs are not available, the guidance suggests applying uncertainty factors (UFs) of 10 to LOAELs, and 100 to LD_{50}s. In addition, the guidance also suggests applying other UFs to RTVs for inter-species extrapolations, and for laboratory-to-field extrapolations (effectively resulting in UFs of approximately 10,000 or more). These UFs are intended to add a degree of conservatism when evaluating risks for wildlife receptors for which specific toxicity data are lacking. While these UFs may be appropriate for use in screening-level assessments, they may add considerable uncertainty to BERAs, potentially compromising the credibility of the risk conclusions and resulting in spurious remedial actions. When UFs are applied to RTVs, risk estimates for wildlife receptors may indicate a much higher potential for risk than is realistically possible. For example, UFs applied to the arsenic RTV for reproductive effects in rats would result in a sublethal HQ of 101 for the white-footed mouse, indicating a high probability of risk at background concentrations of arsenic in soil (such as was detected in Area 2 upland soil). Multiple conservative assumptions for each analyte would result in cumulative risk estimates (i.e., an HI) in the thousands. For these reasons, the Army has decided not to apply UFs to RTVs in the AOC 57 BERA; therefore, the food chain evaluation may underestimate potential risks to wildlife receptors, according to the suggested guidance.

- There is uncertainty associated with potential risks to ecological receptors from exposure to chemicals that had been eliminated from the ERA based on a comparison with background concentrations for surface soil, and upgradient concentrations and/or published values for Massachusetts lakes and ponds for surface water and sediment. Consequently, these potential risks have been quantified as part of the uncertainty analysis. Given that these chemicals were eliminated from the ERA because maximum concentrations were less than background, upgradient, or published concentrations for Massachusetts lakes and ponds, it is anticipated that potential risks from these chemicals are negligible, or are representative of general conditions of the area.

Tables 9-47 through 9-53 depict the CPC selection process for surface soil, surface water, and sediment at Areas 2 and 3 of AOC 57. For those chemicals eliminated as CPCs (excluding the essential nutrients), summary statistics and RME and average exposure concentrations are presented in Appendix O-3, Tables O-3.1 through O-3.6. Risks to ecological receptors were evaluated for these chemicals by the same processes outlined for those chemicals retained as CPCs in the baseline ERA.

Food chain risks for terrestrial and semi-aquatic wildlife were quantified for chemicals eliminated as CPCs using the same representative wildlife receptors and exposure assumptions as for chemicals retained as CPCs. The results of this evaluation are presented in Tables O-4.1 through O-4.10 in Appendix O-4 and summarized in Table O-3.7 in Appendix O-3. These results indicate that wildlife receptors are not at risk from exposure to chemicals eliminated as CPCs because all HIs are less than 1. When combined with the HIs calculated for CPCs that were retained in the ERA, the additional risk to wildlife receptors are negligible (Table O-3.7). For both Area 2 upland and Area 3 surface soil, the combined HIs for the American robin slightly exceed or are equal to 1; population-level effects are not likely to occur for small omnivorous bird populations at these low risk levels. This evidence indicates that terrestrial and semi-aquatic wildlife receptors are not at risk from exposure to chemicals eliminated as CPCs in surface soil, surface water, and sediment.

Potential risks to terrestrial plants and soil invertebrates were evaluated for chemicals eliminated as CPCs in surface soil by the same method as for chemicals retained as CPCs. The results of this evaluation, which are shown in Tables O-3.8 through O-3.10 for Area 2 upland, Area 2 floodplain, and Area 3 (respectively) indicate that soil invertebrates are not at risk from exposure to chemicals eliminated as surface soil CPCs. However RME and average exposure concentrations of aluminum, chromium, and vanadium all exceed phytotoxicity benchmarks by approximately 2, 1, and 1 orders of magnitude (respectively). The phytotoxicity benchmarks for aluminum, chromium, and vanadium were derived by the Oak Ridge National Laboratory (Will and Suter, 1994) by selecting the 10th percentile value of rank ordered LOEC values obtained from studies using sensitive crop species (e.g., soybean, lettuce, tomato, oats, and clover). Unfortunately, few studies for these chemicals were available (n=1, 7, and 2 for aluminum, chromium, and vanadium, respectively). Consequently, the authors assigned a low level of confidence to these benchmarks, suggesting that there is a high degree of uncertainty associated with these phytotoxicity benchmarks. Furthermore, background values for aluminum, chromium, and vanadium in Devens soil exceed the phytotoxicity benchmarks by higher factors (360, 33, and 16, respectively), suggesting that the phytotoxicity benchmarks are overly conservative for this region. These benchmarks have not changed since this document was updated in 1997 (Efroymson et al., 1997). This evidence indicates that terrestrial plants and soil invertebrates are not at risk from exposure to chemicals eliminated as CPCs in surface soil.

Potential risks to aquatic receptors were evaluated for chemicals eliminated as CPCs in surface water and sediment by the same method as for chemicals retained as CPCs. Manganese at Area 3 was the only analyte eliminated as a CPC in surface water. A comparison of the Area 3 manganese RME and average exposure concentrations with the surface water benchmark, presented in Table O-3.11 in Appendix O-3, indicates that aquatic organisms are not at risk. Tables O-3.12 and O-3.13 in Appendix O-3 show a comparison of sediment concentrations of chemicals eliminated as CPCs with sediment benchmarks. These comparisons indicate that RME and average exposure concentrations of cadmium in Area 2 sediment, and arsenic, barium, and lead (RME only) in Area 3 sediment exceed the most conservative sediment benchmarks by factors of approximately 4, 6, 3, and 2 (respectively). Upgradient concentrations of arsenic, barium, and lead exceed these benchmarks by factors of approximately 18, 5, and 7 (respectively). Under laboratory toxicity test conditions, aquatic organisms experienced no adverse effects when exposed to sediment from Area 2 containing much higher concentrations of these metals, suggesting that the sediment benchmarks are overly conservative for evaluating risk at AOC 57. This evidence indicates that aquatic organisms are not at risk from exposure to chemicals eliminated as CPCs in surface water and sediment.

- Risks to wildlife receptors from food chain exposures have been evaluated separately in the baseline ERA based on habitat preferences and/or Area boundaries. There is uncertainty about the additive risks to certain wildlife receptors (e.g., the barred owl and red fox) with large home ranges that may forage in contiguous suitable habitats. To address this uncertainty, the HIs calculated for these receptors from exposure to chemicals retained (RME and average) *and* eliminated (RME only) as CPCs have been summed in Table O-3.7 to estimate their additive risks:

Receptor (exposure)	Area 2 Upland	Area 2 Floodplain	Area 3	**Additive Risk**
Barred owl (RME)	0.00032	0.00032	0.00038	**0.0010**
Barred owl (Average)	0.00013	0.00011	0.00017	**0.00041**
Red fox (RME)	0.00011	NA	0.0011	**0.0012**
Red fox (Average)	0.000045	NA	0.00030	**0.00035**

As can be seen, wildlife receptors that forage in contiguous suitable habitats are not at risk from additive exposures.

- The food-web modeling results suggest that adverse effects to wildlife receptors from exposure to surface soil may occur from RME concentrations of arsenic. However, given the conservative nature by which risks were estimated, it is unlikely that wildlife receptors are at risk. Specifically, the finding that background arsenic levels are also associated with risk indicate that the reference studies used in support of RTV derivation are unduly conservative. In addition, ecological receptors are highly unlikely to be chronically exposed to maximum contaminant concentrations. And, as previously discussed, the contaminants with the greatest HQs are mechanistically distinct, such that combining risks (i.e., HQs) is overly conservative.

- There is uncertainty associated with the food chain risk estimates for wildlife, specifically associated with the exposure concentrations. The risk estimates were calculated using data generated in 1995 and 1996 for the RI, and also using data generated in 1998 and 1999 in response to regulator comments on the Draft RI. While using data from all four years is appropriate, the analytical programs varied slightly in the methods used and detection limits achieved. There was also some variation in the target analyte lists, such that some chemicals analyzed in 1995 were not analyzed in 1998, and vice versa. This may present some uncertainty in the BERA.

- There is uncertainty associated with the analytical results for arsenic. The arsenic results for soil at locations 57S-98-07X and 57S-98-08X has been qualified as estimated because the percent moisture in these samples was greater than 30 percent. It is possible that the arsenic results may be biased high.

- Risks to terrestrial receptors associated with exposure to TPHC, diesel fuel, and EPH/VPH in surface soil, surface water, and sediment may have been under-estimated. Although selected as a CPC for these media, TPHC was not evaluated in the BERA because there are no toxicological benchmarks. TPHC was detected at concentrations in surface soil ranging from 5,100 to 41,000 µg/g, in surface water at concentrations ranging from 250 to 920 µg/L, and in sediment at concentrations ranging from 270 to 3,200 µg/g.

- Risks to avian species may have been over- or under-estimated because bio-accumulation and toxicity data for this taxonomic group are generally lacking in the literature. To estimate risks to avians at AOC 57, mammalian data were used as surrogate values when avian data were lacking; however, there are additional uncertainties associated with extrapolations between these two taxa due to differing life stages and physiological parameters.

- Risks to plants and invertebrates may have been under-estimated because phytotoxicity and invertebrate benchmarks for several analytes are lacking. Specifically, potential risks to plants from exposure to TPHC and trichlorofluoromethane, and potential risks to invertebrates from exposure to antimony, barium, cobalt, manganese, selenium, PCBs, dibenzofuran, trichlorofluoromethane, and TPHC could not be evaluated.

- There is uncertainty associated with using unfiltered surface water data for evaluating risk to aquatic organisms from exposure to inorganic analytes. Risks to aquatic organisms may have been over-estimated because unfiltered data represent the total fraction of analytes that occur in the water column, including those that are sorbed to particulates. In particular, there is uncertainty associated with the concentrations of unfiltered metals detected at sample location 57D-95-04X; the turbidity of this sample was high (504,000 µg/L) and many of the metals (including cadmium, chromium, copper, mercury, and vanadium) were not detected in any other filtered or unfiltered sample. The risk estimates for filtered surface water suggest that aquatic receptors are unlikely to exhibit adverse effects.

- No sediment benchmarks exist for aluminum, cobalt, selenium, trichlorofluoromethane, diesel fuel, or TPHC gas fraction; therefore, risks to aquatic organisms from exposure to these analytes remain an uncertainty. In the absence of acid volatile sulfide data, the bioavailability of metals and TPHCs to exposed species is unknown.

- There is uncertainty associated with the control results in the amphipod (*H. azteca*) toxicity test. Only 64 percent survival was observed in the control sample, as opposed to the recommended minimum of 80 percent. These low survival rates may be attributable to stress to the organisms from shipment from the supply vendor, or possibly from contaminated control sediments collected by the toxicity test laboratory. Although control survival was below acceptable levels, amphipod survival in site samples was not significantly less than amphipod survival observed in the upstream reference location. Therefore, conclusions regarding risks to aquatic life at AOC 57 can be made based on a comparison with the reference results, rather than the control results.

- There is uncertainty associated with the bioaccumulation study performed using the freshwater oligochaete, *Lumbriculus variegatus*. Uncertainties center around several issues, including 1) the reliability of the chemical analysis resulting from sample mishandling, and 2) the detection of aldrin in oligochaete tissue, which may be associated with laboratory equipment contamination or elevated detection limits due to inadequate sample size. Because of the uncertainties surrounding this study, the results were not used in the assessment.

- There is uncertainty associated with the TPHC results for sediment in Cold Spring Brook. The data review performed on chemical analysis revealed that the TPHC concentrations may be biased low (i.e., concentrations of TPHC in Cold Spring

Brook may be higher).

- Risks for analytes detected in the method blanks, trip blanks, and rinseate blanks may have been over-estimated. In particular, there were phthalates, acetone, and chlorinated solvents detected in method blanks associated with water samples, and phthalates, TPHC, and various VOCs detected in method blanks associated with solid media. In addition, several chlorinated solvents, bis(2-ethylhexyl)phthalate, mercury, lead, iron, potassium, and manganese were detected in rinseate blanks, and several chlorinated solvents were detected in trip blanks.

9.2.8 Summary of BERA for AOC 57

Potential risks for ecological receptors were evaluated for CPCs in surface soil, surface water, sediment, and groundwater at AOC 57. The following items summarize the results of the AOC 57 BERA:

- mercury was detected in only one unfiltered surface water sample, and not at all in filtered surface water. The detection in the one unfiltered sample raises uncertainty about the bioavailability of mercury in Area 2 surface water. There are also doubts about the origin of mercury in the one sediment sample in which it was detected. Furthermore, the RTV used to evaluate avian risks for mercury was based on a study using methyl mercury; this RTV may have over-estimated potential risks to wading birds because methyl mercury is not associated with AOC 57. These factors create significant uncertainty regarding the conclusion of the BERA that wading birds may be at risk from exposure to mercury from Area 2 surface water or sediment that may bioaccumulate in fish tissue;

- a survey of Area 2 showed no sign of contaminant induced stress to wetland or terrestrial vegetation, although the BERA indicated that there may be a risk to terrestrial plants from exposure to lead in Area 2 floodplain surface soil;

- analyses of surface water samples indicate that unfiltered concentrations of metals are elevated at both Areas 2 and 3; however, these concentrations may be related to the high turbidity of the samples, and may not be bioavailable to ecological receptors. Therefore, there is uncertainty regarding the finding that aquatic organisms may be at risk from iron in surface water at 57D-95-05X (located adjacent to Area 2);

- while potential risks were also identified for benthic macroinvertebrates from exposure to metals, pesticides, PCB, and PAHs in Areas 2 and 3 sediment based on conservative benchmark comparisons, this conclusion is not supported by the apparent lack of adverse effects in bulk sediment toxicity studies. Benthic macroinvertebrates may be at risk from copper and lead concentrations in sediment at sample location 57D-95-04X (concentrations of these analytes may be correlated with observed adverse growth responses for *C. tentans* in toxicity tests).

Based on a comparison of surface water data with upgradient groundwater data, Cold Spring Brook surface water in the vicinity of Area 2 may be impacted by groundwater discharge. However, there does not appear to be a risk to aquatic receptors from the chemicals common to both these media. Groundwater at Area 3 does not appear to be impacting downgradient surface water in the floodplain of Cold Spring Brook, based on the difference in chemicals detected in these media.

10.0 CONCLUSIONS AND RECOMMENDATIONS

RI activities were conducted by HLA personnel at AOC 57 Areas 2 and 3 to evaluate the nature and distribution of the groundwater and soil contamination detected during previous investigations. Conclusions developed from the RI findings are presented in the following subsections.

10.1 CONCLUSIONS

The following conclusions are based on interpretation of data collected from previous investigations and the RI completed at AOC 57. Tables 10-1 and 10-2 summarize the results of the Human Health and Ecological Risk Assessments.

AOC 57

- The geologic setting at AOC 57 includes a partially reworked soil/fill above the floodplain underlain by glacially deposited silty sand and sand. Surficial floodplain deposits include silt and silty sand underlain by discontinuous organic layers, sand, and silty sand. Bedrock was not encountered at AOC 57 but evidence suggests that depth to bedrock may be approximately 100 to 150 feet bgs.
- For the purpose of this RI the hydrogeologic condition at AOC 57 is dominated by the overburden aquifer. The water table is found in the overburden sands and silty sands. Local groundwater flow is primarily to the south - southeast.

Area 1

- Area 1 consists of an eroded drainage ditch and storm drain outfall south of Barnum Road.
- A contaminated soil removal was performed in 1997 to address PAHs in soil. Following the removal action, Area 1 was recommended for no further action.

- In accordance with recent USEPA requirements, an assessment for future unrestricted land use has been included in this RI. The assessment indicated that there are no unacceptable risks for future unrestricted land use.

Area 2

- Groundwater in the overburden aquifer at Area 2 discharges to Cold Spring Brook and its associated wetlands. The wetlands act to cause a convergence of groundwater flowpaths.

- Estimates of Area 2 hydraulic conductivities range between $1x10^{-1}$ cm/sec ($2x10^{-1}$ ft/min) and $4x10^{-4}$ cm/sec ($8x10^{-4}$ ft/min) with a geometric mean of $2x10^{-2}$ cm/sec ($3x10^{-2}$ ft/min). A groundwater flow velocity of 1.6 feet per day was calculated using the geometric mean of estimated hydraulic conductivities and horizontal hydraulic gradients.

- Evidence suggests that the contaminant source is contaminated soils located in the vicinity of the previous soil removal excavation. Contaminated soils are attributed to the historical disposal of vehicle maintenance waste.

- Soil contamination was detected both on the flat northern portion of the site and in the Cold Spring Brook floodplain. Contamination in the northern portion of the site is primarily TPHCs and is located in the surficial soils. Soil contamination in the floodplain is localized along the southern perimeter of the soil removal excavation. Detected contaminants consist primarily of PCE, TCE, toluene, Aroclor, and TPHC.

- Chlorinated VOCs were detected in field analytical groundwater samples as well as off-site analytical groundwater samples. Specific contaminants observed include PCE, TCE, and toluene. The higher detections were observed in monitoring wells 57M-95-04A, 57M-95-07X, and 57M-95-08A and the piezometer 57P-98-02X all located along the southern portion of the site adjacent to Cold Spring Brook. Elevated levels of arsenic detected in groundwater are due to the mobilization of naturally occurring arsenic in soils.

- Soil and groundwater contaminant distributions appear to be vertically located in the vicinity of the water table.

- Near shore surface water and sediment samples collected from the Cold Spring Brook wetlands adjacent to Area 2 were shown to contain similar chlorinated solvents as were found in Area 2 soils and groundwater. Discharge to the wetlands appears to be primarily located in the area of 57D-95-05X and 57D-98-01X located southwest of the removal excavation. Analytical data indicates that Area 2 is not impacting downstream portions of Cold Spring Brook. Distribution of TPHC, arsenic, and other inorganics within the Cold Spring Brook stream channel suggest an alternate upgradient source for the analytes. Elevated concentrations of TPHC, arsenic, and lead were detected in the area of the brook upstream from Area 2.

- Human health risk evaluations were performed for assumed exposure conditions for both the Area 2 Industrial Land Use scenario (upland) and the Recreational Land Use scenario (wetland).

- The risk assessment evaluated post-removal action conditions for surface soil and subsurface soil. Chemicals of potential concern (CPCs) identified in surface soil and subsurface soil included arsenic, iron, manganese, Aroclor-1260, and petroleum compounds such as EPH and VPH hydrocarbon fractions. CPCs identified in groundwater, surface water, and sediment were similar to those identified in soil, but also included chlorinated VOCs, which were detected at low concentrations.

- Exposures and risks for current site use were evaluated for a site maintenance worker (possible exposure to surface soil), and a trespasser ages 6 through 16 (possible exposure to surface soil, surface water, and sediment). Estimated cancer and non-cancer risks associated with current land use conditions are within acceptable levels established by the USEPA.

- The possible health risks associated with the anticipated future site use were evaluated assuming that the upland portion of the site will be redeveloped for commercial/industrial use, and included evaluation of a commercial industrial worker (possible exposure to surface soil and groundwater) and an excavation worker (possible exposure to surface soil and subsurface soil). Estimated cancer and non-cancer risks associated with future commercial/industrial development and use of upland areas of the site were within acceptable levels established by the USEPA.

- Possible health risks for the future use of the wetland areas were evaluated assuming that the areas could be used for passive recreational/open space use and were evaluated for a recreational child ages 6 through 16 (possible exposure to surface soil, surface water, and sediment). Estimated cancer and non-cancer risks associated with future open space use of the wetland areas of the site were within acceptable levels established the USEPA. However, non-cancer risks associated with excavation of Area 2 wetland subsurface soils exceeded a hazard index of 1 for potential effects to the immune system. A HI of 1 is the threshold value applied by USEPA to evaluate the significance of non-cancer rises. These non-cancer risks were primarily attributable to Aroclor-1260 detected in soil samples at the toe of the Area 2 soil removal excavation.

- To aid in risk management decision-making at Area 2, future unrestricted use exposure was evaluated by assuming that child and adult residents would live at the site (possible exposures to surface soil and groundwater). Non-cancer risks for potential exposures to soils, and cancer and non-cancer risks for potential exposures to groundwater used as potable water, exceeded the USEPA acceptable risk limits. Groundwater risks were primarily attributable to arsenic; if the CSF for arsenic is adjusted downward by one order of magnitude (to account for uncertainty, as acknowledged by USEPA), the groundwater cancer risks would be within the USEPA acceptable cancer risk range. Future potable uses of AOC 57 groundwater is highly unlikely.

Potential risks for ecological receptors were evaluated for CPCs in surface soil, surface water, sediment, and groundwater at AOC 57. The following items summarize the results of the AOC 57 BERA:

- Mercury was detected in only one unfiltered surface water sample at Area 2, and not at all in filtered surface water. The detection in the one unfiltered sample raises uncertainty about the bioavailability of mercury in Area 2 surface water. There are also doubts about the origin of mercury in the one sediment sample in which it was detected. These factors create significant uncertainty regarding the conclusion of the BERA that wading birds may be at risk from exposure to mercury from Area 2 surface water or sediment that may bioaccumulate in fish tissue;

- A survey of Area 2 showed no sign of contaminant induced stress to wetland or terrestrial vegetation, although the BERA indicated that there may be a risk to terrestrial plants from exposure to lead in Area 2 floodplain surface soil;
- Analyses of surface water samples indicate that unfiltered concentrations of metals are elevated at both Areas 2 and 3; however, these concentrations may be related to the high turbidity of the samples, and may not be bioavailable to ecological receptors. Therefore, there is uncertainty regarding the finding that aquatic organisms may be at risk from iron in surface water at 57D-95-05X (located adjacent to Area 2);
- While potential risks were also identified for benthic macroinvertebrates from exposure to metals, pesticides, PCB, and PAHs in Areas 2 and 3 sediment based on conservative benchmark comparisons, this conclusion is not supported by the apparent lack of adverse effects in bulk sediment toxicity studies. Benthic macroinvertebrates may be at risk from copper and lead concentrations in sediment at sample location 57D-95-04X (concentrations of these analytes may be correlated with observed adverse growth responses for *C. tentans* in toxicity tests).
- Based on a comparison of surface water data with upgradient groundwater data, Cold Spring Brook surface water in the vicinity of Area 2 may be impacted by groundwater discharge. However, there does not appear to be a risk to aquatic receptors from the chemicals common to both these media.

Area 3

- Estimates of Area 3 hydraulic conductivities range between $6x10^{-3}$ cm/sec ($1x10^{-2}$ ft/min) and $7x10^{-4}$ cm/sec ($1x10^{-4}$ ft/min) with a geometric mean of $2x10^{-3}$ cm/sec ($4x10^{-3}$ ft/min). A groundwater flow velocity of 0.34 et per day was calculated using the geometric mean of estimated hydraulic conductivities and horizontal hydraulic gradients.

- The identified contaminant source in Area 3 is a disposal area in the vicinity of test pit 57E-95-24X. The disposal area was bounded by test pits 57E-96-28X through 57E-96-31X which encountered assorted vehicle maintenance debris and sawdust.

- Soil contamination at Area 3 includes the VOCs PCE, TCE, toluene, ethylbenzene and xylenes. Detected SVOCs are primarily naphthalene, 1,2-DCB, and 1,4-DCB. In addition, Aroclor and TPHC were detected in source area and downgradient soils.

- Field screening and off-site analyses of groundwater samples indicate that the groundwater contamination is located primarily from the source area in the vicinity of test pit 57E-95-24X south to the monitoring well 57M-96-11X. Contaminants observed in this area include inorganics, VOCs and SVOCs. Elevated levels of cadmium and arsenic were observed in 57M-95-03X and 57M-96-11X, respectively. Piezometers 57P-98-03X and 57P-98-04X located downgradient of 57M-96-11X showed much decreased levels of arsenic in groundwater. Detected VOCs include TEX, TCE, and PCE. Low levels of chlorobenzene and ethylbenzene were the only VOCs detected in the downgradient piezometers. SVOCs are significant groundwater contaminants at Area 3. SVOCs detected consist of 1,2-DCB, 1,4-DCB, and naphthalene. These SVOCs were detected at both the source area well 57M-95-03X and the downgradient well 57M-96-11X. No pesticides, PCBs, or TPHC were detected in Area 3 groundwater.

- Downgradient soil and groundwater distribution of contaminants appears to be vertically localized in the vicinity of the water table. Deeper overburden wells were not installed; however, the proximity to Cold Spring Brook and observed contaminant levels indicate that vertically downward contaminant migration is unlikely.

- Sediment sampling showed that inorganics, VOCs, SVOCs, and petroleum contaminants were consistent with contamination in soils and groundwater. Contaminant concentrations were generally highest near the southern terminus of the removal excavation (57D-98-05X) and decreased or were nondetect further into the wetland. Contaminant distributions in the wetland and Cold Spring Brook indicate that Area 3 is not impacting Cold Spring Brook.

- The Area 3 source area soil removal eliminated the majority of Area 3 soil contaminants. Confirmatory sampling indicates that residual EPH, PCBs, and pesticides are present near the southern end of the excavation.

- Observed arsenic concentrations in groundwater are believed to be due to reducing conditions in the aquifer. The reducing conditions are attributed to the aerobic degradation of the site contaminants.

- The risk assessment evaluated post-removal action conditions for surface soil and subsurface soil. Chemicals of potential concern identified in surface soil and subsurface soil primarily included arsenic, iron, manganese, Aroclor-1260, and petroleum compounds such as EPH and VPH hydrocarbon fractions. CPCs identified in groundwater, surface water, and sediment were similar to those identified in soil, but also included chlorinated VOCs, which were detected at low concentrations.

- Exposures and risks for current site use were evaluated for a site maintenance worker (possible exposure to surface soil), and a trespasser ages 6 through 16 (possible exposure to surface soil, surface water, and sediment). Estimated cancer and non-cancer risks associated with current land use conditions are within acceptable levels established by the USEPA.

- The possible health risks associated with the anticipated future site use were evaluated assuming that the upland portion of the site will be redeveloped for commercial/industrial use, and included evaluation of a commercial industrial worker (possible exposure to surface soil and groundwater) and an excavation worker (possible exposure to surface soil and subsurface soil). Possible health risks for the future use of the wetland areas were evaluated assuming that the areas could be used for passive recreational/open space use and were evaluated for a recreational child ages 6 through 16 (possible exposure to surface soil, surface water, and sediment). Estimated cancer and non-cancer risks associated with future open space use of the wetland areas of the site were within acceptable levels established the USEPA. With the exception of potable use of Area 3 groundwater, estimated cancer and non-cancer risks associated with future commercial/industrial development and use of upland areas of the site were within acceptable levels established by the USEPA.

- To aid in risk management decision-making and to determine if additional response actions may be required at AOC 57, future unrestricted land use was evaluated by assuming that child and adult residents would live at the site (possible exposures to surface soil and groundwater). Non-cancer risks for potential exposures to soils at the Area 3 wetlands, and cancer and non-cancer risks for potential exposures to groundwater used as potable water, exceeded the USEPA acceptable risk limits. Groundwater risks were primarily attributable to arsenic; if the CSF for arsenic is adjusted downward by one order of magnitude (to account for uncertainty, as acknowledged by USEPA), the groundwater cancer risks would be within the USEPA acceptable cancer risk range.

10.2 RECOMMENDATIONS

Based on the results and interpretation of the physical and chemical data and taking into account the future use of this AOC, HLA recommends the following actions:

- Following the 1997 removal action and subsequent unrestricted land use risk assessment, Area 1 is recommended for no further action.

- Based upon the conclusions of the RI and the Human Health Risk Assessment, HLA recommends that a Feasibility Study be performed to evaluate alternatives to remove possible human health risks associated with potential future exposure to wetland soils by an excavation worker at Area 2 and hypothetical future residential exposures to soil and groundwater.

- Based on the results and interpretations of the RI and the Human Health Risk Assessment, HLA recommends that a Feasibility Study be performed to evaluate alternatives to remove potential human health risks associated with potential future potable use of Area 3 groundwater and hypothetical future residential exposures to soil and groundwater.

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ABB-ES	ABB Environmental Services, Inc.
ADL	Arthur D. Little, Inc.
AET	Apparent Effects Threshold
AOC	Area of Contamination
AREE	area requiring environmental evaluation
ARF	Analysis Request Form
ARAR	applicable or relevant and appropriate requirements
AST	aboveground storage tank
ATEC	ATEC Environmental Consultants, Inc.
BAFs	bioaccumulation factors
BCFs	bioconcentration factors
bgs	below ground surface
BNA	base neutralized acids
BRAC	Base Realignment and Closure
BRAC	Base Realignment and Closure Environmental Evaluation
BTEX	benzene, toluene, ethylbenzene, and xylene
°C	degrees Celsius
cm/sec	centimeters per second
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CMR	Code of Massachusetts Regulations
COC	chain-of-custody
COR	Contracting Officer's Representative
CPC	chemical of potential concern
CRL	Certified Reporting Limits
CSF	cancer slope factor
1,2-DCA	1,2-dichloroethane
DCE	1,1-dichloroethene
DDT	dichlorodiphenyl trichloroethane
DOT	Department of Transportation
DQO	Data Quality Objective
DRO	Diesel Range Organics

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

DWEL	Drinking Water Equivalency Level
ECD	electron capture detector
E&E	Ecology & Environment, Inc.
ED	exposure duration
EE	Environmental Evaluation
EE&G	Environmental Engineering and Geotechnics
ELCD	electronic conductivity detector
ELCR	excess lifetime cancer risk
EMO	Environmental Management Office
EPC	exposure point concentration
EPH	Extractable Petroleum Hydrocarbons
ER-L	effects range-low
ER-M	effects range-medium
ESE	Environmental Science and Engineering, Inc.
ETA	Engineering Technologies Associates
ft/ft	feet per foot
ft/min	feet per minute
ft/day	feet per day
ft^2/day	square feet per day
°F	degrees Fahrenheit
FFA	Federal Facilities Agreement
FID	flame ionization detector
FS	Feasibility Study
FSP	Field Sampling Plan
GC/MS	gas chromatograph/mass spectrometer
g/mL	grams per milliliter
gpm	gallons per minute
GPR	ground-penetrating radar
GRO	gasoline range organics
H	Henry's Law Constant
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Table
HI	hazard index

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

HQ	hazard quotient
HSA	hollow-stem augers
IAG	Inter Agency Agreement
ID	inside diameter
IDW	investigation-derived waste
IR	infrared spectrophotometer
IRDMIS	Installation Restoration Data Management Information System
IRIS	Integrated Risk Information System
kg	kilograms
K_{oc}	organic carbon partition coefficient
LEL	lowest effect level
LOAEL	lowest observed adverse effects level
m^3	cubic meters
MAAF	Moore Army Air Field
MADEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
MCP	Massachusetts Contingency Plan
MDL	Method Detection Limits
MEP	Master Environmental Plan
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
MMCL	Massachusetts Maximum Contaminant Level
MNHP	Massachusetts Natural Heritage Program
mph	miles per hour
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean seal level
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan
ND	non-detect

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

NDIR	non-dispersed infrared
NFA	no further action
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effects level
NWR	National Wildlife Refuge
OD	outside diameter
OME	Ontario Ministry of the Environment
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAH	polynuclear aromatic hydrocarbon
PAL	Project Analyte List
PARCC	precision, accuracy, representativeness, completeness, and comparability
PC	personal computer
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PDE	potential dietary exposure
PID	photoionization detector
POP	Project Operations Plan
ppb	parts per billion
ppm	parts per million
PQL	Practical Quantitation Limit
PRE	preliminary risk evaluation
PRI	Potomoc Research, Inc.
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	Remedial Investigation
RME	reasonable maximum exposure

ROD	Record of Decision
RPD	relative percent difference
RTV	reference toxicity value
SA	Study Area
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SFF	site foraging frequency
SI	Site Investigation
SMCL	Secondary Maximum Contaminant Level
SQG	sediment quality guidelines
SQL	sample quantitation limit
SVOA	semivolatile organic analysis
SVOC	semivolatile organic compound
TBC	to be considered
1,1,1-TCA	1,1,1,-trichloroethane
1,1,2,2-TCA	1,1,2,2-trichloroethane
TCE	trichloroethene
TCL	Target Compound List
TDS	total dissolved solids
TEX	toluene, ethylbenzene and xylenes
TIC	tentatively identified compounds
TPHC	total petroleum hydrocarbons
TOC	Total Organic Carbon
TSCA	Toxic Substance Control Act
TSS	total suspended solids
µg/g	micrograms per gram
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µg/ml	micrograms per milliliter
µL	microliter
UCL	upper confidence limit
UF	uncertainty factors

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Center
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
VC	vinyl chloride
VPH	volatile petroleum hydrocarbons
VOA	volatile organic analysis
VOC	volatile organic compound
WPA	Works Progress Administration

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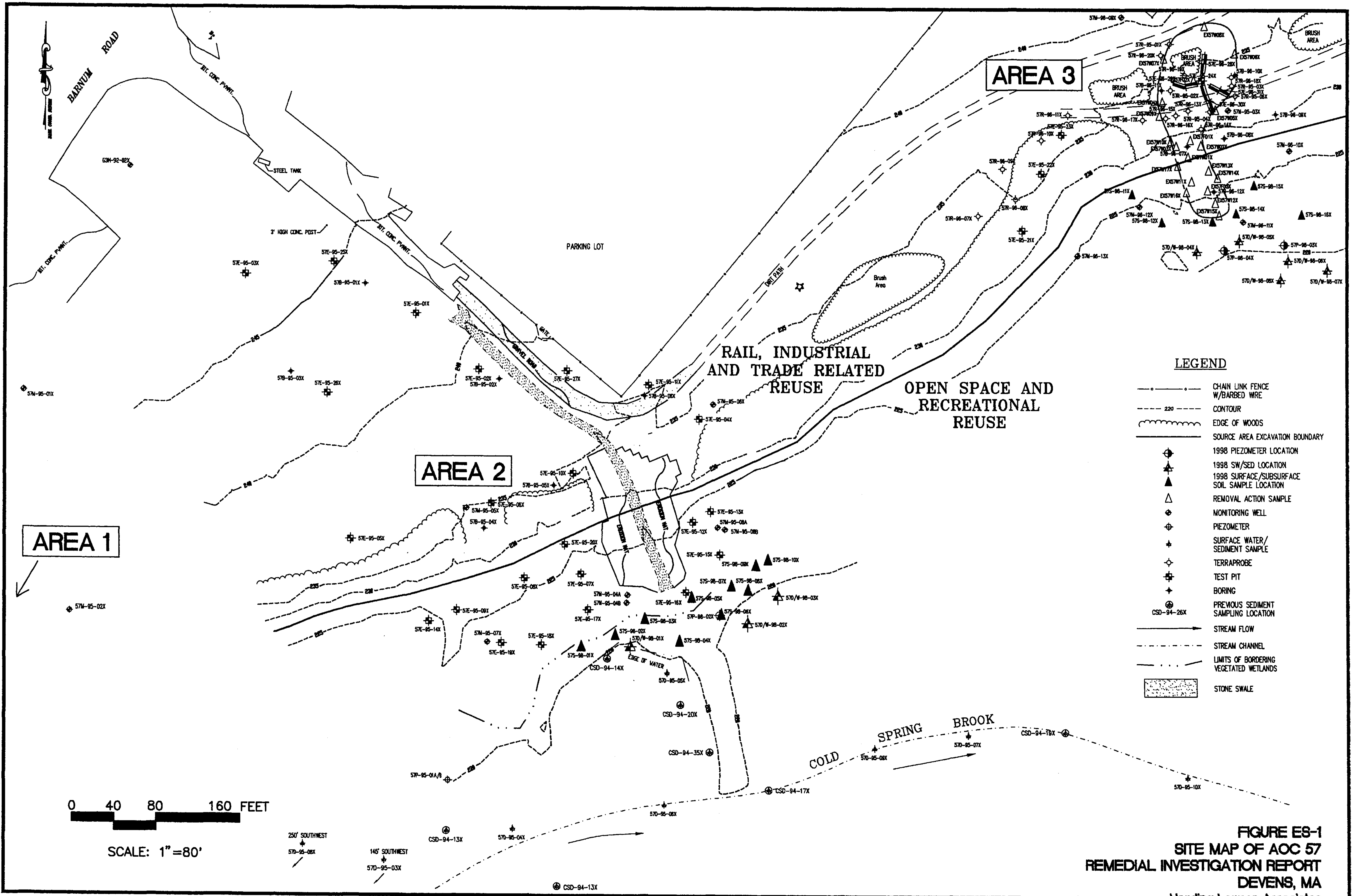

FIGURE ES-1
SITE MAP OF AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

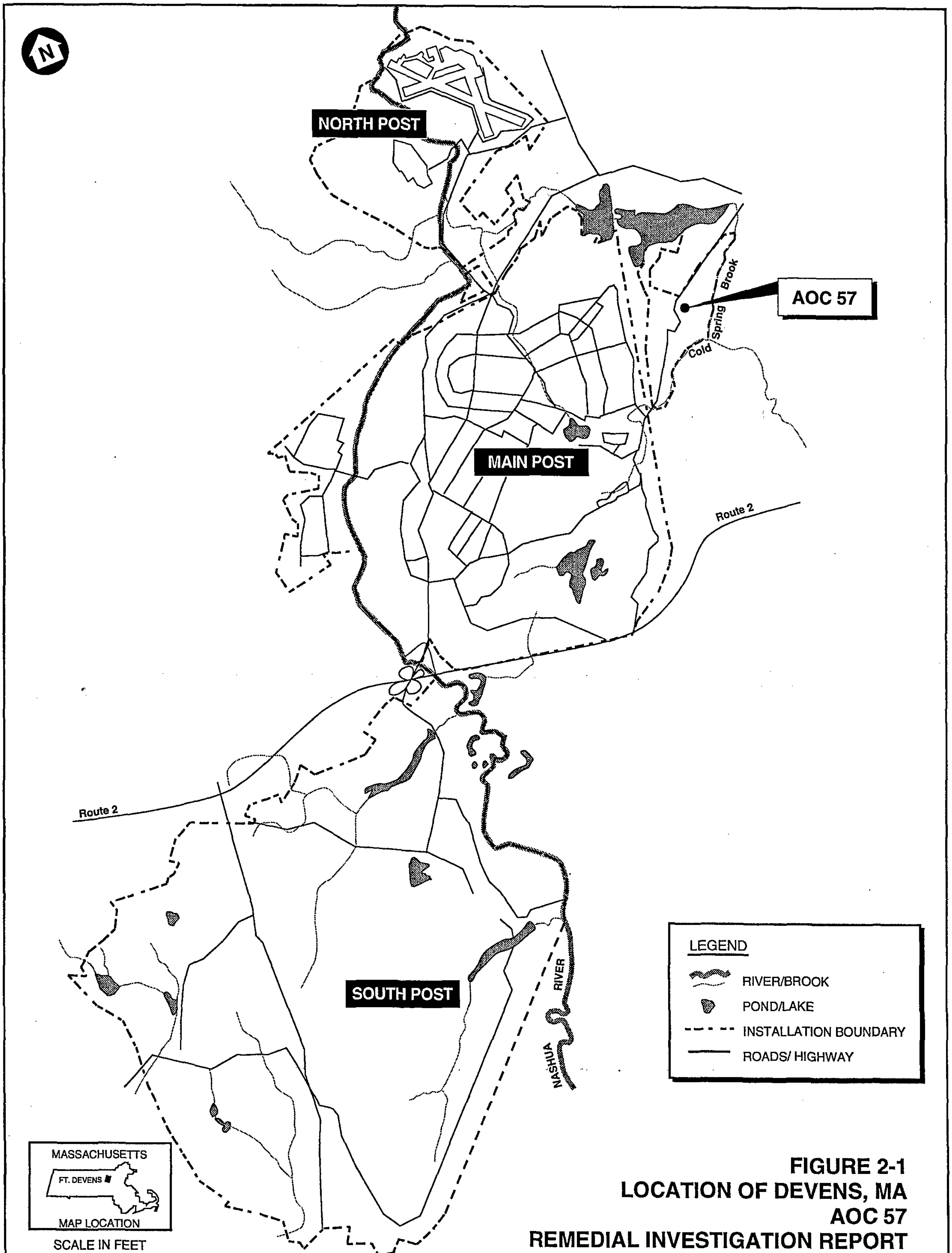

FIGURE 2-1
LOCATION OF DEVENS, MA
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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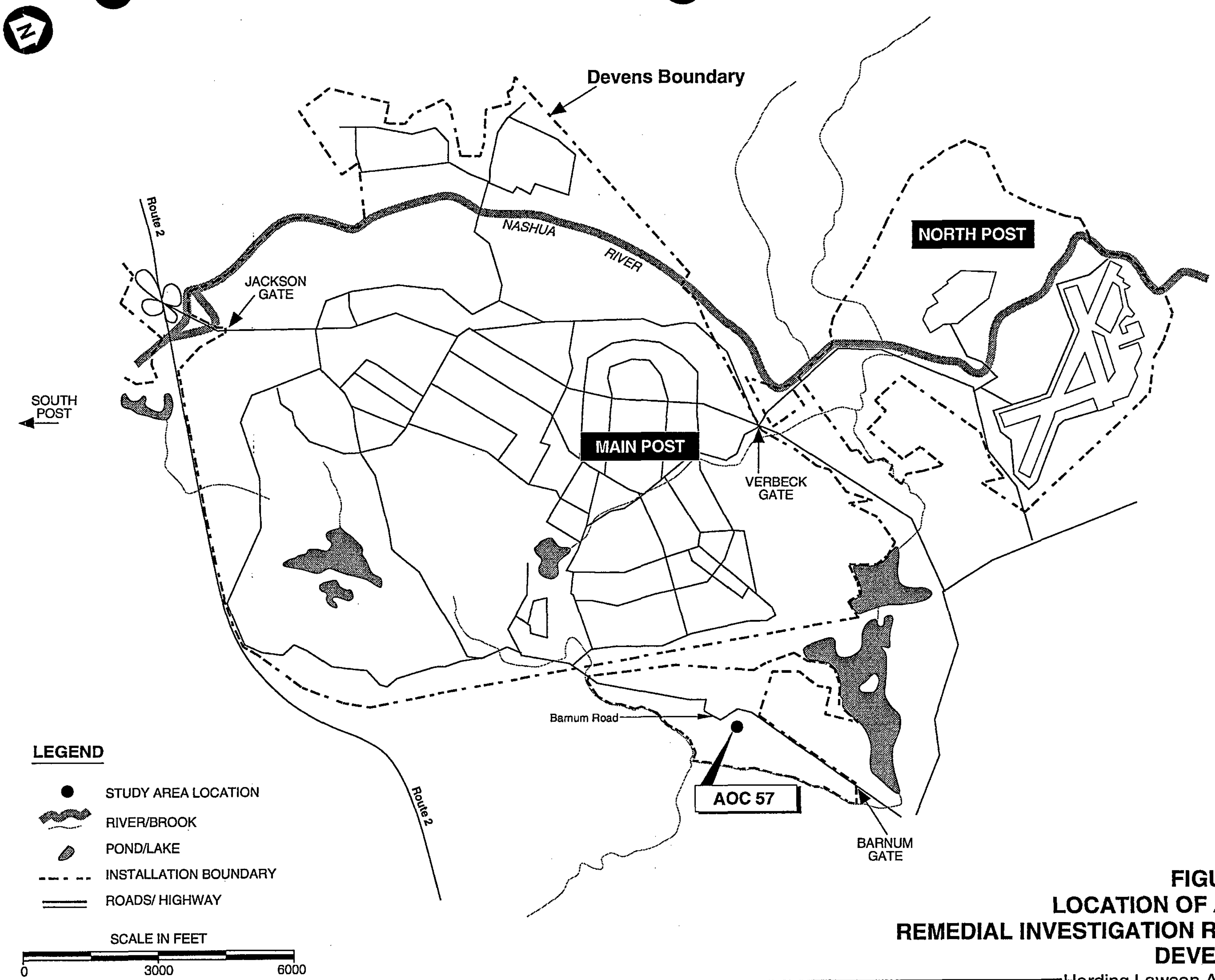

FIGURE 2-2
LOCATION OF AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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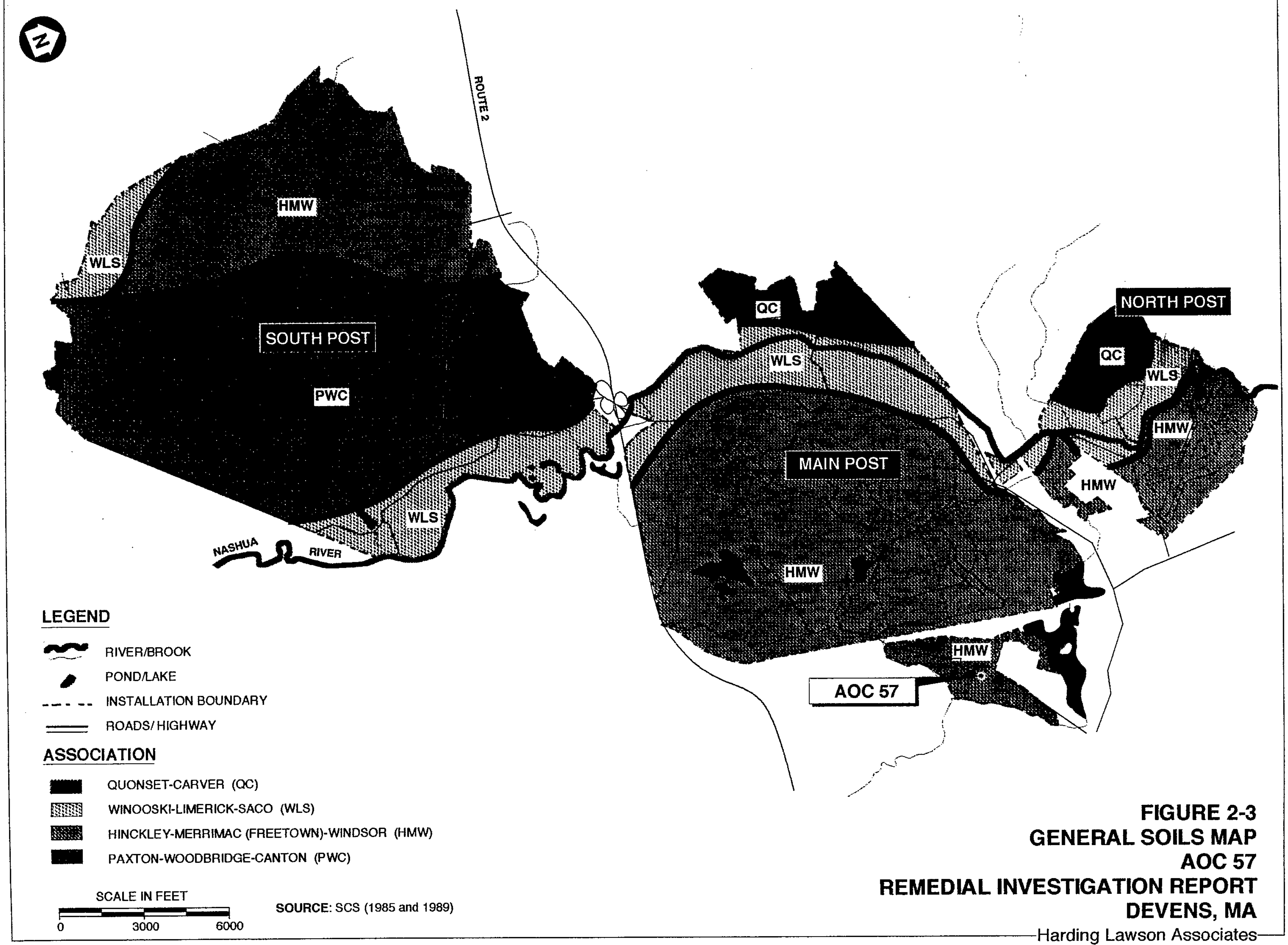

SOURCE: SCS (1985 and 1989)

FIGURE 2-3
GENERAL SOILS MAP
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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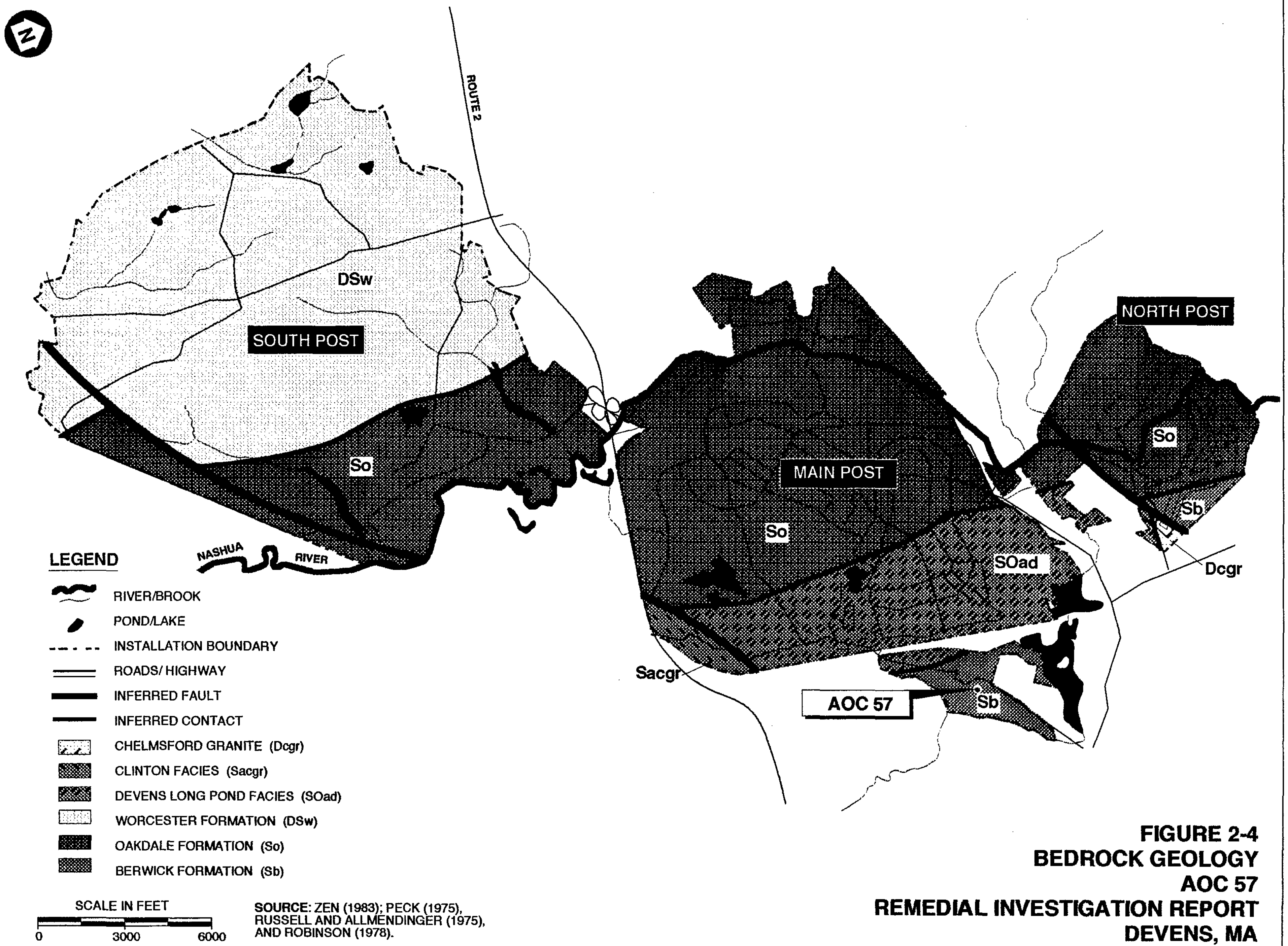
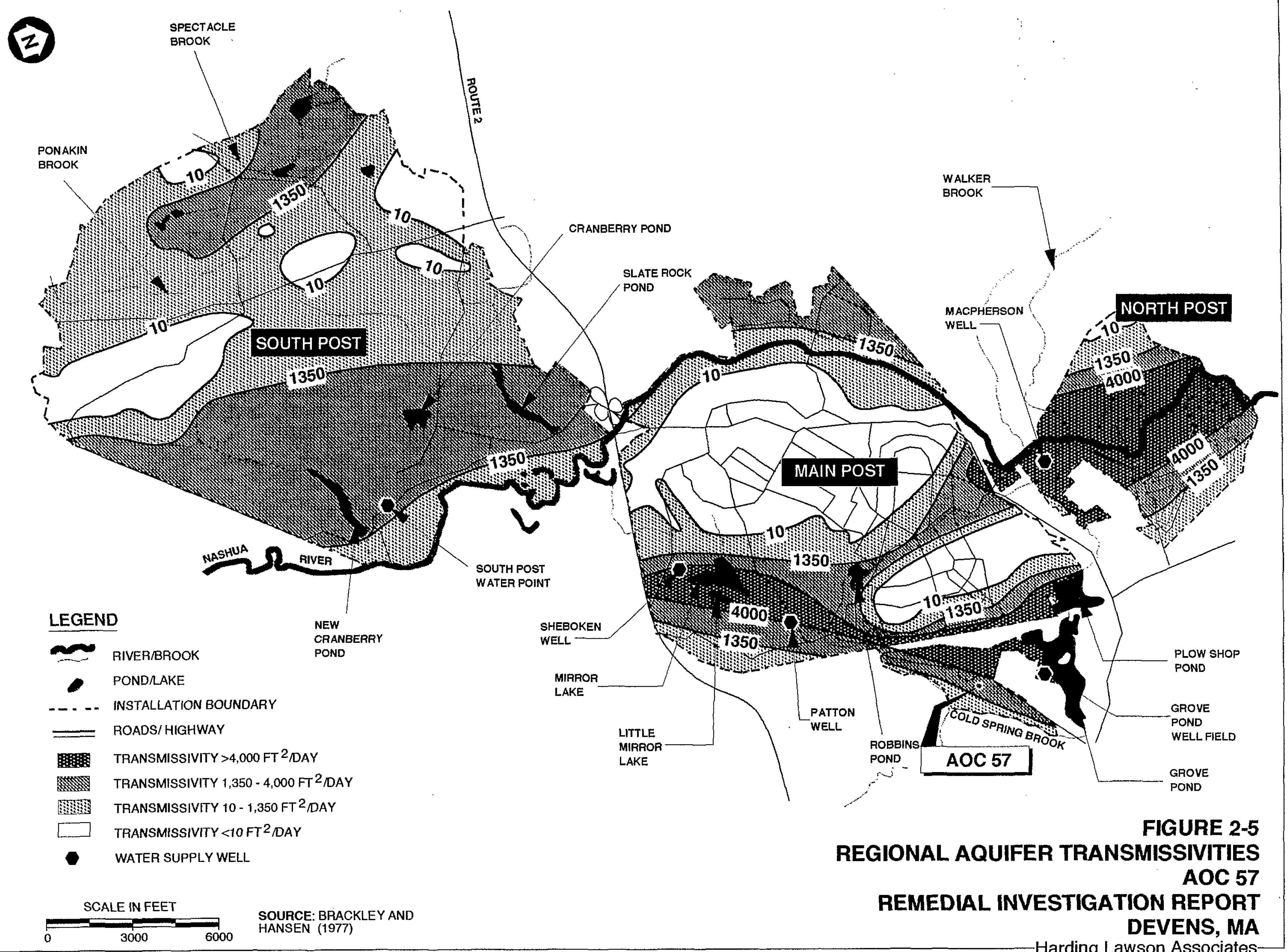


SOURCE: ZEN (1983); PECK (1975), RUSSELL AND ALLMENDINGER (1975), AND ROBINSON (1978).

FIGURE 2-4
BEDROCK GEOLOGY
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA



SOURCE: BRACKLEY AND HANSEN (1977)

FIGURE 2-5
REGIONAL AQUIFER TRANSMISSIVITIES
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

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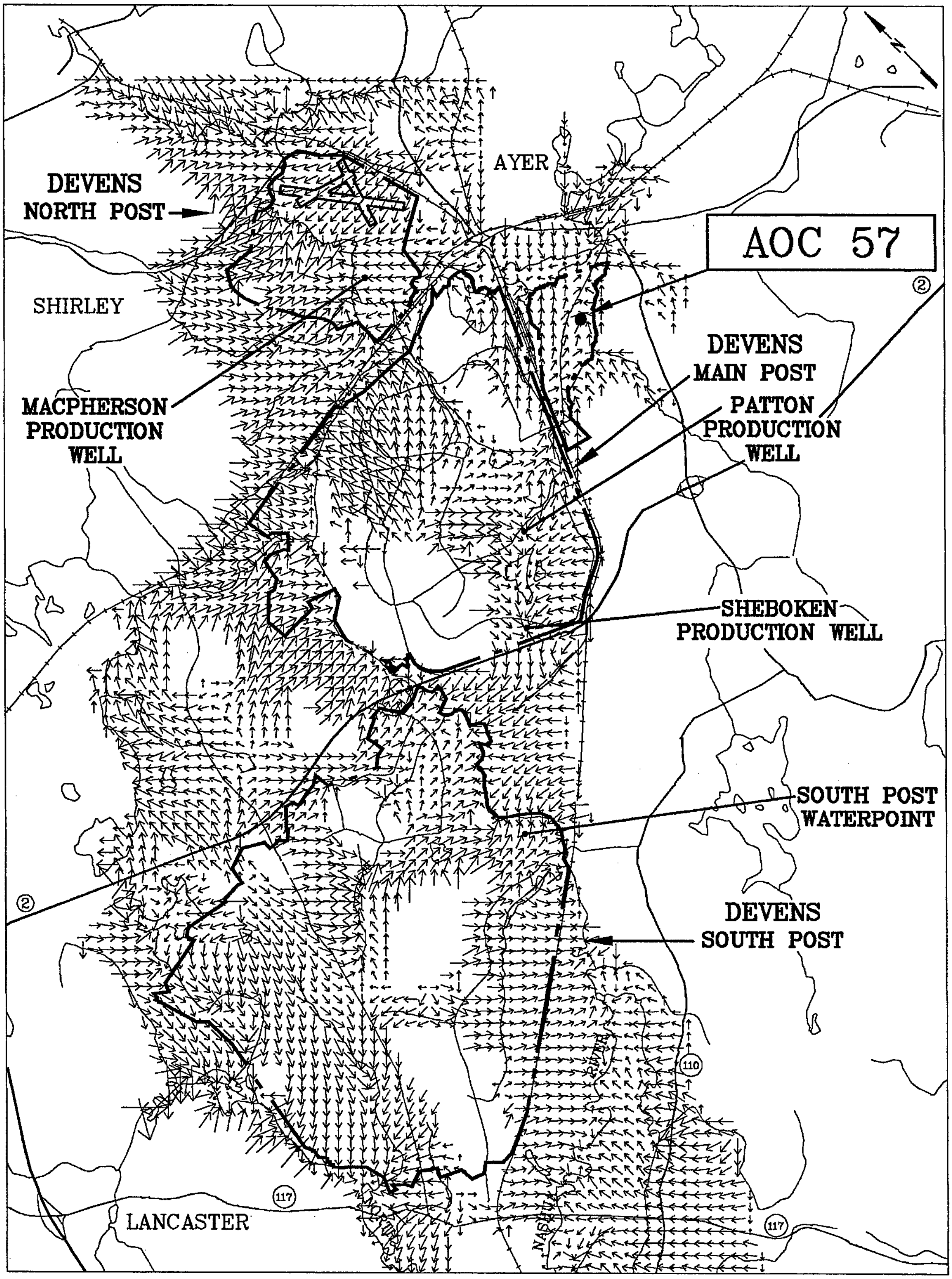

SOURCE:
DRAFT FINAL GROUNDWATER FLOW MODEL AT FORT DEVENS, MA, ETA, INC. MAY, 1995.

LEGEND

↗↗ GROUNDWATER FLOW VECTORS

0 3000 6000 12000 FEET

SCALE: 1"=6000'

FIGURE 2-6
REGIONAL OVERBURDEN
GROUNDWATER FLOW MAP
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

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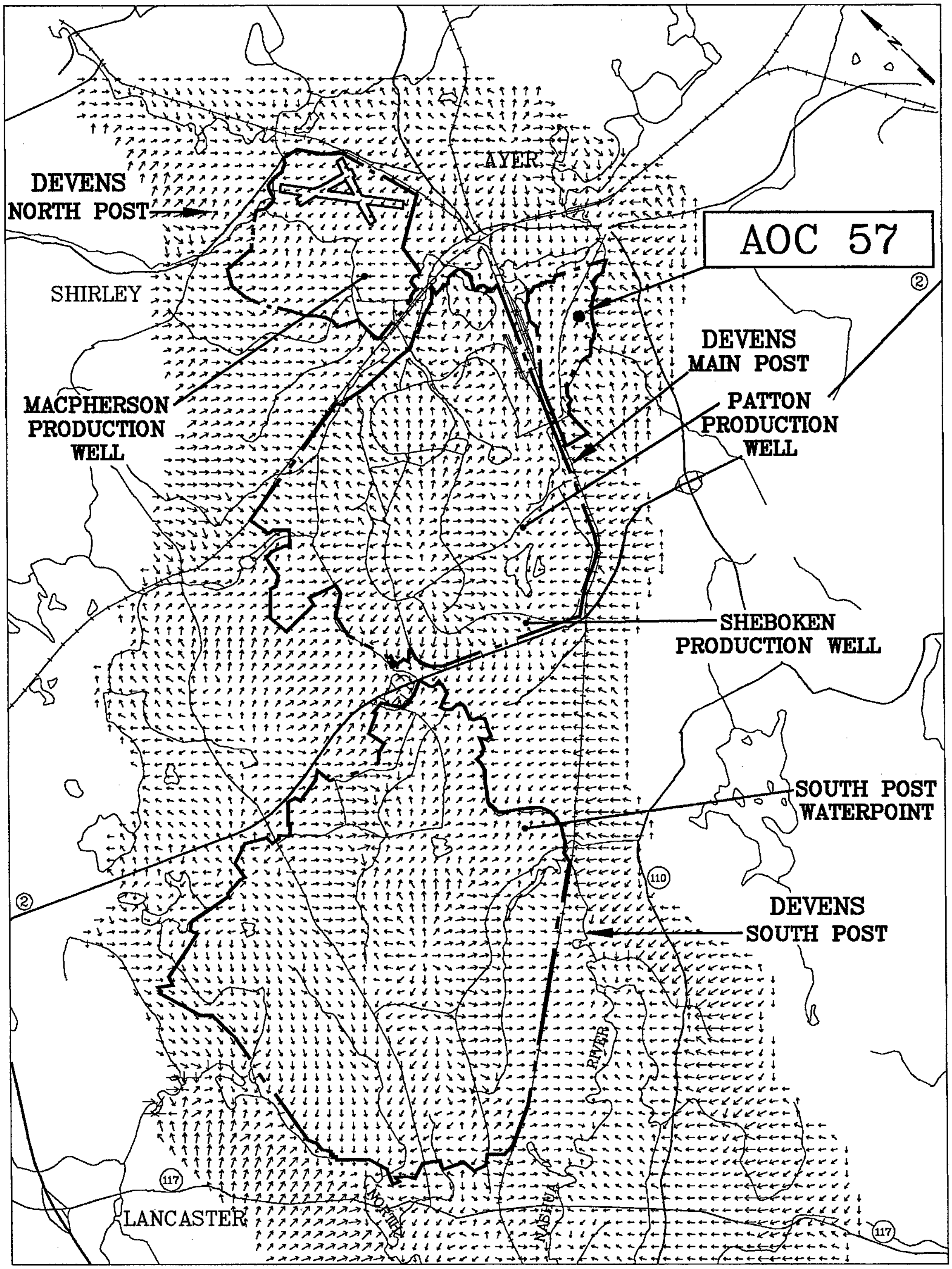

SOURCE:
DRAFT FINAL GROUNDWATER FLOW MODEL AT FORT DEVENS, MA, ETA, INC. MAY, 1995.

LEGEND

GROUNDWATER FLOW VECTORS

0 3000 6000 12000 FEET

SCALE: 1"=6000'

FIGURE 2-7
REGIONAL BEDROCK
GROUNDWATER FLOW MAP
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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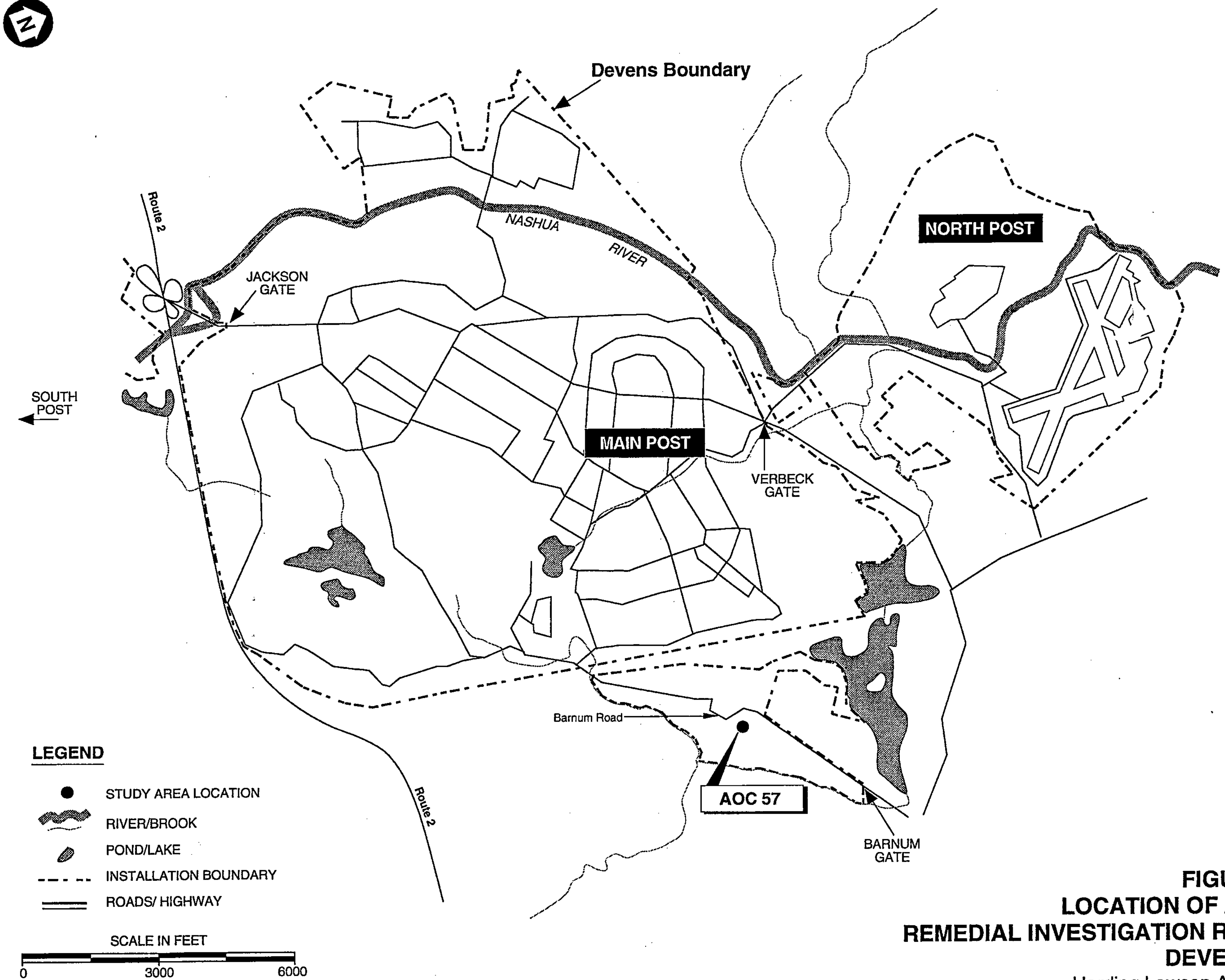

FIGURE 5-1
LOCATION OF AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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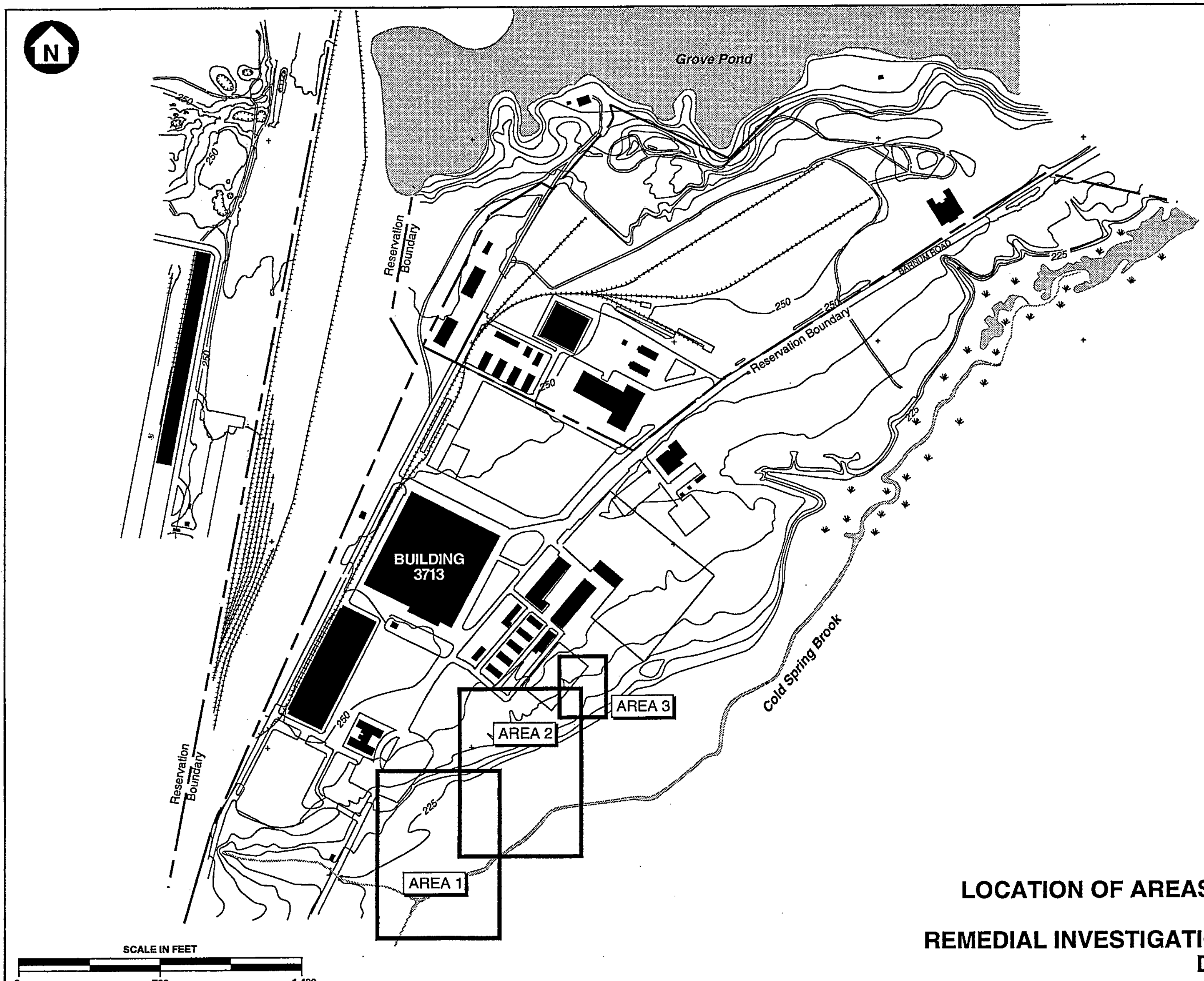

FIGURE 5-2
LOCATION OF AREAS 1, 2, AND 3
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

9908006(c) 12

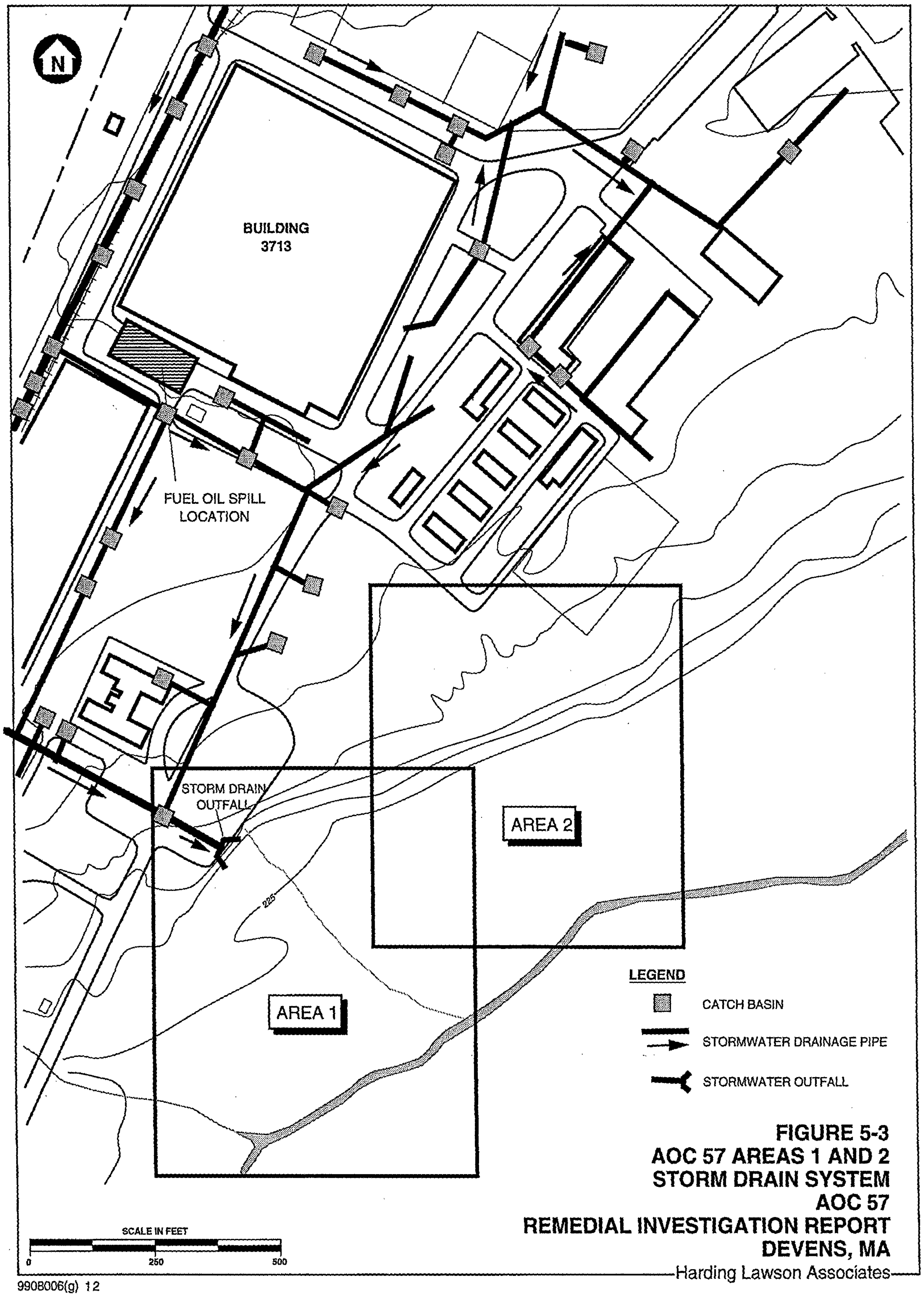

FIGURE 5-3
AOC 57 AREAS 1 AND 2
STORM DRAIN SYSTEM
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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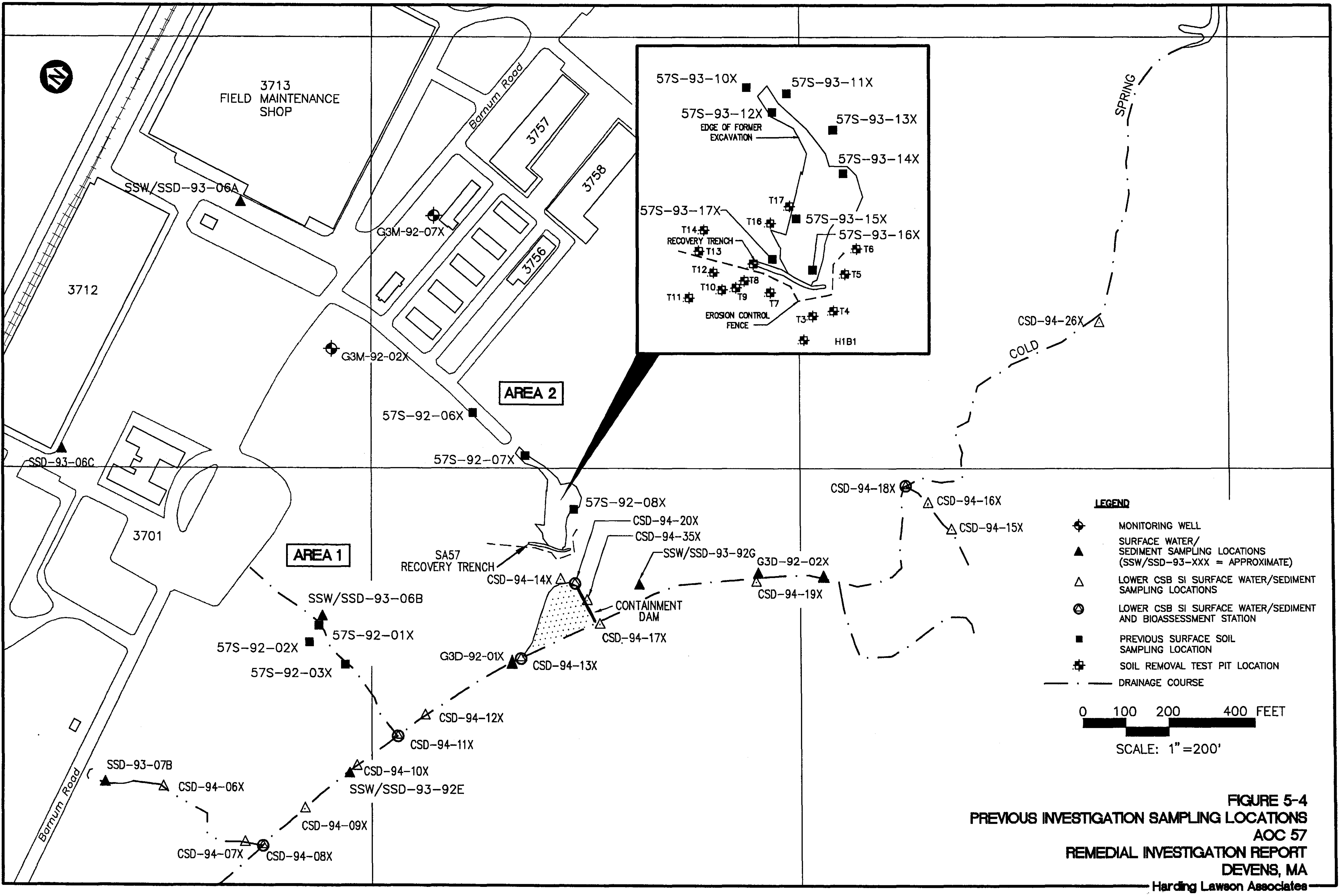
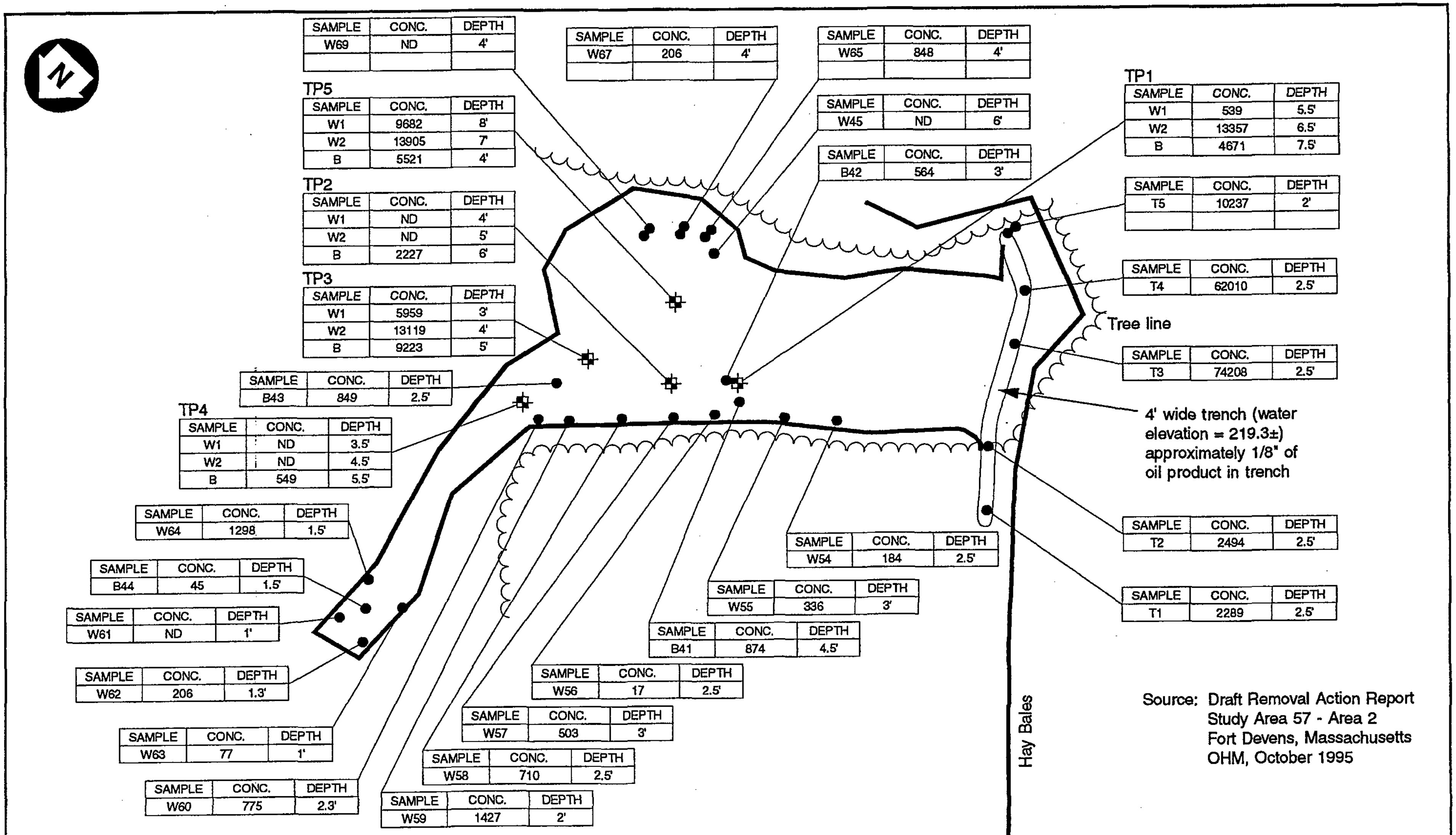


FIGURE 5-4
PREVIOUS INVESTIGATION SAMPLING LOCATIONS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

J:\7466-00\FIG-66.DWG 10/06/99



Source: Draft Removal Action Report
Study Area 57 - Area 2
Fort Devens, Massachusetts
OHM, October 1995

Legend

- ⊕ Test Pit Sample Location
- ● Discrete Sample Location

Notes: SAMPLE Sample designations are preceded with SBSA57

CONC. TPH concentration of sample in mg/Kg

DEPTH Depth of sample in feet

Lower part of excavation still visually contaminated at groundwater depth

Scale in Feet

0 40

FIGURE 5-5
OHM SOIL REMOVAL FIELD ANALYTICAL SAMPLING LOCATIONS
AOC 57/AREA 2
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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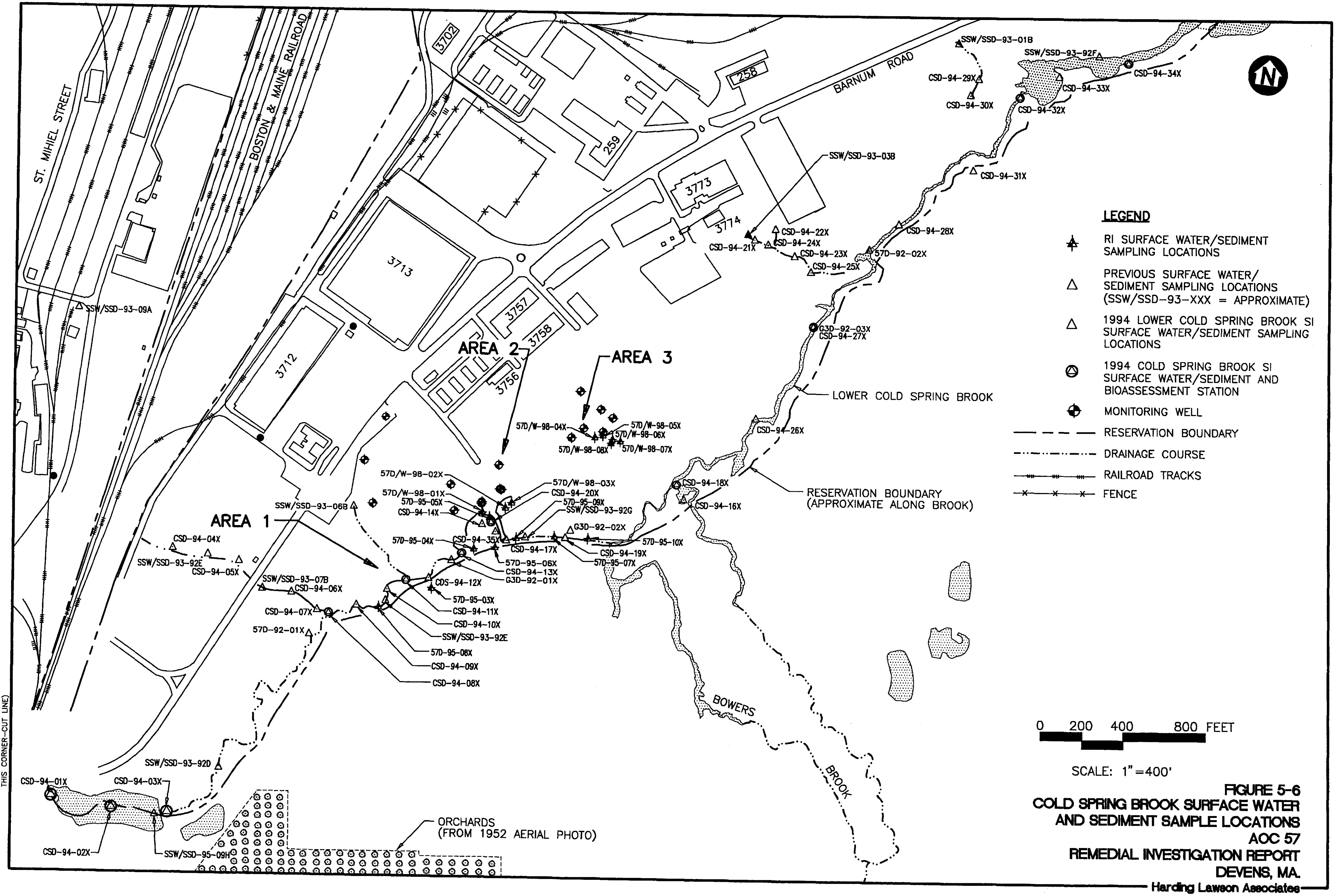

FIGURE 5-6
COLD SPRING BROOK SURFACE WATER
AND SEDIMENT SAMPLE LOCATIONS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA.

Harding Lawson Associates

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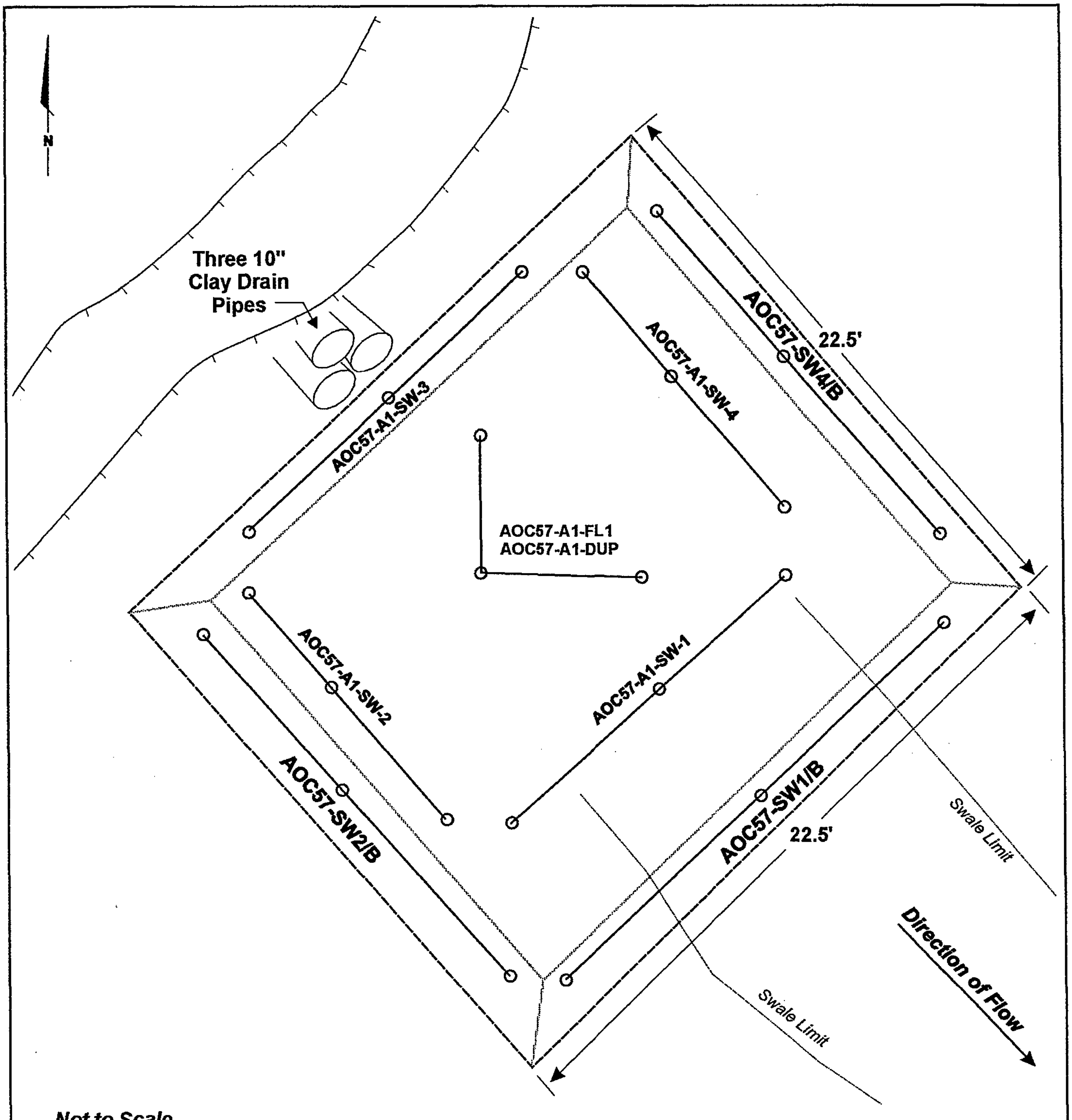
THIS CORNER-CUT LINE)



Not to Scale

Legend

------- Limits of Excavation

—┬— Contour Interval 10 Ft.

○—○ Composite Soil Sample Locations

Base Map Source: Contaminated Soil Removal, Removal Action Report, AOC 57 Area 1, Weston, July 1998. Maps dated Feb. 13, 1997, and March 17, 1997.

FIGURE 5-7
AREA1 SOIL REMOVAL SAMPLE LOCATIONS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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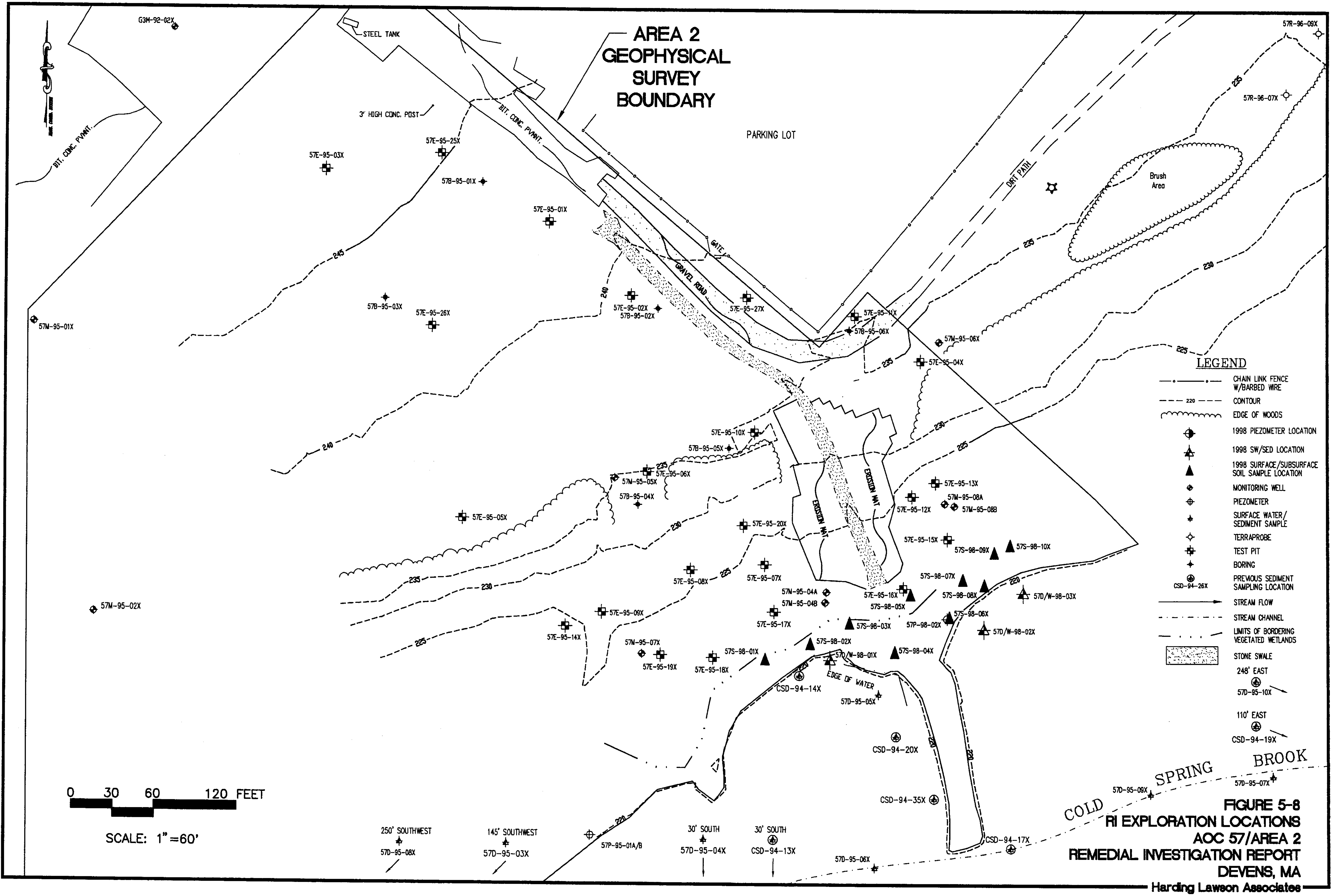

LEGEND

—∘—	CHAIN LINK FENCE W/BARBED WIRE
— — 220 — —	CONTOUR
⌒⌒⌒	EDGE OF WOODS
⊕	1998 PIEZOMETER LOCATION
⚠	1998 SW/SED LOCATION
▲	1998 SURFACE/SUBSURFACE SOIL SAMPLE LOCATION
◈	MONITORING WELL
⌖	PIEZOMETER
✦	SURFACE WATER/ SEDIMENT SAMPLE
✧	TERRAPROBE
⊞	TEST PIT
✦	BORING
⊛ CSD-94-26X	PREVIOUS SEDIMENT SAMPLING LOCATION
——→	STREAM FLOW
—·—·—	STREAM CHANNEL
— · · —	LIMITS OF BORDERING VEGETATED WETLANDS
▨	STONE SWALE
248' EAST ⊛ 57D-95-10X ↘	
110' EAST ⊛ CSD-94-19X ↘	

FIGURE 5-8
RI EXPLORATION LOCATIONS
AOC 57/AREA 2
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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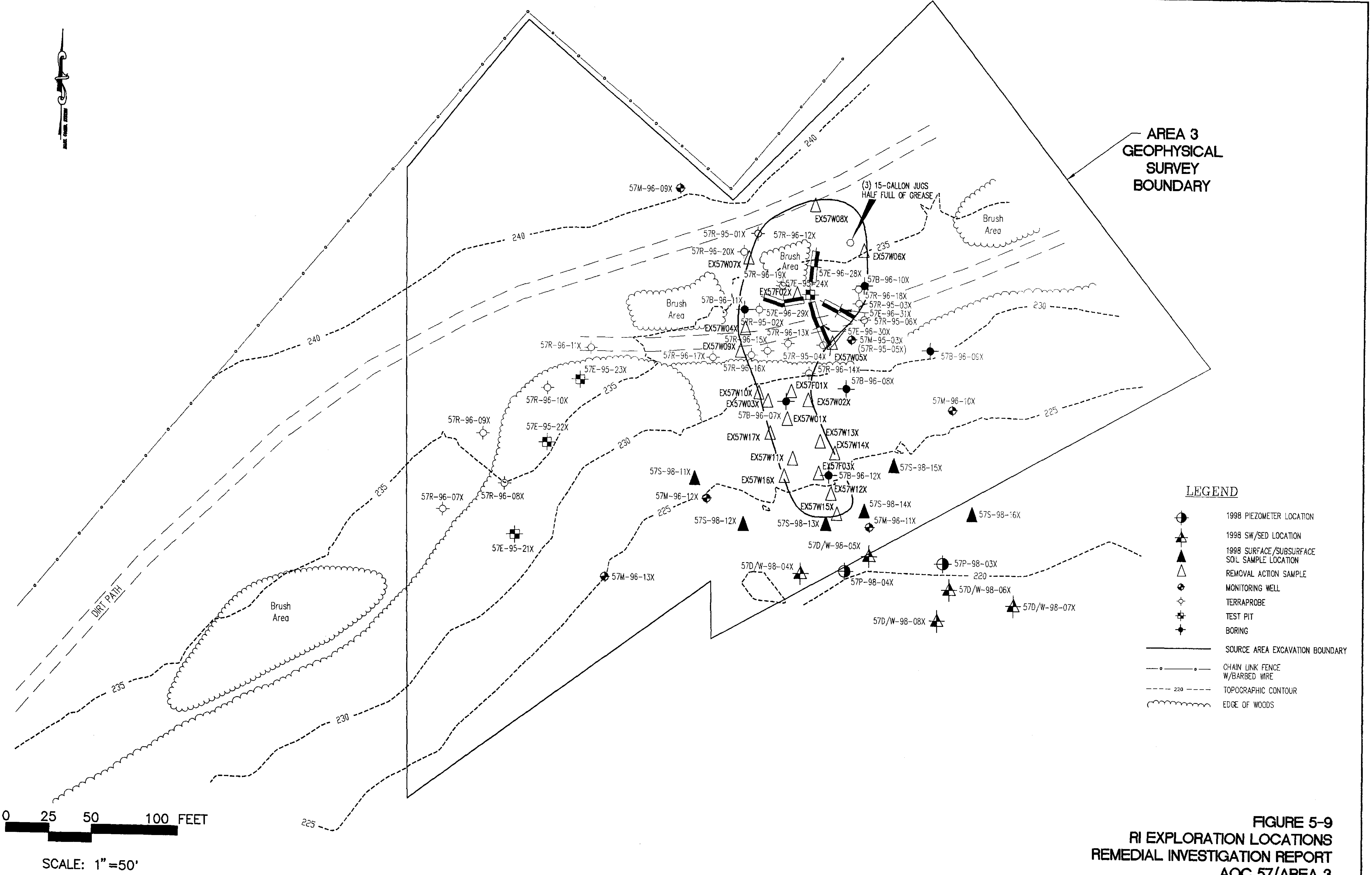

FIGURE 5-9
RI EXPLORATION LOCATIONS
REMEDIAL INVESTIGATION REPORT
AOC 57/AREA 3
DEVENS, MA

Harding Lawson Associates

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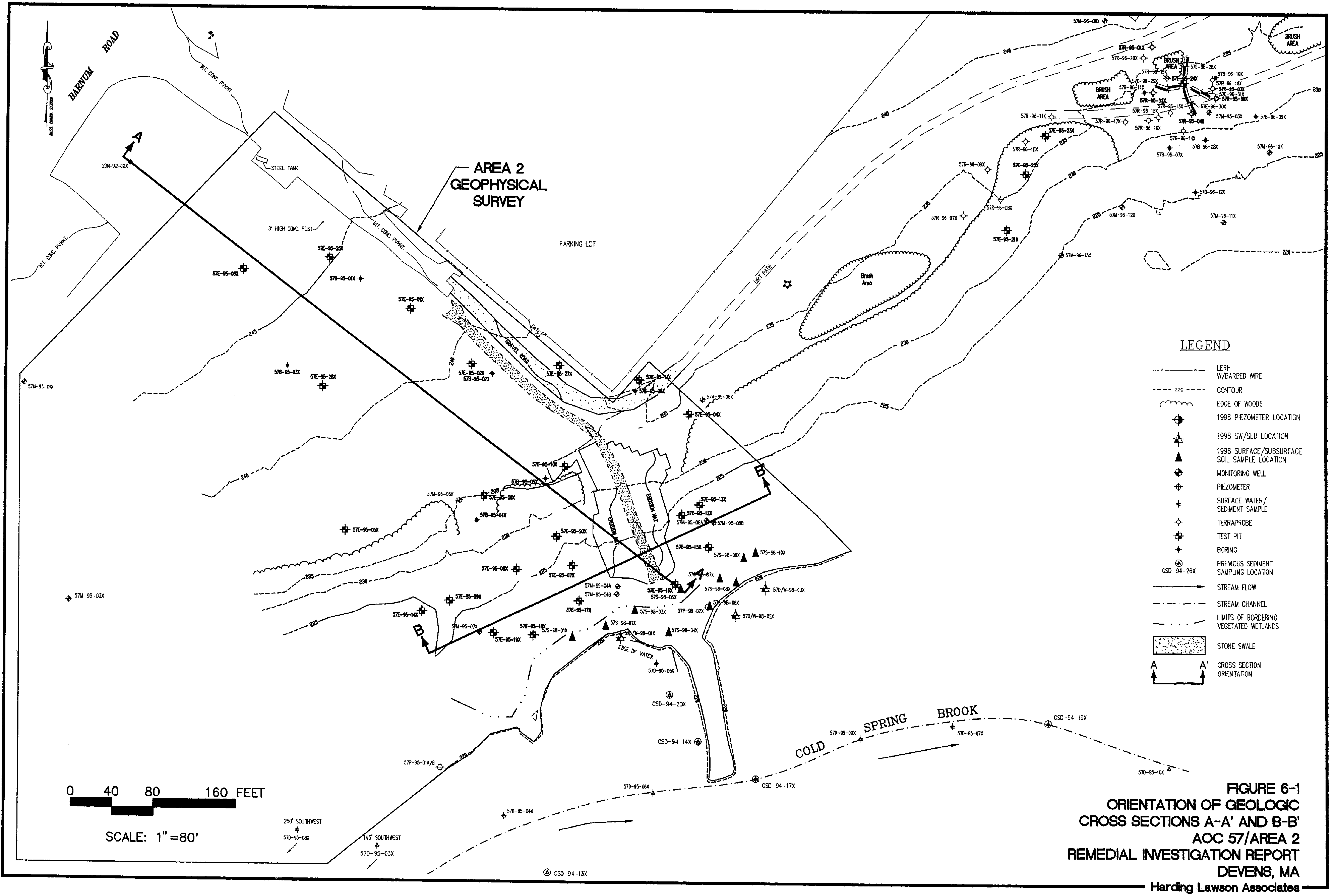

FIGURE 6-1
ORIENTATION OF GEOLOGIC
CROSS SECTIONS A-A' AND B-B'
AOC 57/AREA 2
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

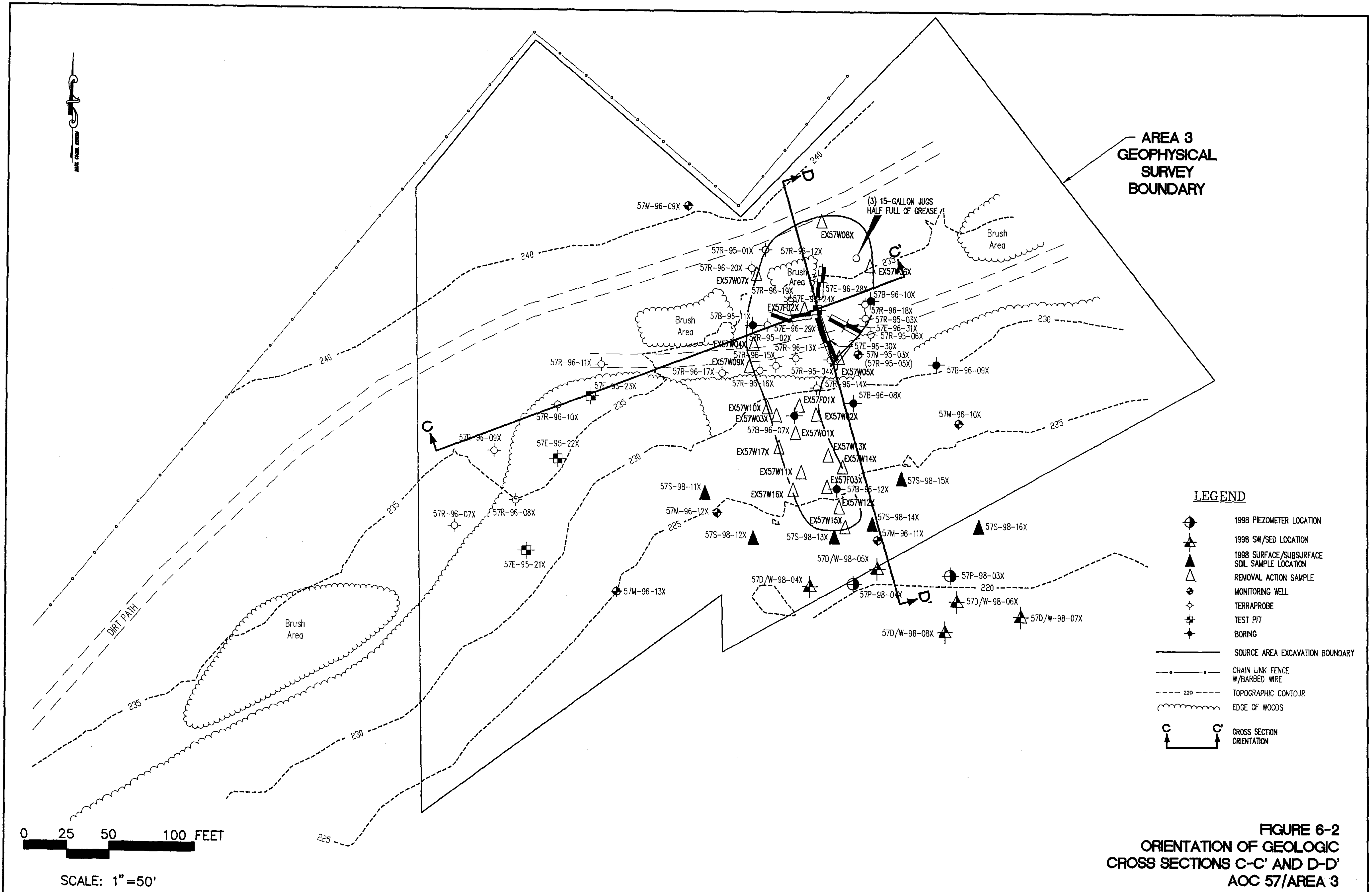

FIGURE 6-2
ORIENTATION OF GEOLOGIC CROSS SECTIONS C-C' AND D-D'
AOC 57/AREA 3
DEVENS, MA

Harding Lawson Associates

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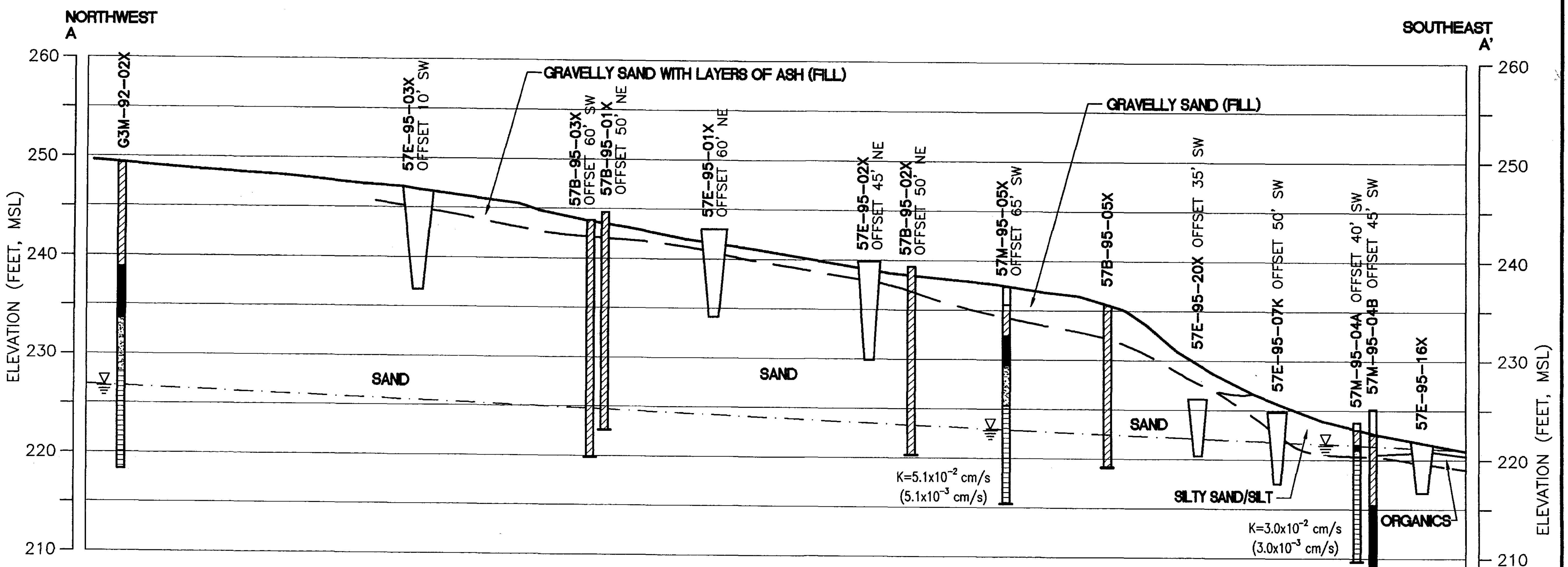

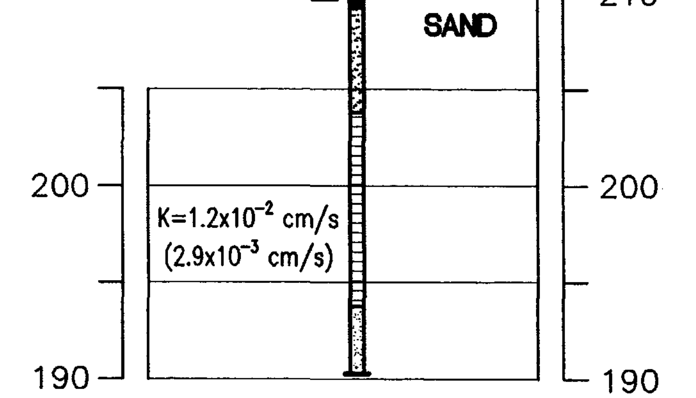

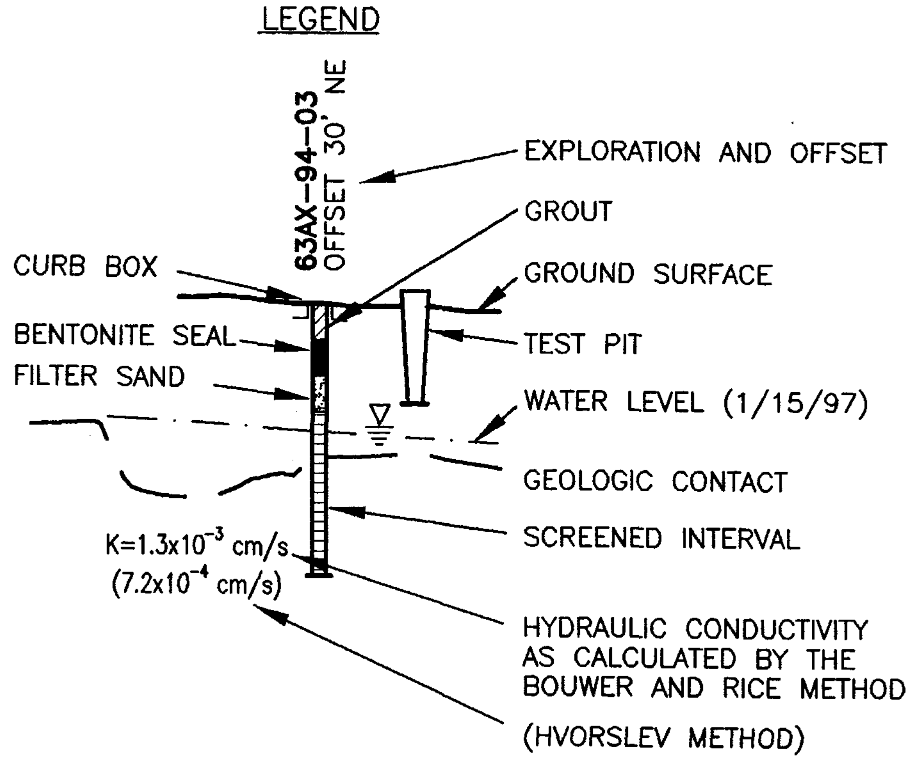

CROSS SECTION A - A'

NOTES:

1. FOR ORIENTATION OF CROSS SECTION, SEE FIGURE 6-1.
2. GEOLOGIC CONDITIONS BETWEEN EXPLORATIONS ARE AN INTERPRETATION OF AVAILABLE DATA. ACTUAL CONDITIONS MAY VARY.
3. MSL = MEAN SEA LEVEL

HORIZONTAL SCALE: 1"=50'
VERTICAL SCALE: 1"=10'
VERTICAL EXAGGERATION: 5:1

FIGURE 6-3
INTERPRETIVE GEOLOGIC CROSS SECTION A-A'
AOC 57/AREA 2
REMEDIAL INVESTIGATION REPORT
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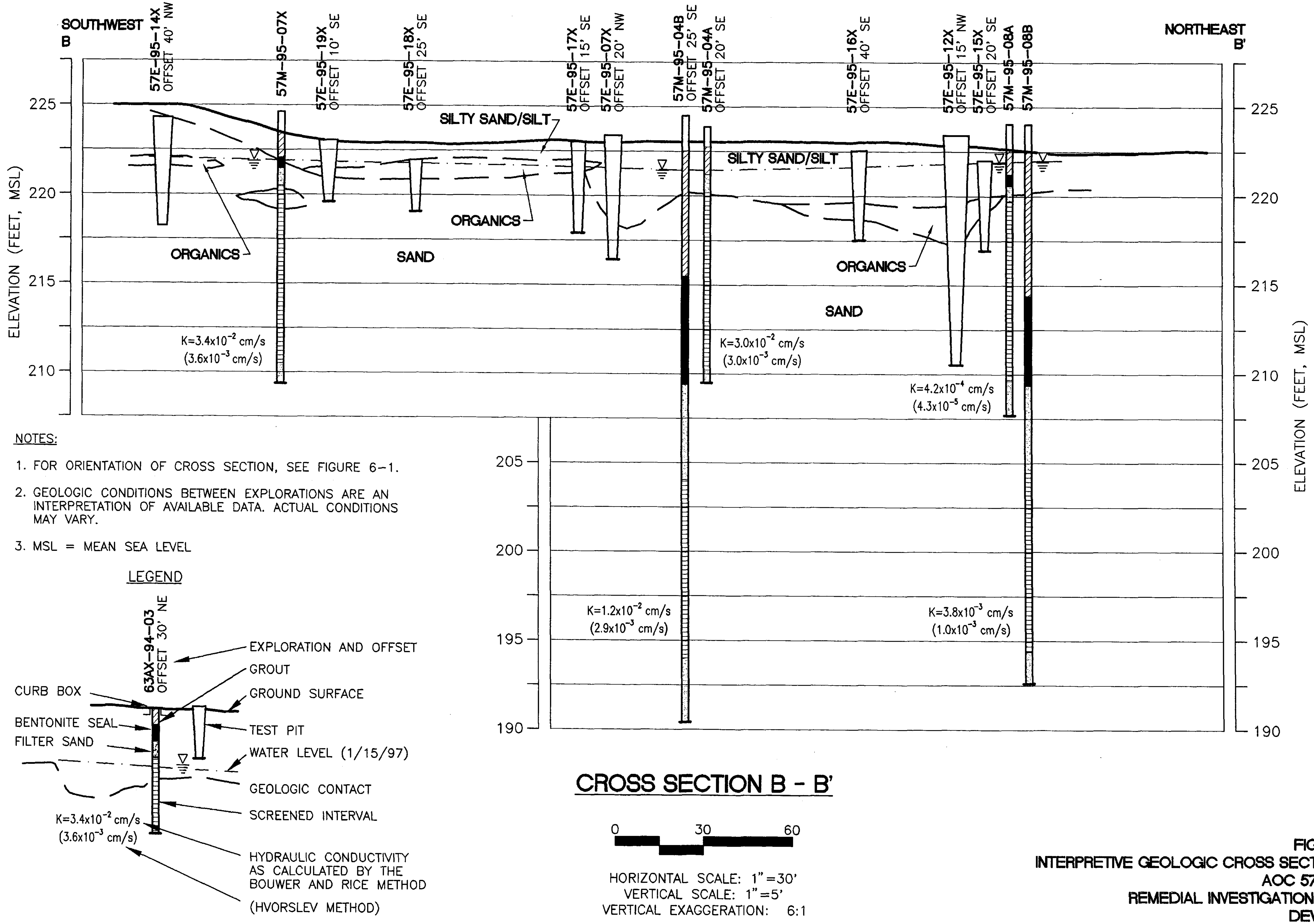

NOTES:

1. FOR ORIENTATION OF CROSS SECTION, SEE FIGURE 6-1.
2. GEOLOGIC CONDITIONS BETWEEN EXPLORATIONS ARE AN INTERPRETATION OF AVAILABLE DATA. ACTUAL CONDITIONS MAY VARY.
3. MSL = MEAN SEA LEVEL

LEGEND

CROSS SECTION B - B'

HORIZONTAL SCALE: 1"=30'
VERTICAL SCALE: 1"=5'
VERTICAL EXAGGERATION: 6:1

FIGURE 6-4
INTERPRETIVE GEOLOGIC CROSS SECTION B-B'
AOC 57/AREA 2
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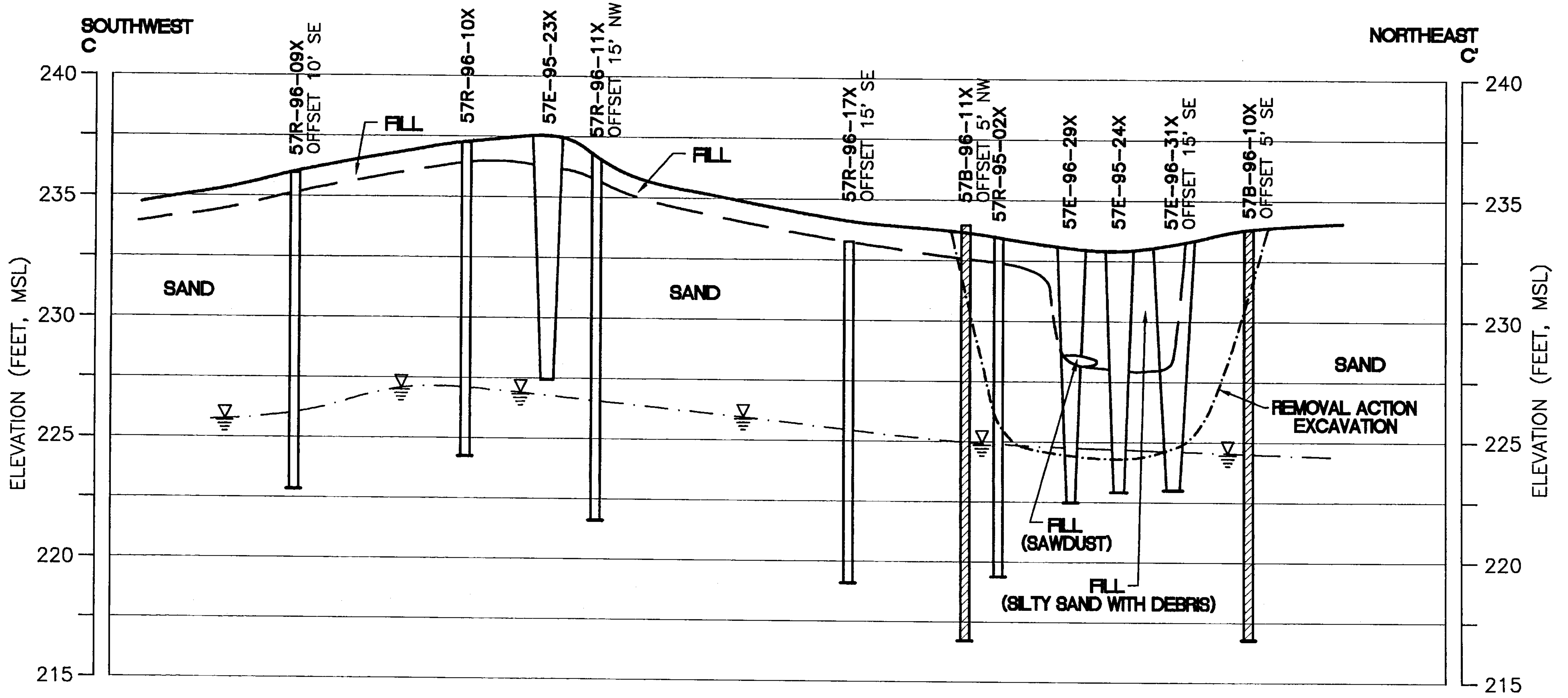
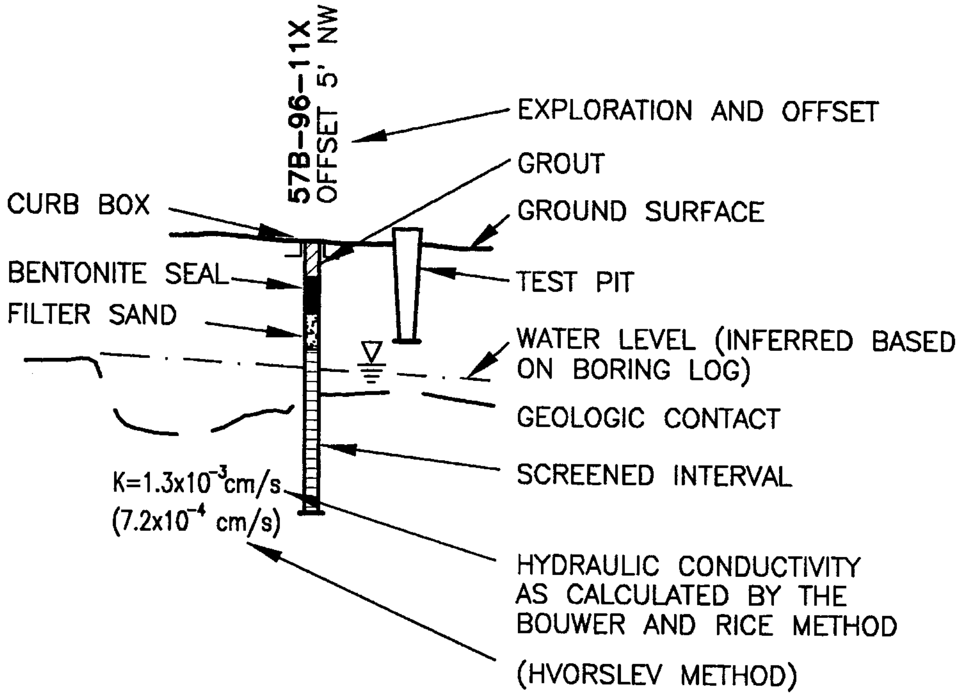


CROSS SECTION C - C'

LEGEND



NOTES:

1. FOR ORIENTATION OF CROSS SECTION, SEE FIGURE 6-2.
2. GEOLOGIC CONDITIONS BETWEEN EXPLORATIONS ARE AN INTERPRETATION OF AVAILABLE DATA. ACTUAL CONDITIONS MAY VARY.
3. MSL = MEAN SEA LEVEL

HORIZONTAL SCALE: 1"=30'
VERTICAL SCALE: 1"=5'
VERTICAL EXAGGERATION: 6:1

FIGURE 6-5
INTERPRETIVE GEOLOGIC CROSS SECTION C-C'
AOC 57/AREA 3
REMEDIAL INVESTIGATION REPORT
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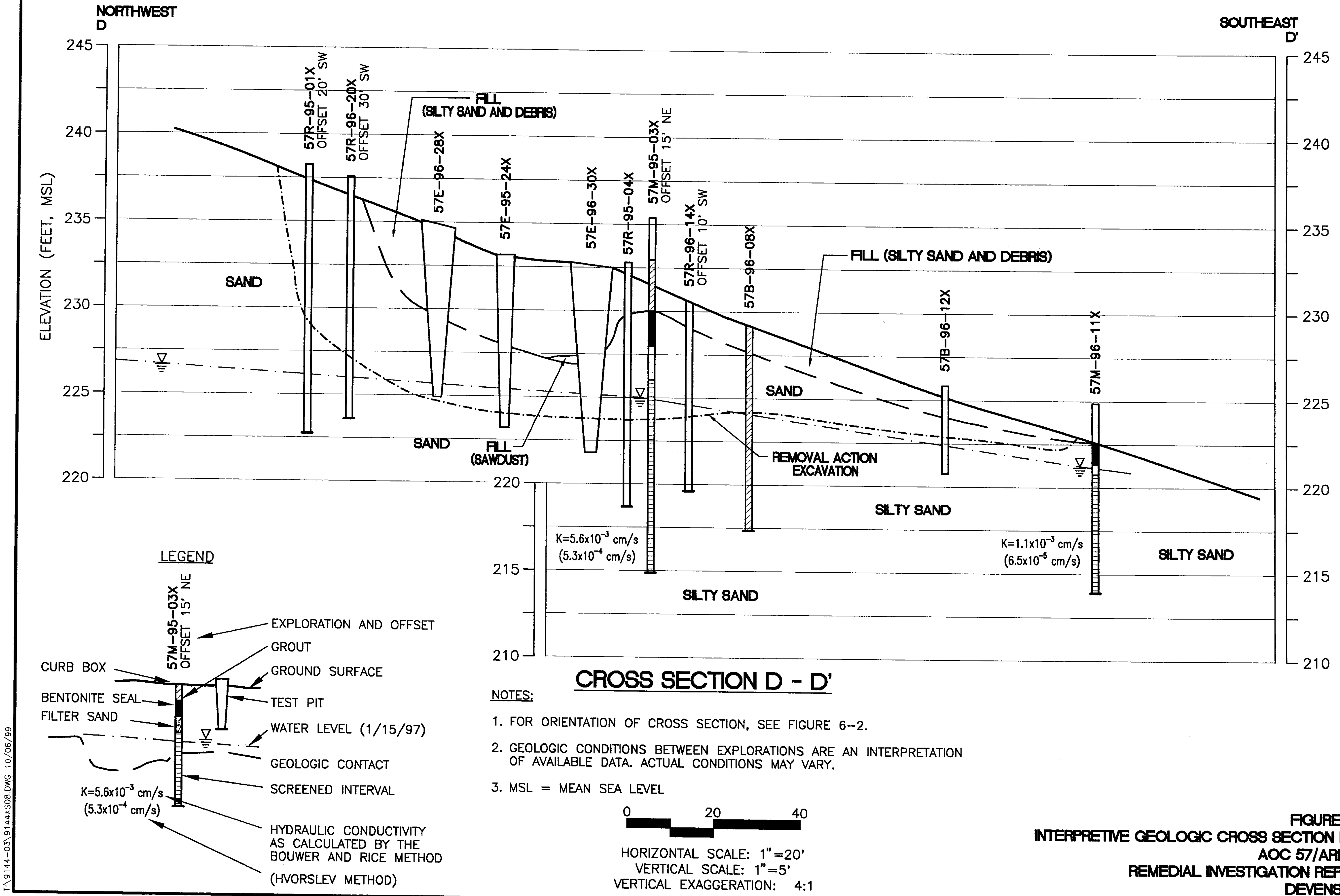

CROSS SECTION D - D'

NOTES:

1. FOR ORIENTATION OF CROSS SECTION, SEE FIGURE 6-2.
2. GEOLOGIC CONDITIONS BETWEEN EXPLORATIONS ARE AN INTERPRETATION OF AVAILABLE DATA. ACTUAL CONDITIONS MAY VARY.
3. MSL = MEAN SEA LEVEL

HORIZONTAL SCALE: 1"=20'
VERTICAL SCALE: 1"=5'
VERTICAL EXAGGERATION: 4:1

FIGURE 6-6
INTERPRETIVE GEOLOGIC CROSS SECTION D-D'
AOC 57/AREA 3
REMEDIAL INVESTIGATION REPORT
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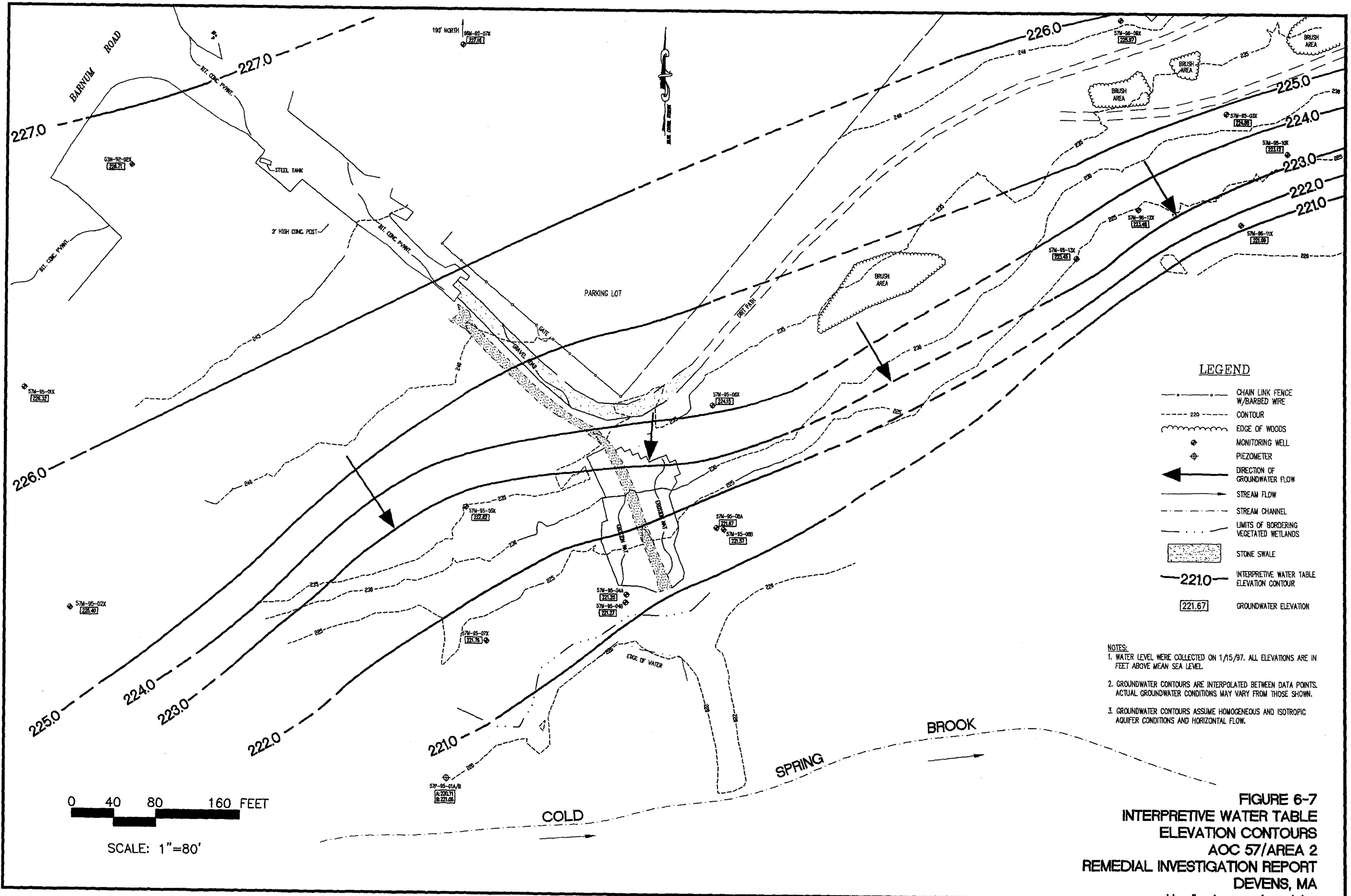

NOTES:

1. WATER LEVEL WERE COLLECTED ON 1/15/97. ALL ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.
2. GROUNDWATER CONTOURS ARE INTERPOLATED BETWEEN DATA POINTS. ACTUAL GROUNDWATER CONDITIONS MAY VARY FROM THOSE SHOWN.
3. GROUNDWATER CONTOURS ASSUME HOMOGENEOUS AND ISOTROPIC AQUIFER CONDITIONS AND HORIZONTAL FLOW.

FIGURE 6-7
INTERPRETIVE WATER TABLE
ELEVATION CONTOURS
AOC 57/AREA 2
REMEDIAL INVESTIGATION REPORT
DEVENS, MA
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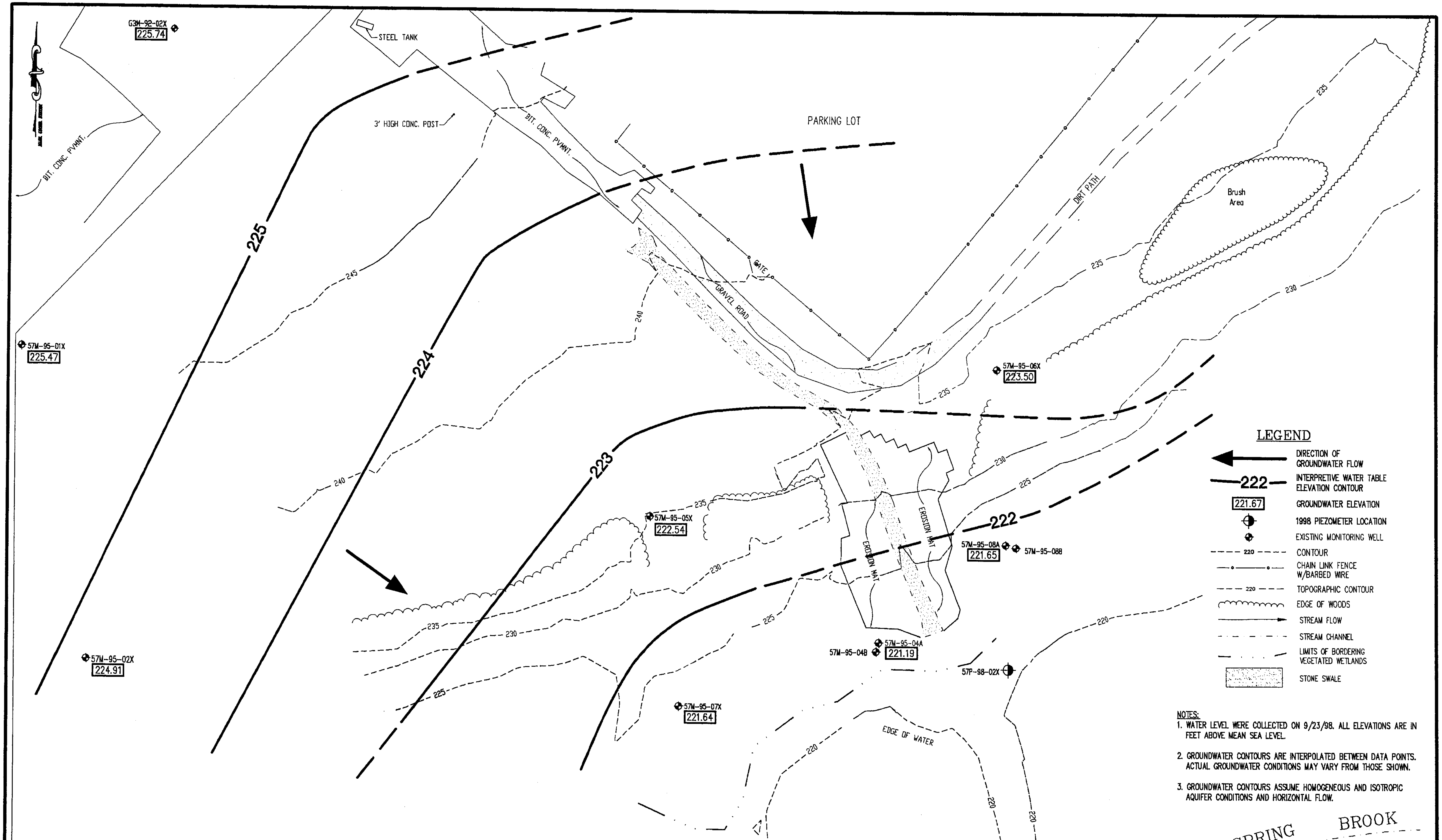

NOTES:
1. WATER LEVEL WERE COLLECTED ON 9/23/98. ALL ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.
2. GROUNDWATER CONTOURS ARE INTERPOLATED BETWEEN DATA POINTS. ACTUAL GROUNDWATER CONDITIONS MAY VARY FROM THOSE SHOWN.
3. GROUNDWATER CONTOURS ASSUME HOMOGENEOUS AND ISOTROPIC AQUIFER CONDITIONS AND HORIZONTAL FLOW.

FIGURE 6-8
INTERPRETIVE WATER TABLE
ELEVATION CONTOURS
AOC 57/AREA 2
REMEDIAL INVESTIGATION REPORT
DEVENS, MA
Harding Lawson Associates

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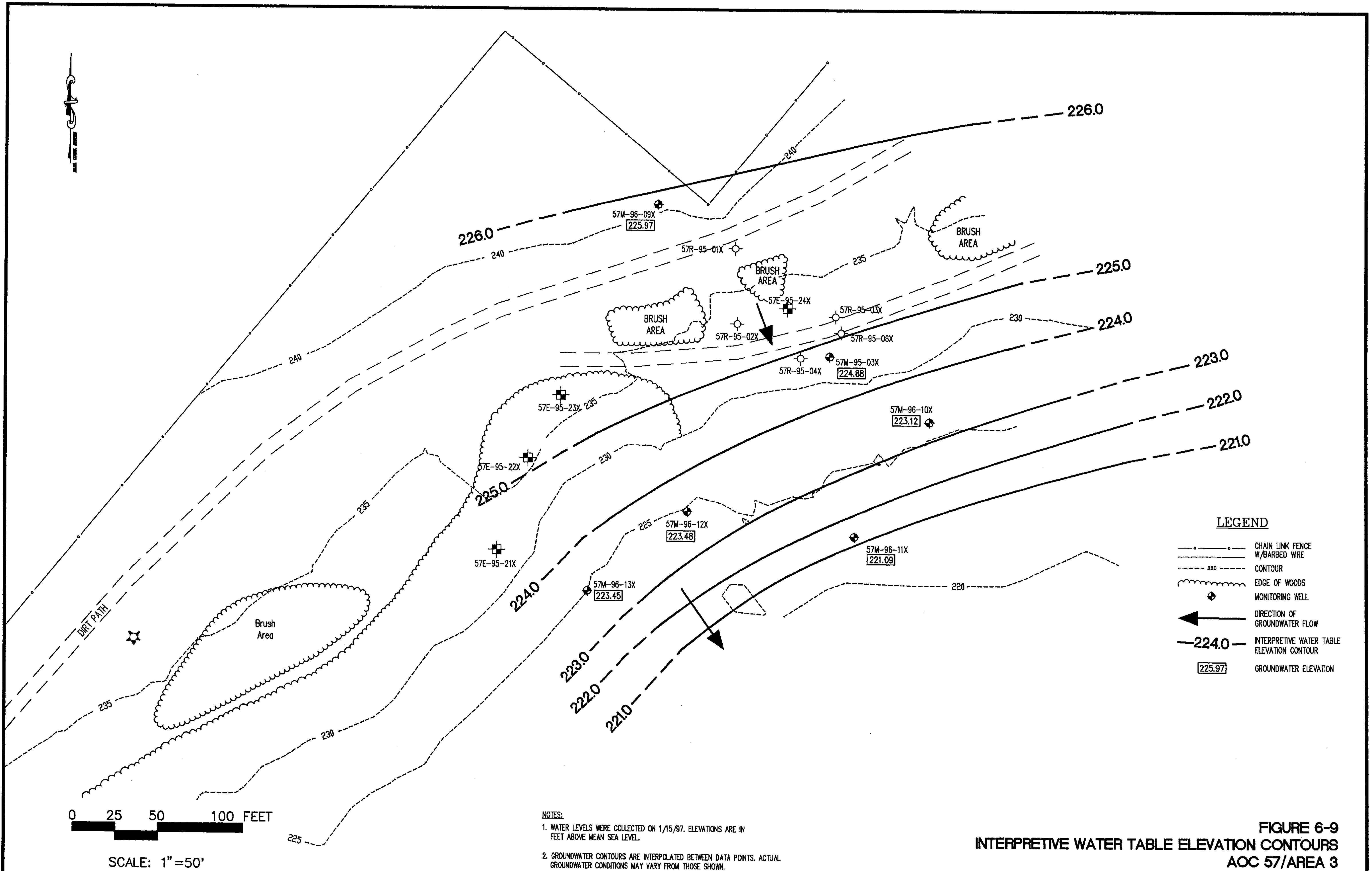

NOTES:

1. WATER LEVELS WERE COLLECTED ON 1/15/97. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.
2. GROUNDWATER CONTOURS ARE INTERPOLATED BETWEEN DATA POINTS. ACTUAL GROUNDWATER CONDITIONS MAY VARY FROM THOSE SHOWN.
3. GROUNDWATER CONTOURS ASSUME HOMOGENEOUS AND ISOTROPIC AQUIFER CONDITIONS AND HORIZONTAL FLOW.

FIGURE 6-9
INTERPRETIVE WATER TABLE ELEVATION CONTOURS
AOC 57/AREA 3
REMEDIAL INVESTIGATION REPORT
DEVENS, MA
Harding Lawson Associates

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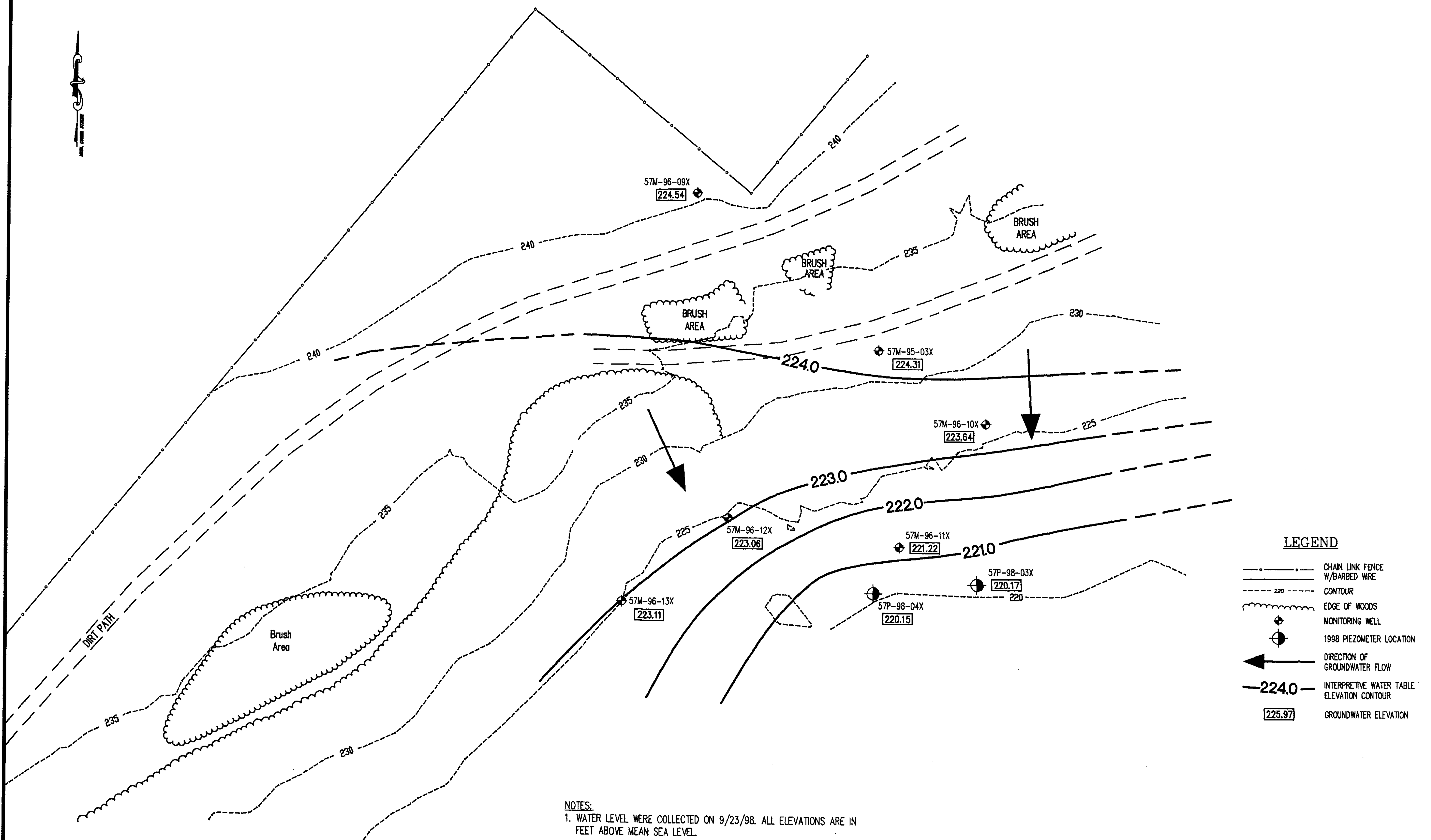

NOTES:

1. WATER LEVEL WERE COLLECTED ON 9/23/98. ALL ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL.
2. GROUNDWATER CONTOURS ARE INTERPOLATED BETWEEN DATA POINTS. ACTUAL GROUNDWATER CONDITIONS MAY VARY FROM THOSE SHOWN.
3. GROUNDWATER CONTOURS ASSUME HOMOGENEOUS AND ISOTROPIC AQUIFER CONDITIONS AND HORIZONTAL FLOW.

FIGURE 6-10
INTERPRETIVE WATER TABLE ELEVATION CONTOURS
AOC 57/AREA 3
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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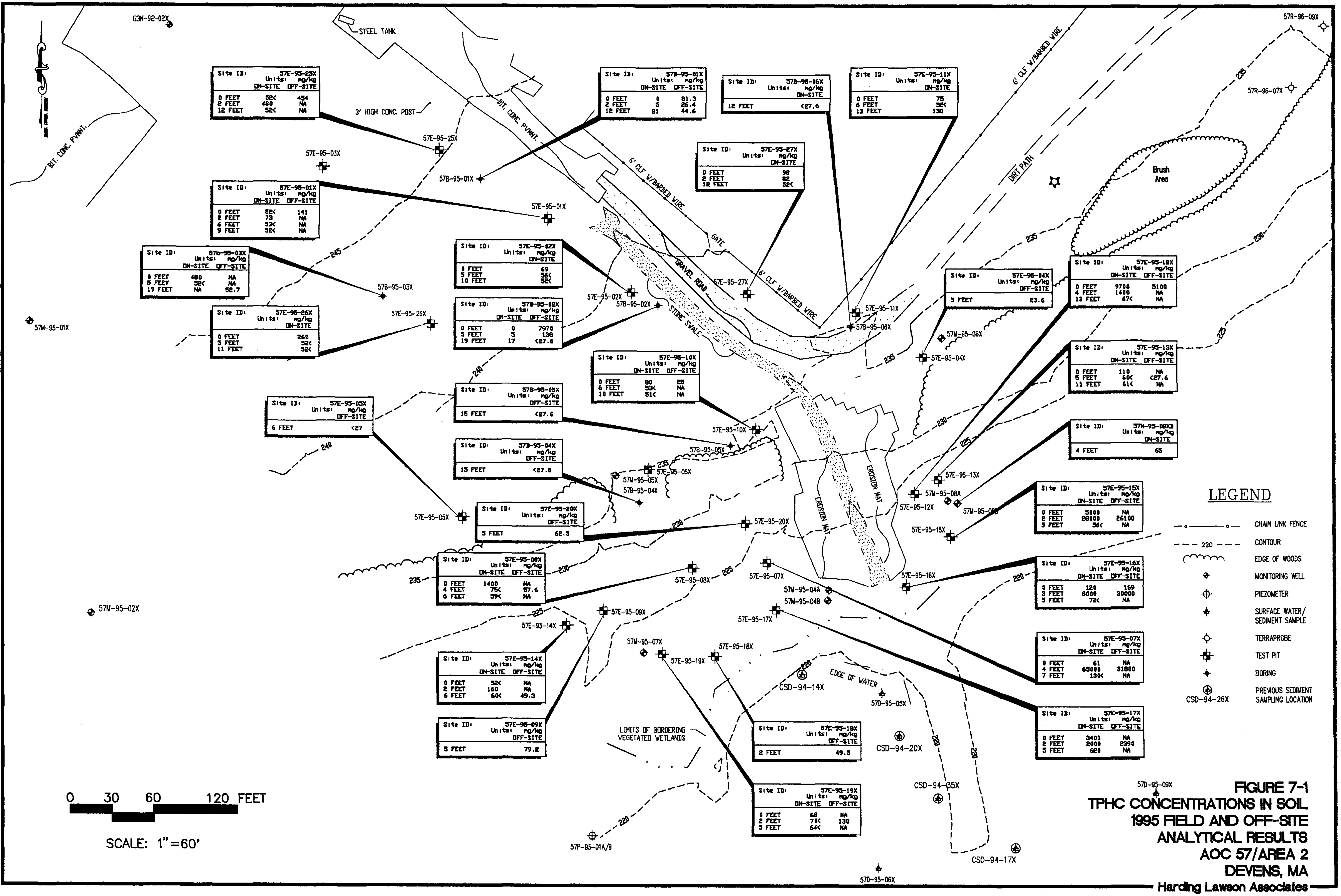

FIGURE 7-1
TPHC CONCENTRATIONS IN SOIL
1995 FIELD AND OFF-SITE
ANALYTICAL RESULTS
AOC 57/AREA 2
DEVENS, MA

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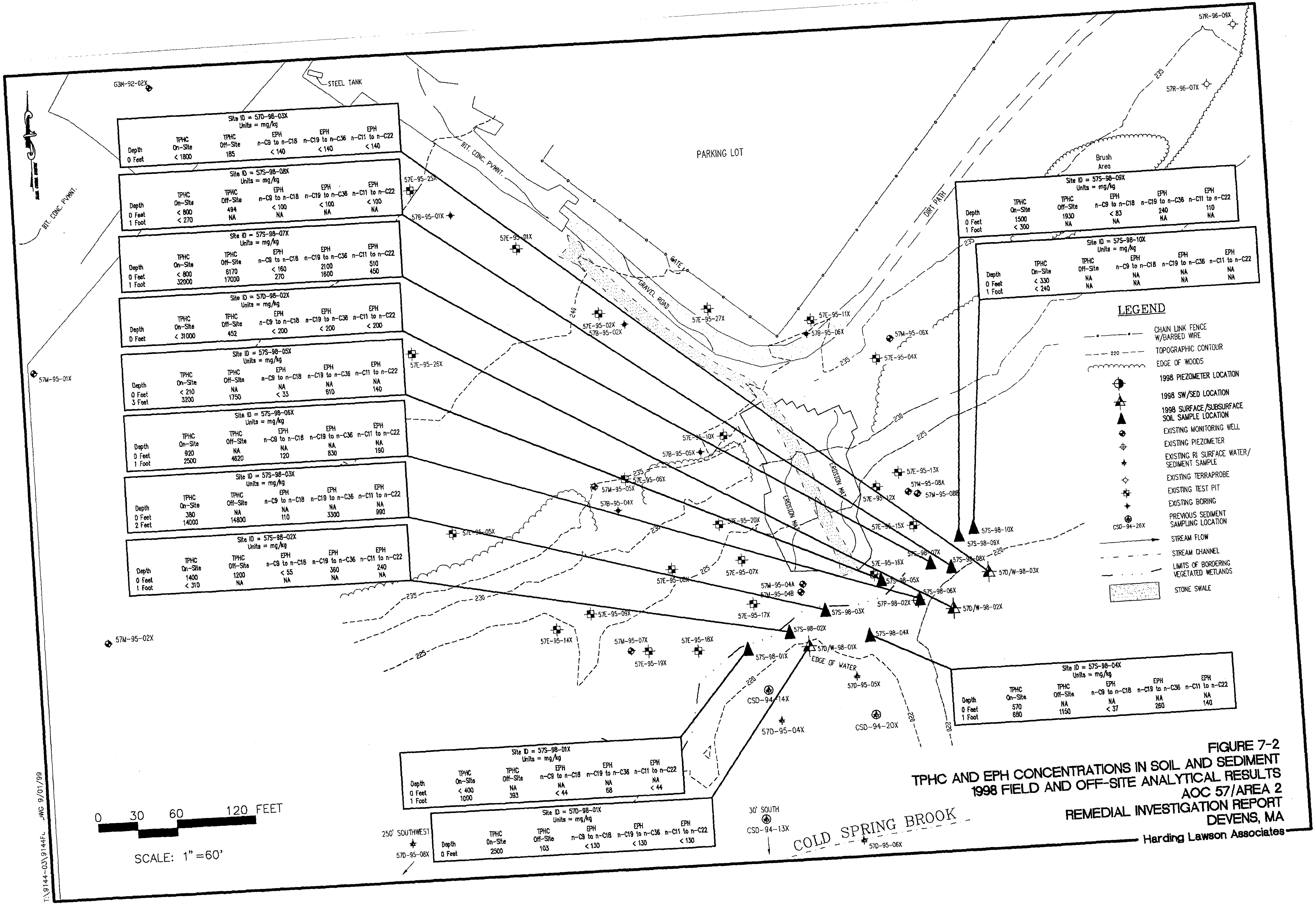

Site ID = 57D-98-03X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	< 1800	185	< 140	< 140	< 140

Site ID = 57S-98-08X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	< 800	494	< 100	< 100	< 100
1 Foot	< 270	NA	NA	NA	NA

Site ID = 57S-98-07X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	< 800	6170	< 160	2100	510
1 Foot	32000	17000	270	1600	450

Site ID = 57D-98-02X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	< 31000	452	< 200	< 200	< 200

Site ID = 57S-98-05X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	< 210	NA	NA	NA	NA
3 Feet	3200	1750	< 33	610	140

Site ID = 57S-98-06X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	920	NA	NA	NA	NA
1 Foot	2500	4620	120	830	190

Site ID = 57S-98-03X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	380	NA	NA	NA	NA
2 Feet	14000	14800	110	3300	990

Site ID = 57S-98-02X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	1400	1200	< 55	360	240
1 Foot	< 310	NA	NA	NA	NA

Site ID = 57S-98-09X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	1500	1930	< 83	240	110
1 Foot	< 300	NA	NA	NA	NA

Site ID = 57S-98-10X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	< 330	NA	NA	NA	NA
1 Foot	< 240	NA	NA	NA	NA

Site ID = 57S-98-04X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	570	NA	NA	NA	NA
1 Foot	680	1150	< 37	260	140

Site ID = 57S-98-01X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	< 400	NA	NA	NA	NA
1 Foot	1000	393	< 44	68	< 44

Site ID = 57D-98-01X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	2500	103	< 130	< 130	< 130

FIGURE 7-2
TPHC AND EPH CONCENTRATIONS IN SOIL AND SEDIMENT
1998 FIELD AND OFF-SITE ANALYTICAL RESULTS
AOC 57/AREA 2
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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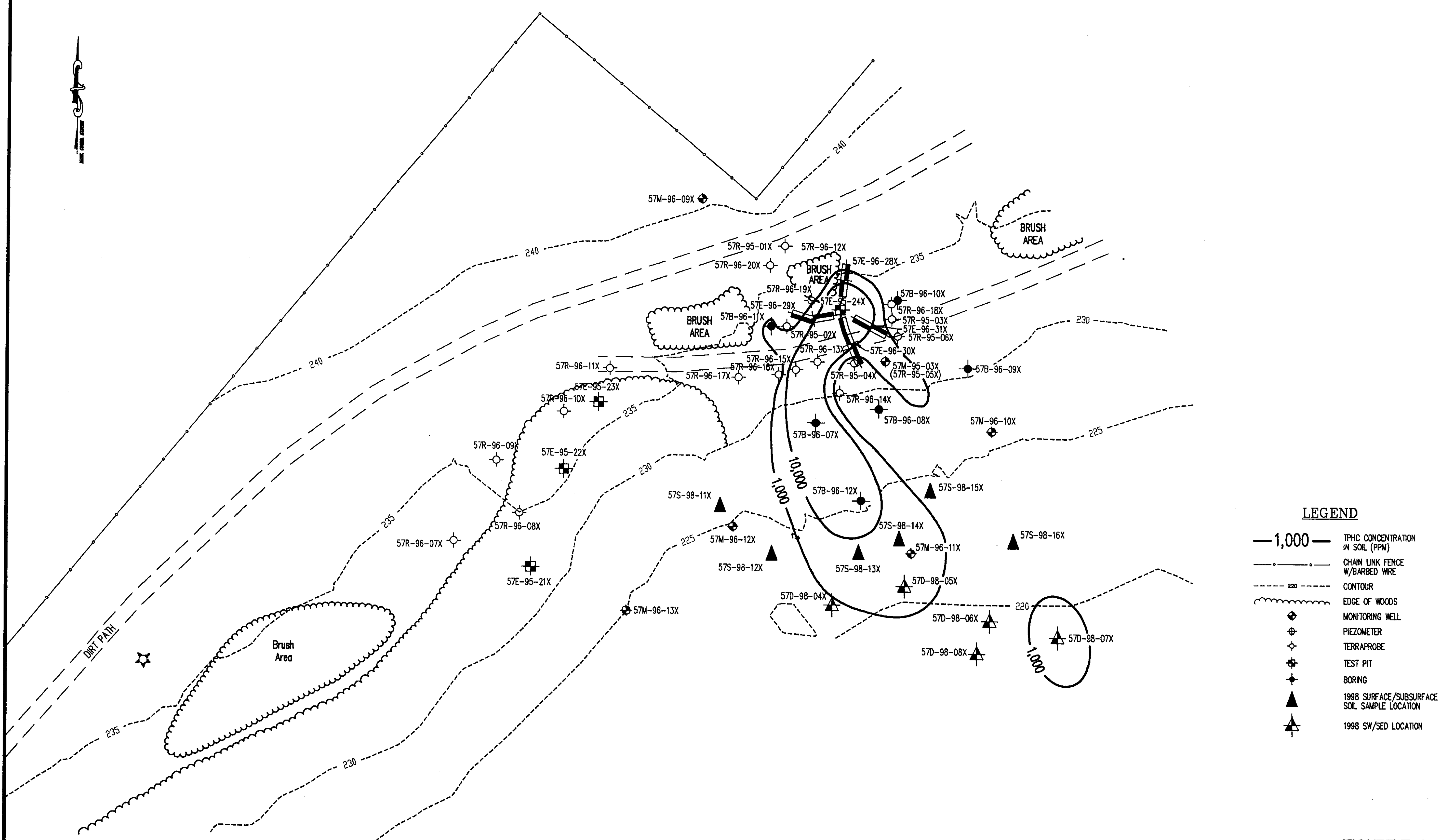

NOTES:

1. CONTOURS ARE BASED ON FIELD ANALYTICAL RESULTS PRESENTED ON TABLES 7-10, 7-11 AND 7-13 OF THE RI TEXT.

FIGURE 7-3
TPHC CONCENTRATIONS IN SURFACE AND SUBSURFACE SOILS (0'-6' BGS)
FIELD ANALYTICAL RESULTS
AOC 57/AREA 3
REMEDIAL INVESTIGATION REPORT
DEVENS, MA
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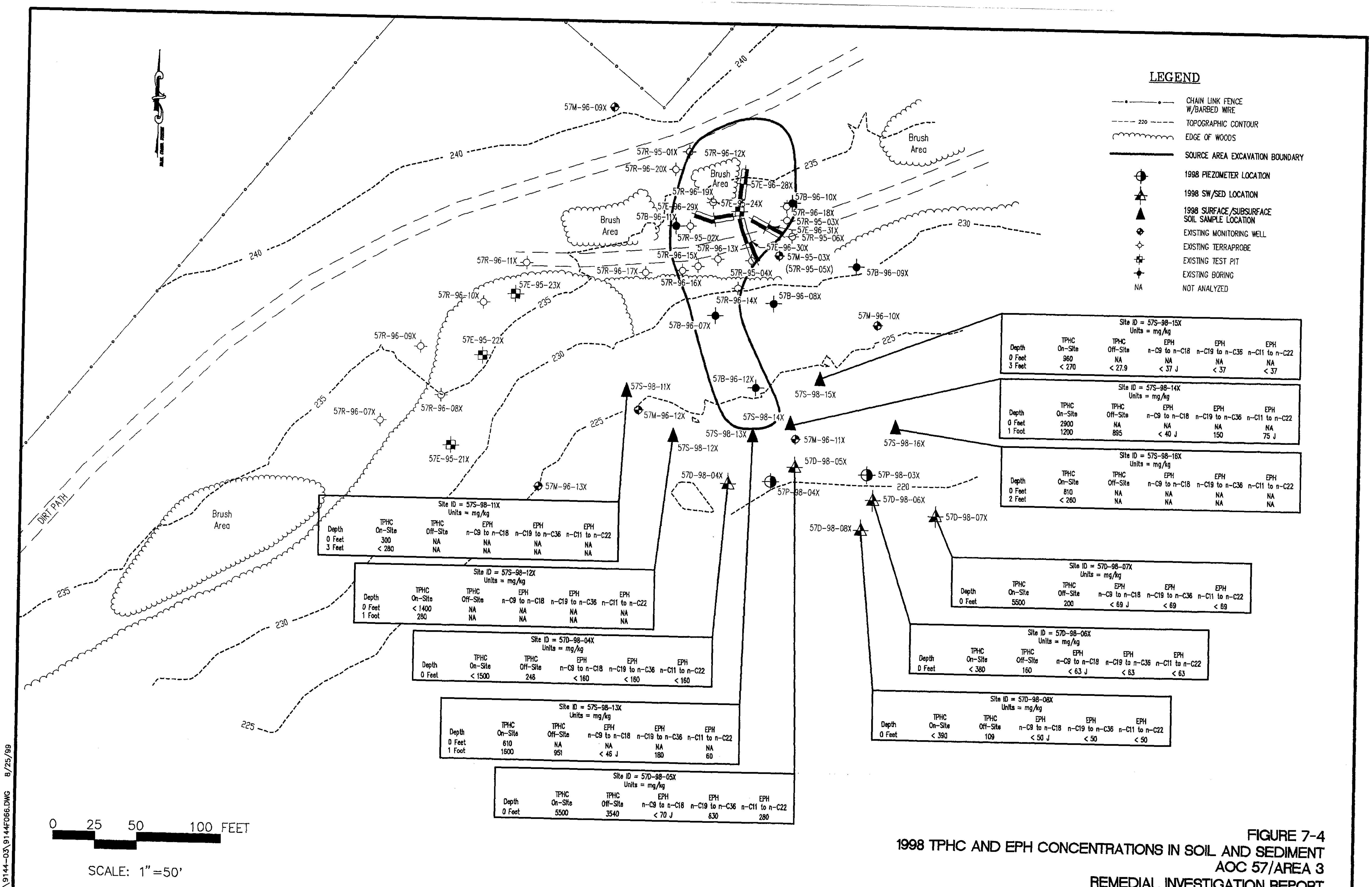

FIGURE 7-4
1998 TPHC AND EPH CONCENTRATIONS IN SOIL AND SEDIMENT
AOC 57/AREA 3
REMEDIAL INVESTIGATION REPORT
DEVENS, MA
Harding Lawson Associates

Site ID = 57S-98-15X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	960	NA	NA	NA	NA
3 Feet	< 270	< 27.9	< 37 J	< 37	< 37

Site ID = 57S-98-14X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	2900	NA	NA	NA	NA
1 Foot	1200	895	< 40 J	150	75 J

Site ID = 57S-98-16X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	810	NA	NA	NA	NA
2 Feet	< 260	NA	NA	NA	NA

Site ID = 57S-98-11X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	300	NA	NA	NA	NA
3 Feet	< 280	NA	NA	NA	NA

Site ID = 57S-98-12X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	< 1400	NA	NA	NA	NA
1 Foot	280	NA	NA	NA	NA

Site ID = 57D-98-04X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	< 1500	248	< 160	< 160	< 160

Site ID = 57S-98-13X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	610	NA	NA	NA	NA
1 Foot	1600	951	< 46 J	180	60

Site ID = 57D-98-05X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	5500	3540	< 70 J	630	280

Site ID = 57D-98-07X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	5500	200	< 69 J	< 69	< 69

Site ID = 57D-98-06X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	< 380	160	< 63 J	< 63	< 63

Site ID = 57D-98-08X
Units = mg/kg

Depth	TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	EPH n-C11 to n-C22
0 Feet	< 390	109	< 50 J	< 50	< 50

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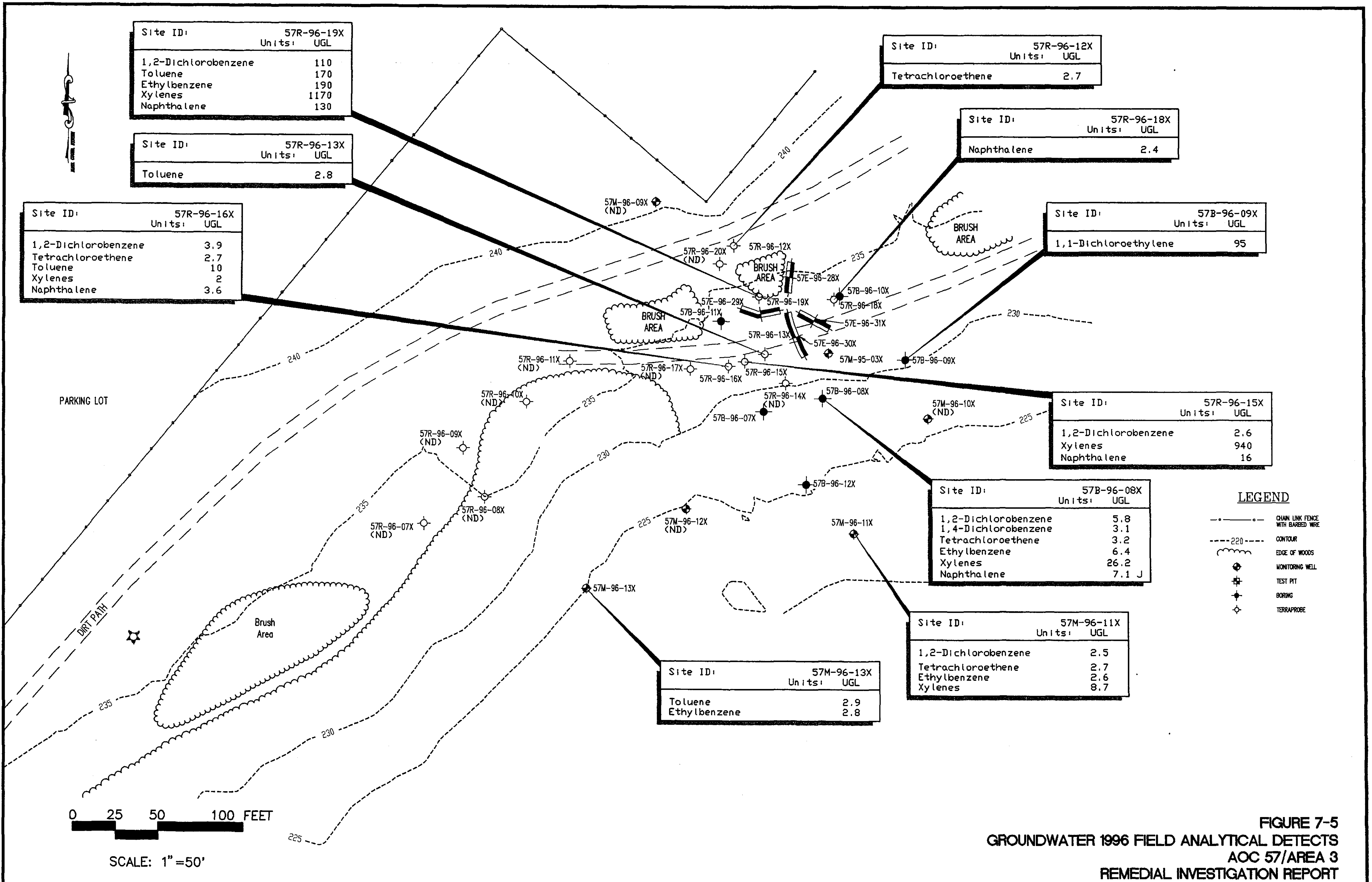

Site ID:	57R-96-19X
Units:	UGL
1,2-Dichlorobenzene	110
Toluene	170
Ethylbenzene	190
Xylenes	1170
Naphthalene	130

Site ID:	57R-96-13X
Units:	UGL
Toluene	2.8

Site ID:	57R-96-16X
Units:	UGL
1,2-Dichlorobenzene	3.9
Tetrachloroethene	2.7
Toluene	10
Xylenes	2
Naphthalene	3.6

Site ID:	57R-96-12X
Units:	UGL
Tetrachloroethene	2.7

Site ID:	57R-96-18X
Units:	UGL
Naphthalene	2.4

Site ID:	57B-96-09X
Units:	UGL
1,1-Dichloroethylene	95

Site ID:	57R-96-15X
Units:	UGL
1,2-Dichlorobenzene	2.6
Xylenes	940
Naphthalene	16

Site ID:	57B-96-08X
Units:	UGL
1,2-Dichlorobenzene	5.8
1,4-Dichlorobenzene	3.1
Tetrachloroethene	3.2
Ethylbenzene	6.4
Xylenes	26.2
Naphthalene	7.1 J

Site ID:	57M-96-11X
Units:	UGL
1,2-Dichlorobenzene	2.5
Tetrachloroethene	2.7
Ethylbenzene	2.6
Xylenes	8.7

Site ID:	57M-96-13X
Units:	UGL
Toluene	2.9
Ethylbenzene	2.8

FIGURE 7-5
GROUNDWATER 1996 FIELD ANALYTICAL DETECTS
AOC 57/AREA 3
REMEDIAL INVESTIGATION REPORT
DEVENS, MA
Harding Lawson Associates

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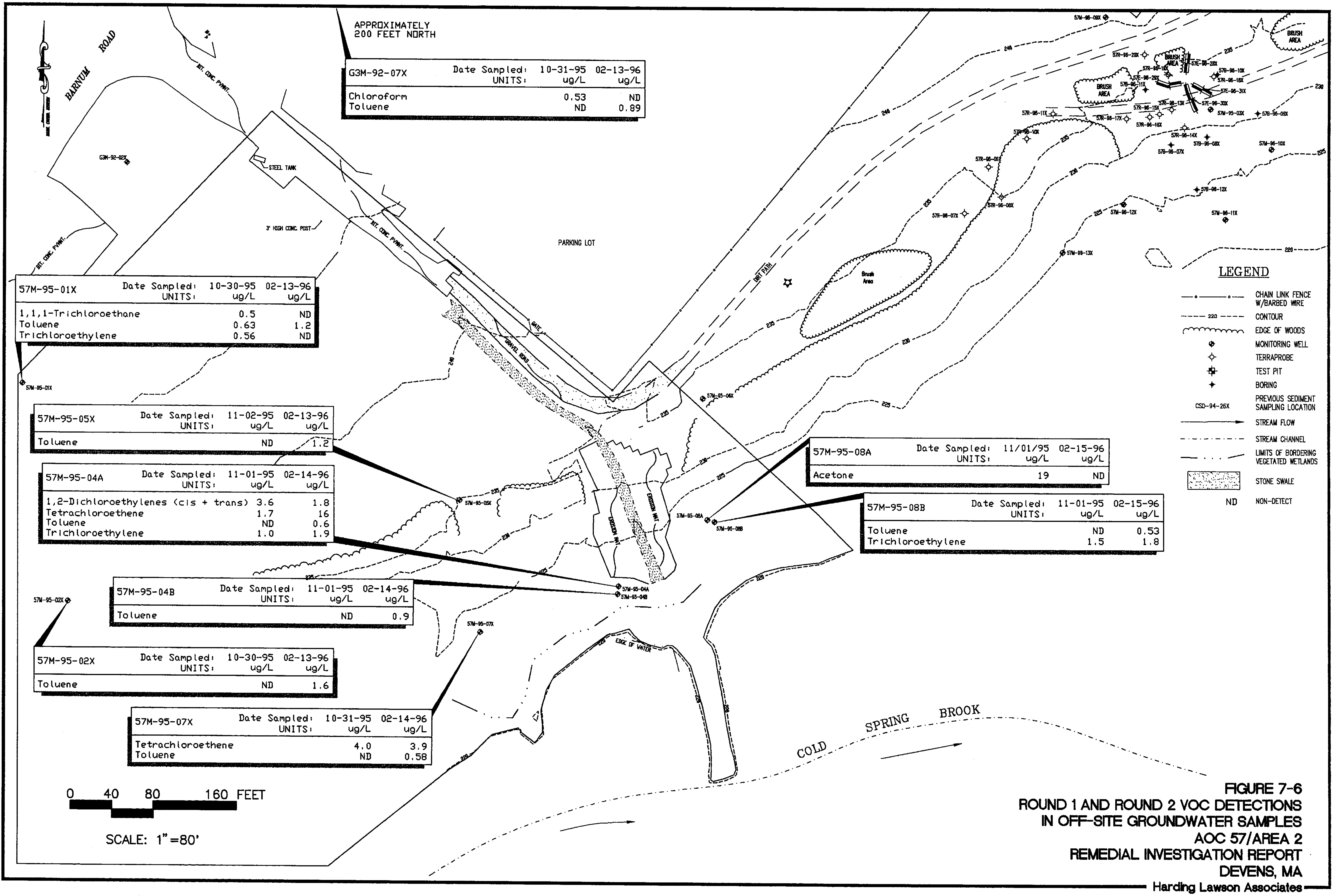

G3M-92-07X	Date Sampled: 10-31-95 UNITS: ug/L	02-13-96 ug/L
Chloroform	0.53	ND
Toluene	ND	0.89

57M-95-01X	Date Sampled: 10-30-95 UNITS: ug/L	02-13-96 ug/L
1,1,1-Trichloroethane	0.5	ND
Toluene	0.63	1.2
Trichloroethylene	0.56	ND

57M-95-05X	Date Sampled: 11-02-95 UNITS: ug/L	02-13-96 ug/L
Toluene	ND	1.2

57M-95-04A	Date Sampled: 11-01-95 UNITS: ug/L	02-14-96 ug/L
1,2-Dichloroethylenes (cis + trans)	3.6	1.8
Tetrachloroethene	1.7	16
Toluene	ND	0.6
Trichloroethylene	1.0	1.9

57M-95-04B	Date Sampled: 11-01-95 UNITS: ug/L	02-14-96 ug/L
Toluene	ND	0.9

57M-95-02X	Date Sampled: 10-30-95 UNITS: ug/L	02-13-96 ug/L
Toluene	ND	1.6

57M-95-07X	Date Sampled: 10-31-95 UNITS: ug/L	02-14-96 ug/L
Tetrachloroethene	4.0	3.9
Toluene	ND	0.58

57M-95-08A	Date Sampled: 11/01/95 UNITS: ug/L	02-15-96 ug/L
Acetone	19	ND

57M-95-08B	Date Sampled: 11-01-95 UNITS: ug/L	02-15-96 ug/L
Toluene	ND	0.53
Trichloroethylene	1.5	1.8

FIGURE 7-6
ROUND 1 AND ROUND 2 VOC DETECTIONS
IN OFF-SITE GROUNDWATER SAMPLES
AOC 57/AREA 2
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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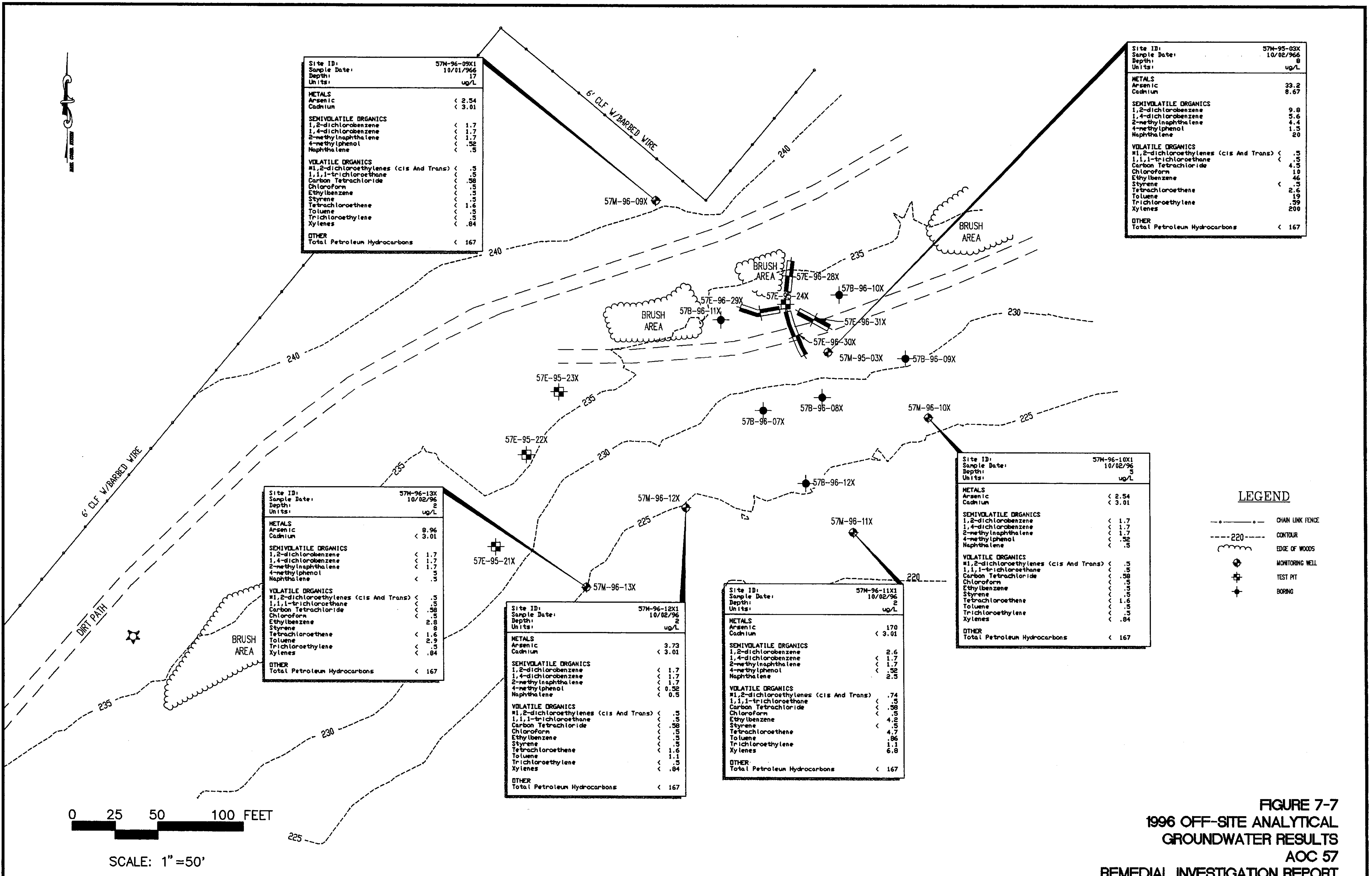


Site ID:	57M-96-09X1
Sample Date:	10/01/966
Depth:	17
Units:	ug/L
METALS	
Arsenic	< 2.54
Cadmium	< 3.01
SEMIVOLATILE ORGANICS	
1,2-dichlorobenzene	< 1.7
1,4-dichlorobenzene	< 1.7
2-methylnaphthalene	< 1.7
4-methylphenol	< .52
Naphthalene	< .5
VOLATILE ORGANICS	
*1,2-dichloroethylenes (cis And Trans)	< .5
1,1,1-trichloroethane	< .5
Carbon Tetrachloride	< .58
Chloroform	< .5
Ethylbenzene	< .5
Styrene	< .5
Tetrachloroethene	< 1.6
Toluene	< .5
Trichloroethylene	< .5
Xylenes	< .84
OTHER	
Total Petroleum Hydrocarbons	< 167

Site ID:	57M-96-13X
Sample Date:	10/02/96
Depth:	2
Units:	ug/L
METALS	
Arsenic	8.96
Cadmium	< 3.01
SEMIVOLATILE ORGANICS	
1,2-dichlorobenzene	< 1.7
1,4-dichlorobenzene	< 1.7
2-methylnaphthalene	< 1.7
4-methylphenol	5
Naphthalene	< .5
VOLATILE ORGANICS	
*1,2-dichloroethylenes (cis And Trans)	< .5
1,1,1-trichloroethane	< .5
Carbon Tetrachloride	< .58
Chloroform	< .5
Ethylbenzene	2.8
Styrene	8
Tetrachloroethene	< 1.6
Toluene	2.9
Trichloroethylene	< .5
Xylenes	< .84
OTHER	
Total Petroleum Hydrocarbons	< 167

Site ID:	57M-96-12X1
Sample Date:	10/02/96
Depth:	2
Units:	ug/L
METALS	
Arsenic	3.73
Cadmium	< 3.01
SEMIVOLATILE ORGANICS	
1,2-dichlorobenzene	< 1.7
1,4-dichlorobenzene	< 1.7
2-methylnaphthalene	< 1.7
4-methylphenol	< 0.52
Naphthalene	< 0.5
VOLATILE ORGANICS	
*1,2-dichloroethylenes (cis And Trans)	< .5
1,1,1-trichloroethane	< .5
Carbon Tetrachloride	< .58
Chloroform	< .5
Ethylbenzene	< .5
Styrene	< .5
Tetrachloroethene	< 1.6
Toluene	1.1
Trichloroethylene	< .5
Xylenes	< .84
OTHER	
Total Petroleum Hydrocarbons	< 167

Site ID:	57M-96-11X1
Sample Date:	10/02/96
Depth:	2
Units:	ug/L
METALS	
Arsenic	170
Cadmium	< 3.01
SEMIVOLATILE ORGANICS	
1,2-dichlorobenzene	2.6
1,4-dichlorobenzene	< 1.7
2-methylnaphthalene	< 1.7
4-methylphenol	< .52
Naphthalene	2.5
VOLATILE ORGANICS	
*1,2-dichloroethylenes (cis And Trans)	.74
1,1,1-trichloroethane	< .5
Carbon Tetrachloride	< .58
Chloroform	< .5
Ethylbenzene	4.2
Styrene	< .5
Tetrachloroethene	4.7
Toluene	.86
Trichloroethylene	1.1
Xylenes	6.8
OTHER	
Total Petroleum Hydrocarbons	< 167

Site ID:	57M-96-10X1
Sample Date:	10/02/96
Depth:	5
Units:	ug/L
METALS	
Arsenic	< 2.54
Cadmium	< 3.01
SEMIVOLATILE ORGANICS	
1,2-dichlorobenzene	< 1.7
1,4-dichlorobenzene	< 1.7
2-methylnaphthalene	< 1.7
4-methylphenol	< .52
Naphthalene	< .5
VOLATILE ORGANICS	
*1,2-dichloroethylenes (cis And Trans)	< .5
1,1,1-trichloroethane	< .5
Carbon Tetrachloride	< .58
Chloroform	< .5
Ethylbenzene	< .5
Styrene	< .5
Tetrachloroethene	< 1.6
Toluene	< .5
Trichloroethylene	< .5
Xylenes	< .84
OTHER	
Total Petroleum Hydrocarbons	< 167

Site ID:	57M-95-03X
Sample Date:	10/02/966
Depth:	8
Units:	ug/L
METALS	
Arsenic	33.2
Cadmium	8.67
SEMIVOLATILE ORGANICS	
1,2-dichlorobenzene	9.8
1,4-dichlorobenzene	5.6
2-methylnaphthalene	4.4
4-methylphenol	1.5
Naphthalene	20
VOLATILE ORGANICS	
*1,2-dichloroethylenes (cis And Trans)	< .5
1,1,1-trichloroethane	< .5
Carbon Tetrachloride	4.5
Chloroform	10
Ethylbenzene	46
Styrene	< .5
Tetrachloroethene	2.6
Toluene	19
Trichloroethylene	.59
Xylenes	200
OTHER	
Total Petroleum Hydrocarbons	< 167

FIGURE 7-7
1996 OFF-SITE ANALYTICAL
GROUNDWATER RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

T:\9144-03\9144F036.DWG 9/01/99

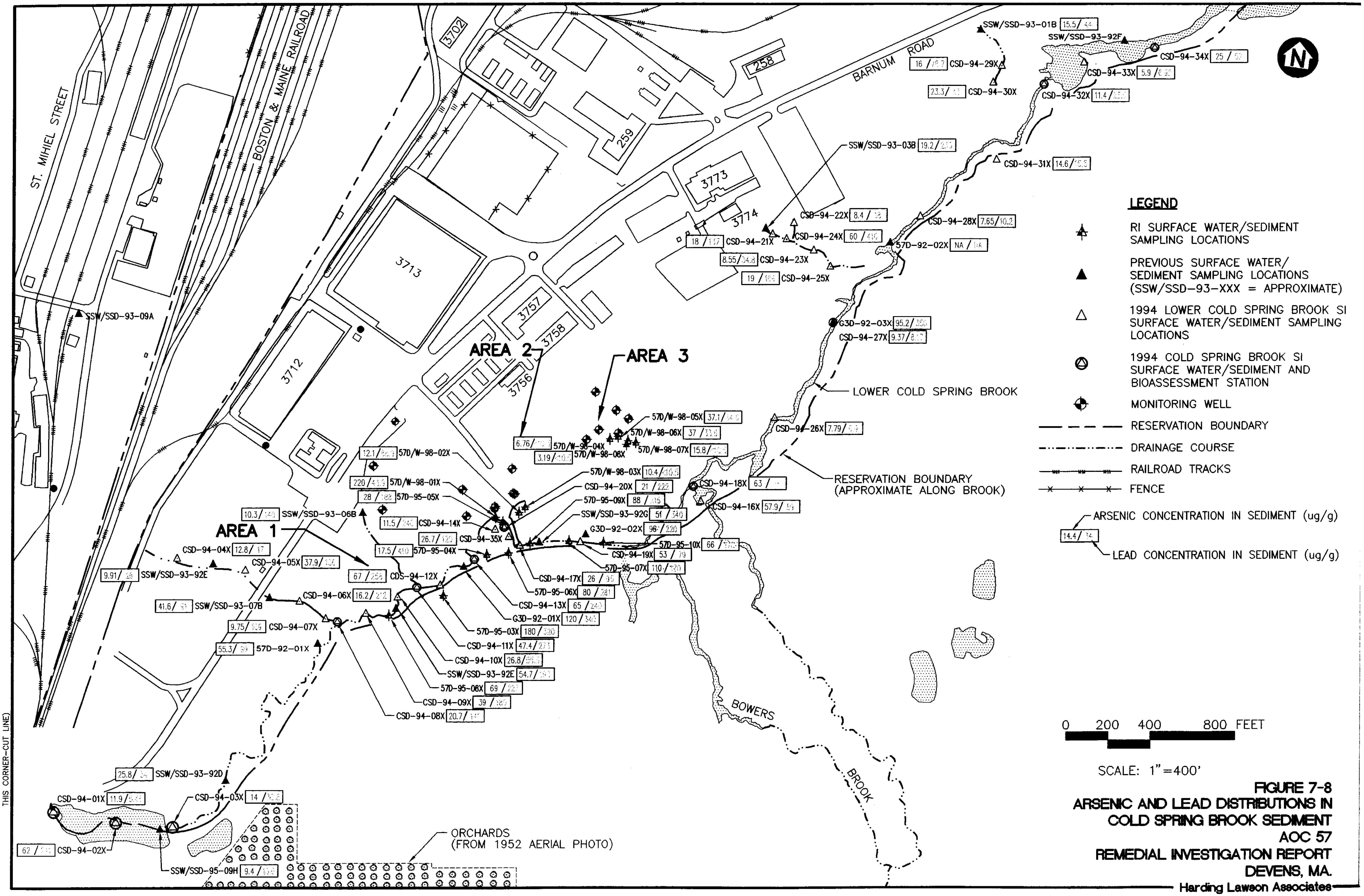
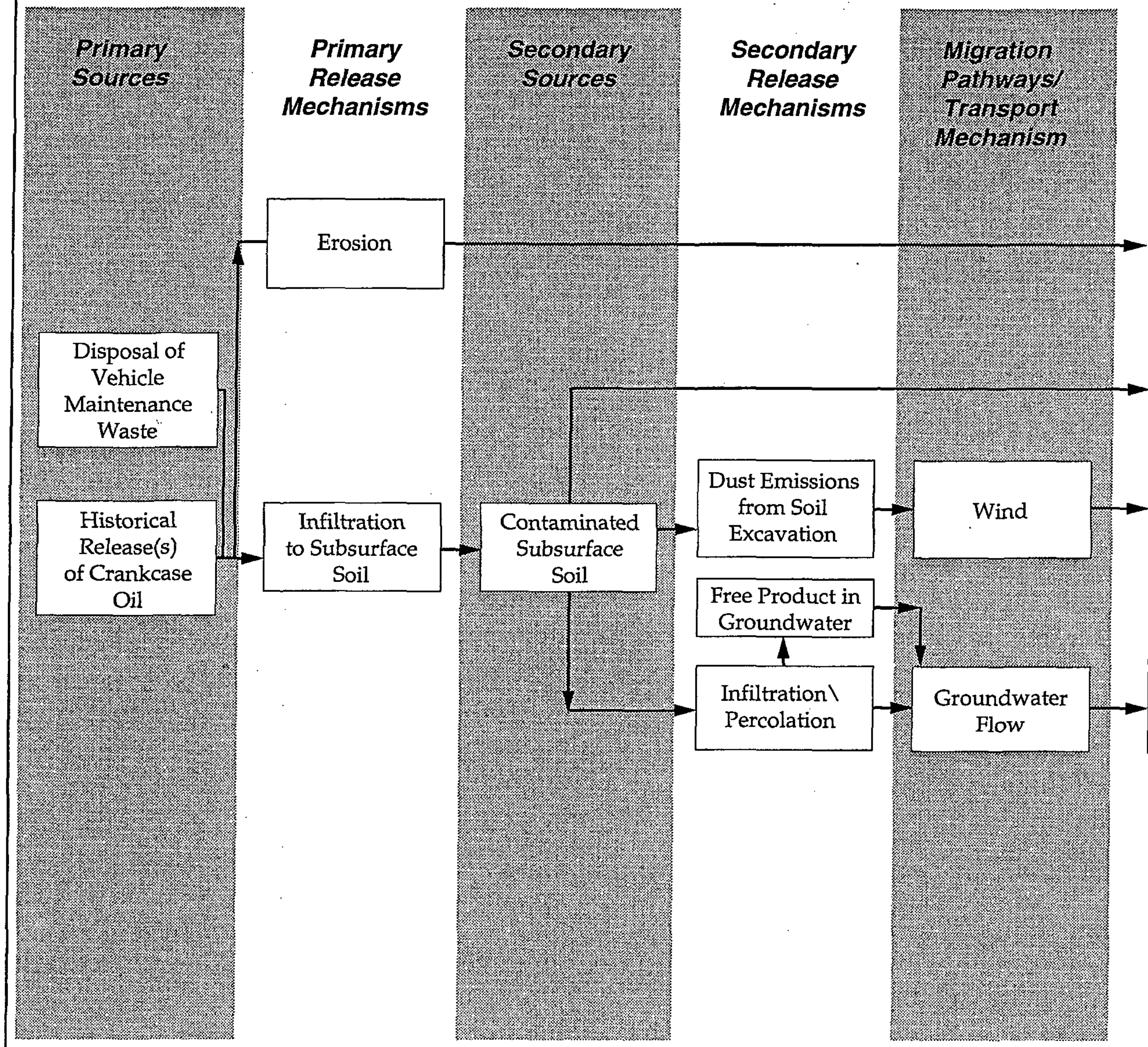


FIGURE 7-8
ARSENIC AND LEAD DISTRIBUTIONS IN COLD SPRING BROOK SEDIMENT
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA.

Harding Lawson Associates

J:\7005-04\7005F013.DWG (ROTATE 7.5 COOR. CORRECT 10-07-99 DEL
THIS CORNER-CUT LINE)

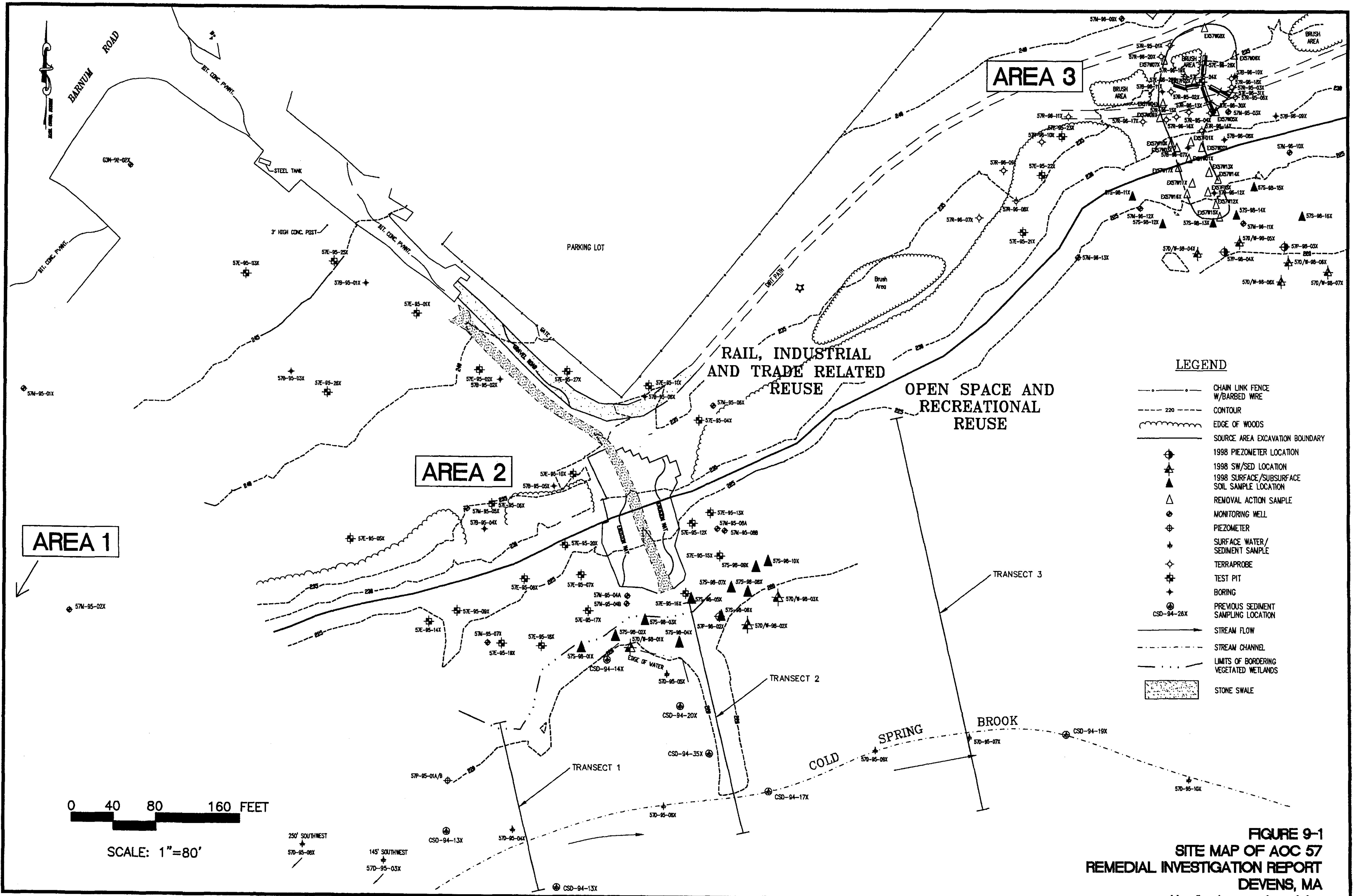


Potential Receptors

Exposure Route	Human		Biota	
	Area Residents	On-Base Personnel	Terrestrial	Aquatic
Surface Water/Sediment				
Ingestion				●
Direct Contact				●
Soil				
Ingestion		●		
Direct Contact	●	●		
Dust				
Inhalation		●		
Groundwater				
Ingestion		●	●	●
Direct Contact		●	●	●

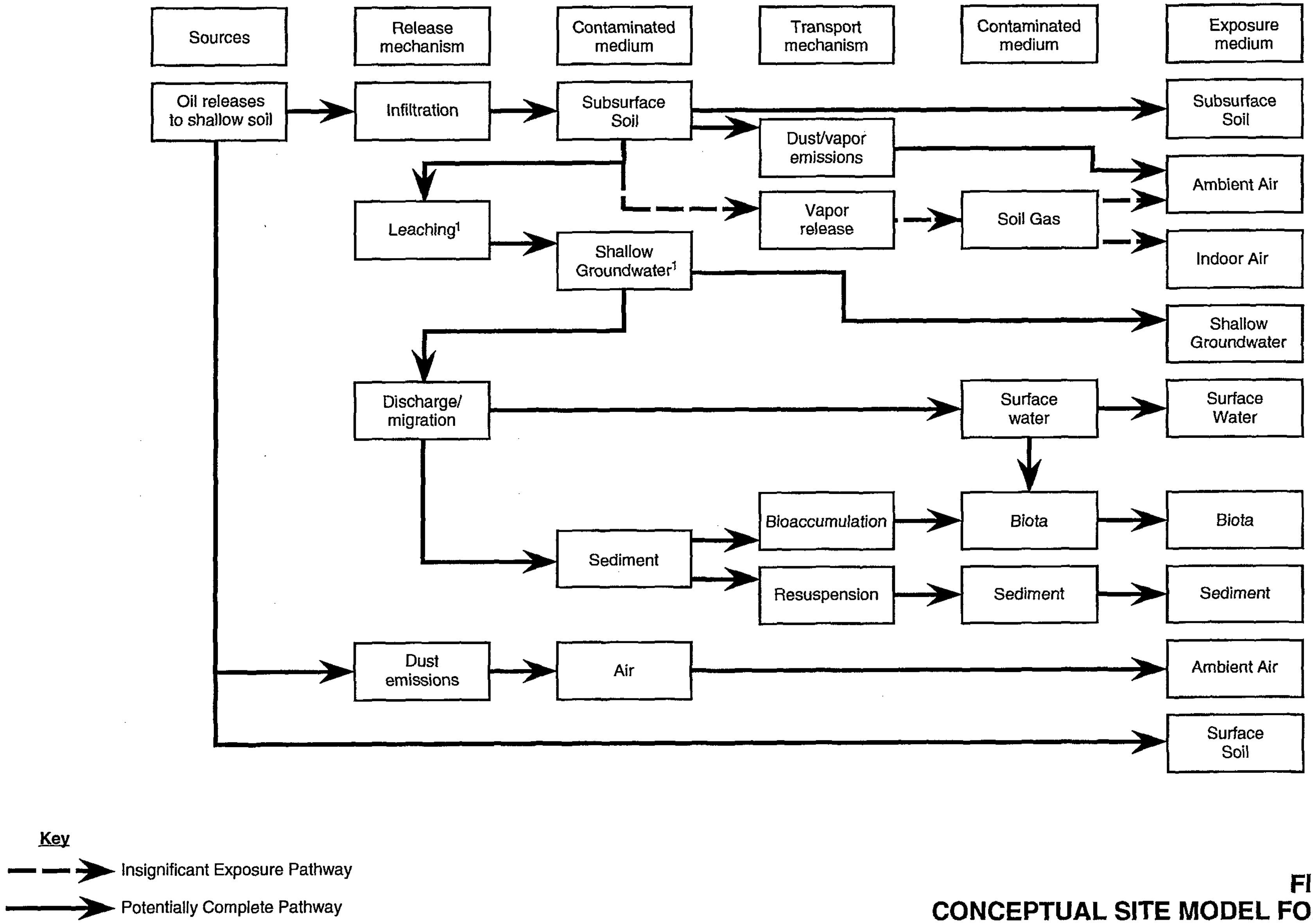
FIGURE 8-1
CONCEPTUAL MODEL FLOW DIAGRAM
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

9908006(e)



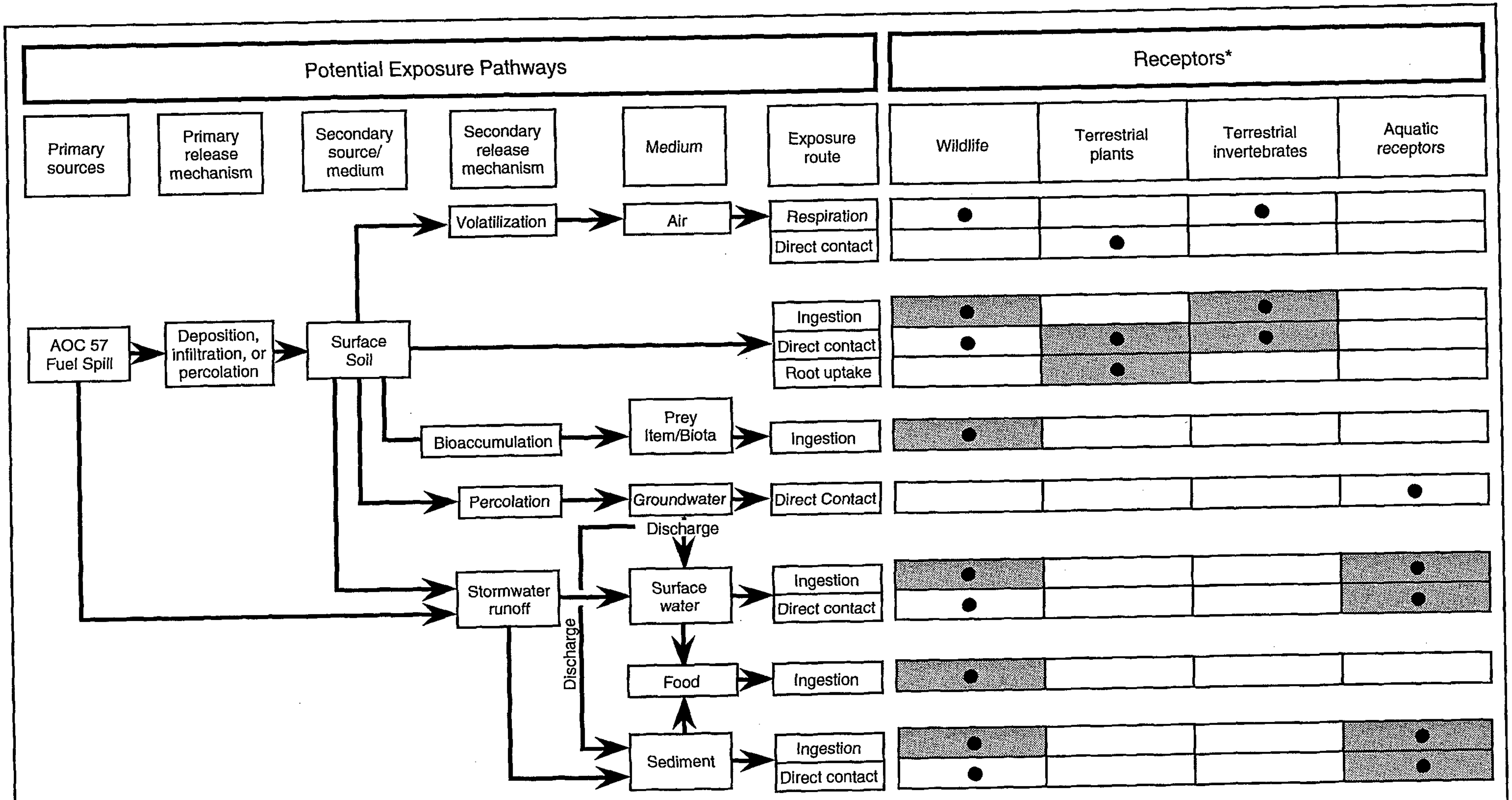
T:\9144-03\9144F071.DWG 10/06/99 EJL

FIGURE 9-1
SITE MAP OF AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MA
Harding Lawson Associates



[1] Petroleum has not migrated to groundwater, however reducing conditions created by oil release may have caused leaching of naturally occurring inorganic constituents from subsurface soil.

FIGURE 9-2
CONCEPTUAL SITE MODEL FOR AOC 57
REMEDIAL INVESTIGATION REPORT
AOC 57
DEVENS, MA



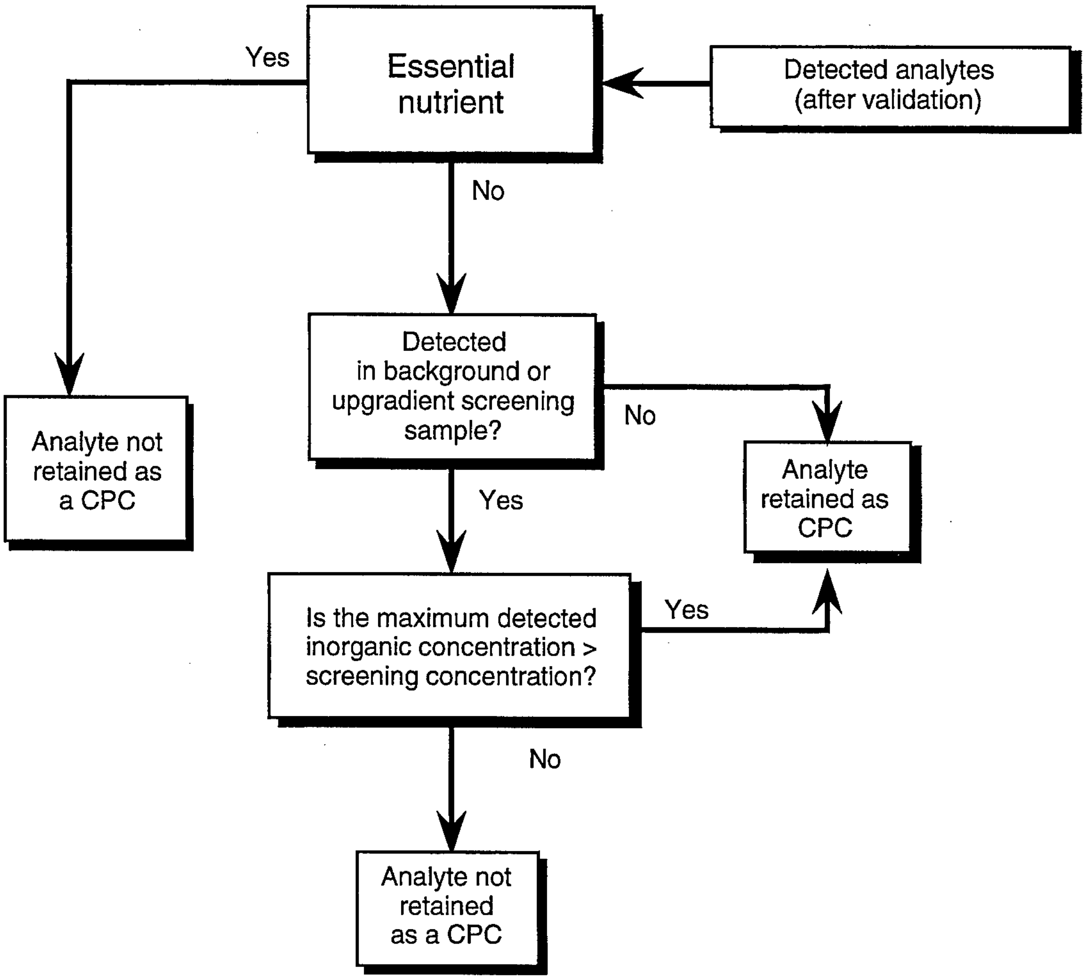
Key

AOC = Area of contamination
ERA = *Ecological risk assessment*
* = Shading indicates the exposure pathways that are quantitatively evaluated for receptors in the AOC 57 ERA. Nonshaded pathways are evaluated qualitatively, not evaluated due to the lack of toxicity information, or not evaluated because it is not considered a significant pathway.

FIGURE 9-3
CONTAMINANT PATHWAY MODEL FOR ECOLOGICAL RECEPTORS EXPOSED TO AOC 57 SURFACE SOIL, SURFACE WATER, SEDIMENT, AND GROUNDWATER
REMEDIAL INVESTIGATION REPORT
AOC 57
DEVENS, MA

Harding Lawson Associates

9910001



Key
CPC = Contaminant of potential concern
AOC = Area of contamination
> = greater than

FIGURE 9-4
ECOLOGICAL CONTAMINANT OF POTENTIAL CONCERN SELECTION PROCESS
REMEDIAL INVESTIGATION REPORT
AOC 57
DEVENS, MA

TABLE 3-1
USAEC DATA FLAGS AND QUALIFIERS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Measurement Boolean	Concentration	Data Qualifier (Upper case letters)	Flagging Codes (Lower case letters or #)
ND	300	J	adf

Measurement Boolean

< = Concentration was less than the certified reporting limit
ND = Not detectable above the indicated value
GT = Greater than the maximum certified concentration
EQ = Equal to the certified reporting limit

Data Qualifiers

? = Control chart for corresponding lot not yet reviewed by AEC Chemist. This qualifier is automatically set when a lot file has been uploaded to the database, but a corresponding control chart has not been approved.
I = The low spike recovery for this lot was high
M = The high spike recovery for this lot was high
J = The low spike recovery for this lot was low
K = Missed holding time for extraction or preparation
L = Missed analysis holding time
N = The high spike recovery for this lot was low
O = Low spike recoveries excessively different
R = Data is rejected and is not useable

Flagging Codes

1 = Result was less than the certified reporting limit but greater than the criteria of detection (COD) for 1990 QA Plan methods
2 = Ending calibration not within acceptable limits
3 = Internal standard not within acceptable limits
7 = Low spike recovery not within control limits
8 = Analyte recovery outside certified range but within acceptable limits. This code is used when analyte concentrations exceeded the certified range by <15 % and the laboratory felt a dilution was not warranted
a = Analyte found in trip blank as well as the sample
b = Analyte found in method blank or QC sample as well as the sample.
c = Analysis was confirmed by a different column or technique.
d = Duplicate analysis
f = Sample was filtered prior to analysis
g = Analyte found in that day's rinsate blank as well as the sample
h = Lot out of control but data accepted due to high recoveries
i = Interences in the sample caused the quantitation and/or identification to be suspect
j = Value is estimated
k = Reported results affected by interferences or high background. An elevated quantitation limit is reported
l = Out of control. Data rejected due to low recoveries
m= High duplicate spike not within control limits
n = Tentatively-identified compound (TIC) by GC/MC with a match greater than 70 %
p = Value is less than the method reporting limit but greater than the instrument detection limit
q = Confirmatory analysis was performed, however sample interferences prevented confirmation
r = Non-target analyte analyzed for but not detected by GC/MS. Laboratory is not certified for this analyte by the given method Analyte was not performance demonstrated or validated
s = Non-target compound analyzed for and detected by GC/MS. Laboratory is not certified for this analyte by the given method. Analyte was not performance demonstrated or validated
t = Non-target compound analyzed for and not detected (non-GC/MS method).
u = Analysis is unconfirmed. Confirmatory analysis was run but did not verify original result
v = Sample was not correctly preserved (i.e. > 4 degrees C or improperly preserved)
z = Non-target analyte analyzed for and detected by non-GC/MS method

TABLE 4-1
FEDERAL ARARs AND TBC GUIDANCE - GROUNDWATER AND SURFACE WATER
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Federal Standards and Guidance					
	Safe Drinking Water Act (SDWA)(a)		Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC)(b)			TBC Region III Tap Water (µg/L)
			For Protection of Human Health		For Protection of Aquatic Life	
	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/l)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)	
Volatile Organics						
acetone	-	-	-	-	-/-	3,700N
benzene	5	zero	0.66	40	5,300/-[2]	0.36C
carbon tetrachloride	5	zero	0.4	6.94	35,200/-[2]	0.16C
chloroform (THM)	100/80[3]	zero	0.19	15.7	28,900/1,240[2]	0.15C
ethylbenzene	700	700	1,400	3,280	32,000/-[2]	1,300N
styrene	100	100	-	-	-/-	1,600N
1,1,2,2-tetrachloroethane	-	-	0.17	10.7	-/2,400[2]	0.052C
tetrachloroethylene	5	zero	0.8	8.85	5,280/840[2]	1.10C
toluene	1,000	1,000	14,300	424,000	17,500/-[2]	750N
1,1,1-trichloroethane	200	200	18,400	1,030,000	-/-	1,300N
trichloroethylene	5	zero	2.7	80.7	45,000/21.900[2]	1.6C
trichlorofluoromethane	-	-	-	-	-/-	1,300N
xylenes (total)	10,000	10,000	-	-	-/-	12,000N
Semivolatile Organics						
acenaphthene	-	-	-	-	-/-	-

continued

TABLE 4-1
FEDERAL ARARS AND TBC GUIDANCE - GROUNDWATER AND SURFACE WATER
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Federal Standards and Guidance					
	Safe Drinking Water Act (SDWA)[a]		Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC)[b]			TBC Region III Tap Water (µg/L)
			For Protection of Human Health		For Protection of Aquatic Life	
	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/l)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)	
anthracene	-	-	-	-	-/-	11,000N
bis(2-ethylhexyl)phthalate	6	zero	-	-	-/-	4.80C
benzo(a)anthracene	-	-	-	-	-/-	0.092C
benzo(a)pyrene	2	zero	-	-	-/-	0.092C
benzo(b)fluoranthene	-	-	-	-	-/-	0.092C
benzo(g,h,i)perylene	-	-	-	-	-/-	-
benzo(k)fluoranthene	-	-	-	-	-/-	0.092C
benzyl alcohol	-	-	-	-	-	11,000N
carbazole	-	-	-	-	-/-	3.4C
chrysene	-	-	-	-	-/-	9.2C
dibenzofuran	-	-	-	-	-/-	150N
di-n-butyl phthalate	-	-	-	-	-	3,700N
fluoranthene	-	-	-	-	-/-	1,500N
fluorene	-	-	-	-	-/-	1,500N

continued

TABLE 4-1
FEDERAL ARARS AND TBC GUIDANCE - GROUNDWATER AND SURFACE WATER
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Federal Standards and Guidance					
	Safe Drinking Water Act (SDWA)$^{(a)}$		Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC)$^{(b)}$			TBC Region III Tap Water (µg/L)
			For Protection of Human Health		For Protection of Aquatic Life	
	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/l)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)	
indeno(1,2,3-c,d)pyrene	-	-	-	-	-/-	0.092C
2-methylnaphthalene	-	-	-	-	-/-	-
naphthalene	-	-	-	-	2,300/620^2	1,500N
n-nitrosodiphenylamine	-	-	4.9	16.1	-/-	14C
phenanthrene	-	-	-	-	30/6.3^5	-
pyrene	-	-	-	-	-/-	1,100N
Inorganics						
aluminum	-	50 to 200^8			-/-	37,000N
antimony	6	6^5	146	45,000	88/30^5	15N
arsenic	50^1	-	0.0022	0.0175	360/190^{2,7}	11N/0.038C
barium	2,000	2,000	1,000		-/-	2,600
beryllium	4^4	4	0.0037	0.0641	130/5.3^2	0.016C
cadmium	5	5	10	-	3.9/1.1^4	18N
calcium	-	-			-/-	-

continued

TABLE 4-1
FEDERAL ARARS AND TBC GUIDANCE - GROUNDWATER AND SURFACE WATER
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Federal Standards and Guidance					
	Safe Drinking Water Act (SDWA)[(a)]		Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC)[(b)]			TBC Region III Tap Water (µg/L)
			For Protection of Human Health		For Protection of Aquatic Life	
	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/l)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)	
chromium (total)	100	100	-	-	1,700/210[4,9]	180
cobalt	-		-	-	-/-	220
copper	TT[10]	1,300	-	-	18/12[4]	1,400N
iron	-	300[8]	300	-	-/1,000	-
lead	TT[11]	zero	50	-	83/3.2[4]	-
magnesium	-	-	-	-	-/-	-
manganese	-	50[8]	50	100	-/-	1,800N
mercury	2	2	0.144	0.146	2.4/0.012	11N
nickel	100[5]	100[5]	13.4	100	1,400/160[4]	730N
potassium	-		-	-	-/-	-
selenium	50	50	10	-	20/5	180N
silver	-	100[8]	50	-	4.1/0.12[4,6]	180N
sodium	-		-	-	-/-	-
vanadium	-					260N

continued

TABLE 4-1
FEDERAL ARARS AND TBC GUIDANCE - GROUNDWATER AND SURFACE WATER
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Federal Standards and Guidance					
	Safe Drinking Water Act (SDWA)$^{(a)}$		Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC)$^{(b)}$			TBC Region III Tap Water (µg/L)
			For Protection of Human Health		For Protection of Aquatic Life	
	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/l)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)	
zinc	-	5,000^{8}	-	-	12/110^{4}	11,000N
Pesticide/PCBs						
DDT	-	-	.000024	.000024	1.1/0.001	0.2C
DDD	-	-	-	-	-/-	0.28C
DDE	-	-	-	-	1,050/-^{2}	0.2C
endrin	2	2	1.0	-	0.18/.0023	11N
alpha chlordane	2^{13}	zero^{13}	0.00046^{13}	0.00048^{13}	2.4/0.0043^{13}	0.052^{13}
gamma chlordane	2^{13}	zero^{13}	0.00046^{13}	0.00048^{13}	2.4/0.0043^{13}	0.052C^{13}
heptachlor	0.4	zero	0.00028	0.00029	0.52/.0038	0.0023C
PCB 1248	0.5^{14}	zero^{14}	0.000079^{14}	0.000079^{14}	2.0/0.014^{14}	0.0087C
PCB 1254	0.5^{14}	zero^{14}	0.000079^{14}	0.000079^{14}	2.0/0.014^{14}	0.73C^{14}
PCB 1260	0.5^{14}	zero^{14}	0.000079^{14}	0.000079^{14}	2.0/0.014^{14}	0.0087C^{14}

continued

TABLE 4-1
FEDERAL ARARS AND TBC GUIDANCE - GROUNDWATER AND SURFACE WATER
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Federal Standards and Guidance					
	Safe Drinking Water Act (SDWA)(a)		Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC)(b)			TBC Region III Tap Water (µg/L)
			For Protection of Human Health		For Protection of Aquatic Life	
	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/l)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)	
Explosives						
cycloetramethylenetetranitramine (HMX)	-	-	-	-	-	-
cyclonite (RDX)	-	-	-	-	-	-
2,4-dinitrotoluene	-	-	-	-	-	73N
2,6-dinitrotoluene	-	-	-	-	-	37N
nitroglycerine	-	-	-	-	-	-
2,4,6-trinitrotoluene	-	-	-	-	-	2.2C
Cations/Anions						
chloride		250,000[8]	-	-	860K/230K	-
phosphate	-	-	-	-	-/-	-
sulfate	-	500,000[15]/250,000[8]	-	-	-/-	-
alkalinity	-	-	-	-	-/20,000	-

continued

TABLE 4-1
FEDERAL ARARS AND TBC GUIDANCE - GROUNDWATER AND SURFACE WATER
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Federal Standards and Guidance					
	Safe Drinking Water Act (SDWA)[a]		Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC)[b]			TBC Region III Tap Water (µg/L)
			For Protection of Human Health		For Protection of Aquatic Life	
Analyte	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/l)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)	
Other						
nitrate/nitrite as N	10,000/1,000[12]	-	10,000/-			58,000N/3,100N
TPH	-	-				-

Notes:

(a) USEPA, "Drinking Water Standards and Health Advisories", Office of Water, Washington, D.C.; May 1995.
(b) USEPA, "Water Quality Criteria Summary", Office of Science and Technology, Health and Ecological Criteria Division, Washington, D.C.; May 1, 1991; criteria shown for carcinogens present a one-in-a-million incremental risk.

CWA = Clean Water Act
µg/L = micrograms per liter
MCL = Maximum Contaminant Level
MCLG = Maximum Contaminant Level Goal
TT = Treatment technique required.
\- = No federal or state guidance criteria or standards exist.
N = Noncarcinogenic effects
C = Carcinogenic effects

1 MCL for arsenic currently under review.
2 Insufficient data to develop criteria. Value presented is the Lowest Observed Effect Level (LOEL).
3 1994 Proposed rule for Disinfectants and Disinfection By-Products: Total for all THMs combined would not exceed the 80 ug/L level.
4 Hardness dependent criteria (100 mg/L $CaCO_3$ used).
5 Standard is being remanded.
6 Proposed level, freshwater acute - 0.92 µg/Ll.
7 Values presented are for trivalent species.
8 Non-enforceable secondary regulation based on aesthetics (e.g., color, odor, taste).
9 Values presented are for hexavalent chromium species.
10 Treatment technique action level 1,300 µg/L.
11 Treatment technique action level 15 µg/l; concentration measured at top.
12 Nitrate or nitrite as nitrogen; standard total nitrate and nitrite is 10,000 µg/l.
13 Values reported for chlordane (CAS #57-74-9).
14 Values reported for total PCBs (CAS #1336-36-3).
15 Proposed criteria.

TABLE 5-4
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57B	lower - bottom	08-26-94	2	12,168	1.79 Aroclor 1260
SBSA57W	lower - SW sidewall	08-26-94	0.9	46,876	
SBSA57W1	lower - NE sidewall	08-29-94	0.5	547	
SBSA57W2	lower - SE sidewall	08-29-94	0.8	181	
SBSA57W3	lower - SE sidewall	08-29-94	0.7	634	
SBSA57W4	lower - SE sidewall	08-29-94	0.4	277	
SBSA57W5	lower - SE sidewall	08-29-94	0.1	139	
SBSA57W6	lower - SE sidewall	08-29-94	0.5	746	
SBSA57W7	lower - SW sidewall	08-29-94	0.1	945	
SBSA57W8	lower - SW sidewall	08-29-94	0.2	19,049	
SBSA57W9	lower - SW sidewall	08-29-94	0.7	31,816	0.64 Aroclor 1260
SBSA57W10	lower - NE sidewall	08-29-94	0.7	987	
SBSA57W11	lower - NE sidewall	08-29-94	1.5	46,658	0.60 Aroclor 1260
SBSA57B1	lower - bottom	08-29-94	1.5	5,356	
SBSA57B2	lower - bottom	08-29-94	1.8	7,020	
SBSA57B3	lower - bottom	08-29-94	2.1	1,739	
SBSA57B4	lower - bottom	08-29-94	2.2	12,348	ND Aroclor 1260
SBSA57B5	lower - bottom	08-29-94	1.7	17,635	
SBSA57B6	lower - bottom	08-29-94	1.8	33,764	
SBSA57B7	lower - bottom	08-29-94	2	33,806	0.92 Aroclor 1260
SBSA57B8	lower - bottom	08-29-94	2.1	25,935	
SBSA57JB	middle - SW sidewall	08-29-94	NA	173,974	excavator bucket
SBSA57T2B	upper - SW trench	08-30-94	3	ND	
SBSA57T2A	upper - SW trench	08-30-94	2.9	1,429	
SBSA57T1B	upper - NE trench	08-30-94	2.5	ND	

TABLE 5-4
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57T1A	upper - NE trench	08-30-94	3	5,272	
SBSA57T1	lower - SE trench	09-01-94	2.5	2,289	
SBSA57T2	lower - SE trench	09-01-94	2.5	2,494	
SBSA57T3	lower - SE trench	09-01-94	2.5	74,208	
SBSA57T4	lower - SE trench	09-01-94	2.5	62,010	
SBSA57T5	lower - SE trench	09-01-94	2	10,237	
SBSA57T6	lower - SE trench	09-01-94	2.5	119	
SBSA57TP1	lower - NE test pit	09-01-94	NA	50,119	excavator bucket
SBSA57B30	middle - bottom	09-02-94	2.5	3,508	0.21 Aroclor 1260
SBSA57W30	middle - NE sidewall	09-02-94	2	2,604	
SBSA57W31	middle - NE sidewall	09-02-94	2	ND	
SBSA57W32	middle - NE sidewall	09-02-94	2	7,588	
SBSA57W34	middle - SW sidewall	09-02-94	2	969	
SBSA57T3B1	lower - SE test pit	09-06-94	3.7	ND	
SBSA57T3B2	lower - SE test pit	09-06-94	3.7	65	
SBSA57T3W1	lower - SE test pit	09-06-94	2.7	947	
SBSA57T3W2	lower - SE test pit	09-06-94	2.7	46,546	0.12 Aroclor 1260
SBSA57T3T	lower - SE test pit	09-06-94	NA	1,316	excavator bucket
SBSA57H1B1	lower - SE test pit	09-06-94	2.3	1,331	
SBSA57T4B1	lower - E test pit	09-06-94	3.5	20,418	0.2 Aroclor 1260
SBSA57T4W1	lower - E test pit	09-06-94	2.5	158	
SBSA57T5B1	lower - NE test pit	09-06-94	4	38,746	
SBSA57T5B2	lower - NE test pit	09-06-94	3.5	24,352	

TABLE 5-4
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57T6B1	lower - NE test pit	09-06-94	3.5	25	
SBSA57T6B2	lower - NE test pit	09-06-94	4	557	
SBSA57T7B1	lower - SE test pit	09-06-94	3.5	ND	
SBSA57T7W1	lower - SE test pit	09-06-94	NA	1,464	Entire wall scraped
SBSA57T8B1	lower - SE test pit	09-06-94	3.5	ND	
SBSA57T8W1	lower - SE test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T9B1	lower - S test pit	09-06-94	3.5	ND	
SBSA57T9W1	lower - S test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T10B1	lower - S test pit	09-06-94	3.5	1,686	
SBSA57T10W1	lower - S test pit	09-06-94	NA	10,491	Entire wall scraped
SBSA57T11B1	lower - S test pit	09-06-94	3.5	ND	
SBSA57T11W1	lower - S test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T12B1	lower - S test pit	09-06-94	3.5	ND	
SBSA57T12W1	lower - S test pit	09-06-94	NA	58	Entire wall scraped
SBSA57T13B1	lower - SW test pit	09-06-94	3.5	3,792	
SBSA57T13W1	lower - SW test pit	09-06-94	NA	1,980	Entire wall scraped
SBSA57T14B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T14W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T15B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T15W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T16B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T16W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T17B1	middle - SW test pit	09-06-94	3.5	ND	
SBSA57T17W1	middle - SW test pit	09-06-94	NA	ND	Entire wall scraped

TABLE 5-4
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57W35A	middle - SW sidewall	09-07-94	2.7	23	
SBSA57W36	upper - SW sidewall	09-07-94	1	90	
SBSA57W37	upper - NE sidewall	09-07-94	1	273	
SBSA57W38	upper - SW sidewall	09-07-94	0.5	553	
SBSA57W39	upper - NE sidewall	09-07-94	0.7	23	
SBSA57W40	upper - SW sidewall	09-07-94	1	13	
SBSA57W41	upper - NE sidewall	09-07-94	1	147	
SBSA57W42	upper - SW sidewall	09-07-94	0.7	313	
SBSA57W43	middle - NE sidewall	09-07-94	1.8	3,914	
SBSA57W44	middle - SW sidewall	09-07-94	1	3,843	
SBSA57W45	middle - NE sidewall	09-07-94	2.1	1,042	
SBSA57W46	middle - NE sidewall	09-07-94	2.3	4,464	
SBSA57W47	middle - NE sidewall	09-07-94	2.1	509	
SBSA57B31	middle - bottom	09-07-94	3.5	14,800	
SBSA57B32	upper - bottom	09-07-94	1	55	
SBSA57B33	upper - bottom	09-07-94	1	14	
SBSA57B34	upper - bottom	09-07-94	1	34	
SBSA57B35	middle - bottom	09-07-94	1.3	142	
SBSA57B36	middle - bottom	09-07-94	1.3	2,109	
SBSA57B37	middle - bottom	09-08-94	4	8,264	
SBSA57B38	middle - bottom	09-08-94	3.8	483	
SBSA57B39	middle - bottom	09-08-94	3.7	ND	
SBSA57W48	middle - NE sidewall	09-08-94	2.4	9	
SBSA57W51	middle - NE sidewall	09-08-94	3.5	1,436	

TABLE 5-4
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57W52	middle - NE sidewall	09-08-94	2.8	813	
SBSA57W53	middle - NE sidewall	09-08-94	3.7	8	
SBSA57B41	middle - bottom	09-09-94	4.5	874	
SBSA57B42	middle - bottom	09-09-94	3	564	
SBSA57B43	middle - bottom	09-09-94	2.5	840	
SBSA57B44	middle - bottom	09-09-94	1.5	45	
SBSA57B45	middle - bottom	09-09-94	6	ND	
SBSA57W54	middle - SW sidewall	09-09-94	2.5	984	
SBSA57W55	middle - SW sidewall	09-09-94	3	336	
SBSA57W56	middle - SW sidewall	09-09-94	2.5	17	
SBSA57W57	middle - SW sidewall	09-09-94	3	503	
SBSA57W58	middle - SW sidewall	09-09-94	2.5	710	
SBSA57W59	upper - SW sidewall	09-09-94	2	1,427	
SBSA57W60	upper - SW sidewall	09-09-94	2.3	775	
SBSA57W61	upper - NE sidewall	09-09-94	1	ND	
SBSA57W62	upper - SW sidewall	09-09-94	1.3	206	
SBSA57W63	upper - SW sidewall	09-09-94	1	77	
SBSA57W64	upper - NE sidewall	09-09-94	1.5	1,298	
SBSA57W65	middle - NE sidewall	09-09-94	4	848	
SBSA57W66	middle - NE sidewall	09-09-94	5	7	
SBSA57W67	middle - NE sidewall	09-09-94	4	206	
SBSA57W68	middle - NE sidewall	09-09-94	5	ND	
SBSA57W69	middle - NE sidewall	09-09-94	4	ND	
SBSA57W70	middle - NE sidewall	09-09-94	5	ND	

TABLE 5-4
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57TP1B	middle- bottom test pit	09-09-94	7.5	9,671	
SBSA57TP1W1	middle- bottom test pit	09-09-94	5.5	539	
SBSA57TP1W2	middle- bottom test pit	09-09-94	6.5	13,353	
SBSA57TP2B	middle- bottom test pit	09-09-94	6	2,227	
SBSA57TP2W1	middle- bottom test pit	09-09-94	4	ND	
SBSA57TP2W2	middle- bottom test pit	09-09-94	5	ND	
SBSA57TP3B	upper- bottom test pit	09-09-94	5	9,223	
SBSA57TP3W1	upper- bottom test pit	09-09-94	3	5,959	
SBSA57TP3W2	upper- bottom test pit	09-09-94	4	13,119	
SBSA57TP4B	upper- bottom test pit	09-09-94	5.5	549	
SBSA57TP4W1	upper- bottom test pit	09-09-94	3.5	ND	
SBSA57TP4W2	upper- bottom test pit	09-09-94	4.5	ND	
SBSA57TP5B	middle- bottom test pit	09-09-94	9	5,521	
SBSA57TP5W1	middle- bottom test pit	09-09-94	8	9,682	
SBSA57TP5W2	middle- bottom test pit	09-09-94	7	13,908	

NOTES:

[1] Sample location is subdivided into general and specific location - "general" refers to which part of Area 2 (lower is closer to wetland); "specific" refers to whether it was a bottom, sidewall, or testpit sample - refer to Figures 5-3 and 5-4.
ND - Indicates non-detect
NA – Not applicable
Note - Depths are approximate

TABLE 5-5
OHM SOIL REMOVAL OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Sample ID	**SBSA571**	**SBSA572**	**SBSA573**	**LSSA571**	**LSSA5702**	**SBSA57CH1**
Date Collected	**08-29-94**	**08-29-94**	**08-29-94**	**08-31-94**	**09-01-94**	**09-01-94**
Matrix	**Soil**	**Soil**	**Soil**	**Oil**	**Oil**	**Soil**
Fuel ID	N/A	N/A	N/A	30% Kerosene	N/A	Kerosene
				70%Lube Oil		Light Lube Oil
TPH[1] (mg/kg)						
light range	1050	624	716	N/A	4000	1380
medium range	3610	3140	2270	N/A	86800	4090
heavy range	36000	35100	26300	N/A	663000	44600
Metals (mg/kg)						
Aluminum	5200	2900	3640	N/A	410	5170
Arsenic	7.8	9.3	7.3	N/A	ND	8.3
Barium	183	37.1	35.8	N/A	53.6	81.1
Cadmium	5.4	ND	ND	N/A	ND	2.5
Calcium	908	322	301	N/A	ND	1010
Chromium	19.7	23.4	19	N/A	12.2	12.8
Copper	53.6	13.2	12.8	N/A	14.4	39.4
Iron	5130	2710	3640	N/A	37.8	4330
Lead	464	199	137	N/A	64.5	306
Magnesium	704	457	734	N/A	ND	536
Manganese	52.6	23.7	32.1	N/A	ND	69.4
Nickel	7.7	5	5.8	N/A	ND	6.6
Potassium	197	155	198	N/A	ND	146
Vanadium	8	ND	6.5	N/A	ND	5.9
Zinc	438	33	41.3	N/A	5.1	139

TABLE 5-5
OHM SOIL REMOVAL OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Sample ID	SBSA571	SBSA572	SBSA573	LSSA571	LSSA5702	SBSA57CH1
Date Collected	**08-29-94**	**08-29-94**	**08-29-94**	**08-31-94**	**09-01-94**	**09-01-94**
Matrix	**Soil**	**Soil**	**Soil**	**Oil**	**Oil**	**Soil**
Volatiles (mg/kg)						
Ethylbenzene	9.4	ND	ND	N/A	ND	ND
Toluene	12.9	ND	ND	N/A	ND	6.53
Xylenes	63.8	11.6	5.3	N/A	13	25.4
PCBs (mg/kg)						
Aroclor 1242	N/A	N/A	N/A	N/A	29.7	5.8
Aroclor 1254	N/A	N/A	N/A	N/A	28.4	ND
Aroclor 1260	N/A	N/A	N/A	N/A	81.9	4.6

NOTES:
[1] TPH was determined by GC analysis not IR
mg/kg = milligrams per kilogram
N/A = not applicable
ND = compound not detected

TABLE 5-6
AREA 1 SOIL REMOVAL ANALYTICAL RESULTS ABOVE REGULATORY LEVELS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Sample Identification	Compound	Concentration (µg/g)	MCP S-1/GW-1 Regulatory Level (µg/g)
AOC57-A1-SW1	**PAHs**		
	Benzo(a)anthracene	2.36	0.7
	Benzo(b)fluoranthene	4.4	0.7
	Benzo(a)pyrene	2.11	0.7
	Indeno(1,2,3-cd)pyrene	1.75	0.7
AOC57-A1-SW2	**EPH**		
	C_{10}-C_{22} Aromatics	532	200
	PAHs		
	Benzo(a)anthracene	7.53	0.7
	Benzo(a)pyrene	8.15	0.7
	Chrysene	10.7	7
	Dibenzo(a,h)anthracene	2.47	0.7
	Indeno(1,2,3-cd)pyrene	6.0	0.7
AOC57-A1-SW4	**PAHs**		
	Benzo(a)anthracene	3.07	0.7
	Benzo(b)fluoranthene	6.69	0.7
	Benzo(a)pyrene	3.44	0.7
	Dibenzo(a,h)anthracene	1.13	0.7
	Indeno(1,2,3-cd)pyrene	3.02	0.7
AOC57-A1-SW1/B	**PAHs**		
	Benzo(a)anthracene	2.0	0.7
	Benzo(b)fluoranthene	2.8	0.7
	Benzo(a)pyrene	2.4	0.7
	Indeno(1,2,3-cd)pyrene	1.8	0.7
AOC57-A1-SW4/B	**PAHs**		
	Benzo(a)anthracene	5.1	0.7
	Benzo(a)pyrene	6.1	0.7
	Benzo(b)fluoranthene	6.1	0.7
	Indeno(1,2,3-cd)pyrene	4.7	0.7

Notes:

(µg/g) = Micrograms Per

MCP = Massachusetts Contingency Plan

PAHs = polyaromatic hydrocarbons

EPH = extractable petroleum hydrocarbons

T[illegible] 5-7
SUMMARY OF TEST PITS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPLORATION ID	COMPLETION DEPTH (FEET bgs)	SAMPLE INTERVALS (FEET bgs)	ANALYTICAL SAMPLES COLLECTED	TOTAL VOCS BY PID (PPM)	SOIL TYPE (USCS)	COMMENTS
REMEDIAL INVESTIGATION						
57E-95-01X	9	0-1	F	BKG	SW (0-1.5)	
		1-2	F			D BROWN SILTY-SAND(2"-6") LENS
		5-6	F,O,G		SP(1.5-9)	
		8-9	O			
57E-95-02X	10	0.50	F,O	BKG		
		5.00	F,O,G	BKG	SW(0-2)	ASH LAYER
		10.00	O	BKG	SW(2-10)	
57E-95-03X	10	1.00	O	BKG	SW(0-2)	
		2.00	O		SP(2-10)	4-6" BLACK LENS
		5.00	F,O,G			
		10.00	O			
57E-95-04X	12	1.00	F	BKG	SP-SM(0-2)	
		5.00	F,O	BKG	SP (2-12)	
		12.00	F	BKG		
57E-95-05X	13	1.00	F	BKG	SM(1-1.5)	
		6.00	F,O,G	BKG	SP (1.5-13)	
		13.00	F	BKG		
57E-95-06X	11	1.00	F,O,G	BKG	SM(0-1)	ASH LAYER
		6.00	F,O,G	BKG	SM (1-3)	
		11.00	F	BKG	SP (3-11)	
57E-95-07X	7	1.00	F	BKG	SM(0-3)	
		4.00	F,O	140	SM (3-4)	FUEL ODOR 4-7'
		7.00	F	53	SP(4-7)	GW 7 FEET BGS
57E-95-08X	6	1.00	F	BKG	SM (0-5)	
		4.00	F,O,G	BKG	SM	DEBRIS,SEPTIC ODOR
		6.00	F	BKG	SP(5-6)	GW 6 Feet bgs
57E-95-09X	8	1.00	F	BKG	SW(0-1)	BLACK ORGANIC(4-5)
		5.00	F,O	BKG	SW(1-4)	STRONG SEPTIC ODOR
		8.00	F	BKG	SP (5-8)	
57E-95-10X	10	0.00	0-1 F,O	BKG	(0-2)	
		6.00	F,O	BKG	SM(2-5)	
		10.00	F	BKG	SM5-10)	
57E-95-11X	13	0-1	F	BKG	SM (0-2)	
		5-6	F,O	BKG	SM (2-13)	
		12-13	F	BKG		

TABLE 5-7
SUMMARY OF TEST PITS
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REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPLORATION ID	COMPLETION DEPTH (FEET bgs)	SAMPLE INTERVALS (FEET bgs)	ANALYTICAL SAMPLES COLLECTED	TOTAL VOCS BY PID (PPM)	SOIL TYPE (USCS)	COMMENTS
57E-95-12X	13	0-1	F,O,G	BKG	SM(0-3)	
		3-4	F,O,G	1.4	BLACK ORGANIC(3-6)	STRONG FUEL ODOR
		12-13	F	BKG	SP (6-13)	GW 8 FEET BGS
57E-95-13X	11	0-1	F	0.03	('0-2)	
		4-5	F,O	BKG	SP(3-11)	
		10-11	F	BKG		
57E-95-14X	6	0-1	F	BKG	SP (0-1)	
		1-2	F	BKG	BLACK ORGANIC (6" Thick)	SEPTIC ODOR
		5-6	F,O	BKG	SP (2-6)	GW 6 FEET BGS
57E-95-15X	5	0-1	F	BKG	SM (0-1)	
		1-2	F,O,G	12	BLACK ORGANIC LAYER(1.5-2)	FUEL ODOR
		4-5	F	3.2	SP (2-5)	
57E-95-16X	5	0-1	F,O	BKG	SM (0-1)	
		2-3	F,O,G	7.8	BLACK ORGANIC (1-2)	FUEL ODOR
		4-5	F	3.2	SP (2-5)	FUEL ODOR, GW 5 FEET BGS
57E-95-17X	5	0-1	F,O,G	BKG	SM (0-2)	
		2-3	F,O	21.5		STRONG FUEL ODOR
		4-5	F	93	SP(2-5)	STRONG FUEL ODOR
57E-95-18X	3	0-1	F	BKG	BLACK ORGANIC (0-1)	
		1-2	F,O,G	BKG	SP (1-2)	
		2.5-3	F	BKG	SP (2-3)	
57E-95-19X	3.5	0-1	F	BKG	SM (0-1.5)	
		1-2	F,O	BKG	BLACK ORGANIC (1.5-2)	
		2-3	F	BKG	SP (2-3.5)	GW 3.5 FEET BGS
57E-95-20X	6	0-1	F	BKG	SP (0-1)	
		2-3	F	BKG	SW (1-3)	
		4-5	F,O	BKG	SP (3-5)	GW 6 FEET BGS
57E-95-21X	10	0-1	F	BKG	SM (0-1)	DEBRIS, ASHES
		2-3	F	BKG	SP(1-3)	DEBRIS, TRACE SILT
		5-6	F	BKG	DEBRIS (3-6)	ASH, D BWN LENS (4-5)
		9-10	F	BKG	SM(5-10)	
57E-95-22X	10	0-1	F	BKG	SAMPLE BENEATH DRUM	
		3-4	F	BKG	SM DEBRIS, ASH (0-5)	
		9-10	F	BKG	SP (5-10)	NO GW ENCOUNTERED
57E-95-23X	10	0-1	F	BKG	SM DEBRIS (0-5)	
		3-4	F	BKG		
		9-10	F	BKG	SP (5-10)	NO GW ENCOUNTERED

T[illegible] 5-7
SUMMARY OF TEST PITS
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REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPLORATION ID	COMPLETION DEPTH (FEET bgs)	SAMPLE INTERVALS (FEET bgs)	ANALYTICAL SAMPLES COLLECTED	TOTAL VOCS BY PID (PPM)	SOIL TYPE (USCS)	COMMENTS
57E-95-24X	10	0-1	F	BKG	VEGETATION, TOPSOIL (0-0.5)	VEHICLE TRANSMISSION
		3-4	F	19	SM, COAL (0-4)	OILY ODOR
		6-7	F	48	SM (4-7)	GASOLINE ODOR
		9-10	F	29	SM	GASOLINE ODOR
57E-95-25X	12	0-1	F	BKG	SM (0-1)	
		1-2	F	BKG	SW(1-2)	PIECES OF PAVEMENT
		11-12	F	BKG	SP	
57E-95-26X	11	0-1	F	BKG	SM (0-1)	COAL/ASH 1-2 INCHES BGS
		2-3	F,O	BKG	SM (1-3)	
		10-11	F	BKG	SP (3-11)	
57E-95-27X	12	0-1	F	BKG	SM (0-1)	BLK COAL ASH 3 INCHES BGS
		1-1.5	F	BKG	SM (1-1.5)	
		11-12	F,O	BKG	SP (1.5-12)	NO GW ENCOUNTERED
REMEDIAL INVESTIGATION MOD 001						
57E-96-28X	10	0-3	F	BKG	SM (0-2.5)	
		5-6	F	146		
		9-10	F,O	105		
		7-8	F	BKG	SW-SM DEBRIS (2.5-5)	
		8-9	F	BKG	SP (5-10)	
57E-96-29X	11	1-2	PID ONLY	BKG	L TAN SM (0-2)	TOP SOIL
		4-5	F	0.8	SW (2-4.5)	DEBRIS-FILL
		9-10	F	3	SP	SEPTIC ODOR
		3-4	F	BKG	(4.5-11)	
		4-4.5	PID ONLY	BKG		SAW DUST LAYER
		6-7	F	BKG		
		10-11	F	0.4		
57E-96-30X	10-11	1-2	F	BKG	SM TOP SOIL (0-1)	
		3-4	F	4.1	SM (1-4)	
		5-6	F,O	18.2	SW(4-6)	DEBRIS
		8-9	F	22		
		4.5-5	F	54		
		7-8	PID ONLY	120	SP (6-11)	
		10.5-11	F	12		
		4-5	F	BKG		
		8-9	F	4		

T 5-7
SUMMARY OF TEST PITS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPLORATION ID	COMPLETION DEPTH (FEET bgs)	SAMPLE INTERVALS (FEET bgs)	ANALYTICAL SAMPLES COLLECTED	TOTAL VOCS BY PID (PPM)	SOIL TYPE (USCS)	COMMENTS
57E-96-31X	10	3-4	F	102	SM TOP SOIL (0-2)	
		8-9	F	30	SW-SM FILL (2-4)	DEBRIS
		5-6	F,O	4	SM STAINED (4-5)	
		9-10	F	152	SM(5-10)	
		6-7	F	0.3		
		8-9	F	BKG		

NOTES:
BKG = Background
ppm = Parts per million
F = Field screening
O = Offsite screening
G = Grain analysis using Sieve screen
USCS = Unified Soil Classification System
SW = Well graded sand
SP = Poorly graded sand
SM = Silty sand

TABLE 5-8
SUMMARY OF SOIL BORINGS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPLORATION ID	COMPLETION DEPTH (Feet bgs)	REFERENCE SAMPLE INTERVALS (Feet bgs)	OFF-SITE LABORATORY ANALYTICAL SAMPLES COLLECTED	SOIL TYPE (USCS)	TOTAL VOCS BY PID (PPM)	COMMENTS
PREVIOUS INVESTIGATIONS						
G3M-92-02X	31	0-2		SP	10	VOC readings believed to be due to high ambient humidity
		5-7		SP	15	
		10-12		SP	25	
		15-17		SP	10	
		20-22		SP	8	
		25-27	25-27	SP	0	
G3M-92-07X	32	0-2		SW/SP	<5	
		5-7		SP	0.3	
		10-12		SP	0.2	
		15-17		SP	0.7	
		20-22		SP	0.4	
		25-27	25-27	SP	0.3	
REMEDIAL INVESTIGATIONS						
57B-95-01X	23	0-2	0-2	SW-SM	0	
		5-7	5-7	SW	0	
		10-12		SW	0	
		15-17		SW	0	
		17-19		SW	0	
		19-21		SP	0	
		21-23	21-23	SP	0	
57B-95-02X	19	O-2	0-2	SM	0	
		5-7	5-7	SW-SM	0	
		10-12		SW-SM	0	
		15-17		SW-SM	0	
		17-19	17-19	SW-SM	0	
57B-95-03X	24	0-2	0-2	SM	0	
		5-7	5-7	SW-SM	0	
		10-12		SP	0	
		15-17		SW-SM	0	
		17-19		SW-SM	0	
		19-21		SW-SM	NR	
		21-23	21-23	SW-SM	NR	
57B-95-04X	17	0-2		SM	0	
		5-7		SW-SM	0	
		10-12		SW	0	
		15-17	15-17	SP	0	
57B-95-05X	17	0-2		SM	0	
		5-7		SW-SM	0	
		10-12		SW-SM	0	
		15-17	15-17	SW-SM	0	
57B-95-06X	16	0-2		SW-SM	0	
		5-7		SM	0	
		10-12		SW-SM	0	
		12-14	12-14	SW	0	
		14-16		SW	0	
57M-95-01X	30	0-2		SM/SW	NR	
		2-4		SW	NR	
		4-6		SP	NR	
		6-8		SP-SW	NR	
		8-10		SW	NR	

TABLE 5-8
SUMMARY OF SOIL BORINGS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPLORATION ID	COMPLETION DEPTH (Feet bgs)	REFERENCE SAMPLE INTERVALS (Feet bgs)	OFF-SITE LABORATORY ANALYTICAL SAMPLES COLLECTED	SOIL TYPE (USCS)	TOTAL VOCS BY PID (PPM)	COMMENTS
		10-12		SW/SP	NR	
		12-14		SP	NR	
		14-16		SW	NR	
		16-18		SP	NR	
		18-20		SP	NR	
		20-22		SP	NR	
		22-24	22-24	SP	NR	
		24-26		SP	NR	
		26-28		SP	NR	
		28-30		SP	NR	
57M-95-02X	25	0-2		SM	0	
		5-7		SM	0	
		10-12		SW-SM	0	
		15-17		SW-SM	0	
		17-19		SW	0	
		19-21	19-21	SW	0	
57M-95-03X	18	0-2		SM	0	
		2-4		SM	0	
		4-6		SM	0	
		6-8		SM	0	
		8-10		SW-SM	0	
		10-12	10-12	SM	4.2	
		12-14		SW-SM	2.3	
		14-16		SW-SM	15.4	
		16-18		SW-SM	13.5	
57M-95-04A	13	1.5-3.5		OL/SP	0.2	
57M-95-04B	32	0-2		OL/SP	0.2	
		2-4	2-4	ML/SP	0.2	
		5-7		SP	0.2	
		10-12		SP	0.2	
		15-17		SP	0.2	
		20-22		SP	0.2	
		25-27		SP	0.2	
		30-32		SP	0.2	
57M-95-05X	20	0-2		SM	0	
		5-7		SM/SW	0	
		10-12		SW-SM	0	
		12-14		SW-SM	0.4	
		14-16	14-16	SW-SM	0.4	
57M-95-06X	23	0-2		SM/SP	0.2	
		5-7		SP	0.2	
		10-12		SP	0.2	
		15-17		SP	0.2	
		20-23		SP	0.2	
57M-95-07X	14	0-2		SM/ML	8.7	
		2-4		SM	4.9	
		4-6	4-6	SW-SM	0	
		6-8		SW-SM	4.2	
		8-10		SW-SM	1.1	
		10-12		SW-SM	3.4	
		12-14		SW-SM	0.3	
57M-95-08A	15	0-7				See boring 57M-95-08B
		7-9	7-9	SW-SM	0	
		9-15				See boring 57M-95-08B

TABLE 5-8
SUMMARY OF SOIL BORINGS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPLORATION ID	COMPLETION DEPTH (Feet bgs)	REFERENCE SAMPLE INTERVALS (Feet bgs)	OFF-SITE LABORATORY ANALYTICAL SAMPLES COLLECTED	SOIL TYPE (USCS)	TOTAL VOCS BY PID (PPM)	COMMENTS
57M-95-08B	30	0-2		SM-ML	0	
		2-4		SM	1.1	
		4-6	4-6	SM	0	
		6-8		SW-SM	0	
		8-10		SW-SM	0	
		10-12		SW-SM	0	
		12-14		SM	0	
		14-16		SM	0	
		16-18		SM	0	
		18-20		SM	0	
		20-22		SM	0	
		22-24		SM	0	
		24-26				No recovery
		26-28		SM	0	
		28-30		SM	0	
57P-95-01A, -01B	17	0-2		SW-SM	0	
		5-7		SW-SM	0	
		10-12		SM	0	
		15-17		SW-SM	0	
REMEDIAL INVESTIGATION MOD 001						
57B-96-07X	12	0-2	0-2	SP	230	
		5-7	5-7	SP	300	
		10-12		SP	11	
57B-96-08X	12	0-2	0-2	SW	0.4	
		5-7	5-7	SP	0	
		10-12		SM	1	
57B-96-09X	12	0-2	0-2	SM	0	
		5-7	5-7	SP	0	
		10-12		SP	0	
57B-96-10X	17	5-7	5-7	SP	0	
		10-12	10-12	SP	0	
		15-17		SP	0	
57B-96-11X	17	5-7	5-7	SP	0	
		10-12	10-12	SP	0	
		15-17		SP	0	
57B-96-12X	5				64	
57M-96-09X	21	0-2		SM	0	
		4-6		SP-SM	0	
		9-11		SP	0	
		14-16	14-16	SP	0	
		19-21		SP	0	
57M-96-10X	13	5-7	5-7	SM	0	
57M-96-11X	12	5-7	5-7	SM	0.4	
57M-96-12X	12	5-7	5-7	SM	0	
57M-96-13X	12	5-7	5-7	SM	0	

NOTES:
NR = Not recorded
USCS = Unified Soil Classification System
SW = Well graded sand
SP = Poorly graded sand
SM = Silty sand
OL = Organic soils
ppm = Parts per million

TABLE 5-9
MONITORING WELL COMPLETION DETAILS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

WELL IDENTIFICATION	SOIL DRILLING METHOD	MEDIA SCREENED (USCS)	WELL SCREEN DEPTH (Feet bgs)	WELL SCREEN ELEVATION (Feet MSL)	COMPLETION DEPTH (Feet bgs)	CONSTRUCTION MATERIAL
PREVIOUS INVESTIGATIONS						
G3M-92-02X	HSA	SP	21-31	230.0-220.0	31	4" ID PVC
G3M-92-07X	HSA	SP	22-32	229.9-219.9	32	4" ID PVC
REMEDIAL INVESTIGATION						
57M-95-01X	HSA	SP	19-29	226.7-216.7	29	4" ID PVC
57M-95-02X	HSA	SW	14-24	226.0-216	25	4" ID PVC
57M-95-03X	HSA	SW-SM	7-17	225,5-215.5	18	4" ID PVC
57M-95-04A	HSA	SP	2.4-12.4	220.3-210.3	13	4" ID PVC
57M-95-04B	HSA	SP	18.5-28.5	203.9-193.9	30	4" ID PVC
57M-95-05X	HSA	SW-SM	10-20	224.9-214.9	20	4" ID PVC
57M-95-06X	HSA	SP	11.9-21.9	222.5-212.5	23	4" ID PVC
57M-95-07X	HSA	SW-SM	3-13	220.4-210.4	14	4" ID PVC
57M-95-08A	HSA	SW-SM	3-13	219.7-209.7	15	4" ID PVC
57M-95-08B	HSA	SM	18-28	204.2-194.2	30	4" ID PVC
57P-95-01A	HSA	SW-SM	2-5	220-217	15	1" ID PVC
57P-95-01B	HSA	SM	10-15	212-207	15	1" ID PVC
REMEDIAL INVESTIGATION MOD 001						
57M-96-09X	HSA	SP	12.8-22.8	227.4-217.4	23	2" ID PVC
57M-96-10X	HSA	SM	3-13	224.1-214.1	13	2" ID PVC
57M-96-11X	HSA	SM	2-12	220.2-210.2	12	2" ID PVC
57M-96-12X	HSA	SM	2-12	222.8-212.8	12	2" ID PVC
57M-96-13X	HSA	SM	2-12	223.1-213.1	12	2" ID PVC
Supplemental Investigation						
57P-98-02X	Hand Auger	SP-SM	0.3-2.3	220.1-218.1	2.3	1" ID PVC
57P-98-03X	Hand Auger	SP	2.5-5.5	218.0-215.0	5.5	1" ID PVC
57P-98-04X	Hand Auger	SP	2-5	218.3-215.3	5	1" ID PVC

Notes:

NA= Not Applicable
HSA= Boring advanced with hollow stem auger.
USCS = Unified Soil Classification System
SW = Well graded sand
SP = Poorly graded sand
SM = Silty Sand

MSL = Mean Sea Level
ID = Inside Diameter
PVC = Polyvinyl Chloride

TABLE 6-1
SUMMARY OF WATER LEVEL ELEVATION DATA
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

WELL ID	REF. POINT	ELEV. OF REF POINT (FEET MSL)	DECEMBER 7, 1995		MARCH 26, 1996		JULY 23, 1996	
			DEPTH TO WATER (FEET)	ELEV. OF WATER (FEET MSL)	DEPTH TO WATER (FEET)	ELEV. OF WATER (FEET MSL)	DEPTH TO WATER (FEET)	ELEV. OF WATER (FEET MSL)
G3M-92-02X	PVC	251.00	26.28	224.72	25.50	225.5	24.81	226.19
G3M-92-07X	PVC	251.88	26.93	224.95	26.12	225.76	25.28	226.6
57M-95-01X	PVC	248.19	23.64	224.55	22.86	225.33	22.33	225.86
57M-95-02X	PVC	242.16	18.06	224.1	17.37	224.79	17.09	225.07
57M-95-03X	PVC	234.97	11.12	223.85	9.57	225.4	10.02	224.95
57M-95-04A	PVC	223.83	3.01	220.82	2.72	221.11	2.75	221.08
57M-95-04B	PVC	224.67	3.84	220.83	3.54	221.13	3.58	221.09
57M-95-05X	PVC	237.31	15.34	221.97	14.89	222.42	15.77	221.54
57M-95-06X	PVC	236.56	13.56	223	12.81	223.75	12.72	223.84
57M-95-07X	PVC	224.57	3.35	221.22	3.03	221.54	3.01	221.56
57M-95-08A	PVC	224.11	2.92	221.19	2.64	221.47	2.66	221.45
57M-95-08B	PVC	224.70	3.69	221.01	3.34	221.36	3.35	221.35
57M-96-09X	PVC	242.62	-	-	-	-	-	-
57M-96-10X	PVC	229.55	-	-	-	-	-	-
57M-96-11X	PVC	224.38	-	-	-	-	-	-
57M-96-12X	PVC	227.87	-	-	-	-	-	-
57M-96-13X	PVC	227.73	-	-	-	-	-	-
57P-95-01A	PVC	223.29	3.79	219.5	2.64	220.65	2.66	220.63
57P-95-01B	PVC	223.10	3.35	219.75	2.17	220.93	2.18	220.92
57P-98-02X	PVC	222.82	-	-	-	-	-	-
57P-98-03X	PVC	222.49	-	-	-	-	-	-
57P-98-04X	PVC	223.06	-	-	-	-	-	-

NOTES:
ELEV. = Elevation
MSL = Mean Sea Level
PVC = Top of Polyvinyl Chloride well riser

TABLE 6-1
SUMMARY OF WATER LEVEL ELEVATION DATA
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

WELL ID	JANUARY 15, 1997		JUNE 2, 1997		SEPTMEBER 23, 1998	
	DEPTH TO WATER (FEET)	ELEV. OF WATER (FEET MSL)	DEPTH TO WATER (FEET)	ELEV. OF WATER (FEET MSL)	DEPTH TO WATER (FEET)	ELEV. OF WATER (FEET MSL)
G3M-92-02X	24.29	226.71	24.21	226.79	25.26	225.74
G3M-92-07X	24.72	227.16	24.61	227.27	25.72	226.16
57M-95-01X	21.87	226.32	21.87	226.32	22.72	225.47
57M-95-02X	16.76	225.4	16.75	225.41	17.25	224.91
57M-95-03X	10.09	224.88	10.42	224.55	10.66	224.31
57M-95-04A	2.58	221.25	2.58	221.25	2.64	221.19
57M-95-04B	3.40	221.27	3.38	221.29	3.49	221.18
57M-95-05X	14.49	222.82	14.51	222.8	14.77	222.54
57M-95-06X	12.41	224.15	12.52	224.04	13.06	223.5
57M-95-07X	2.81	221.76	2.82	221.75	2.93	221.64
57M-95-08A	2.44	221.67	2.53	221.58	2.46	221.65
57M-95-08B	3.13	221.57	3.15	221.55	3.35	221.35
57M-96-09X	16.65	225.97	16.80	225.82	18.08	224.54
57M-96-10X	6.43	223.12	6.80	222.75	5.91	223.64
57M-96-11X	3.29	221.09	3.37	221.01	3.16	221.22
57M-96-12X	4.39	223.48	4.47	223.4	4.81	223.06
57M-96-13X	4.28	223.45	4.38	223.35	4.62	223.11
57P-95-01A	2.58	220.71	2.59	220.7	2.62	220.67
57P-95-01B	2.04	221.06	2.06	221.04	2.15	220.95
57P-98-02X	-	-	-	-	2.61	220.21
57P-98-03X	-	-	-	-	2.32	220.17
57P-98-04X	-	-	-	-	2.91	220.15

NOTES:
ELEV. = Elevation
MSL = Mean Sea Le
PVC = Top of Polyv

TABLE 6-2
SUMMARY OF HYDRAULIC CONDUCTIVITY TEST RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

									Bouwer and Rice		Hvorslev		
Well ID	Well Diam. (in)	Screen Int. (feet, bgs)	Filter Pack Int. (feet, bgs)	Saturated Height (feet)	Rc (feet)	Rw (feet)	Le (feet)	Hw (feet)	Hydraulic Cond. (ft/min)	Hydraulic Cond. (cm/s)	Hydraulic Cond. (ft/min)	Hydraulic Cond. (cm/s)	Screened Geology (USCS)
57M-95-01X	4	19 to 29	13 to 29	7.09	0.29	0.46	7.09	7.09	2.40E-01	1.22E-01	2.49E-02	1.26E-02	SP
57M-95-02X	4	14 to 24	9 to 25	8.81	0.29	0.46	9.81	9.81	1.80E-01	9.14E-02	1.61E-02	8.17E-03	SW-SM
57M-95-03X	4	7 to 17	5 to 18	9.51	0.29	0.46	10.51	10.51	1.10E-02	5.59E-03	1.04E-03	5.27E-04	SW-SM
57M-95-04A	4	2.4 to 12.4	1.9 to 13	10.15	0.29	0.46	10.75	10.75	5.70E-02	2.90E-02	5.70E-03	2.90E-03	SP
57M-95-04B	4	18.5 to 28.5	13 to 30	27.31	0.17	0.46	17	28.81	2.30E-02	1.17E-02	5.77E-03	2.93E-03	SP
57M-95-05X	4	10 to 20	6 to 20	7.09	0.29	0.46	7.09	7.09	1.00E-01	5.08E-02	1.01E-02	5.14E-03	SW-SM
57M-95-06X	4	11.9 to 21.9	8 to 23	11.22	0.29	0.46	12.32	12.32	1.70E-02	8.64E-03	1.66E-03	8.42E-04	SP
57M-95-07X	4	3 to 13	2 to 14	11.37	0.29	0.46	12.37	12.37	6.70E-02	3.40E-02	7.00E-03	3.56E-03	SW-SM
57M-95-08A	4	3 to 13	2 to 15	11.32	0.29	0.46	13	13.32	8.30E-04	4.22E-04	8.42E-05	4.28E-05	SW-SM
57M-95-08B	4	18 to 28	13 to 30	26.64	0.17	0.46	17	28.64	7.40E-03	3.76E-03	2.02E-03	1.03E-03	SM
57M-96-09X	2	12.8 to 22.8	8 to 23	8.53	0.2	0.33	8.73	8.73	8.15E-03	4.14E-03	4.18E-04	2.13E-04	SP
57M-96-10X	2	3 to 13	2 to 13	9.03	0.2	0.33	9.03	9.03	1.36E-03	6.89E-04	4.39E-05	2.23E-05	SM
57M-96-11X	2	2 to 12	1.5 to 12	10.91	0.2	0.33	10.91	10.91	2.11E-03	1.07E-03	1.28E-04	6.53E-05	SM
57M-96-12X	2	2 to 12	1.5 to 12	10.66	0.2	0.33	10.66	10.66	2.60E-03	1.32E-03	1.20E-04	6.10E-05	SM
57M-96-13X	2	2 to 12	1.5 to 12	10.39	0.2	0.33	10.39	10.39	2.96E-03	1.50E-03	1.62E-04	8.24E-05	SM
								Geom. Mean	**1.34E-02**	**6.79E-03**	**1.18E-03**	**6.01E-04**	
								Average	4.80E-02	2.44E-02	5.02E-03	2.55E-03	

Notes:

Hydraulic conductivities for 1996-series wells are the average of results of two rising head tests.

Data analyzed using AQTESOLV (Bouwer & Rice Solution).

Rc = Well casing radius for fully saturated filterpacks and equivalent casing radius which accounts for filterpack resaturation at n=30% for partially saturated filterpacks.

Rw = Radius of borehole.

Le = Saturated length of filterpack.

Hw = Height of Water Column above filterpack bottom.

Saturated Height is height of water column measured in well.

All measurements in feet unless otherwise noted.

USCS = Unified Soil Classification

SW = Well Graded Sand.

SP = Poorly Graded Sand.

SM = Silty Sand.

SW-SM = Well graded sand with silt

TABLE 7-7
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57B	lower - bottom	08-26-94	2	12,168	1.79 Aroclor 1260
SBSA57W	lower - SW sidewall	08-26-94	0.9	46,876	
SBSA57W1	lower - NE sidewall	08-29-94	0.5	547	
SBSA57W2	lower - SE sidewall	08-29-94	0.8	181	
SBSA57W3	lower - SE sidewall	08-29-94	0.7	634	
SBSA57W4	lower - SE sidewall	08-29-94	0.4	277	
SBSA57W5	lower - SE sidewall	08-29-94	0.1	139	
SBSA57W6	lower - SE sidewall	08-29-94	0.5	746	
SBSA57W7	lower - SW sidewall	08-29-94	0.1	945	
SBSA57W8	lower - SW sidewall	08-29-94	0.2	19,049	
SBSA57W9	lower - SW sidewall	08-29-94	0.7	31,816	0.64 Aroclor 1260
SBSA57W10	lower - NE sidewall	08-29-94	0.7	987	
SBSA57W11	lower - NE sidewall	08-29-94	1.5	46,658	0.60 Aroclor 1260
SBSA57B1	lower - bottom	08-29-94	1.5	5,356	
SBSA57B2	lower - bottom	08-29-94	1.8	7,020	
SBSA57B3	lower - bottom	08-29-94	2.1	1,739	
SBSA57B4	lower - bottom	08-29-94	2.2	12,348	ND Aroclor 1260
SBSA57B5	lower - bottom	08-29-94	1.7	17,635	
SBSA57B6	lower - bottom	08-29-94	1.8	33,764	
SBSA57B7	lower - bottom	08-29-94	2	33,806	0.92 Aroclor 1260
SBSA57B8	lower - bottom	08-29-94	2.1	25,935	
SBSA57JB	middle - SW sidewall	08-29-94	NA	173,974	excavator bucket
SBSA57T2B	upper - SW trench	08-30-94	3	ND	
SBSA57T2A	upper - SW trench	08-30-94	2.9	1,429	

TABLE 7-7
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57T1B	upper - NE trench	08-30-94	2.5	ND	
SBSA57T1A	upper - NE trench	08-30-94	3	5,272	
SBSA57T1	lower - SE trench	09-01-94	2.5	2,289	
SBSA57T2	lower - SE trench	09-01-94	2.5	2,494	
SBSA57T3	lower - SE trench	09-01-94	2.5	74,208	
SBSA57T4	lower - SE trench	09-01-94	2.5	62,010	
SBSA57T5	lower - SE trench	09-01-94	2	10,237	
SBSA57T6	lower - SE trench	09-01-94	2.5	119	
SBSA57TP1	lower - NE test pit	09-01-94	NA	50,119	excavator bucket
SBSA57B30	middle - bottom	09-02-94	2.5	3,508	0.21 Aroclor 1260
SBSA57W30	middle - NE sidewall	09-02-94	2	2,604	
SBSA57W31	middle - NE sidewall	09-02-94	2	ND	
SBSA57W32	middle - NE sidewall	09-02-94	2	7,588	
SBSA57W34	middle - SW sidewall	09-02-94	2	969	
SBSA57T3B1	lower - SE test pit	09-06-94	3.7	ND	
SBSA57T3B2	lower - SE test pit	09-06-94	3.7	65	
SBSA57T3W1	lower - SE test pit	09-06-94	2.7	947	
SBSA57T3W2	lower - SE test pit	09-06-94	2.7	46,546	0.12 Aroclor 1260
SBSA57T3T	lower - SE test pit	09-06-94	NA	1,316	excavator bucket
SBSA57H1B1	lower - SE test pit	09-06-94	2.3	1,331	
SBSA57T4B1	lower - E test pit	09-06-94	3.5	20,418	0.2 Aroclor 1260
SBSA57T4W1	lower - E test pit	09-06-94	2.5	158	
SBSA57T5B1	lower - NE test pit	09-06-94	4	38,746	
SBSA57T5B2	lower - NE test pit	09-06-94	3.5	24,352	

TABLE 7-7
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57T6B1	lower - NE test pit	09-06-94	3.5	25	
SBSA57T6B2	lower - NE test pit	09-06-94	4	557	
SBSA57T7B1	lower - SE test pit	09-06-94	3.5	ND	
SBSA57T7W1	lower - SE test pit	09-06-94	NA	1,464	Entire wall scraped
SBSA57T8B1	lower - SE test pit	09-06-94	3.5	ND	
SBSA57T8W1	lower - SE test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T9B1	lower - S test pit	09-06-94	3.5	ND	
SBSA57T9W1	lower - S test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T10B1	lower - S test pit	09-06-94	3.5	1,686	
SBSA57T10W1	lower - S test pit	09-06-94	NA	10,491	Entire wall scraped
SBSA57T11B1	lower - S test pit	09-06-94	3.5	ND	
SBSA57T11W1	lower - S test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T12B1	lower - S test pit	09-06-94	3.5	ND	
SBSA57T12W1	lower - S test pit	09-06-94	NA	58	Entire wall scraped
SBSA57T13B1	lower - SW test pit	09-06-94	3.5	3,792	
SBSA57T13W1	lower - SW test pit	09-06-94	NA	1,980	Entire wall scraped
SBSA57T14B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T14W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T15B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T15W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T16B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T16W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T17B1	middle - SW test pit	09-06-94	3.5	ND	
SBSA57T17W1	middle - SW test pit	09-06-94	NA	ND	Entire wall scraped

TABLE 7-7
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57W35A	middle - SW sidewall	09-07-94	2.7	23	
SBSA57W36	upper - SW sidewall	09-07-94	1	90	
SBSA57W37	upper - NE sidewall	09-07-94	1	273	
SBSA57W38	upper - SW sidewall	09-07-94	0.5	553	
SBSA57W39	upper - NE sidewall	09-07-94	0.7	23	
SBSA57W40	upper - SW sidewall	09-07-94	1	13	
SBSA57W41	upper - NE sidewall	09-07-94	1	147	
SBSA57W42	upper - SW sidewall	09-07-94	0.7	313	
SBSA57W43	middle - NE sidewall	09-07-94	1.8	3,914	
SBSA57W44	middle - SW sidewall	09-07-94	1	3,843	
SBSA57W45	middle - NE sidewall	09-07-94	2.1	1,042	
SBSA57W46	middle - NE sidewall	09-07-94	2.3	4,464	
SBSA57W47	middle - NE sidewall	09-07-94	2.1	509	
SBSA57B31	middle - bottom	09-07-94	3.5	14,800	
SBSA57B32	upper - bottom	09-07-94	1	55	
SBSA57B33	upper - bottom	09-07-94	1	14	
SBSA57B34	upper - bottom	09-07-94	1	34	
SBSA57B35	middle - bottom	09-07-94	1.3	142	
SBSA57B36	middle - bottom	09-07-94	1.3	2,109	
SBSA57B37	middle - bottom	09-08-94	4	8,264	
SBSA57B38	middle - bottom	09-08-94	3.8	483	
SBSA57B39	middle - bottom	09-08-94	3.7	ND	
SBSA57W48	middle - NE sidewall	09-08-94	2.4	9	

TABLE 7-7
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (μg/g)	COMMENTS
SBSA57W52	middle - NE sidewall	09-08-94	2.8	813	
SBSA57W53	middle - NE sidewall	09-08-94	3.7	8	
SBSA57B41	middle - bottom	09-09-94	4.5	874	
SBSA57B42	middle - bottom	09-09-94	3	564	
SBSA57B43	middle - bottom	09-09-94	2.5	840	
SBSA57B44	middle - bottom	09-09-94	1.5	45	
SBSA57B45	middle - bottom	09-09-94	6	ND	
SBSA57W54	middle - SW sidewall	09-09-94	2.5	984	
SBSA57W55	middle - SW sidewall	09-09-94	3	336	
SBSA57W56	middle - SW sidewall	09-09-94	2.5	17	
SBSA57W57	middle - SW sidewall	09-09-94	3	503	
SBSA57W58	middle - SW sidewall	09-09-94	2.5	710	
SBSA57W59	upper - SW sidewall	09-09-94	2	1,427	
SBSA57W60	upper - SW sidewall	09-09-94	2.3	775	
SBSA57W61	upper - NE sidewall	09-09-94	1	ND	
SBSA57W62	upper - SW sidewall	09-09-94	1.3	206	
SBSA57W63	upper - SW sidewall	09-09-94	1	77	
SBSA57W64	upper - NE sidewall	09-09-94	1.5	1,298	
SBSA57W65	middle - NE sidewall	09-09-94	4	848	
SBSA57W66	middle - NE sidewall	09-09-94	5	7	
SBSA57W67	middle - NE sidewall	09-09-94	4	206	
SBSA57W68	middle - NE sidewall	09-09-94	5	ND	
SBSA57W69	middle - NE sidewall	09-09-94	4	ND	
SBSA57W70	middle - NE sidewall	09-09-94	5	ND	

TABLE 7-7
OHM SOIL REMOVAL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION[1] GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57TP1B	middle- bottom test pit	09-09-94	7.5	9,671	
SBSA57TP1W1	middle- bottom test pit	09-09-94	5.5	539	
SBSA57TP1W2	middle- bottom test pit	09-09-94	6.5	13,353	
SBSA57TP2B	middle- bottom test pit	09-09-94	6	2,227	
SBSA57TP2W1	middle- bottom test pit	09-09-94	4	ND	
SBSA57TP2W2	middle- bottom test pit	09-09-94	5	ND	
SBSA57TP3B	upper- bottom test pit	09-09-94	5	9,223	
SBSA57TP3W1	upper- bottom test pit	09-09-94	3	5,959	
SBSA57TP3W2	upper- bottom test pit	09-09-94	4	13,119	
SBSA57TP4B	upper- bottom test pit	09-09-94	5.5	549	
SBSA57TP4W1	upper- bottom test pit	09-09-94	3.5	ND	
SBSA57TP4W2	upper- bottom test pit	09-09-94	4.5	ND	
SBSA57TP5B	middle- bottom test pit	09-09-94	9	5,521	
SBSA57TP5W1	middle- bottom test pit	09-09-94	8	9,682	
SBSA57TP5W2	middle- bottom test pit	09-09-94	7	13,908	

NOTES:

[1] Sample location is subdivided into general and specific location - "general" refers to which part of Area 2 (lower is closer to wetland); "specific" refers to whether it was a bottom, sidewall , or testpit sample - refer to Figures 5-3 and 5-4.

ND - Indicates non-detect

NA – Not applicable

Note - Depths are approximate

TABLE 7-8
OHM SOIL REMOVAL OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Sample ID	**SBSA571**	**SBSA572**	**SBSA573**	**LSSA571**	**LSSA5702**	**SBSA57CH1**
Date Collected	**08-29-94**	**08-29-94**	**08-29-94**	**08-31-94**	**09-01-94**	**09-01-94**
Matrix	**Soil**	**Soil**	**Soil**	**Oil**	**Oil**	**Soil**
Fuel ID	N/A	N/A	N/A	30% Kerosene	N/A	Kerosene
				70%Lube Oil		Light Lube Oil
TPH[1] (mg/kg)						
light range	1050	624	716	N/A	4000	1380
medium range	3610	3140	2270	N/A	86800	4090
heavy range	36000	35100	26300	N/A	663000	44600
Metals (mg/kg)						
Aluminum	5200	2900	3640	N/A	410	5170
Arsenic	7.8	9.3	7.3	N/A	ND	8.3
Barium	183	37.1	35.8	N/A	53.6	81.1
Cadmium	5.4	ND	ND	N/A	ND	2.5
Calcium	908	322	301	N/A	ND	1010
Chromium	19.7	23.4	19	N/A	12.2	12.8
Copper	53.6	13.2	12.8	N/A	14.4	39.4
Iron	5130	2710	3640	N/A	37.8	4330
Lead	464	199	137	N/A	64.5	306
Magnesium	704	457	734	N/A	ND	536
Manganese	52.6	23.7	32.1	N/A	ND	69.4
Nickel	7.7	5	5.8	N/A	ND	6.6
Potassium	197	155	198	N/A	ND	146
Vanadium	8	ND	6.5	N/A	ND	5.9
Zinc	438	33	41.3	N/A	5.1	139

TABLE 7-8
OHM SOIL REMOVAL OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Sample ID	SBSA571	SBSA572	SBSA573	LSSA571	LSSA5702	SBSA57CH1
Date Collected	08-29-94	08-29-94	08-29-94	08-31-94	09-01-94	09-01-94
Matrix	Soil	Soil	Soil	Oil	Oil	Soil
Volatiles (mg/kg)						
Ethylbenzene	9.4	ND	ND	N/A	ND	ND
Toluene	12.9	ND	ND	N/A	ND	6.53
Xylenes	63.8	11.6	5.3	N/A	13	25.4
PCBs (mg/kg)						
Aroclor 1242	N/A	N/A	N/A	N/A	29.7	5.8
Aroclor 1254	N/A	N/A	N/A	N/A	28.4	ND
Aroclor 1260	N/A	N/A	N/A	N/A	81.9	4.6

NOTES:
[1] TPH was determined by GC analysis not IR
mg/kg = milligrams per kilogram
N/A = not applicable
ND = compound not detected

TABLE 7-9
AREA 1 SOIL REMOVAL ANALYTICAL RESULTS ABOVE REGULATORY LEVELS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Sample Identification	Compound	Concentration µg/g	MCP S-1/GW-1 Regulatory Level (µg/g)
AOC57-A1-SW1	**PAHs**		
	Benzo(a)anthracene	2.36	0.7
	Benzo(b)fluoranthene	4.4	0.7
	Benzo(a)pyrene	2.11	0.7
	Indeno(1,2,3-cd)pyrene	1.75	0.7
AOC57-A1-SW2	**EPH**		
	C_{10}-C_{22} Aromatics	532	200
	PAHs		
	Benzo(a)anthracene	7.53	0.7
	Benzo(a)pyrene	8.15	0.7
	Chrysene	10.7	7
	Dibenzo(a,h)anthracene	2.47	0.7
	Indeno(1,2,3-cd)pyrene	6.0	0.7
AOC57-A1-SW4	**PAHs**		
	Benzo(a)anthracene	3.07	0.7
	Benzo(b)fluoranthene	6.69	0.7
	Benzo(a)pyrene	3.44	0.7
	Dibenzo(a,h)anthracene	1.13	0.7
	Indeno(1,2,3-cd)pyrene	3.02	0.7
AOC57-A1-SW1/B	**PAHs**		
	Benzo(a)anthracene	2.0	0.7
	Benzo(b)fluoranthene	2.8	0.7
	Benzo(a)pyrene	2.4	0.7
	Indeno(1,2,3-cd)pyrene	1.8	0.7
AOC57-A1-SW4/B	**PAHs**		
	Benzo(a)anthracene	5.1	0.7
	Benzo(a)pyrene	6.1	0.7
	Benzo(b)fluoranthene	6.1	0.7
	Indeno(1,2,3-cd)pyrene	4.7	0.7

Notes:
µg/g = micrograms per gram
MCP = Massachusetts Contingency Plan
PAHs = polyaromatic hydrocarbons
EPH = extractable petroleum hydrocarbons

TABLE 7-10
RI TEST PIT SOIL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2									
	Lab Sample ID:	57E-95-01X	57E-95-01X	57E-95-01X	57E-95-01X	57E-95-02X	57E-95-02X	57E-95-02X	57E-95-03X	57E-95-03X	57E-95-03X
	Date analyzed:	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95
	Depth (bgs):	0	2	6	9	0	5	10	0	2	5
	Dilution:	1.03	1.1	1.05	1.04	1.14	1.12	1.03	1.08	1.14	1.03
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/kg/250 µg/kg	5.2 U	5.5 U	5.3 U	5.2 U	5.7 U	5.6 U	5.2 U	5.4 U	5.7 U	5.2 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.1 UJ	2.2 UJ	2.1 UJ	2.1 UJ	2.3 UJ	2.2 UJ	2.1 UJ	2.2 UJ	2.3 UJ	2.1 UJ
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
Trichloroethene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.1 UJ	2.2 UJ	2.1 UJ	2.1 U	2.3 UJ	2.2 U	2.1 UJ	2.2 UJ	2.3 U	2.1 UJ
Toluene	2 µg/kg/250 µg/kg	2.1 U	3.2	2.1 U	2.1 UJ	2.3 U	2.2 UJ	2.1 U	2.3	2.3 UJ	2.1 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
m/p-Xylene	4 µg/kg/500 µg/kg	4.1 U	4.4 U	4.2 U	4.2 U	4.6 U	4.5 U	4.1 U	4.3 U	4.6 U	4.1 U
o-Xylene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	100 U	110 U	110 U	100 U	110 U	110 U	100 U	110 U	110 U	100 U
TPH-IR (1995)	50 mg/kg	52 U	73	53 U	52 U	69	56 U	52 U	54 U	57 U	52 U
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Detection limits are reported for 1995/1996 field programs.

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting limit

NA = Not analyzed

TABLE 7-10
RI TEST PIT SOIL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2									
	Lab Sample ID:	57E-95-03X	57E-95-04X	57E-95-04X	57E-95-04X	57E-95-05X	57E-95-05X	57E-95-05X	57E-95-06X	57E-95-06X	57E-95-06X
	Date analyzed:	29-Sep-95	9-Oct-95	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	Sep-95	29-Sep-95	29-Sep-95	29-Sep-95
	Depth (bgs):	10	0	5	12	0	6	13	0	6	11
	Dilution:	1.03	1.05	1.04	1.04	1.11	1.02	1.03	1.06	1.03	1.05
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/kg/250 µg/kg	5.2 U	NA	5.2 U	5.2 U	5.6 U	5.1 U	5.2 U	5.3 U	5.2 U	5.3 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/kg/250 µg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	2.1 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.1 UJ	NA	2.1 UJ	2.1 UJ	2.2 UJ	2.0 U	2.1 UJ	2.1 UJ	2.1 UJ	2.1 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	2.1 U
Trichloroethene	2 µg/kg/250 µg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	2.1 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	2.1 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.1 UJ	NA	2.1 U	2.1 U	2.2 UJ	2.0 U	2.1 U	2.1 U	2.1 U	2.1 U
Toluene	2 µg/kg/250 µg/kg	2.1 U	NA	2.1 UJ	2.1 UJ	2.2 U	2.0 UJ	2.1 UJ	2.5 J	2.1 UJ	2.4 J
Chlorobenzene	2 µg/kg/250 µg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	2.3
Ethylbenzene	2 µg/kg/250 µg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	22 E
m/p-Xylene	4 µg/kg/500 µg/kg	4.1 U	NA	4.2 U	4.2 U	4.4 U	4.1 U	4.1 U	4.2 U	4.1 U	22 E
o-Xylene	2 µg/kg/250 µg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	25 E
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	100 U	NA	100 U	100 U	110 U	100 U	100 U	110 U	100 U	110 U
TPH-IR (1995)	50 mg/kg	52 U	53 U	52 U	52 U	56 U	51 U	52 U	53 U	52 U	53 U
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Detection limits are reported for 1995/1996 field prog
U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed

TABLE 7-10
RI TEST PIT SOIL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2									
	Lab Sample ID:	57E-95-07X	57E-95-07X	57E-95-07X	57E-95-08X	57E-95-08X	57E-95-08X	57E-95-09X	57E-95-09X	57E-95-09X	57E-95-10X
	Date analyzed:	29-Sep-95	4-Oct-95	4-Oct-95	3-Oct-95	Oct-95	4-Oct-95	4-Oct-95	4-Oct-95	4-Oct-95	29-Sep-95
	Depth (bgs):	0	4	7	0	4	6	0	5	8	0
	Dilution:	1.11	390	2.5	1.43	1.49	1.18	1.1	1.37	1.22	1.11
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/kg/250 µg/kg	5.6 U	6100 E	13 U	7.2 U	7.5 U	5.9 U	5.5 U	6.9 U	6.1 U	5.6 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/kg/250 µg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.2 UJ	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U
Trichloroethene	2 µg/kg/250 µg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U
Toluene	2 µg/kg/250 µg/kg	2.2 UJ	3400	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.4 J
Chlorobenzene	2 µg/kg/250 µg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.2 U	14000	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U
m/p-Xylene	4 µg/kg/500 µg/kg	4.4 U	56000	10 U	5.7 U	6.0 U	4.7 U	4.4 U	5.5 U	4.9 U	4.4 U
o-Xylene	2 µg/kg/250 µg/kg	2.2 U	36000	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	110 U	8.6 e+ 6E	250	140 U	150 U	120 U	110 U	140 U	120 U	110 U
TPH-IR (1995)	50 mg/kg	61	65000	130 U	1400	75 U	59 U	55 U	69 U	61 U	80
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Detection limits are reported for 1995/1996 field prog

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reportin

NA = Not analyzed

TABLE 7-10
RI TEST PIT SOIL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2									
	Lab Sample ID:	57E-95-10X	57E-95-10X	57E-95-11X	57E-95-11X	57E-95-11X	57E-95-12X	57E-95-12X	57E-95-12X	57E-95-13X	57E-95-13X
	Date analyzed:	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	3-Oct-95	3-Oct-95	4-Oct-95	3-Oct-95	3-Oct-95
	Depth (bgs):	6	10	0	6	13	0	4	13	0	5
	Dilution:	1.05	1.02	1.04	1.04	1.03	1.08	3.12	1.33	1.23	1.19
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/kg/250 µg/kg	5.3 U	5.1 U	5.2 U	5.2 U	5.2 U	5.4 U	16 U	6.7 U	6.2 U	6.0 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/kg/250 µg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	6.2 U	2.7 U	2.5 U	2.4 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.1 UJ	2.0 U	2.1 U	2.1 U	2.1 UJ	2.2 U	6.2 U	2.7 U	2.5 U	2.4 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	6.2 U	2.7 U	2.5 U	2.4 U
Trichloroethene	2 µg/kg/250 µg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	6.2 U	2.7 U	2.5 U	2.4 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	6.2 U	2.7 U	2.5 U	2.4 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 UJ	2.2 U	6.2 U	2.7 U	2.5 U	2.4 U
Toluene	2 µg/kg/250 µg/kg	2.1 UJ	2.0 UJ	2.1 UJ	2.1 UJ	2.1 U	2.2 U	20	2.7 U	2.5 U	2.4 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	42	2.7 U	2.5 U	2.4 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	65	2.7 U	2.5 U	2.4 U
m/p-Xylene	4 µg/kg/500 µg/kg	4.2 U	4.1 U	4.2 U	4.2 U	4.1 U	4.3 U	97	5.3 U	4.9 U	4.8 U
o-Xylene	2 µg/kg/250 µg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	220	2.7 U	2.5 U	2.4 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	110 U	NA	NA	NA	NA
TPH-GRO	100 µg/kg	110 U	100 U	100 U	100 U	100 U	110 U	79000 E	130 U	120 U	120 U
TPH-IR (1995)	50 mg/kg	53 U	51 U	75	52 U	130	9700	1400	67 U	110	60 U
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Detection limits are reported for 1995/1996 field prog
U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed

TABLE 7-10
RI TEST PIT SOIL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2									
	Lab Sample ID:	57E-95-13X	57E-95-14X	57E-95-14X	57E-95-14X	57E-95-15X	57E-95-15X	57E-95-15X	57E-95-16X	57E-95-16X	57E-95-16X
	Date analyzed:	3-Oct-95	3-Oct-95	3-Oct-95	3-Oct-95	4-Oct-95	5-Oct-95	4-Oct-95	4-Oct-95	4-Oct-95	4-Oct-95
	Depth (bgs):	11	0	2	6	0	2	5	0	3	5
	Dilution:	1.22	1.03	1.69	1.2	1.32	1.64	1.12	1.25	1.04	1.43
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/kg/250 µg/kg	6.1 U	5.2 U	8.5 U	6.0 U	6.6 UJ	8.2 U	5.6 U	6.3 U	5.2 UJ	7.2 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	3.3 U	2.2 U	2.5 U	2.1 U	2.9 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	3.3 U	2.2 U	2.5 U	2.1 U	2.9 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	3.3 U	2.2 U	2.5 U	2.1 U	2.9 U
Trichloroethene	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	3.3 U	2.2 U	2.5 U	2.1 U	2.9 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	4.8	2.2 U	2.5 U	2.1 U	2.9 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	3.3 U	2.2 U	2.5 U	2.1 U	2.9 U
Toluene	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	5.6	2.2 U	2.5 U	65	2.9 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	16	2.2 U	2.5 U	2.1 U	2.9 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	54	2.2 U	2.5 U	7.9	2.9 U
m/p-Xylene	4 µg/kg/500 µg/kg	4.9 U	4.1 U	6.8 U	4.8 U	5.3 U	75	4.5 U	5.0 U	4.2 U	5.7 U
o-Xylene	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	170	2.2 U	2.5 U	2.1 U	2.9 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	120 U	NA	170 U	120 U	NA	900	NA	NA	NA	NA
TPH-GRO	100 µg/kg	120 U	100 U	170 U	120 U	130 U	49000 E	110 U	130 U	100 U	140 U
TPH-IR (1995)	50 mg/kg	61 U	52 U	160	60 U	5000	28000	56 U	120	8000	72 U
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Detection limits are reported for 1995/1996 field prog
U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed

TABLE 7-10
RI TEST PIT SOIL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2									
	Lab Sample ID:	57E-95-17X	57E-95-17X	57E-95-17X	57E-95-18X	57E-95-18X	57E-95-18X	57E-95-19X	57E-95-19X	57E-95-19X	57E-95-20X
	Date analyzed:	4-Oct-95	5-Oct-95	5-Oct-95	5-Oct-95	4-Oct-95	5-Oct-95	5-Oct-95	4-Oct-95	5-Oct-95	4-Oct-95
	Depth (bgs):	0	2	5	0	2	3	0	2	3	0
	Dilution:	1.23	1.45	5.9	1.43	1.28	1.25	1.02	1.39	1.28	1.08
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/kg/250 µg/kg	6.2 UJ	7.3 U	30 U	7.2 U	6.4 U	6.3 U	5.1 U	7.0 UJ	6.4 U	5.4 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/kg/250 µg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	4.9	2.0 U	2.8 U	2.6 U	2.2 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Trichloroethene	2 µg/kg/250 µg/kg	2.5 U	2.9 U	21	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Toluene	2 µg/kg/250 µg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.5 U	2.9 U	150	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.5 U	2.9 U	71	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
m/p-Xylene	4 µg/kg/500 µg/kg	4.9 U	5.8 U	72	5.7 U	5.1 U	5.0 U	4.1 U	5.6 U	5.1 U	4.3 U
o-Xylene	2 µg/kg/250 µg/kg	2.5 U	2.9 U	220	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	150 U	120	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	120 U	5800 E	52000 E	550	130 U	130 U	100 U	140 U	130 U	110 U
TPH-IR (1995)	50 mg/kg	3400	2000	620	72 U	64 U	63 U	68	70 U	64 U	54 U
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Detection limits are reported for 1995/1996 field prog

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reportin

NA = Not analyzed

TABLE 7-10
RI TEST PIT SOIL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2									
	Lab Sample ID: Date analyzed: Depth (bgs): Dilution:	57E-95-20X 4-Oct-95 3 1.05	57E-95-20X 4-Oct-95 5 1.16	57E-95-25X 28-Sep-95 0 1.03	57E-95-25X 28-Sep-95 2 1.12	57E-95-25X 28-Sep-95 12 1.03	57E-95-26X 28-Sep-95 0 1.03	57E-95-26X 28-Sep-95 5 1.04	57E-95-26X 6-Oct-95 11 1.04	57E-95-27X 6-Oct-95 0 1.07	57E-95-27X 6-Oct-95 2 1.12
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/kg/250 µg/kg	5.3 UJ	5.8 U	5.2 U	5.6 U	5.2 U	5.2 U	5.2 U	5.2 U	5.4 U	5.6 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Trichloroethene	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.5	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Toluene	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 UJ	2.1 U	2.1 U	2.2 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
m/p-Xylene	4 µg/kg/500 µg/kg	4.2 U	4.6 U	4.1 U	4.5 U	4.1 U	4.1 U	4.2 U	4.2 U	4.3 U	4.5 U
o-Xylene	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	110 U	120 U	100 U	110 U	100 U	100 U	100 U	100 U	110 U	110 U
TPH-IR (1995)	50 mg/kg	3400	58 U	52 U	480	52 U	260	52 U	52 U	98	82
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Detection limits are reported for 1995/1996 field prog
U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed

TABLE 7-10
RI TEST PIT SOIL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2	AREA 3								
	Lab Sample ID:	57E-95-27X	57E-95-21X	57E-95-21X	57E-95-21X	57E-95-22X	57E-95-22X	57E-95-22X	57E-95-23X	57E-95-23X	57E-95-23X
	Date analyzed:	6-Oct-95	5-Oct-95	5-Oct-95	5-Oct-95	6-Oct-95	5-Oct-95	5-Oct-95	6-Oct-95	5-Oct-95	5-Oct-95
	Depth (bgs):	12	0	6	10	0	4	10	0	4	10
	Dilution:	1.04	1.22	1.09	1.03	1.16	1.11	1.03	1.15	1.03	1.04
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/kg/250 µg/kg	5.2 U	6.1 U	5.5 U	5.2 U	5.8 U	5.6 U	5.2 U	5.8 U	5.2 U	5.2 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Trichloroethene	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Toluene	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.7	2.1 U	2.3 U	2.1 U	2.1 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
m/p-Xylene	4 µg/kg/500 µg/kg	4.2 U	4.9 U	4.4 U	4.1 U	4.6 U	4.4 U	4.1 U	4.6 U	4.1 U	4.2 U
o-Xylene	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	100 U	120 U	110 U	100 U	120 U	110 U	100 U	460	100 U	100 U
TPH-IR (1995)	50 mg/kg	52 U	160	55 U	52 U	58 U	56 U	52 U	58 U	52 U	52 U
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
Detection limits are reported for 1995/1996 field prog
U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed

TABLE 7-10
RI TEST PIT SOIL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3									
	Lab Sample ID:	57E-95-24X	57E-95-24X	57E-95-24X	57E-95-24X	57E-96-28X	57E-96-28X	57E-96-28X	57E-96-28X	57E-96-28X	57E-96-29X
	Date analyzed:	5-Oct-95	6-Oct-95	5-Oct-95	5-Oct-95	20-Aug-96	20-Aug-96	20-Aug-96	20-Aug-96	20-Aug-96	20-Aug-96
	Depth (bgs):	0	4	7	10	3	6	8	9	10	4
	Dilution:	1.09	1.27	1.04	1.25	130	138	134	159	155	131
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	260 U	280 U	270 U	320 U	310 U	260 U
1,1-DCE	5 µg/kg/250 µg/kg	5.5 U	6.4 U	5.2 U	6.3 U	260 U	280 U	270 U	320 U	310 U	260 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	260 U	280 U	270 U	320 U	310 U	260 U
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	260 U	280 U	270 U	320 U	310 U	260 U
Chloroform	2 µg/kg/250 µg/kg	2.2 U	2.5 U	6.2	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Trichloroethene	2 µg/kg/250 µg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Toluene	2 µg/kg/250 µg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.2 U	2.5 U	19	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.2 U	2.5 U	15	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
m/p-Xylene	4 µg/kg/500 µg/kg	4.4 U	5.7	20	5.0 U	520 U	560	540 U	640 U	620 U	520 U
o-Xylene	2 µg/kg/250 µg/kg	2.2 U	27	5.8	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	180	310	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	110 U	32000 E	33000 E	130 U	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	55 U	33000	6000	63 U	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	51 U	16000	1500	170	160	1200

Notes:
Detection limits are reported for 1995/1996 field prog
U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed

TABLE 7-10
RI TEST PIT SOIL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3									
	Lab Sample ID:	57E-96-29X	57E-96-29X	57E-96-29X	57E-96-29X	57E-96-30X	57E-96-30X	57E-96-30X	57E-96-30X	57E-96-30X	57E-96-30X
	Date analyzed:	20-Aug-96	20-Aug-96	20-Aug-96	20-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96
	Depth (bgs):	5	7	10	11	2	4	4D	5	5A	6
	Dilution:	135	138	158	153	135	138	138	140	131	130
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
1,1-DCE	5 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
t-1,2-DCE	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
c-1,2-DCE	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Chloroform	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
1,1,1-TCA	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Trichloroethene	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Tetrachloroethene	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Toluene	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Chlorobenzene	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Ethylbenzene	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	3000	260 U	490
m/p-Xylene	4 µg/kg/500 µg/kg	540 U	550 U	630 U	610 U	540 U	550 U	550 U	13000	580	2600
o-Xylene	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	8000	790	1200
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	4500	57 U	63	160	15000	15000	NA	53000 E	1000	8900

Notes:
Detection limits are reported for 1995/1996 field prog

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reportin

NA = Not analyzed

TABLE 7-10
RI TEST PIT SOIL FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3									
	Lab Sample ID:	57E-96-30X	57E-96-30X	57E-96-30X	57E-96-31X	57E-96-31X	57E-96-31X	57E-96-31X	57E-96-31X	57E-96-31X	57E-96-31X
	Date analyzed:	22-Aug-96	22-Aug-96	22-Aug-96	27-Aug-96	26-Aug-96	26-Aug-96	27-Aug-96	27-Aug-96	27-Aug-96	27-Aug-96
	Depth (bgs):	9	9A	11	4	6	6D	7	9	10	9A
	Dilution:	151	160	161	675	135	135	134	740	1500	161
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
1,1-DCE	5 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
t-1,2-DCE	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
c-1,2-DCE	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Chloroform	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
1,1,1-TCA	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Trichloroethene	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Tetrachloroethene	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Benzene	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Toluene	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Chlorobenzene	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Ethylbenzene	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1800	270 U	270 U	270 U	1500 U	8800	320 U
m/p-Xylene	4 µg/kg/500 µg/kg	600 U	640 U	640 U	4000	540 U	540 U	540 U	3000 U	26000	640 U
o-Xylene	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1600	270 U	270 U	270 U	1500 U	9900	320 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	5800 J	560	270 U	870 J	3800 J	12000 J	320 U
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	610	1100	410	63000 E	10000	14000	55 U	9400 E	13000 E	65

Notes:
Detection limits are reported for 1995/1996 field prog
U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed

TABLE 7-11
RI SOIL BORING AND TERRAPROBE FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2									AREA 3
	Lab Sample ID:	57B-95-03X	57B-95-03X	57B-95-04X	57B-95-05X	57B-95-06X	57M-95-07X	57M-95-08A	57M-95-08B	57P-95-01A	57R-95-01X
	Date analyzed:	10-Oct-95	11-Oct-95	11-Oct-95	11-Oct-95	11-Oct-95	12-Oct-95	12-Oct-95	12-Oct-95	12-Oct-95	10-Oct-95
	Depth (bgs):	0	5	15	15	12	4	7	4	5	0
	Dilution:	1.07	1.04	1.26	1.32	1.21	1.23	1.27	1.29	1.28	1.07
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/kg/250 µg/kg	5.4 UJ	5.2 UJ	6.3 UJ	6.6 UJ	6.1 UJ	6.2 UJ	6.4 UJ	6.5 UJ	6.4 UJ	5.4 J
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/kg/250 µg/kg	2.1 U	2.1 UJ	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Trichloroethene	2 µg/kg/250 µg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Toluene	2 µg/kg/250 µg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
m/p-Xylene	4 µg/kg/540 µg/kg	4.3 U	4.2 U	5.0 U	5.3 U	4.8 U	4.9 U	5.1 U	5.2 U	5.1 U	4.3 U
o-Xylene	2 µg/kg/250 µg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	110 U	100 U	130 U	130 U	120 U	120 U	130 U	130 U	130 U	110 U
TPH-IR (1995)	50 mg/kg	480	52 U	63 U	66 U	61 U	62 U	64 U	65	64 U	54 U
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reporting limit
NA = Not analyzed
B = Analyte found in method blank

TABLE 7-11
RI SOIL BORING AND TERRAPROBE FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA3									
	Lab Sample ID:	57R-95-01X	57R-95-01X	57R-95-02X	57R-95-02X	57R-95-02X	57R-95-03X	57R-95-03X	57R-95-03X	57R-95-04X	57R-95-04X
	Date analyzed:	10-Oct-95	10-Oct-95	10-Oct-95	10-Oct-95	10-Oct-95	10-Oct-95	11-Oct-95	11-Oct-95	11-Oct-95	11-Oct-95
	Depth (bgs):	6	12	0	4	10	0	4	10	0	4
	Dilution:	1.04	1.11	1.08	1.09	1.33	1.08	1.04	1.31	1.08	1.05
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/kg/250 µg/kg	5.2 UJ	5.6 UJ	5.4 UJ	5.5 UJ	6.7 UJ	5.4 UJ	5.2 UJ	6.6 UJ	5.4 UJ	5.3 UJ
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 UJ	2.6 U	2.2 UJ	2.1 UJ
1,1,1-TCA	2 µg/kg/250 µg/kg	2.1 UJ	2.2 U	2.2 U	2.2 U	2.7 U	2.2 UJ	2.1 U	2.6 UJ	2.2 U	2.1 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Trichloroethene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Toluene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
m/p-Xylene	4 µg/kg/540 µg/kg	4.2 U	4.4 U	4.3 U	4.4 U	5.3 U	4.3 U	4.2 U	5.2 U	4.3 U	4.2 U
o-Xylene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	100 U	110 U	110 U	110 U	130 U	110 U	100 U	130 U	110 U	110 U
TPH-IR (1995)	50 mg/kg	52 U	56 U	140	55 U	67 U	450	52 U	400	95	440
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed
B = Analyte found in method blank

TABLE 7-11
RI SOIL BORING AND TERRAPROBE FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3									
	Lab Sample ID:	57R-95-04X	57R-95-05X	57R-95-05X	57R-95-05X	57B-96-07X	57B-96-07X	57B-96-07X	57B-96-08X	57B-96-08X	57B-96-08X
	Date analyzed:	10-Oct-95	11-Oct-95	11-Oct-95	11-Oct-95	29-Aug-96	Aug-96	29-Aug-96	3-Sep-96	29-Aug-96	3-Sep-96
	Depth (bgs):	10	0	4	10	0	5	10	0	5	10
	Dilution:	1.3	1.06	1.06	2.64	680	800	166	133	166	161
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA	NA	NA	NA	1400 U	1600 U	330 U	270 U	330 U	320 U
1,1-DCE	5 µg/kg/250 µg/kg	6.5 UJ	5.3 UJ	5.3 UJ	13 UJ	1400 U	1600 U	330 U	270 U	330 U	320 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	1400 U	1600 U	330 U	270 U	330 U	320 U
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	1400 U	1600 U	330 U	270 U	330 U	320 U
Chloroform	2 µg/kg/250 µg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Trichloroethene	2 µg/kg/250 µg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	1400 U	1600 U	330 U	270 U	330 U	320 U
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	1400 U	14000	330 U	270 U	330 U	320 U
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	1400 U	46000	330 U	270 U	330 U	320 U
Benzene	2 µg/kg/250 µg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Toluene	2 µg/kg/250 µg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Chlorobenzene	2 µg/kg/250 µg/kg	49	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	11000	330 U	270 U	330 U	320 U
m/p-Xylene	4 µg/kg/540 µg/kg	5.2 U	4.2 U	4.2 U	11 U	2700 U	58000	730	530 U	660 U	640 U
o-Xylene	2 µg/kg/250 µg/kg	2.6 U	2.1 U	2.1 U	9.9	1400 U	28000	720	270 U	330 U	320 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	2300 J	27000 J	440 J	270 U	330 U	320 U
TPH-DRO	100 mg/kg	NA	NA	110	130 U	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	130 U	110 U	4400 E	2100	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	65 U	190	4500	180	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	12000 E	14000 E	190	53	66 U	64 U

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed
B = Analyte found in method blank

TABLE 7-11
RI SOIL BORING AND TERRAPROBE FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3									
	Lab Sample ID:	57B-96-09X	57B-96-09X	57B-96-09X	57M-96-09X	57M-96-09X	57M-96-09X	57M-96-09X	57M-96-09X	57B-96-10X	57B-96-10X
	Date analyzed:	3-Sep-96	Aug-96	29-Aug-96	5-Sep-96	5-Sep-96	6-Sep-96	9-Sep-96	9-Sep-96	9-Sep-96	9-Sep-96
	Depth (bgs):	0	5	10	0	4	9	14	19	5	10
	Dilution:	130	153	174	133	130	131	158	160	131	163
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
1,1-DCE	5 µg/kg/250 µg/kg	260 U	310 U	370	270 UJ	260 UJ	260 U	320 U	320 U	260 U	330 U
t-1,2-DCE	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
c-1,2-DCE	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Chloroform	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
1,1,1-TCA	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Trichloroethene	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Tetrachloroethene	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
1,3-DCB	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
1,4-DCB	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
1,2-DCB	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Benzene	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Toluene	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Chlorobenzene	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Ethylbenzene	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
m/p-Xylene	4 µg/kg/540 µg/kg	520 U	610 U	700 U	530 U	520 U	520 U	630 U	640 U	520 U	650 U
o-Xylene	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Naphthalene	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	150	61 U	70 U	53 U	52 U	52 U	63 U	64 U	52 U	65

Notes:

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E = Concentration exceeds the maximum reportin
NA = Not analyzed
B = Analyte found in method blank

TABLE 7-11
RI SOIL BORING AND TERRAPROBE FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3									
	Lab Sample ID:	57B-96-10X	57B-96-11X	57B-96-11X	57B-96-11X	57B-96-11X	57B-96-12X	57R-95-06X	57R-96-07X	57R-96-07X	57R-96-07X
	Date analyzed:	Sep-96	10-Sep-96	10-Sep-96	10-Sep-96	10-Sep-96	10-Sep-96	11-Oct-95	21-Aug-96	21-Aug-96	21-Aug-96
	Depth (bgs):	15	5	10	10D	15	5	10	2	6	10
	Dilution:	175	136	155	161	163	1490	1.29	131	133	165
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	260 U	270 U	330 U
1,1-DCE	5 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	6.5 UJ	260 U	270 U	330 U
t-1,2-DCE	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	260 U	270 U	330 U
c-1,2-DCE	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	260 U	270 U	330 U
Chloroform	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
1,1,1-TCA	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
Trichloroethene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
Tetrachloroethene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
1,3-DCB	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
Toluene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
Chlorobenzene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	4700	2.6 U	260 U	270 U	330 U
Ethylbenzene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
m/p-Xylene	4 µg/kg/540 µg/kg	700 U	540 U	620 U	640 U	650 U	13000	5.2 U	520 U	530 U	660 U
o-Xylene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	4700	2.6 U	260 U	270 U	330 U
Naphthalene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	8300	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA	NA	130 U	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA	NA	65 U	NA	NA	NA
TPH-IR (1996)	50 mg/kg	70	7400	62 U	64 U	65 U	13000 E	NA	52 U	53 U	66

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed
B = Analyte found in method blank

TABLE 7-11
RI SOIL BORING AND TERRAPROBE FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3									
	Lab Sample ID:	57R-96-08X	57R-96-08X	57R-96-08X	57R-96-08X	57R-96-09X	57R-96-09X	57R-96-09X	57R-96-10X	57R-96-10X	57R-96-10X
	Date analyzed:	21-Aug-96	21-Aug-96	21-Aug-96	21-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	23-Aug-96
	Depth (bgs):	2	2D	6	10	2	6	10	2	6	10
	Dilution:	133	133	133	159	130	134	155	133	135	149
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
1,1-DCE	5 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
t-1,2-DCE	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
c-1,2-DCE	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Chloroform	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
1,1,1-TCA	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Trichloroethene	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Tetrachloroethene	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Toluene	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Chlorobenzene	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Ethylbenzene	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
m/p-Xylene	4 µg/kg/540 µg/kg	530 U	530 U	530 U	640 U	520 U	540 U	620 U	530 U	540 U	600 U
o-Xylene	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	1900
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	53 U	NA	53 U	64 U	52 U	54 U	62	150	54 U	60

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed
B = Analyte found in method blank

TABLE 7-11
RI SOIL BORING AND TERRAPROBE FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3									
	Lab Sample ID:	57R-96-10X	57R-96-11X	57R-96-11X	57R-96-11X	57R-96-12X	57R-96-12X	57R-96-12X	57R-96-12X	57R-96-13X	57R-96-13X
	Date analyzed:	23-Aug-96	23-Aug-96	23-Aug-96	23-Aug-96	23-Aug-96	23-Aug-96	23-Aug-96	26-Aug-96	26-Aug-96	27-Aug-96
	Depth (bgs):	10D	2	6	10	2	6	6D	10	3	5
	Dilution:	149	135	135	154	138	130	130	144	134	138
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
1,1-DCE	5 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
t-1,2-DCE	2 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
c-1,2-DCE	2 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Chloroform	2 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
1,1,1-TCA	2 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Trichloroethene	2 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Tetrachloroethene	2 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
1,3-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	290 U	270 U	280 U
1,4-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	290 U	270 U	280 U
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	290 U	270 U	280 U
Benzene	2 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Toluene	2 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Chlorobenzene	2 µg/kg/250 µg/kg	300	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Ethylbenzene	2 µg/kg/250 µg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	270
m/p-Xylene	4 µg/kg/540 µg/kg	600 U	540 U	540 U	620 U	550 U	520 U	520 U	580 U	540 U	1300
o-Xylene	2 µg/kg/250 µg/kg	530	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	670
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	290 U	860	2200 J
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	NA	150	260	62	150	52 U	52 U	58	9400 E	39000

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the *maximum reportin*
NA = Not analyzed
B = Analyte found in method blank

TABLE 7-11
RI SOIL BORING AND TERRAPROBE FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3									
	Lab Sample ID:	57R-96-13X	57R-96-14X	57R-96-14X	57R-96-14X	57R-96-15X	57R-96-15X	57R-96-15X	57R-96-16X	57R-96-16X	57R-96-16X
	Date analyzed:	27-Aug-96	26-Aug-96	26-Aug-96	26-Aug-96	28-Aug-96	28-Aug-96	29-Aug-96	29-Aug-96	29-Aug-96	29-Aug-96
	Depth (bgs):	9	3	5	9	3	5	9	3	3D	5
	Dilution:	166	136	161	160	268	675	780	131	131	141
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
1,1-DCE	5 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
t-1,2-DCE	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
c-1,2-DCE	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Chloroform	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1800 B	380 B	260 U	280 U
1,1,1-TCA	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Trichloroethene	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Tetrachloroethene	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
1,3-DCB	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
1,4-DCB	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1600	2200	260 U	260 U	280 U
1,2-DCB	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	3700	6300	260 U	260 U	280 U
Benzene	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Toluene	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Chlorobenzene	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Ethylbenzene	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	2100	260 U	260 U	280 U
m/p-Xylene	4 µg/kg/540 µg/kg	660 U	540 U	640 U	640 U	1100 U	4400	9000	520 U	520 U	560 U
o-Xylene	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	2600	6700	260 U	260 U	280 U
Naphthalene	2 µg/kg/250 µg/kg	330 U	1200	320 U	320 U	2000	7100	12000 J	260 U	930 J	280 U
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	320	55	66 U	64	12000 E	12000 E	14000 E	53	53	57

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed
B = Analyte found in method blank

TABLE 7-11
RI SOIL BORING AND TERRAPROBE FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3									
	Lab Sample ID:	57R-96-16X	57R-96-17X	57R-96-17X	57R-96-17X	57R-96-17X	57R-96-18X	57R-96-18X	57R-96-18X	57R-96-19X	57R-96-19X
	Date analyzed:	3-Sep-96	4-Sep-96	4-Sep-96	4-Sep-96	4-Sep-96	4-Sep-96	5-Sep-96	5-Sep-96	9-Sep-96	9-Sep-96
	Depth (bgs):	9	3	5	9	9D	3	5	9	3	5
	Dilution:	164	129	134	161	161	138	135	168	135	143
Analytes	**Reporting Limit 1995/1996**										
Vinyl Chloride	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
1,1-DCE	5 µg/kg/250 µg/kg	330 U	260 UJ	270 UJ	320 UJ	320 UJ	280 UJ	270 UJ	340 UJ	270 U	290 U
t-1,2-DCE	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
c-1,2-DCE	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Chloroform	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
1,1,1-TCA	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Trichloroethene	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Tetrachloroethene	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
1,3-DCB	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
1,4-DCB	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
1,2-DCB	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Benzene	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Toluene	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Chlorobenzene	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Ethylbenzene	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
m/p-Xylene	4 µg/kg/540 µg/kg	660 U	520 U	540 U	640 U	640 U	550 U	540 U	670 U	540 U	570 U
o-Xylene	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Naphthalene	2 µg/kg/250 µg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	66	52 U	54 U	65	64 U	55	54 U	67 U	150	54 U

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed
B = Analyte found in method blank

TABLE 7-11
RI SOIL BORING AND TERRAPROBE FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3				
	Lab Sample ID: Date analyzed: Depth (bgs): Dilution:	57R-96-19X 9-Sep-96 9 164	57R-96-20X 5-Sep-96 2 135	57R-96-20X 6-Sep-96 2D 135	57R-96-20X 9-Sep-96 6 131	57R-96-20X 9-Sep-96 10 250
Analytes	**Reporting Limit 1995/1996**					
Vinyl Chloride	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
1,1-DCE	5 µg/kg/250 µg/kg	330 U	270 UJ	270 U	260 U	500 U
t-1,2-DCE	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
c-1,2-DCE	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
Chloroform	2 µg/kg/250 µg/kg	330 U	340	270 U	260 U	500 U
1,1,1-TCA	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
Trichloroethene	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
Tetrachloroethene	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
1,3-DCB	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
1,4-DCB	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
1,2-DCB	2 µg/kg/250 µg/kg	510	270 U	270 U	260 U	500 U
Benzene	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
Toluene	2 µg/kg/250 µg/kg	370	270 U	270 U	260 U	500 U
Chlorobenzene	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
Ethylbenzene	2 µg/kg/250 µg/kg	670	270 U	270 U	260 U	500 U
m/p-Xylene	4 µg/kg/540 µg/kg	4500	540 U	540 U	520 U	1000 U
o-Xylene	2 µg/kg/250 µg/kg	1100	270 U	270 U	260 U	500 U
Naphthalene	2 µg/kg/250 µg/kg	1700	270 U	270 U	260 U	500 U
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	700	54 U	54 U	52 U	200

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed
B = Analyte found in method blank

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2									
Site ID:		57B-95-01X		57B-95-01X		57B-95-01X		57B-95-02X		57B-95-02X	
Field Sample Number:		BX570100		BX570105		BX570121		BD570205		BX570200	
Lab Sample Number:	Devens	DV4S*141		DV4S*142		DV4S*143		DV4S*441		DV4S*144	
Sample Date:	Background	09/26/95		09/26/95		09/26/95		09/27/95		09/27/95	
Depth:	Concentrations	0		5		21		5		0	
Units:	µg/g	µg/g		µg/g		µg/g		µg/g		µg/g	
METALS											
Aluminum	18000	7530	IM	4620	IM	2210	IM	3050	D IM	7500	IM
Antimony	0.5	< 1.09		< 1.09		< 1.09		< 1.09	D	< 1.09	
Arsenic	19	15		9.66		4.61		8.93	D	19	
Barium	54	40.9		17.6		8.86		8.62	D	18.9	
Beryllium	0.81	< .5		< .5		< .5		< .5	D	< .5	
Cadmium	1.28	< .7		< .7		< .7		< .7	D	< .7	
Calcium	810	700		477		258		227	D	158	
Chromium	33	27		14		< 4.05		6.39	D	13	
Cobalt	4.7	4.9		3.79		< 1.42		1.83	D	6.15	
Copper	13.5	11.6		8.42		3.13		4.76	D	12.2	
Iron	18000	13300		8080		4230		5970	D	13200	
Lead	48	10		2.96		1.62		2.96	D	10	
Magnesium	5500	3200		1930		893		1360	D	2560	
Manganese	380	240		187		70.4		86.4	D	481	
Nickel	14.6	19.5		12		3.64		7.23	D	18.5	
Potassium	2400	1170		742		381		325	D	583	
Selenium	--	< .25		< .25		< .25		< .25	D	< .25	
Silver	0.086	< .589		< .589		< .589		< .589	D	< .589	
Sodium	131	299		309		347		245	D	260	
Vanadium	32.3	15.5		8.5		< 3.39		4.9	D	11.1	
Zinc	43.9	26.4		19.8		< 8.03		13.6	D	25.8	
PESTICIDES/PCBS											
4,4'-dde		< .00765		< .00765		< .00765		< .00765	D	< .00765	
4,4'-ddt		< .00707		< .00707		< .00707		< .00707	D	< .00707	
Aldrin		< .00729		< .00729		< .00729		< .00729	D	< .00729	
Chlordane - Alpha		< .005	T	< .005	T	< .005	T	< .005	TD	< .005	T
Dieldrin		< .00629		< .00629		< .00629		< .00629	D	< .00629	
Endosulfan I		< .00602		< .00602		< .00602		< .00602	D	< .00602	
Heptachlor Epoxide		< .0062		< .0062		< .0062		< .0062	D	< .0062	
Pcb 1242		< .082	T	< .082	T	< .082	T	< .082	TD	< .082	T
Pcb 1248		< .082	T	< .082	T	< .082	T	< .082	TD	< .082	T
Pcb 1260		< .0804		< .0804		< .0804		< .0804	D	< .0804	
SVOCs											
1,2,4-trichlorobenzene		< .04		< .04		< .04		< .04	D	< .2	
1,2-dichlorobenzene		< .11		< .11		< .11		< .11	D	< .6	
1,4-dichlorobenzene		< .098		< .098		< .098		< .098	D	< .5	
2-methylnaphthalene		.43		< .049		< .049		< .049	D	.4	
Acenaphthene		< .036		< .036		< .036		< .036	D	< .2	
Chrysene		< .12		< .12		< .12		< .12	D	< .6	
Dibenzofuran		.16		< .035		< .035		< .035	D	< .2	
Fluoranthene		.097		< .068		< .068		< .068	D	< .3	
Fluorene		< .033		< .033		< .033		< .033	D	< .2	
Naphthalene		.42		< .037		< .037		< .037	D	.4	
Phenanthrene		.28		< .033		< .033		< .033	D	< .2	
Pyrene		.087		< .033		< .033		< .033	D	< .2	

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/g		57B-95-01X BX570100 DV4S*141 09/26/95 0 µg/g		57B-95-01X BX570105 DV4S*142 09/26/95 5 µg/g		57B-95-01X BX570121 DV4S*143 09/26/95 21 µg/g		57B-95-02X BD570205 DV4S*441 09/27/95 5 µg/g			57B-95-02X BX570200 DV4S*144 09/27/95 0 µg/g
Bis(2-ethylhexyl) Phthalate			2.7	<	.62	<	.62	<	.62	D	<	3
Di-n-butyl Phthalate		<	.061	<	.061	<	.061	<	.061	D	<	.3
TPH BY GC												
TPH MOTOR OIL PATTERN			NA		NA		NA		NA			NA
VOCs												
*1,2-dichloroethylenes (cis And Trans)		<	.003	<	.003	<	.003	<	.003	D	<	.003
2-hexanone		<	.032	<	.032	<	.032	<	.032	D	<	.032
Acetone		<	.017	<	.017	<	.017	<	.017	D	<	.017
Chloroform			.00089	<	.00087	<	.00087	<	.00087	D	<	.00087
Dichloromethane		<	.012	<	.012	<	.012	<	.012	D	<	.012
Ethylbenzene		<	.0017	<	.0017	<	.0017	<	.0017	D	<	.0017
Tetrachloroethene		<	.00081	<	.00081	<	.00081	<	.00081	D	<	.00081
Toluene		<	.00078	<	.00078	<	.00078	<	.00078	D		.0016
Trichloroethylene		<	.0028	<	.0028	<	.0028	<	.0028	D	<	.0028
Trichlorofluoromethane			.017		.013		.014	<	.0059	D	<	.0059
Xylenes		<	.0015	<	.0015	<	.0015	<	.0015	D	<	.0015
OTHER												
Total Organic Carbon												
Total Petroleum Hydrocarbons			81.3		26.4		44.6		138	D		7970

NOTES:

FLC = USAEC Flagging Code

DQ = Data Qualifier

< = Concentration was less than the certified reporting limit

D = Duplicate Sample

T = Non-target compound analyzed for and not detected (non-GC/MS method)

I = Interferences in the sample caused the quantitation and/or identification to be suspect

M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or technique

Z = Non-target analyte analyzed for and detected by non-GC/MS method

J = Value is estimated

▨ = Exceeds established Devens background levels

NA = Not Analyzed

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2														
Site ID:			57B-95-02X			57B-95-02X			57B-95-03X			57B-95-04X			57B-95-05X	
Field Sample Number:			BX570205			BX570217			BX570319			BX570415			BX570515	
Lab Sample Number:	Devens		DV4S*145			DV4S*146			DV4S*147			DV4S*150			DV4S*151	
Sample Date:	Background		09/27/95			09/27/95			09/27/95			09/28/95			09/28/95	
Depth:	Concentrations		5			17			19			15			15	
Units:	µg/g		µg/g			µg/g			µg/g			µg/g			µg/g	
METALS																
Aluminum	18000		3800	IM		2470	IM		2220	IM		2500	IM		2910	IM
Antimony	0.5	<	1.09		<	1.09		<	1.09		<	1.09		<	1.09	
Arsenic	19		9.6			6.15			5.75			8.1			10.6	
Barium	54		11.1			7.55			6.91			10.7		<	5.18	
Beryllium	0.81	<	.5		<	.5		<	.5		<	.5		<	.5	
Cadmium	1.28	<	.7		<	.7		<	.7		<	.7		<	.7	
Calcium	810		264			208			319			276			325	
Chromium	33		8.38		<	4.05		<	4.05		<	4.05		<	4.05	
Cobalt	4.7		2.54		<	1.42		<	1.42		<	1.42		<	1.42	
Copper	13.5		5.76			3.74			4.33			3.93			3.9	
Iron	18000		7190			4740			4490			4560			5580	
Lead	48		2.76			1.98			3.93			2.09			1.72	
Magnesium	5500		1820			998			894			903			1170	
Manganese	380		118			87.1			79.1			135			76.2	
Nickel	14.6		8.35			5.16			4.2			5.57			4.58	
Potassium	2400		509			333			319			523			315	
Selenium	--	<	.25		<	.25		<	.25		<	.25		<	.25	
Silver	0.086	<	.589		<	.589		<	.589		<	.589		<	.589	
Sodium	131		263			313			297			373			304	
Vanadium	32.3		6.49		<	3.39		<	3.39		<	3.39		<	3.39	
Zinc	43.9		16.5		<	8.03		<	8.03		<	8.03		<	8.03	
PESTICIDES/PCBS																
4,4'-dde		<	.00765		<	.00765		<	.00765		<	.00765		<	.00765	
4,4'-ddt		<	.00707		<	.00707		<	.00707		<	.00707		<	.00707	
Aldrin		<	.00729		<	.00729		<	.00729		<	.00729		<	.00729	
Chlordane - Alpha		<	.005	T	<	.005	T	<	.005	T	<	.005	T	<	.005	T
Dieldrin		<	.00629		<	.00629		<	.00629		<	.00629		<	.00629	
Endosulfan I		<	.00602		<	.00602		<	.00602		<	.00602		<	.00602	
Heptachlor Epoxide		<	.0062		<	.0062		<	.0062		<	.0062		<	.0062	
Pcb 1242		<	.082	T	<	.082	T	<	.082	T	<	.082	T	<	.082	T
Pcb 1248		<	.082	T	<	.082	T	<	.082	T	<	.082	T	<	.082	T
Pcb 1260		<	.0804		<	.0804		<	.0804		<	.0804		<	.0804	
SVOCs																
1,2,4-trichlorobenzene		<	.04		<	.04		<	.04		<	.04		<	.04	
1,2-dichlorobenzene		<	.11		<	.11		<	.11		<	.11		<	.11	
1,4-dichlorobenzene		<	.098		<	.098		<	.098		<	.098		<	.098	
2-methylnaphthalene		<	.049		<	.049		<	.049		<	.049		<	.049	
Acenaphthene		<	.036		<	.036		<	.036		<	.036		<	.036	
Chrysene		<	.12		<	.12		<	.12		<	.12		<	.12	
Dibenzofuran		<	.035		<	.035		<	.035		<	.035		<	.035	
Fluoranthene		<	.068		<	.068		<	.068		<	.068		<	.068	
Fluorene		<	.033		<	.033		<	.033		<	.033		<	.033	
Naphthalene		<	.037		<	.037		<	.037		<	.037		<	.037	
Phenanthrene		<	.033		<	.033		<	.033		<	.033		<	.033	
Pyrene		<	.033		<	.033		<	.033		<	.033		<	.033	

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID:	Devens Background Concentrations µg/g		57B-95-02X		57B-95-02X		57B-95-03X		57B-95-04X		57B-95-05X
Field Sample Number:			BX570205		BX570217		BX570319		BX570415		BX570515
Lab Sample Number:			DV4S*145		DV4S*146		DV4S*147		DV4S*150		DV4S*151
Sample Date:			09/27/95		09/27/95		09/27/95		09/28/95		09/28/95
Depth:			5		17		19		15		15
Units:			µg/g		µg/g		µg/g		µg/g		µg/g
Bis(2-ethylhexyl) Phthalate		<	.62	<	.62	<	.62	<	.62	<	.62
Di-n-butyl Phthalate		<	.061	<	.061	<	.061	<	.061	<	.061
TPH BY GC											
TPH MOTOR OIL PATTERN											
VOCs											
*1,2-dichloroethylenes (cis And Trans)		<	.003	<	.003	<	.003	<	.003	<	.003
2-hexanone		<	.032	<	.032	<	.032	<	.032	<	.032
Acetone		<	.017	<	.017	<	.017	<	.017		.025
Chloroform		<	.00087	<	.00087	<	.00087	<	.00087	<	.00087
Dichloromethane		<	.012		.049		.019		.033	<	.012
Ethylbenzene		<	.0017	<	.0017	<	.0017	<	.0017	<	.0017
Tetrachloroethene		<	.00081	<	.00081	<	.00081	<	.00081	<	.00081
Toluene		<	.00078		.0014		.0045	<	.00078		.0037
Trichloroethylene		<	.0028	<	.0028	<	.0028	<	.0028	<	.0028
Trichlorofluoromethane		<	.0059	<	.0059	<	.0059	<	.0059		.0068
Xylenes		<	.0015	<	.0015	<	.0015	<	.0015	<	.0015
OTHER											
Total Organic Carbon											
Total Petroleum Hydrocarbons			87	<	27.6		52.7	<	27.8	<	27.6

NOTES:
FLC = USAEC Flagging Code
DQ = Data Qualifier
< = Concentration was less than the certified reporting limit

T = Non-target compound analyzed for and not detected (non-GC/MS method)
I = Interferences in the sample caused the quantitation and/or identification to be suspect
M = High duplicate spike not within control limits
C = Analysis was confirmed by a different column or technique
Z = Non-target analyte analyzed for and detected by non-GC/MS method
J = Value is estimated
▨ = Exceeds established Devens background levels

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2											
Site ID:			57B-95-06X			57E-95-01X			57E-95-02X			57E-95-04X	
Field Sample Number:			BX570612			EX570106			EX570200			ED570405	
Lab Sample Number:	Devens		DV4S*152			DV4S*101			DV4S*102			DV4S*436	
Sample Date:	Background		09/28/95			09/18/95			09/18/95			09/19/95	
Depth:	Concentrations		12			0			0			5	
Units:	µg/g		µg/g			µg/g			µg/g			µg/g	
METALS													
Aluminum	18000		2860	IM		2590			3920			2730	D
Antimony	0.5	<	1.09		<	1.09		<	1.09		<	1.09	D
Arsenic	19		7.49			9.87			9.73			10.7	D
Barium	54		11.5			7.05			32.1			11.3	D
Beryllium	0.81	<	.5		<	.5		<	.5		<	.5	D
Cadmium	1.28	<	.7		<	.7		<	.7		<	.7	D
Calcium	810		384			400			580			176	D
Chromium	33	<	4.05		<	4.05			8.94		<	4.05	D
Cobalt	4.7		2.25			2.73			2.76			1.82	D
Copper	13.5		4.4			4.14			11.6			3.26	D
Iron	18000		5420			4640			8420			4550	D
Lead	48		1.8			2.02			22.9			1.81	D
Magnesium	5500		1040			773			1140			848	D
Manganese	380		79.4			68.1			79.2			226	D
Nickel	14.6		5.99			5.55			8.5			5.15	D
Potassium	2400		422			356			427			428	D
Selenium	--	<	.25		<	.25			.883		<	.25	D
Silver	0.086	<	.589		<	.589		<	.589		<	.589	D
Sodium	131		328			185			436			286	D
Vanadium	32.3		4.66		<	3.39			11.1			4.37	D
Zinc	43.9		11.6		<	8.03			17.2			10	D
PESTICIDES/PCBS													
4,4'-dde		<	.00765		<	.00765			.0199	C	<	.00765	D
4,4'-ddt		<	.00707		<	.00707			.0257	C	<	.00707	D
Aldrin		<	.00729		<	.00729		<	.00729		<	.00729	D
Chlordane - Alpha		<	.005	T	<	.005	T	<	.005	T	<	.005	TD
Dieldrin		<	.00629		<	.00629		<	.00629		<	.00629	D
Endosulfan I		<	.00602		<	.00602		<	.00602		<	.00602	D
Heptachlor Epoxide		<	.0062		<	.0062		<	.0062		<	.0062	D
Pcb 1242		<	.082	T	<	.082	T	<	.082	T	<	.082	TD
Pcb 1248		<	.082	T	<	.082	T	<	.082	T	<	.082	TD
Pcb 1260		<	.0804		<	.0804		<	.0804		<	.0804	D
SVOCs													
1,2,4-trichlorobenzene		<	.04		<	.04		<	.2		<	.04	D
1,2-dichlorobenzene		<	.11		<	.11		<	.6		<	.11	D
1,4-dichlorobenzene		<	.098		<	.098		<	.5		<	.098	D
2-methylnaphthalene		<	.049		<	.049		<	.2		<	.049	D
Acenaphthene		<	.036		<	.036		<	.2		<	.036	D
Chrysene		<	.12		<	.12		<	.6		<	.12	D
Dibenzofuran		<	.035		<	.035		<	.2		<	.035	D
Fluoranthene		<	.068		<	.068		<	.3		<	.068	D
Fluorene		<	.033		<	.033		<	.2		<	.033	D
Naphthalene		<	.037		<	.037		<	.2		<	.037	D
Phenanthrene		<	.033		<	.033			.2		<	.033	D
Pyrene		<	.033		<	.033			.4		<	.033	D

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/g	57B-95-06X BX570612 DV4S*152 09/28/95 12 µg/g	57E-95-01X EX570106 DV4S*101 09/18/95 0 µg/g	57E-95-02X EX570200 DV4S*102 09/18/95 0 µg/g	57E-95-04X ED570405 DV4S*436 09/19/95 5 µg/g	
Bis(2-ethylhexyl) Phthalate		< .62	< .62	< 3	< .62	D
Di-n-butyl Phthalate		< .061	< .061	< .3	< .061	D
TPH BY GC						
TPH MOTOR OIL PATTERN			NA	NA	NA	
VOCs						
*1,2-dichloroethylenes (cis And Trans)		< .003	< .003	< .003	< .003	D
2-hexanone		< .032	< .032	< .032	< .032	D
Acetone		< .017	< .017	< .017	< .017	D
Chloroform		< .00087	< .00087	< .00087	< .00087	D
Dichloromethane		< .012	< .012	< .012	< .012	D
Ethylbenzene		< .0017	< .0017	.0024	< .0017	D
Tetrachloroethene		< .00081	< .00081	< .00081	< .00081	D
Toluene		< .00078	< .00078	.0025	< .00078	D
Trichloroethylene		< .0028	< .0028	< .0028	< .0028	D
Trichlorofluoromethane		.008	.0057	< .0059	< .0059	D
Xylenes		< .0015	< .0015	.029	< .0015	D
OTHER						
Total Organic Carbon						
Total Petroleum Hydrocarbons		< 27.6	141	454	23.6	D

NOTES:
FLC = USAEC Flagging Code
DQ = Data Qualifier
< = Concentration was less than the certified reporting limit

T = Non-target compound analyzed for and not detected (non-GC/MS method)
I = Interferences in the sample caused the quantitation and/or identification to be suspect
M = High duplicate spike not within control limits
C = Analysis was confirmed by a different column or technique
Z = Non-target analyte analyzed for and detected by non-GC/MS method
J = Value is estimated
▨ = Exceeds established Devens background levels

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2				
Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/g	57E-95-04X EX570405 DV4S*104 09/19/95 5 µg/g	57E-95-05X EX570506 DV4S*105 09/19/95 6 µg/g	57E-95-07X EX570704 DV4S*107 09/19/95 4 µg/g	57E-95-08X EX570804 DV4S*108 09/20/95 4 µg/g	57E-95-09X EX570905 DV4S*109 09/20/95 5 µg/g
METALS						
Aluminum	18000	2750	4720	4810	3990	2700
Antimony	0.5	< 1.09	< 1.09	< 1.09	< 1.09	< 1.09
Arsenic	19	9.68	11	3.5	11	4.38
Barium	54	10.2	17.2	34.7	52.9	17.1
Beryllium	0.81	< .5	< .5	< .5	< .5	< .5
Cadmium	1.28	< .7	< .7	< .7	< .7	< .7
Calcium	810	205	325	1190	746	610
Chromium	33	< 4.05	11.5	< 4.05	< 4.05	< 4.05
Cobalt	4.7	1.67	3.87	2.61	< 1.42	< 1.42
Copper	13.5	3.33	7.49	8.13	4.41	1.97
Iron	18000	4300	7080	5910	2380	1980
Lead	48	1.83	4.62	34.6	188	6.87
Magnesium	5500	896	1670	518	243	186
Manganese	380	231	333	175	25.5	18.7
Nickel	14.6	5.05	9.34	5.48	4.19	< 1.71
Potassium	2400	344	606	156	268	197
Selenium	--	< .25	< .25	.645	1.22	.669
Silver	0.086	< .589	< .589	< .589	< .589	< .589
Sodium	131	283	426	433	726	470
Vanadium	32.3	3.77	8.07	< 3.39	9.79	< 3.39
Zinc	43.9	9.76	14.9	30.4	52.6	< 8.03
PESTICIDES/PCBS						
4,4'-dde		< .00765	< .00765	< .00765	< .00765	< .00765
4,4'-ddt		< .00707	< .00707	< .00707	< .00707	< .00707
Aldrin		< .00729	< .00729	< .00729	< .00729	< .00729
Chlordane - Alpha		< .005 T	< .005 T	< .005 T	< .005 T	< .005 T
Dieldrin		< .00629	< .00629	< .00629	< .00629	< .00629
Endosulfan I		< .00602	< .00602	< .00602	< .00602	< .00602
Heptachlor Epoxide		< .0062	< .0062	< .0062	< .0062	< .0062
Pcb 1242		< .082 T	< .082 T	< .082 T	< .082 T	< .082 T
Pcb 1248		< .082 T	< .082 T	< .082 T	< .082 T	< .082 T
Pcb 1260		< .0804	< .0804	< .0804	< .0804	< .0804
SVOCs						
1,2,4-trichlorobenzene		< .04	< .04	< .4	< .04	< .2
1,2-dichlorobenzene		< .11	< .11	< 1	< .11	< .6
1,4-dichlorobenzene		< .098	< .098	< 1	< .098	< .5
2-methylnaphthalene		< .049	< .049	6	< .049	< .2
Acenaphthene		< .036	< .036	< .4	< .036	< .2
Chrysene		< .12	< .12	< 1	< .12	< .6
Dibenzofuran		< .035	< .035	< .4	< .035	< .2
Fluoranthene		< .068	< .068	< .7	< .068	.7
Fluorene		< .033	< .033	< .3	< .033	< .2
Naphthalene		< .037	< .037	6	< .037	< .2
Phenanthrene		< .033	< .033	< .3	< .033	.3
Pyrene		< .033	< .033	< .3	< .033	.6

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID:	Devens Background Concentrations µg/g	57E-95-04X	57E-95-05X	57E-95-07X	57E-95-08X	57E-95-09X
Field Sample Number:		EX570405	EX570506	EX570704	EX570804	EX570905
Lab Sample Number:		DV4S*104	DV4S*105	DV4S*107	DV4S*108	DV4S*109
Sample Date:		09/19/95	09/19/95	09/19/95	09/20/95	09/20/95
Depth:		5	6	4	4	5
Units:		µg/g	µg/g	µg/g	µg/g	µg/g
Bis(2-ethylhexyl) Phthalate		< .62	< .62	< 6	< .62	< 3
Di-n-butyl Phthalate		< .061	< .061	< .6	< .061	< .3
TPH BY GC						
TPH MOTOR OIL PATTERN		NA	NA	NA	NA	NA
VOCs						
*1,2-dichloroethylenes (cis And Trans)		< .003	< .003	.0039	< .003	< .003
2-hexanone		< .032	< .032	< .032	< .032	< .032
Acetone		< .017	< .017	< .017	< .017	< .017
Chloroform		< .00087	< .00087	< .00087	< .00087	< .00087
Dichloromethane		< .012	< .012	< .012	< .012	< .012
Ethylbenzene		< .0017	< .0017	.051	< .0017	< .0017
Tetrachloroethene		< .00081	< .00081	.0059	< .00081	< .00081
Toluene		< .00078	< .00078	.023	< .00078	< .00078
Trichloroethylene		< .0028	< .0028	.011	< .0028	< .0028
Trichlorofluoromethane		.0083	.007	< .0059	< .0059	< .0059
Xylenes		< .0015	< .0015	.27	< .0015	< .0015
OTHER						
Total Organic Carbon						
Total Petroleum Hydrocarbons		< 27.6	< 20.7	31800	57.6	79.2

NOTES:
FLC = USAEC Flagging Code
DQ = Data Qualifier
< = Concentration was less than the certified reporting limit

T = Non-target compound analyzed for and not detected (non-GC/MS method)
I = Interferences in the sample caused the quantitation and/or identification to be suspect
M = High duplicate spike not within control limits
C = Analysis was confirmed by a different column or technique
Z = Non-target analyte analyzed for and detected by non-GC/MS method
J = Value is estimated
▨ = Exceeds established Devens background levels

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2									
Site ID:		57E-95-10X		57E-95-12X		57E-95-13X		57E-95-14X		57E-95-15X	
Field Sample Number:		EX571000		EX571200		EX571305		EX571406		EX571502	
Lab Sample Number:	Devens	DV4S*110		DV4S*112		DV4S*113		DV4S*114		DV4S*115	
Sample Date:	Background	09/19/95		09/20/95		09/21/95		09/21/95		09/21/95	
Depth:	Concentrations	0		0		5		6		2	
Units:	µg/g	µg/g		µg/g		µg/g		µg/g		µg/g	
METALS											
Aluminum	18000	7100		6180		4630		2960		9720	
Antimony	0.5	< 1.09		< 1.09		< 1.09		< 1.09		< 1.09	
Arsenic	19	7.86		9.54		21		18		2.14	
Barium	54	18.8		25.9		22.1		< 5.18		37.1	
Beryllium	0.81	.705		< .5		< .5		< .5		< .5	
Cadmium	1.28	< .7		< .7		< .7		< .7		< .7	
Calcium	810	134		255		846		261		595	
Chromium	33	7.69		13.6		2410		< 4.05		10.4	
Cobalt	4.7	1.86		1.93		4.7		2.43		< 1.42	
Copper	13.5	4.14		12.4		5.7		4.51		9.36	
Iron	18000	7030		7920		6690		5940		4910	
Lead	48	8.05		225		5060		2.26		76.2	
Magnesium	5500	926		1150		1400		1020		808	
Manganese	380	274		97.2		76.5		66.8		51.9	
Nickel	14.6	6.61		7.35		6.3		6.16		5.78	
Potassium	2400	144		327		309		386		300	
Selenium	--	< .25		< .25		< .25		< .25		.569	
Silver	0.086	< .589		< .589		< .589		< .589		< .589	
Sodium	131	337		446		335		410		725	
Vanadium	32.3	7.58		14		7.6		< 3.39		11.9	
Zinc	43.9	13.7		22.7		753		< 8.03		42.9	
PESTICIDES/PCBS											
4,4'-dde		< .00765		< .00765		< .00765		< .00765		< .00765	
4,4'-ddt		< .00707		< .00707		< .00707		< .00707		< .00707	
Aldrin		< .00729		< .00729		< .00729		< .00729		< .00729	
Chlordane - Alpha		< .005	T	< .005	T	< .005	T	< .005	T	< .005	T
Dieldrin		< .00629		.0192	C	< .00629		< .00629		.0115	C
Endosulfan I		< .00602		< .00602		< .00602		< .00602		< .00602	
Heptachlor Epoxide		< .0062		< .0062		< .0062		< .0062		< .0062	
Pcb 1242		< .082	T	< .082	T	< .082	T	< .082	T	< .082	T
Pcb 1248		< .082	T	< .082	T	< .082	T	< .082	T	< .082	T
Pcb 1260		< .0804		4.2	C	< .0804		< .0804		7.3	C
SVOCs											
1,2,4-trichlorobenzene		< .04		< .4		< .04		< .04		< .8	
1,2-dichlorobenzene		< .11		< 1		< .11		< .11		< 2	
1,4-dichlorobenzene		< .098		< 1		< .098		< .098		< 2	
2-methylnaphthalene		< .049		< .5		< .049		< .049		< 1	
Acenaphthene		< .036		< .4		< .036		< .036		< .7	
Chrysene		< .12		< 1		< .12		< .12		< 2	
Dibenzofuran		< .035		< .4		< .035		< .035		< .7	
Fluoranthene		.11		< .7		< .068		< .068		< 1	
Fluorene		< .033		< .3		< .033		< .033		< .7	
Naphthalene		< .037		< .4		< .037		< .037		< .7	
Phenanthrene		.045		< .3		< .033		< .033		< .7	
Pyrene		.12		< .3		< .033		< .033		< .7	

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/g	57E-95-10X EX571000 DV4S*110 09/19/95 0 µg/g	57E-95-12X EX571200 DV4S*112 09/20/95 0 µg/g	57E-95-13X EX571305 DV4S*113 09/21/95 5 µg/g	57E-95-14X EX571406 DV4S*114 09/21/95 6 µg/g	57E-95-15X EX571502 DV4S*115 09/21/95 2 µg/g
Bis(2-ethylhexyl) Phthalate		< .62	< 6	< .62	< .62	< 10
Di-n-butyl Phthalate		< .061	< .6	< .061	< .061	< 1
TPH BY GC						
TPH MOTOR OIL PATTERN		NA	NA	NA	NA	NA
VOCs						
*1,2-dichloroethylenes (cis And Trans)		< .003	< .003	< .003	< .003	< .003
2-hexanone		< .032	< .032	< .032	< .032	< .032
Acetone		< .017	< .017	< .017	.037	< .017
Chloroform		< .00087	< .00087	< .00087	< .00087	< .00087
Dichloromethane		< .012	< .012	< .012	< .012	< .012
Ethylbenzene		< .0017	< .0017	< .0017	< .0017	< .0017
Tetrachloroethene		.003	.0011	< .00081	< .00081	.0023
Toluene		.0037	.0083	< .00078	< .00078	.0017
Trichloroethylene		< .0028	< .0028	< .0028	< .0028	< .0028
Trichlorofluoromethane		.0074	.0073	< .0059	< .0059	< .0059
Xylenes		< .0015	< .0015	< .0015	< .0015	< .0015
OTHER						
Total Organic Carbon						
Total Petroleum Hydrocarbons		25	5110	< 27.6	49.3	26100

NOTES:
FLC = USAEC Flagging Code
DQ = Data Qualifier
< = Concentration was less than the certified reporting limit

T = Non-target compound analyzed for and not detected (non-GC/MS method)
I = Interferences in the sample caused the quantitation and/or identification to be suspect
M = High duplicate spike not within control limits
C = Analysis was confirmed by a different column or technique
Z = Non-target analyte analyzed for and detected by non-GC/MS method
J = Value is estimated
▨ = Exceeds established Devens background levels

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2									
Site ID:		57E-95-16X		57E-95-16X		57E-95-17X		57E-95-18X		57E-95-19X	
Field Sample Number:		EX571600		EX571602		EX571700		EX571802		EX571902	
Lab Sample Number:	Devens Background Concentrations	DV4S*121		DV4S*116		DV4S*117		DV4S*118		DV4S*119	
Sample Date:		09/21/95		09/21/95		09/21/95		09/21/95		09/21/95	
Depth:		0		2		0		2		2	
Units:	μg/g	μg/g		μg/g		μg/g		μg/g		μg/g	
METALS											
Aluminum	18000	3140	IM	4430		5460		9940		3530	
Antimony	0.5	< 1.09		< 1.09		1.62		< 1.09		< 1.09	
Arsenic	19	7.06		12.7		9.06		10.6		1.71	
Barium	54	13.6		116		37.5		< 5.18		< 5.18	
Beryllium	0.81	< .5		< .5		.708		< .5		< .5	
Cadmium	1.28	< .7		< .7		< .7		< .7		< .7	
Calcium	810	414		659		528		< 100		< 100	
Chromium	33	8.96		35.6		15.4		8.94		< 4.05	
Cobalt	4.7	2.09		< 1.42		2.31		< 1.42		< 1.42	
Copper	13.5	6.72		17.6		14.4		2.87		< .965	
Iron	18000	5390		6880		7190		6370		762	
Lead	48	40.5		224		110		4.62		4.15	
Magnesium	5500	1120		633		1390		739		< 100	
Manganese	380	74.9		72.7		138		34.8		3.95	
Nickel	14.6	6.09		5.76		10.4		6.12		< 1.71	
Potassium	2400	345		257		460		197		< 100	
Selenium	--	< .25		1.1		.449		< .25		.652	
Silver	0.086	< .589		.959		< .589		< .589		< .589	
Sodium	131	294		661		346		404		560	
Vanadium	32.3	5.65		9.58		12.5		10.1		< 3.39	
Zinc	43.9	23.2		66.7		41		< 8.03		< 8.03	
PESTICIDES/PCBS											
4,4'-dde		< .00765		< .00765		.00928	C	< .00765		< .00765	
4,4'-ddt		< .00707		< .00707		< .00707		< .00707		< .00707	
Aldrin		< .00729		< .00729		< .00729		< .00729		< .00729	
Chlordane - Alpha		< .005	T	< .005	T	< .005	T	< .005	T	< .005	T
Dieldrin		.0127	C	< .00629		.032	C	< .00629		< .00629	
Endosulfan I		< .00602		.081	C	< .00602		< .00602		< .00602	
Heptachlor Epoxide		< .0062		< .0062		< .0062		< .0062		< .0062	
Pcb 1242		< .082	T	< .082	T	< .082	T	< .082	T	< .082	T
Pcb 1248		< .082	T	3.2	CZ	< .082	T	< .082	T	< .082	T
Pcb 1260		.188	C	12	C	.342	C	< .0804		< .0804	
SVOCs											
1,2,4-trichlorobenzene		< .2		< 2		< .4		< .04		< .04	
1,2-dichlorobenzene		< .6		< 4		< 1		< .11		< .11	
1,4-dichlorobenzene		< .5		< 4		< 1		< .098		< .098	
2-methylnaphthalene		< .2		< 2		< .5		< .049		< .049	
Acenaphthene		< .2		< 1		< .4		< .036		< .036	
Chrysene		< .6		< 5		< 1		< .12		< .12	
Dibenzofuran		< .2		< 1		< .4		< .035		< .035	
Fluoranthene		< .3		< 3		1		< .068		< .068	
Fluorene		< .2		< 1		< .3		< .033		< .033	
Naphthalene		< .2		< 1		< .4		< .037		< .037	
Phenanthrene		< .2		< 1		.6		< .033		< .033	
Pyrene		< .2		< 1		1		< .033		< .033	

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/g	57E-95-16X EX571600 DV4S*121 09/21/95 0 µg/g	57E-95-16X EX571602 DV4S*116 09/21/95 2 µg/g	57E-95-17X EX571700 DV4S*117 09/21/95 0 µg/g	57E-95-18X EX571802 DV4S*118 09/21/95 2 µg/g	57E-95-19X EX571902 DV4S*119 09/21/95 2 µg/g
Bis(2-ethylhexyl) Phthalate		< 3	< 20	< 6	< .62	< .62
Di-n-butyl Phthalate		< .3	< 2	2	< .061	< .061
TPH BY GC						
TPH MOTOR OIL PATTERN		NA	NA	NA	NA	NA
VOCs						
*1,2-dichloroethylenes (cis And Trans)		< .003	< .003	< .003	< .003	< .003
2-hexanone		< .032	< .032	< .032	< .032	< .032
Acetone		< .017	.067	< .017	.03	.034
Chloroform		< .00087	< .00087	< .00087	< .00087	< .00087
Dichloromethane		< .012	< .012	.015	< .012	< .012
Ethylbenzene		< .0017	.0058	< .0017	< .0017	< .0017
Tetrachloroethene		< .00081	< .00081	.0047	< .00081	< .00081
Toluene		< .00078	.011	.0072	< .00078	< .00078
Trichloroethylene		< .0028	< .0028	< .0028	< .0028	< .0028
Trichlorofluoromethane		.0084	< .0059	.014	< .0059	< .0059
Xylenes		< .0015	< .0015	< .0015	< .0015	< .0015
OTHER						
Total Organic Carbon						
Total Petroleum Hydrocarbons		169	30000	2390	49.5	130

NOTES:
FLC = USAEC Flagging Code
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< = Concentration was less than the certified reporting limit

T = Non-target compound analyzed for and not detected (non-GC/MS method)
I = Interferences in the sample caused the quantitation and/or identification to be suspect
M = High duplicate spike not within control limits
C = Analysis was confirmed by a different column or technique
Z = Non-target analyte analyzed for and detected by non-GC/MS method
J = Value is estimated
▨ = Exceeds established Devens background levels

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2		AREA 3							
Site ID:	Devens Background Concentrations µg/g	57E-95-20X		57B-96-07X		57B-96-07X		57B-96-08X		57B-96-08X	
Field Sample Number:		EX572005		BX570700		BX570705		BX570800		BX570805	
Lab Sample Number:		DV4S*120		DV4S*520		DV4S*521		DV4S*522		DV4S*523	
Sample Date:		09/21/95		08/28/96		08/28/96		08/29/96		08/29/96	
Depth:		5		0		5		0		5	
Units:		µg/g		µg/g		µg/g		µg/g		µg/g	
METALS											
Aluminum	18000	4370		5350		3510		6370		4730	
Antimony	0.5	< 1.09		< 1.09		< 1.09		< 1.09		< 1.09	
Arsenic	19	9.57		7.97		5.7		41		9.67	
Barium	54	8.07		54.8		13.5		29.3		16	
Beryllium	0.81	< .5		< .5		< .5		< .5		< .5	
Cadmium	1.28	< .7		10.8		< .7		1.5		< .7	
Calcium	810	121		295		624		283		957	
Chromium	33	9.19		11.8		5.91		11.7		6.75	
Cobalt	4.7	1.94		< 1.42		< 1.42		3.23		< 1.42	
Copper	13.5	6.09		26.9		3.87		6.83		5.48	
Iron	18000	5980		5810		3970		8040		5960	
Lead	48	2.43		425		4.14	J	32.7		2.97	J
Magnesium	5500	1560		957		1040		1650		1170	
Manganese	380	60.2		52.2		48.4		548		59.6	
Nickel	14.6	8.26		9.19		5.64		11.1		6.38	
Potassium	2400	378		250		642		683		649	
Selenium	--	< .25		< .25		< .25		< .25		< .25	
Silver	0.086	< .589		< .589		< .589		< .589		4.46	
Sodium	131	306		425		489		435		555	
Vanadium	32.3	6.72		6.26		5.46		9.16		7.1	
Zinc	43.9	12.6		159		12.1		28.5		18.3	
PESTICIDES/PCBS											
4,4'-dde		< .00765		< .00765		< .00765		< .00765		< .00765	
4,4'-ddt		< .00707		< .00707		< .00707		< .00707		< .00707	
Aldrin		< .00729		< .00729		< .00729		< .00729		< .00729	
Chlordane - Alpha		< .005	T	< .005	T	< .005	T	< .005	T	< .005	T
Dieldrin		< .00629		< .00629		< .00629		< .00629		< .00629	
Endosulfan I		< .00602		< .00602		< .00602		< .00602		< .00602	
Heptachlor Epoxide		< .0062		< .0062		< .0062		< .0062		< .0062	
Pcb 1242		< .082	T	3.4	CZ	2.6	ZC	< .082	T	< .082	T
Pcb 1248		< .082	T	< .082	T	< .082	T	< .082	T	< .082	T
Pcb 1260		< .0804		8	C	6.1	C	< .0804		< .0804	
SVOCs											
1,2,4-trichlorobenzene		< .04		< .4		.5		< .04		< .04	
1,2-dichlorobenzene		< .11		< 1		8		< .11		< .11	
1,4-dichlorobenzene		< .098		< 1		2		< .098		< .098	
2-methylnaphthalene		< .049		< .5		9		< .049		< .049	
Acenaphthene		< .036		< .4		.5		< .036		< .036	
Chrysene		< .12		< 1		< .6		< .12		< .12	
Dibenzofuran		< .035		< .4		< .2		< .035		< .035	
Fluoranthene		< .068		< .7		< .3		< .068		< .068	
Fluorene		< .033		< .3		.5		< .033		< .033	
Naphthalene		< .037		< .4		9		< .037		< .037	
Phenanthrene		< .033		< .3		1		< .033		< .033	
Pyrene		< .033		< .3		.8		< .033		< .033	

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID:	Devens Background Concentrations		57E-95-20X		57B-96-07X		57B-96-07X		57B-96-08X		57B-96-08X
Field Sample Number:			EX572005		BX570700		BX570705		BX570800		BX570805
Lab Sample Number:			DV4S*120		DV4S*520		DV4S*521		DV4S*522		DV4S*523
Sample Date:			09/21/95		08/28/96		08/28/96		08/29/96		08/29/96
Depth:			5		0		5		0		5
Units:	µg/g		µg/g		µg/g		µg/g		µg/g		µg/g
Bis(2-ethylhexyl) Phthalate		<	.62	<	6	<	3	<	.62	<	.62
Di-n-butyl Phthalate		<	.061	<	.6	<	.3	<	.061	<	.061
TPH BY GC											
TPH MOTOR OIL PATTERN			NA		21500		8930	<	50	<	50
VOCs											
*1,2-dichloroethylenes (cis And Trans)		<	.003	<	.003	<	0.0085	<	0.0017	<	0.0017
2-hexanone		<	.032	<	.032	<	0.16	<	0.032	<	0.032
Acetone		<	.017	<	.017	<	0.085	<	0.017	<	0.017
Chloroform		<	.00087	<	.00087	<	0.0044	<	0.00087	<	0.00087
Dichloromethane		<	.012	<	.012	<	0.012	<	0.012	<	0.012
Ethylbenzene		<	.0017	<	.0017	<	1.2	<	0.0017	<	0.0017
Tetrachloroethene		<	.00081		.0057	<	0.0041	<	0.00081	<	0.00081
Toluene		<	.00078	<	.00078		0.31		0.0061	<	0.00078
Trichloroethylene		<	.0028	<	.0028	<	0.014	<	0.0028	<	0.0028
Trichlorofluoromethane		<	.0059	<	.0059		0.036	<	0.0059	<	0.0059
Xylenes		<	.0015	<	.0015		22	<	0.0015	<	0.0015
OTHER											
Total Organic Carbon											
Total Petroleum Hydrocarbons			62.5		41400		31600		50	<	27.8

NOTES:
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< = Concentration was less than the certified reporting limit

T = Non-target compound analyzed for and not detected (non-GC/MS method)
I = Interferences in the sample caused the quantitation and/or identification to be suspect
M = High duplicate spike not within control limits
C = Analysis was confirmed by a different column or technique
Z = Non-target analyte analyzed for and detected by non-GC/MS method
J = Value is estimated
▨ = Exceeds established Devens background levels

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3									
Site ID:		57B-96-09X		57B-96-09X		57B-96-10X		57B-96-10X		57B-96-11X	
Field Sample Number:		BX570900		BX570905		BX571005		BX571010		BD571110	
Lab Sample Number:	Devens	DV4S*524		DV4S*525		DV4S*526		DV4S*527		DV4S*539	
Sample Date:	Background	08/29/96		08/29/96		09/03/96		09/03/96		09/03/96	
Depth:	Concentrations	0		5		5		10		10	
Units:	µg/g	µg/g		µg/g		µg/g		µg/g		µg/g	
METALS											
Aluminum	18000	7100		5610		3700		3560		3370	D
Antimony	0.5	< 1.09		< 1.09		< 1.09		< 1.09		< 1.09	D
Arsenic	19	5.23		8.39		36		5.15		5.17	D
Barium	54	11.1		13.3		11.2		14.4		13.2	D
Beryllium	0.81	< .5		< .5		.674		.5		< .5	D
Cadmium	1.28	< .7		< .7		< .7		< .7		< .7	D
Calcium	810	< 100		292		164		1100		1380	D
Chromium	33	10.6		7.57		5.1		6.54		< 4.05	D
Cobalt	4.7	2.37		2.7		2.52		1.42		< 1.42	D
Copper	13.5	5.29		5.47		3.4		5.13		4.97	D
Iron	18000	7430		6410		6460		5430		5010	D
Lead	48	7.84	J	3.95	J	2.1	J	3.01	J	1.91	D J
Magnesium	5500	1540		1340		1020		1140		989	D
Manganese	380	88.6		65.2		81.3		54.6		56.1	D
Nickel	14.6	10.5		7.3		6.25		6		6.49	D
Potassium	2400	209		521		535		717		582	D
Selenium	--	< .25		< .25		< .25		< .25		< .25	D
Silver	0.086	< .589		1.12		< .589		< .589		< .589	D
Sodium	131	400		505		416		538		535	D
Vanadium	32.3	9.41		7.99		5.56		6.71		5.55	D
Zinc	43.9	16.7		17.8		14.4		12.9		14.9	D
PESTICIDES/PCBS											
4,4'-dde		.0081	C	< .00765		< .00765		< .00765		< .00765	
4,4'-ddt		.0121	C	< .00707		< .00707		< .00707		< .00707	
Aldrin		< .00729		< .00729		< .00729		< .00729		< .00729	
Chlordane - Alpha		< .005	T	< .005	T	< .005	T	< .005	T	< .005	T
Dieldrin		< .00629		< .00629		< .00629		< .00629		< .00629	
Endosulfan I		< .00602		< .00602		< .00602		< .00602		< .00602	
Heptachlor Epoxide		< .0062		< .0062		< .0062		< .0062		< .0062	
Pcb 1242		< .082	T	< .082	T	< .082	T	< .082	T	< .082	T
Pcb 1248		< .082	T	< .082	T	< .082	T	< .082	T	< .082	T
Pcb 1260		< .0804		< .0804		< .0804		< .0804		< .0804	
SVOCs											
1,2,4-trichlorobenzene		< .04		< .04		< .04		< .04		< .04	D
1,2-dichlorobenzene		< .11		< .11		< .11		< .11		< .11	D
1,4-dichlorobenzene		< .098		< .098		< .098		< .098		< .098	D
2-methylnaphthalene		< .049		< .049		< .049		< .049		< .049	D
Acenaphthene		< .036		< .036		< .036		< .036		< .036	D
Chrysene		< .12		< .12		< .12		< .12		< .12	D
Dibenzofuran		< .035		< .035		< .035		< .035		< .035	D
Fluoranthene		.14		< .068		< .068		< .068		< .068	D
Fluorene		< .033		< .033		< .033		< .033		< .033	D
Naphthalene		.048		< .037		< .037		< .037		< .037	D
Phenanthrene		.11		< .033		< .033		< .033		< .033	D
Pyrene		.15		< .033		< .033		< .033		< .033	D

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/g		57B-96-09X BX570900 DV4S*524 08/29/96 0 µg/g			57B-96-09X BX570905 DV4S*525 08/29/96 5 µg/g			57B-96-10X BX571005 DV4S*526 09/03/96 5 µg/g			57B-96-10X BX571010 DV4S*527 09/03/96 10 µg/g			57B-96-11X BD571110 DV4S*539 09/03/96 10 µg/g	
Bis(2-ethylhexyl) Phthalate		<	.62		<	.62		<	.62		<	.62		<	.62	D
Di-n-butyl Phthalate		<	.061		<	.061		<	.061		<	.061		<	.061	D
TPH BY GC																
TPH MOTOR OIL PATTERN		<	50		<	50		<	52.1		<	63		<	63	
VOCs																
*1,2-dichloroethylenes (cis And Trans)		<	0.0017		<	0.0017		<	.003		<	.003		<	.003	D
2-hexanone		<	0.032		<	0.032		<	.032		<	.032		<	.032	D
Acetone		<	0.017		<	0.017		<	.017		<	.017		<	.017	D
Chloroform		<	0.00087		<	0.00087		<	.00087		<	.00087		<	.00087	D
Dichloromethane		<	0.012		<	0.012		<	.012		<	.012		<	.012	D
Ethylbenzene		<	0.0017		<	0.0017		<	.0017		<	.0017		<	.0017	D
Tetrachloroethene		<	0.00081		<	0.00081		<	.00081		<	.00081		<	.00081	D
Toluene		<	0.003		<	0.0012		<	.00078		<	.00078		<	.00078	D
Trichloroethylene		<	0.0028		<	0.0028		<	.0028		<	.0028		<	.0028	D
Trichlorofluoromethane		<	0.0059		<	0.0059		<	.0059		<	.0059		<	.0059	D
Xylenes		<	0.0015		<	0.0068		<	.0015		<	.0015		<	.0015	D
OTHER																
Total Organic Carbon																
Total Petroleum Hydrocarbons			39.4		<	27.8		<	27.6		<	27.8			35.4	D

NOTES:
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Z = Non-target analyte analyzed for and detected by non-GC/MS method
J = Value is estimated
▨ = Exceeds established Devens background levels

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3					
Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/g	57B-96-11X BX571105 DV4S*528 09/03/96 .5 µg/g	57B-96-11X BX571110 DV4S*529 09/03/96 10 µg/g	57E-95-24X EX572404 DV4S*124 09/22/95 4 µg/g	57E-95-25X EX572500 DV4S*125 09/22/95 0 µg/g	57E-96-28X EX572810 DV4S*516 08/19/96 10 µg/g	57E-96-29X EX572911 DV4S*517 08/20/96 11 µg/g
METALS							
Aluminum	18000	2790	3940	7550 IM	7450 IM	2420	2460
Antimony	0.5	< 1.09	< 1.09	2.89	< 1.09	< 1.09	< 1.09
Arsenic	19	16	4.8	9.79	21	6.26	6.41
Barium	54	14.8	15.5	46.6	20.6	14.2	9.68
Beryllium	0.81	< .5	< .5	< .5	< .5	< .5	< .5
Cadmium	1.28	< .7	< .7	5.14	< .7	< .7	< .7
Calcium	810	668	602	590	889	930	591
Chromium	33	< 4.05	6.04	19.6	22.9	< 4.05	< 4.05
Cobalt	4.7	< 1.42	1.97	< 1.42	7.53	< 1.42	< 1.42
Copper	13.5	4.92	4.26	28.3	15.6	4.34	3.87
Iron	18000	4910	4790	6010	16400	2700	3920
Lead	48	13 J	2.05 J	181	19.1	4.33 J	1.91 J
Magnesium	5500	774	1190	1270	4020	641	736
Manganese	380	40.8	57.8	43.4	336	31.7	43.5
Nickel	14.6	4	6.99	8.82	30.7	4.98	4.85
Potassium	2400	450	742	310	944	407	431
Selenium	--	< .25	< .25	< .25	< .25	< .25	< .25
Silver	0.086	< .589	< .589	< .589	< .589	< .589	< .589
Sodium	131	463	542	355	301	408	500
Vanadium	32.3	4.4	6.34	11.3	14.7	< 3.39	< 3.39
Zinc	43.9	11.5	16	62.5	38.1	15.5	19.4
PESTICIDES/PCBS							
4,4'-dde		0.017	< .00765	< .00765	< .00765	< .00765	< .00765
4,4'-ddt		< .00707	< .00707	< .00707	< .00707	< .00707	< .00707
Aldrin		< .00729	< .00729	.0255 C	< .00729	< .00729	< .00729
Chlordane - Alpha		< .005 T	< .005 T	< .005 T	< .005 T	.0103 C	< .005 T
Dieldrin		< .00629	< .00629	< .00629	< .00629	< .00629	< .00629
Endosulfan I		< .00602	< .00602	< .00602	< .00602	< .00602	< .00602
Heptachlor Epoxide		< .0062	< .0062	< .0062	< .0062	< .0062	< .0062
Pcb 1242		< .082 T	< .082 T	< .082 T	< .082 T	< .082 T	< .082 T
Pcb 1248		< .082 T	< .082 T	3.6 CZ	< .082 T	< .082 T	< .082 T
Pcb 1260		7.4	< .0804	10 C	< .0804	1.7 C	.0998 C
SVOCs							
1,2,4-trichlorobenzene		< .2	< .04	< 3	< .08	.5	< .04
1,2-dichlorobenzene		< .6	< .11	< 9	< .2	6	< .11
1,4-dichlorobenzene		< .5	< .098	< 8	< .2	4	< .098
2-methylnaphthalene		< .2	< .049	< 4	< .1	.4	< .049
Acenaphthene		< .2	< .036	< 3	< .07	< .2	< .036
Chrysene		< .6	< .12	< 10	< .2	1	< .12
Dibenzofuran		< .2	< .035	< 3	< .07	< .2	< .035
Fluoranthene		< .3	< .068	< 5	.3	1	< .068
Fluorene		< .2	< .033	< 3	< .07	.3	< .033
Naphthalene		< .2	< .037	< 3	.1	2	< .037
Phenanthrene		< .2	< .033	< 3	.1	.4	< .033
Pyrene		< .2	< .033	< 3	.2	3	.055

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/g	57B-96-11X BX571105 DV4S*528 09/03/96 5 µg/g	57B-96-11X BX571110 DV4S*529 09/03/96 10 µg/g	57E-95-24X EX572404 DV4S*124 09/22/95 4 µg/g	57E-95-25X EX572500 DV4S*125 09/22/95 0 µg/g	57E-96-28X EX572810 DV4S*516 08/19/96 10 µg/g	57E-96-29X EX572911 DV4S*517 08/20/96 11 µg/g
Bis(2-ethylhexyl) Phthalate		< 3	< .62	< 50	2	< 3	< .62
Di-n-butyl Phthalate		< .3	< .061	< 5	< .1	< .3	< .061
TPH BY GC							
TPH MOTOR OIL PATTERN		< 2240	< 61	NA	NA	19700	286
VOCs							
*1,2-dichloroethylenes (cis And Trans)		< .003	< .003	< .003	< .003	< .003	< .003
2-hexanone		< .032	< .032	< .032	< .032	.03	< .032
Acetone		< .017	< .017	< .017	< .017	< .017	< .017
Chloroform		< .00087	< .00087	< .00087	< .00087	< .00087	< .00087
Dichloromethane		< .012	< .012	< .012	< .012	< .012	< .012
Ethylbenzene		< .0017	< .0017	< .0017	< .0017	.0042	< .0017
Tetrachloroethene		< .00081	< .00081	.0018	< .00081	.0094	< .00081
Toluene		< .00078	.0018	< .00078	< .00078	< .00078	< .00078
Trichloroethylene		< .0028	< .0028	< .0028	< .0028	< .0028	< .0028
Trichlorofluoromethane		< .0059	< .0059	.0075	.0073	< .0059	< .0059
Xylenes		< .0015	< .0015	< .0015	< .0015	.066	< .0015
OTHER							
Total Organic Carbon							
Total Petroleum Hydrocarbons		4250	< 27.8	64900	81.1	36100	262

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TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3			AREA 2	
Site ID:		57E-96-30X	57E-96-31X	57M-95-03X	57M-95-04A	57M-95-04X
Field Sample Number:		EX573006	EX573106	BX570310	BX574A01	BX570402
Lab Sample Number:	Devens	DV4S*518	DV4S*519	DV4S*155	DV4S*161	DV4S*156
Sample Date:	Background	08/20/96	08/21/96	10/03/95	10/04/95	10/03/95
Depth:	Concentrations	6	6	10	1	2
Units:	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
METALS						
Aluminum	18000	3240	3060	NA	NA	NA
Antimony	0.5	< 1.09	< 1.09	NA	NA	NA
Arsenic	19	6.74	17	NA	NA	NA
Barium	54	12	10.1	NA	NA	NA
Beryllium	0.81	< .5	< .5	NA	NA	NA
Cadmium	1.28	< .7	< .7	NA	NA	NA
Calcium	810	789	385	NA	NA	NA
Chromium	33	5.25	< 4.05	NA	NA	NA
Cobalt	4.7	< 1.42	< 1.42	NA	NA	NA
Copper	13.5	4.93	5.37	NA	NA	NA
Iron	18000	3980	5020	NA	NA	NA
Lead	48	5.07 J	25.5	NA	NA	NA
Magnesium	5500	898	745	NA	NA	NA
Manganese	380	53.2	51.3	NA	NA	NA
Nickel	14.6	6.05	3.94	NA	NA	NA
Potassium	2400	523	294	NA	NA	NA
Selenium	--	< .25	< .25	NA	NA	NA
Silver	0.086	< .589	< .589	NA	NA	NA
Sodium	131	456	403	NA	NA	NA
Vanadium	32.3	4.92	4.58	NA	NA	NA
Zinc	43.9	10.5	11.9	NA	NA	NA
PESTICIDES/PCBS						
4,4'-dde		< .00765	< .00765	NA	NA	NA
4,4'-ddt		< .00707	< .00707	NA	NA	NA
Aldrin		< .00729	< .00729	NA	NA	NA
Chlordane - Alpha		< .005 T	.068 C	NA	NA	NA
Dieldrin		< .00629	< .00629	NA	NA	NA
Endosulfan I		< .00602	< .00602	NA	NA	NA
Heptachlor Epoxide		< .0062	.00691 C	NA	NA	NA
Pcb 1242		< .082 T	< .082 T	NA	NA	NA
Pcb 1248		< .082 T	< .082 T	NA	NA	NA
Pcb 1260		< .0804	< .0804	NA	NA	NA
SVOCs						
1,2,4-trichlorobenzene		< .08	< .2	NA	NA	NA
1,2-dichlorobenzene		< .2	< .6	NA	NA	NA
1,4-dichlorobenzene		< .2	< .5	NA	NA	NA
2-methylnaphthalene		< .1	< .2	NA	NA	NA
Acenaphthene		< .07	< .2	NA	NA	NA
Chrysene		< .2	< .6	NA	NA	NA
Dibenzofuran		< .07	< .2	NA	NA	NA
Fluoranthene		< .1	< .3	NA	NA	NA
Fluorene		< .07	< .2	NA	NA	NA
Naphthalene		2	< .2	NA	NA	NA
Phenanthrene		< .07	< .2	NA	NA	NA
Pyrene		< .07	< .5	NA	NA	NA

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/g	57E-96-30X EX573006 DV4S*518 08/20/96 6 µg/g	57E-96-31X EX573106 DV4S*519 08/21/96 6 µg/g	57M-95-03X BX570310 DV4S*155 10/03/95 10 µg/g	57M-95-04A BX574A01 DV4S*161 10/04/95 1 µg/g	57M-95-04X BX570402 DV4S*156 10/03/95 2 µg/g
Bis(2-ethylhexyl) Phthalate		< 1	< 3	NA	NA	NA
Di-n-butyl Phthalate		< .1	< .3	NA	NA	NA
TPH BY GC						
TPH MOTOR OIL PATTERN		5320	6800	NA	NA	NA
VOCs						
*1,2-dichloroethylenes (cis And Trans)		< .003	< .003	NA	NA	NA
2-hexanone		.071	< .032	NA	NA	NA
Acetone		< .017	< .017	NA	NA	NA
Chloroform		< .00087	< .00087	NA	NA	NA
Dichloromethane		< .012	< .012	NA	NA	NA
Ethylbenzene		< .0017	< .0017	NA	NA	NA
Tetrachloroethene		< .00081	< .00081	NA	NA	NA
Toluene		< .00078	< .00078	NA	NA	NA
Trichloroethylene		< .0028	< .0028	NA	NA	NA
Trichlorofluoromethane		< .0059	< .0059	NA	NA	NA
Xylenes		.13	< .0015	NA	NA	NA
OTHER						
Total Organic Carbon				566	5450	36400
Total Petroleum Hydrocarbons		6960	18300			

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J = Value is estimated
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TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2				
Site ID:	Devens Background Concentrations	57M-95-05X	57M-95-06X	57M-95-07X	57M-95-08A	57M-95-08B
Field Sample Number:		BX570514	BX570615	BX570704	BX578A07	BX578B04
Lab Sample Number:		DV4S*157	DV4S*158	DV4S*159	DV4S*162	DV4S*160
Sample Date:		10/03/95	10/04/95	10/04/95	10/10/95	10/06/95
Depth:		14	15	4	7	4
Units:	μg/g	μg/g	μg/g	μg/g	μg/g	μg/g
METALS						
Aluminum	18000	NA	NA	NA	NA	NA
Antimony	0.5	NA	NA	NA	NA	NA
Arsenic	19	NA	NA	NA	NA	NA
Barium	54	NA	NA	NA	NA	NA
Beryllium	0.81	NA	NA	NA	NA	NA
Cadmium	1.28	NA	NA	NA	NA	NA
Calcium	810	NA	NA	NA	NA	NA
Chromium	33	NA	NA	NA	NA	NA
Cobalt	4.7	NA	NA	NA	NA	NA
Copper	13.5	NA	NA	NA	NA	NA
Iron	18000	NA	NA	NA	NA	NA
Lead	48	NA	NA	NA	NA	NA
Magnesium	5500	NA	NA	NA	NA	NA
Manganese	380	NA	NA	NA	NA	NA
Nickel	14.6	NA	NA	NA	NA	NA
Potassium	2400	NA	NA	NA	NA	NA
Selenium	--	NA	NA	NA	NA	NA
Silver	0.086	NA	NA	NA	NA	NA
Sodium	131	NA	NA	NA	NA	NA
Vanadium	32.3	NA	NA	NA	NA	NA
Zinc	43.9	NA	NA	NA	NA	NA
PESTICIDES/PCBS						
4,4'-dde		NA	NA	NA	NA	NA
4,4'-ddt		NA	NA	NA	NA	NA
Aldrin		NA	NA	NA	NA	NA
Chlordane - Alpha		NA	NA	NA	NA	NA
Dieldrin		NA	NA	NA	NA	NA
Endosulfan I		NA	NA	NA	NA	NA
Heptachlor Epoxide		NA	NA	NA	NA	NA
Pcb 1242		NA	NA	NA	NA	NA
Pcb 1248		NA	NA	NA	NA	NA
Pcb 1260		NA	NA	NA	NA	NA
SVOCs						
1,2,4-trichlorobenzene		NA	NA	NA	NA	NA
1,2-dichlorobenzene		NA	NA	NA	NA	NA
1,4-dichlorobenzene		NA	NA	NA	NA	NA
2-methylnaphthalene		NA	NA	NA	NA	NA
Acenaphthene		NA	NA	NA	NA	NA
Chrysene		NA	NA	NA	NA	NA
Dibenzofuran		NA	NA	NA	NA	NA
Fluoranthene		NA	NA	NA	NA	NA
Fluorene		NA	NA	NA	NA	NA
Naphthalene		NA	NA	NA	NA	NA
Phenanthrene		NA	NA	NA	NA	NA
Pyrene		NA	NA	NA	NA	NA

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID:		57M-95-05X	57M-95-06X	57M-95-07X	57M-95-08A	57M-95-08B
Field Sample Number:		BX570514	BX570615	BX570704	BX578A07	BX578B04
Lab Sample Number:	Devens	DV4S*157	DV4S*158	DV4S*159	DV4S*162	DV4S*160
Sample Date:	Background	10/03/95	10/04/95	10/04/95	10/10/95	10/06/95
Depth:	Concentrations	14	15	4	7	4
Units:	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
Bis(2-ethylhexyl) Phthalate		NA	NA	NA	NA	NA
Di-n-butyl Phthalate		NA	NA	NA	NA	NA
TPH BY GC						
TPH MOTOR OIL PATTERN		NA	NA	NA	NA	NA
VOCs						
*1,2-dichloroethylenes (cis And Trans)		NA	NA	NA	NA	NA
2-hexanone		NA	NA	NA	NA	NA
Acetone		NA	NA	NA	NA	NA
Chloroform		NA	NA	NA	NA	NA
Dichloromethane		NA	NA	NA	NA	NA
Ethylbenzene		NA	NA	NA	NA	NA
Tetrachloroethene		NA	NA	NA	NA	NA
Toluene		NA	NA	NA	NA	NA
Trichloroethylene		NA	NA	NA	NA	NA
Trichlorofluoromethane		NA	NA	NA	NA	NA
Xylenes		NA	NA	NA	NA	NA
OTHER						
Total Organic Carbon		673	561	1380	523	752
Total Petroleum Hydrocarbons						

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M = High duplicate spike not within control limits
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TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3				
Site ID:		57M-96-09X	57M-96-10X	57M-96-11X	57M-96-12X	57M-96-13X
Field Sample Number:		BX570914	BX571005	BX571105	BX571204	BX571305
Lab Sample Number:	Devens	DV4S*530	DV4S*531	DV4S*532	DV4S*563	DV4S*564
Sample Date:	Background	08/27/96	08/30/96	08/30/96	08/29/96	08/29/96
Depth:	Concentrations	14	5	5	4	5
Units:	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
METALS						
Aluminum	18000	NA	NA	NA	NA	NA
Antimony	0.5	NA	NA	NA	NA	NA
Arsenic	19	NA	NA	NA	NA	NA
Barium	54	NA	NA	NA	NA	NA
Beryllium	0.81	NA	NA	NA	NA	NA
Cadmium	1.28	NA	NA	NA	NA	NA
Calcium	810	NA	NA	NA	NA	NA
Chromium	33	NA	NA	NA	NA	NA
Cobalt	4.7	NA	NA	NA	NA	NA
Copper	13.5	NA	NA	NA	NA	NA
Iron	18000	NA	NA	NA	NA	NA
Lead	48	NA	NA	NA	NA	NA
Magnesium	5500	NA	NA	NA	NA	NA
Manganese	380	NA	NA	NA	NA	NA
Nickel	14.6	NA	NA	NA	NA	NA
Potassium	2400	NA	NA	NA	NA	NA
Selenium	--	NA	NA	NA	NA	NA
Silver	0.086	NA	NA	NA	NA	NA
Sodium	131	NA	NA	NA	NA	NA
Vanadium	32.3	NA	NA	NA	NA	NA
Zinc	43.9	NA	NA	NA	NA	NA
PESTICIDES/PCBS						
4,4'-dde		NA	NA	NA	NA	NA
4,4'-ddt		NA	NA	NA	NA	NA
Aldrin		NA	NA	NA	NA	NA
Chlordane - Alpha		NA	NA	NA	NA	NA
Dieldrin		NA	NA	NA	NA	NA
Endosulfan I		NA	NA	NA	NA	NA
Heptachlor Epoxide		NA	NA	NA	NA	NA
Pcb 1242		NA	NA	NA	NA	NA
Pcb 1248		NA	NA	NA	NA	NA
Pcb 1260		NA	NA	NA	NA	NA
SVOCs						
1,2,4-trichlorobenzene		NA	NA	NA	NA	NA
1,2-dichlorobenzene		NA	NA	NA	NA	NA
1,4-dichlorobenzene		NA	NA	NA	NA	NA
2-methylnaphthalene		NA	NA	NA	NA	NA
Acenaphthene		NA	NA	NA	NA	NA
Chrysene		NA	NA	NA	NA	NA
Dibenzofuran		NA	NA	NA	NA	NA
Fluoranthene		NA	NA	NA	NA	NA
Fluorene		NA	NA	NA	NA	NA
Naphthalene		NA	NA	NA	NA	NA
Phenanthrene		NA	NA	NA	NA	NA
Pyrene		NA	NA	NA	NA	NA

TABLE 7-12
RI SOIL OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID:	Devens Background Concentrations	57M-96-09X	57M-96-10X	57M-96-11X	57M-96-12X	57M-96-13X
Field Sample Number:		BX570914	BX571005	BX571105	BX571204	BX571305
Lab Sample Number:		DV4S*530	DV4S*531	DV4S*532	DV4S*563	DV4S*564
Sample Date:		08/27/96	08/30/96	08/30/96	08/29/96	08/29/96
Depth:		14	5	5	4	5
Units:	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
Bis(2-ethylhexyl) Phthalate		NA	NA	NA	NA	NA
Di-n-butyl Phthalate		NA	NA	NA	NA	NA
TPH BY GC						
TPH MOTOR OIL PATTERN		NA	NA	NA	NA	NA
VOCs						
*1,2-dichloroethylenes (cis And Trans)		NA	NA	NA	NA	NA
2-hexanone		NA	NA	NA	NA	NA
Acetone		NA	NA	NA	NA	NA
Chloroform		NA	NA	NA	NA	NA
Dichloromethane		NA	NA	NA	NA	NA
Ethylbenzene		NA	NA	NA	NA	NA
Tetrachloroethene		NA	NA	NA	NA	NA
Toluene		NA	NA	NA	NA	NA
Trichloroethylene		NA	NA	NA	NA	NA
Trichlorofluoromethane		NA	NA	NA	NA	NA
Xylenes		NA	NA	NA	NA	NA
OTHER						
Total Organic Carbon		792	1180	722	834	719
Total Petroleum Hydrocarbons						

NOTES:
FLC = USAEC Flagging Code
DQ = Data Qualifier
< = Concentration was less than the certified reporting limit

T = Non-target compound analyzed for and not detected (non-GC/MS method)
I = Interferences in the sample caused the quantitation and/or identification to be suspect
M = High duplicate spike not within control limits
C = Analysis was confirmed by a different column or technique
Z = Non-target analyte analyzed for and detected by non-GC/MS method
J = Value is estimated
▨ = Exceeds established Devens background levels

TA[illegible]13
1998 SOIL FIELD AND OFF[illegible]E ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Parm	Method	Analyte	Units	Area 2						
				57S-98-01X SX570101 5/19/98	57S-98-02X SX570200 5/19/98	57S-98-03X SX570302 5/19/98	57S-98-04X SX570401 5/19/98	57S-98-05X SX570503 5/19/98	57S-98-06X SX570601 5/19/98	57S-98-07X SD570700 5/19/98
Volatile Organics										
	LM19	1,1,1-trichloroethane	µg/g	LT .0044	LT .0044	LT .0044	LT .0044	LT .0044	LT .0044	LT .0044 d
	LM19	*1,2-dichloroethylenes (cis And Trans)	µg/g	LT .003	LT .003	LT .003	LT .003	LT .003	.01	LT .003 d
	LM19	Acetone	µg/g	LT .017	LT .017	LT .017	LT .017	LT .017	LT .017	LT .017 d
	LM19	Chlorobenzene	µg/g	LT .00086	LT .00086	LT .00086	LT .00086	LT .00086	LT .00086	LT .00086 d
	LM19	Ethylbenzene	µg/g	LT .0017	LT .0017	LT .0017	LT .0017	LT .0017	.0033	LT .0017 d
	LM19	Toluene	µg/g	LT .00078	LT .00078	LT .00078	LT .00078	LT .00078	LT .00078	LT .00078 d
	LM19	Trichloroethylene	µg/g	LT .0028	LT .0028	LT .0028	LT .0028	LT .0028	LT .0028	LT .0028 d
	LM19	Xylenes	µg/g	LT .0015	LT .0015	LT .0015	LT .0015	LT .0015	LT .0015	LT .0015 d
Semivolatile Organics										
	LM18	1,2-dichlorobenzene	µg/g	LT .11	LT .6	LT 2	LT .6	LT .6	LT .6	LT .11 d
	LM18	1,4-dichlorobenzene	µg/g	LT .098	LT .5	LT 2	LT .5	LT .5	LT .5	LT .098 d
	LM18	2-methylnaphthalene	µg/g	LT .049	.6	LT 1	LT .2	LT .2	LT .2	LT .049 d
	LM18	Acenaphthylene	µg/g	LT .033	.4	LT .7	LT .2	LT .2	LT .2	LT .033 d
	LM18	bis(2-ethylhexyl) Phthalate	µg/g	LT .62	LT 3	LT 10	LT 3	LT 3	LT 3	LT .62 d
	LM18	Benzo[k]fluoranthene	µg/g	LT .066	1	LT 1	LT .3	LT .3	LT .3	LT .066 d
	LM18	Chrysene	µg/g	LT .12	1	LT 2	LT .6	LT .6	LT .6	LT .12 d
	LM18	Fluoranthene	µg/g	LT .068	2	LT 1	LT .3	LT .3	LT .3	LT .068 d
	LM18	Naphthalene	µg/g	LT .037	.4	LT .7	LT .2	LT .2	LT .2	LT .037 d
	LM18	Phenanthrene	µg/g	LT .033	1	LT .7	LT .2	LT .2	.3	LT .033 d
	LM18	Pyrene	µg/g	LT .033	2	LT .7	LT .2	LT .2	.4	LT .033 d
Pesticides/PCBs										
	LH10	Chlordane - Alpha	µg/g	ND .00133 t	ND .00133 t	ND .00133 t	ND .00133 t	ND .00133 t	ND .00133 t	ND .00133 td
	LH10	Dieldrin	µg/g	LT .00629	LT .00629	.043 c	LT .00629	LT .00629	LT .00629	LT .00629 d
	LH10	Chlordane - Gamma	µg/g	ND .00133 t	ND .00133 t	ND .00133 t	ND .00133 t	ND .00133 t	ND .00133 t	ND .00133 td
	LH10	4,4'-DDD	µg/g	LT .00826	LT .00826	.044 c	LT .00826	.027 c	LT .00826	LT .00826 d
	LH10	4,4'-DDE	µg/g	LT .00765	.0194 c	LT .00765	LT .00765	LT .00765	LT .00765	LT .00765 d
	LH10	4,4'-DDT	µg/g	LT .00707	.12 c	.0352 c	LT .00707	LT .00707	LT .00707	.0625 cd
	LH16	Pcb 1260	µg/g	LT .0804	.548 c	5.2 c	.186 c	.224 c	LT .0804	.581 dc
Other										
	9071	Total Petroleum Hydrocarbons	µg/g	393	1200	14800	1150	1750	4620	1830 d
Metals-ICP										
	JS16	Barium	µg/g	17.2	113	51.1	15.5	22.7	10.7	60.3 d
	JS16	Copper	µg/g	3.01	41.3	14.7	7	6.13	2.45	28.3 d
	JS16	Manganese	µg/g	36.7	679	86.8	69.2	74.6	128	66.3 d
	JS16	Lead	µg/g	18.7	271	167	39.7	42.9	24.9	297 d
	JS16	Zinc	µg/g	14.9	150	46.6	20.1	29.3	LT 8.03	77.4 d
Metals-ICP-MS										
	J301	Arsenic	µg/g	15.3	45	20	7.02	25	20.6	38.8 d
	J301	Selenium	µg/g	1.3	3	2.14	0.39	0.704	0.951	2.66
VPH Ranges (µg/g)										
		n-C5 to n-C8 Aliphatic	µg/g	<1.3	< 2.5 j	< 1.6 j	< 1.3	< 1.0	<2.3 j	< 8.7 j
		n-C9 to n-C12 Aliphatic	µg/g	4.3	2.5 j	1.9 j	< 1.3	2.1	3.9 j	15 j
		n-C9 to n-C10 Aromatic	µg/g	<1.3	< 2.5 j	< 1.6 j	< 1.3	< 1.0	<2.3 j	21 j
EPH Ranges (µg/g)										
		n-C9 to n-C18 Aliphatic	µg/g	<44 j	<55 j	110 j	<37 j	<33 j	120 j	<170 j
		n-C19 to n-C36 Aliphatic	µg/g	68	360	3300	260	610	830	1800
		n-C11 to n-C22 Aromatic	µg/g	<44	240	990	140	140	190	590
On-Site TPH, µg/g-dry)			µg/g	1000	1400	14000	680	3200	2500	<740

Notes:
C = analysis confirmed
d = duplicate
j = estimate
LT = less than
t = non-target compound
▨ = exceeds established Devens background concentration

TA[illegible]13
1998 SOIL FIELD AND OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Parm	Method	Analyte	Units	Area 2 57S-98-07X SX570700 5/19/98	 57S-98-07X SX570701 5/19/98	 57S-98-08X SX570800 5/19/98	 57S-98-09X SX570900 5/19/98	Area 3 57S-98-13X SX571301 5/20/98	 57S-98-14X SX571401 5/20/98	 57S-98-15X SX571503 5/20/98
Volatile Organics										
	LM19	1,1,1-trichloroethane	µg/g	LT .0044	LT .0044	LT .0044	LT .0044	LT .0044	LT .0044	.013
	LM19	*1,2-dichloroethylenes (cis And Trans)	µg/g	LT .003	.016	LT .003	LT .003	LT .003	LT .003	LT .003
	LM19	Acetone	µg/g	.33	.073	LT .017	LT .017	LT .017	LT .017	LT .017
	LM19	Chlorobenzene	µg/g	LT .00086	LT .00086	LT .00086	LT .00086	.012	LT .00086	LT .00086
	LM19	Ethylbenzene	µg/g	LT .0017	.022	LT .0017	LT .0017	LT .0017	LT .0017	LT .0017
	LM19	Toluene	µg/g	LT .00078	LT .00078	LT .00078	LT .00078	LT .00078	LT .00078	.0013
	LM19	Trichloroethylene	µg/g	LT .0028	LT .0028	LT .0028	LT .0028	.0042	LT .0028	LT .0028
	LM19	Xylenes	µg/g	LT .0015	LT .0015	LT .0015	LT .0015	LT .0015	LT .0015	.0041
Semivolatile Organics										
	LM18	1,2-dichlorobenzene	µg/g	LT .6	LT 1	LT .6	LT .6	.35	LT .11	LT .11
	LM18	1,4-dichlorobenzene	µg/g	LT .5	LT 1	LT .5	LT .5	.48	LT .098	LT .098
	LM18	2-methylnaphthalene	µg/g	LT .2	LT .5	LT .2	LT .2	LT .049	LT .049	LT .049
	LM18	Acenaphthylene	µg/g	LT .2	LT .3	LT .2	LT .2	LT .033	LT .033	LT .033
	LM18	bis(2-ethylhexyl) Phthalate	µg/g	LT 3	LT 6	LT 3	LT 3	LT .62	LT .62	14
	LM18	Benzo[k]fluoranthene	µg/g	LT .3	LT .7	LT .3	LT .3	LT .066	LT .066	LT .066
	LM18	Chrysene	µg/g	LT .6	LT 1	LT .6	LT .6	LT .12	LT .12	LT .12
	LM18	Fluoranthene	µg/g	LT .3	LT .7	2	LT .3	.13	LT .068	LT .068
	LM18	Naphthalene	µg/g	LT .2	LT .4	LT .2	LT .2	LT .037	LT .037	LT .037
	LM18	Phenanthrene	µg/g	LT .2	LT .3	1	.8	.067	LT .033	LT .033
	LM18	Pyrene	µg/g	LT .2	LT .3	2	.9	.096	LT .033	LT .033
Pesticides/PCBs										
	LH10	Chlordane - Alpha	µg/g	ND .00133 t	ND .00133 t	ND .00132 t	ND .00133 t	.00282 cz	ND .00133 t	ND .00133 t
	LH10	Dieldrin	µg/g	LT .00629	LT .00629	LT .00629	.0228 c	LT .00629	LT .00629	LT .00629
	LH10	Chlordane - Gamma	µg/g	ND .00133 t	ND .00133 t	ND .00132 t	ND .00133 t	.00278 cz	ND .00133 t	ND .00133 t
	LH10	4,4'-DDD	µg/g	LT .00826	LT .00826	LT .00826	.0372 c	.0234 c	LT .00826	LT .00826
	LH10	4,4'-DDE	µg/g	LT .00765	LT .00765	.0361 c	.0524 c	LT .00765	LT .00765	LT .00765
	LH10	4,4'-DDT	µg/g	.0713 c	LT .00707	.0351 c	.18 c	LT .00707	.0248 c	LT .00707
	LH16	Pcb 1260	µg/g	.466 c	.513 c	LT .0804	.255 c	LT .0804	.474 c	LT .0804
Other										
	9071	Total Petroleum Hydrocarbons	µg/g	6170	17000	494	1930	951	895	LT 27.9
Metals-ICP										
	JS16	Barium	µg/g	▨ 66.8	50.9	▨ 110	▨ 69.1	17.1	14.6	13.1
	JS16	Copper	µg/g	▨ 30.3	8.78	▨ 16	▨ 30.7	2.93	3.46	2.2
	JS16	Manganese	µg/g	81.8	131	46	161	170	69.5	70.8
	JS16	Lead	µg/g	▨ 320	▨ 63.9	▨ 173	▨ 299	22	LT 10.5	LT 10.5
	JS16	Zinc	µg/g	▨ 84.6	▨ 96.6	▨ 78.5	▨ 73.6	15.8	27.5	13.3
Metals-ICP-MS										
	J301	Arsenic	µg/g	61.2	44.8	13.4	43.2	25.6	28	28.2
	J301	Selenium	µg/g	4.42	3.51	2.75	4.25	1.56	IT 0.250	0.485
VPH Ranges (µg/g)										
		n-C5 to n-C8 Aliphatic	µg/g	<9.3 j	< 3.5 j	<5.3 j	<3.6 j	<1.8 j	<1.4	<1.3
		n-C9 to n-C12 Aliphatic	µg/g	<9.3 j	15 j	6.4 j	6.4 j	3.7 j	<1.4	<1.3
		n-C9 to n-C10 Aromatic	µg/g	12 j	< 3.5 j	13 j	<3.6 j	<1.8 j	<1.4	<1.3
EPH Ranges (µg/g)										
		n-C9 to n-C18 Aliphatic	µg/g	<160 j	270 j	<100 j	<83 j	<46 j	<40 j	<37 j
		n-C19 to n-C36 Aliphatic	µg/g	2100	1600	<100	240	180	150	<37
		n-C11 to n-C22 Aromatic	µg/g	510	450	<100	110	60	75 j	<37
On-Site TPH: µg/g-dry)			µg/g	<800	32000	<800	1500	1600	1200	<270

Notes:

C = analysis confirmed
d = duplicate
j = estimate
LT = less than
t = non-target compound
▨ = exceeds established Devens background concentration

TABLE 7-14
RI GROUNDWATER FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 2				AREA 3				
	Lab Sample ID: Date analyzed: Depth (bgs): Dilution:	57M-95-01X 12-Oct-95 17 1	57M-95-02X 3-Oct-95 17 1	57M-95-06X 4-Oct-95 15 1	57M-95-07X 5-Oct-95 3 1	57R-95-02X 3-Oct-95 12 1	57R-95-03X 3-Oct-95 12 1	57R-95-04X 3-Oct-95 12 1	57R-95-05X 3-Oct-95 11 5	57R-95-06X 2-Oct-95 11 1
Analytes	**Reporting Limit**									
Vinyl Chloride	2 µg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/l	5.0 UJ	5.0 U	5.0 UJ	5.0 U	5.0 U	5.0 U	5.0 U	25 U	5.0 U
t-1,2-DCE	2 µg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	10 U	2.0 U
1,1,1-TCA	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	10 U	2.0 U
Carbon Tetrachloride	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	10 U	2.0 U
Trichloroethene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	10 U	2.0 U
Tetrachloroethene	2 µg/l	2.0 U	2.0 U	2.0 U	2.5	2.1	2.0 U	2.5	10 U	2.0 U
1,3-DCB	2 µg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	3.5	2.0 U	110	2.0 U
Toluene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.6	240	2.0 UJ
Chlorobenzene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	15	2.0 U
Ethylbenzene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	3.1	410	2.0 U
m/p-Xylene	4 µg/l	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	6.7	7	1100	4.0 U
o-Xylene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	23	2.6	550	7.4
Naphthalene	2 µg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-dro	100 mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-gro	100 µg/l	100 U	100 U	100 U	100 U	100 U	100 U	100 U	43000 E	100 U

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting limit

NA = Not analyzed

TABLE 7-14
RI GROUNDWATER FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3								
	Lab Sample ID:	57R-96-08X	57R-96-09X	57R-96-09X	57R-96-10X	57R-96-11X	57R-96-11X	57R-96-12X	57R-96-12X	57R-96-13X
	Date analyzed:	20-Aug-96	21-Aug-96	27-Aug-96	21-Aug-96	21-Aug-96	28-Aug-96	21-Aug-96	28-Aug-96	21-Aug-96
	Depth (bgs):	11	13	13A	13	15	15A	14	14A	11
	Dilution:	1	1	1	1	1	1	1	1	1
Analytes	**Reporting Limit**									
Vinyl Chloride	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
1,1-DCE	5 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
t-1,2-DCE	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
c-1,2-DCE	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Chloroform	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
1,1,1-TCA	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Carbon Tetrachloride	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Trichloroethene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Tetrachloroethene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.7	2.0 U
1,3-DCB	2 µg/l	NA	NA	2.0 U	NA	NA	2.0 U	NA	2.0 U	NA
1,4-DCB	2 µg/l	NA	NA	2.0 U	NA	NA	2.0 U	NA	2.0 U	NA
1,2-DCB	2 µg/l	NA	NA	2.0 U	NA	NA	2.0 U	NA	2.0 U	NA
Benzene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Toluene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.8
Chlorobenzene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Ethylbenzene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
m/p-Xylene	4 µg/l	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U
o-Xylene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Naphthalene	2 µg/l	NA	NA	2.0 U	NA	NA	2.0 U	NA	2.0 U	NA
TPH-dro	100 mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-gro	100 µg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin;
NA = Not analyzed

TABLE 7-14
RI GROUNDWATER FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3								
	Lab Sample ID:	57R-96-14X	57R-96-14X	57R-96-15X	57R-96-15X	57R-96-16X	57R-96-16X	57R-96-17X	57R-96-18X	57R-96-19X
	Date analyzed:	21-Aug-96	28-Aug-96	23-Aug-96	26-Aug-96	23-Aug-96	28-Aug-96	26-Aug-96	26-Aug-96	28-Aug-96
	Depth (bgs):	10	11A	10	10A	10	11	11	11	11
	Dilution:	1	1	100	1	1	1	1	1	50
Analytes	**Reporting Limit**									
Vinyl Chloride	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	100 U
1,1-DCE	5 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	100 U
t-1,2-DCE	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	100 U
c-1,2-DCE	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	100 U
Chloroform	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	100 U
1,1,1-TCA	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	100 U
Carbon Tetrachloride	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	100 U
Trichloroethene	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	100 U
Tetrachloroethene	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.7	2.0 U	2.0 U	100 U
1,3-DCB	2 µg/l	NA	2.0 U	NA	2.0 U	NA	2.0 U	2.0 U	2.0 U	100 U
1,4-DCB	2 µg/l	NA	2.0 U	NA	2.0 U	NA	2.0 U	2.0 U	2.0 U	100 U
1,2-DCB	2 µg/l	NA	2.0 U	NA	2.6	NA	3.9	2.0 U	2.0 U	110
Benzene	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	100 U
Toluene	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	10	2.0 U	2.0 U	170
Chlorobenzene	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	100 U
Ethylbenzene	2 µg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	190
m/p-Xylene	4 µg/l	4.0 U	4.0 U	450	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	720
o-Xylene	2 µg/l	2.0 U	2.0 U	490	2.4	2	2.0 U	2.0 U	2.0 U	450
Naphthalene	2 µg/l	NA	2.0 U	NA	16	NA	3.6	2.0 U	2.4	130
TPH-dro	100 mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-gro	100 µg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reportin

NA = Not analyzed

TABLE 7-14
RI GROUNDWATER FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3								
	Lab Sample ID:	57R-96-20X	57M-95-03X	57B-96-08X	57B-96-09X	57M-96-09X	57M-96-10X	57M-96-11X	57M-96-12X	57M-96-13X
	Date analyzed:	28-Aug-96	4-Oct-95	29-Aug-96	29-Aug-96	27-Aug-96	3-Sep-96	3-Sep-96	3-Sep-96	3-Sep-96
	Depth (bgs):	14		10	10	17	10	10	10	5
	Dilution:	1	1	1	1	1	1	1	1	1
Analytes	**Reporting Limit**									
Vinyl Chloride	2 µg/l	2.0 U	NA	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
1,1-DCE	5 µg/l	2.0 U	5.0 UJ	2.0 U	95	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
t-1,2-DCE	2 µg/l	2.0 U	NA	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
c-1,2-DCE	2 µg/l	2.0 U	NA	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Chloroform	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
1,1,1-TCA	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Carbon Tetrachloride	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Trichloroethene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Tetrachloroethene	2 µg/l	2.0 U	2.0 U	3.2	2.0 U	2.0 U	2.0 U	2.7	2.0 U	2.0 U
1,3-DCB	2 µg/l	2.0 U	NA	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
1,4-DCB	2 µg/l	2.0 U	NA	3.1	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
1,2-DCB	2 µg/l	2.0 U	NA	5.8	2.0 U	2.0 U	2.0 U	2.5	2.0 U	2.0 U
Benzene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Toluene	2 µg/l	2.0 U	14	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.9
Chlorobenzene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Ethylbenzene	2 µg/l	2.0 U	9.1	6.4	2.0 U	2.0 U	2.0 U	2.6	2.0 U	2.8
m/p-Xylene	4 µg/l	4.0 U	31	17	4.0 U	4.0 U	4.0 U	4	4.0 U	4.0 U
o-Xylene	2 µg/l	2.0 U	17	9.2	2.0 U	2.0 U	2.0 U	4.7	2.0 U	2.0 U
Naphthalene	2 µg/l	2.0 U	NA	7.1 J	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
TPH-dro	100 mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-gro	100 µg/l	NA	100 U	NA	NA	NA	NA	NA	NA	NA

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed

TABLE 7-14
RI GROUNDWATER FIELD ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		AREA 3							
	Lab Sample ID:	57M-96-13X	57M-96-08A	57M-96-08B	57B-95-02X	57B-95-03X	57B-95-04X	57B-95-05X	57B-95-06X
	Date analyzed:	3-Sep-96	11-Oct-95	9-Oct-95	3-Oct-95	3-Oct-95	3-Oct-95	3-Oct-95	3-Oct-95
	Depth (bgs):	5D	4	4	17	21	13	15	14
	Dilution:	1	1	1	1	1	1	1	1
Analytes	**Reporting Limit**								
Vinyl Chloride	2 µg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 µg/l	2.0 U	5.0 UJ	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
t-1,2-DCE	2 µg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 µg/l	2.0 U	2.0 UJ	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
1,1,1-TCA	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Carbon Tetrachloride	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Trichloroethene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Tetrachloroethene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
1,3-DCB	2 µg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 µg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Toluene	2 µg/l	2.6	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Chlorobenzene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Ethylbenzene	2 µg/l	2.6	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
m/p-Xylene	4 µg/l	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U
o-Xylene	2 µg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Naphthalene	2 µg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA
TPH-dro	100 mg/l	NA	NA	NA	NA	NA	NA	NA	NA
TPH-gro	100 µg/l	NA	100 U	100 U	100 U	100 U	100 U	100 U	100 U

Notes:

U = Concentration is less than reporting limit
J = Value is estimated
E = Concentration exceeds the maximum reportin
NA = Not analyzed

TABLE 7-15
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Sample Date:		57M-95-01X		57M-95-01X		57M-95-01X		57M-95-01X		57M-95-01X		57M-95-01X	
Field Sample Number:		MD5701X2		MD5701X2		MX5701X1		MX5701X1		MX5701X2		MX5701X2	
Lab Sample Number:	Devens	DV4F*455		DV4W*455		DV4F*167		DV4W*167		DV4F*168		DV4W*168	
Sample Date:	Background	2/13/96		02/13/96		10/30/95		10/30/95		02/13/96		02/13/96	
Depth:	Concentrations	24		24		24		24		24		24	
Units:	µg/L	µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
METALS													
Aluminum	6870	< 141	DF	< 141	D	< 141	F	4180		< 141	F	< 141	
Arsenic	10.5	< 2.54	DF	< 2.54	D	< 2.54	F	24.5		< 2.54	F	< 2.54	
Barium	39.6	51.9	DF	12.8	D	14.8	F	33.9		12.2	F	12.6	
Cadmium	4.01	< 4.01	DF	< 4.01	D	< 4.01	F	< 4.01		< 4.01	F	< 4.01	
Calcium	14700	5850	DF	5960	D	5620	F	6650		5860	F	6050	
Copper	8.09	< 8.09	DF	< 8.09	D	< 8.09	F	10.1		< 8.09	F	< 8.09	
Iron	9100	< 38.8	DF	< 38.8	D	72.9	F	5660		< 38.8	F	< 38.8	
Lead	4.25	< 1.26	DF	< 1.26	D	1.41	F	8.46		< 1.26	F	< 1.26	
Magnesium	3480	639	DF	627	D	612	F	1200		651	F	650	
Manganese	291	31.2	DF	30.4	D	38.5	F	512		30.5	F	32.1	
Potassium	2370	1730	DF	1410	D	1090	F	2700		1540	F	1120	
Sodium	10800	16500	DF	16600	D	14500	F	17300		15700	F	16200	
Zinc	21.1	< 21.1	DF	< 21.1	D	< 21.1	F	< 21.1		< 21.1	F	< 21.1	
PESTICIDES/PCBS													
Endosulfan Ii				< .023	D			< .023				< .023	
SEMIVOLATILE ORGANICS													
1,2-dichlorobenzene				< 1.7	D			< 1.7	N			< 1.7	
1,4-dichlorobenzene				< 1.7	D			< 1.7	N			< 1.7	
2-methylnaphthalene				< 1.7	D			< 1.7	N			< 1.7	
4-methylphenol				< .52	D			< .52	N			< .52	
Diethyl Phthalate				< 2	D			< 2	N			< 2	
Naphthalene				< .5	D			< .5	N			< .5	
Bis(2-ethylhexyl) Phthalate				< 4.8	D			< 4.8	N			< 4.8	
VOLATILE ORGANICS													
*1,2-dichloroethylenes (cis And Trans)				< .5	D			< .5				< .5	
1,1,1-trichloroethane				< .5	D			.5				< .5	
Acetone				< 13	D			< 13				< 13	
Carbon Tetrachloride				< .58	D			< .58				< .58	
Chloroform				< .5	D			< .5				< .5	
Dichloromethane				< 2.3	D			< 2.3				< 2.3	
Ethylbenzene				< .5	D			< .5				< .5	
Styrene				< .5	D			< .5				< .5	
Tetrachloroethene				< 1.6	D			< 1.6				< 1.6	
Toluene				< .5	D			.63				1.2	
Trichloroethylene				< .5	D			.56				< .5	
Xylenes				< .84	D			< .84				< .84	
WET CHEMISTRY													
Alkalinity				6000	D			8000				5000	
Chloride				27400	D			28500				25200	
Nitrite, Nitrate-non Specific				1100	D			800				1200	
Nitrogen By Kjeldahl Method				200	D			210				248	
Phosphate				< 13.3	D			280				13.6	
Sulfate				11000	D			< 10000				10000	
Total Dissolved Solids				91000	D			76000				70000	
Total Hardness				18400	D			14000				20000	
Total Suspended Solids				< 4000	D			232000				5000	
OTHER													
Total Petroleum Hydrocarbons				< 181	D			356				< 183	

TABLE 7-15
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Sample Date:			57M-95-02X			57M-95-02X			57M-95-02X			57M-95-02X			57M-95-04A	
Field Sample Number:			MX5702X1			MX5702X1			MX5702X2			MX5702X2			MX5704A1	
Lab Sample Number:	Devens		DV4F*169			DV4W*169			DV4F*170			DV4W*170			DV4F*173	
Sample Date:	Background		10/30/95			10/30/95			02/13/96			02/13/96			11/01/95	
Depth:	Concentrations		19			19			19			19			7.4	
Units:	µg/L		µg/L			µg/L			µg/L			µg/L			µg/L	
METALS																
Aluminum	6870	<	141	F	<	141		<	141	F	<	141		<	141	F
Arsenic	10.5	<	2.54	F	<	2.54		<	2.54	F	<	2.54			2.77	F
Barium	39.6		24.8	F		21			10.4	F		10.3			45.6	F
Cadmium	4.01	<	4.01	F	<	4.01		<	4.01	F	<	4.01		<	4.01	F
Calcium	14700		19300	F		13600			13100	F		12900			7770	F
Copper	8.09	<	8.09	F		9.81		<	8.09	F	<	8.09		<	8.09	F
Iron	9100	<	38.8	F		132		<	38.8	F	<	38.8			1380	F
Lead	4.25	<	1.26	F		3.25		<	1.26	F	<	1.26		<	1.26	F
Magnesium	3480		1520	F		1050			765	F		747			774	F
Manganese	291	<	2.75	F		7.52		<	2.75	F	<	2.75			1410	F
Potassium	2370		2180	F		1800			1560	F		1110			1240	F
Sodium	10800		44300	F		35300			13700	F		13200			6400	F
Zinc	21.1	<	21.1	F	<	21.1		<	21.1	F	<	21.1		<	21.1	F
PESTICIDES/PCBS																
Endosulfan Ii					<	.023					<	.023				
SEMIVOLATILE ORGANICS																
1,2-dichlorobenzene					<	1.7	N				<	1.7				
1,4-dichlorobenzene					<	1.7	N				<	1.7				
2-methylnaphthalene					<	1.7	N				<	1.7				
4-methylphenol					<	.52	N				<	.52				
Diethyl Phthalate						2.3	N					3.2				
Naphthalene					<	.5	N				<	.5				
Bis(2-ethylhexyl) Phthalate					<	4.8	N				<	4.8				
VOLATILE ORGANICS																
*1,2-dichloroethylenes (cis And Trans)					<	.5					<	.5				
1,1,1-trichloroethane					<	.5					<	.5				
Acetone					<	13					<	13				
Carbon Tetrachloride					<	.58					<	.58				
Chloroform					<	.5					<	.5				
Dichloromethane					<	2.3					<	2.3				
Ethylbenzene					<	.5					<	.5				
Styrene					<	.5					<	.5				
Tetrachloroethene					<	1.6					<	1.6				
Toluene					<	.5						1.6				
Trichloroethylene					<	.5					<	.5				
Xylenes					<	.84					<	.84				
WET CHEMISTRY																
Alkalinity						20000						140000				
Chloride						55000						17600				
Nitrite, Nitrate-non Specific						2300						660				
Nitrogen By Kjeldahl Method					<	183						238				
Phosphate					<	13.3						15.8				
Sulfate						15000						14000				
Total Dissolved Solids						153000						96000				
Total Hardness						42000						37200				
Total Suspended Solids						4000					<	4000				
OTHER																
Total Petroleum Hydrocarbons					<	169					<	187				

TABLE 7-15
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID Sample Date:		57M-95-04A		57M-95-04A		57M-95-04A		57M-95-04B		57M-95-04B		57M-95-04B	
Field Sample Number:		MX5704A1		MX5704A2		MX5704A2		MX5704B1		MX5704B1		MX5704B2	
Lab Sample Number:	Devens	DV4W*173		DV4F*174		DV4W*174		DV4F*185		DV4W*185		DV4F*459	
Sample Date:	Background	11/01/95		02/14/96		02/14/96		11/01/95		11/01/95		02/14/96	
Depth:	Concentrations	7.4		7.4		7.4		23.5		23.5		23.5	
Units:	µg/L	µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
METALS													
Aluminum	6870	395		< 141	F	< 141		< 141	F	< 141		< 141	F
Arsenic	10.5	13.4		3.94	F	4.9		< 2.54	F	< 2.54		< 2.54	F
Barium	39.6	63.5		27.7	F	27.6		10.7	F	9.81		10.6	F
Cadmium	4.01	< 4.01		< 4.01	F	< 4.01		< 4.01	F	< 4.01		< 4.01	F
Calcium	14700	8880		7680	F	7720		9660	F	9770		12600	F
Copper	8.09	10.3		< 8.09	F	< 8.09		< 8.09	F	< 8.09		< 8.09	F
Iron	9100	6310		3530	F	3610		< 38.8	F	87.4		< 38.8	F
Lead	4.25	2.17		< 1.26	F	< 1.26		< 1.26	F	1.84		< 1.26	F
Magnesium	3480	828		904	F	866		981	F	999		1370	F
Manganese	291	3700		533	F	552		356	F	382		516	F
Potassium	2370	4140		1360	F	1030		2640	F	2790		2990	F
Sodium	10800	11800		5820	F	5850		30700	F	28900		34500	F
Zinc	21.1	25.3		< 21.1	F	< 21.1		< 21.1	F	< 21.1		< 21.1	F
PESTICIDES/PCBS													
Endosulfan Ii		< .023				< .023				< .023			
SEMIVOLATILE ORGANICS													
1,2-dichlorobenzene		< 1.7				< 1.7				< 1.7			
1,4-dichlorobenzene		< 1.7				< 1.7				< 1.7			
2-methylnaphthalene		< 1.7				< 1.7				< 1.7			
4-methylphenol		< .52				< .52				< .52			
Diethyl Phthalate		< 2				< 2				< 2			
Naphthalene		< .5				< .5				< .5			
Bis(2-ethylhexyl) Phthalate		< 4.8				< 4.8				5			
VOLATILE ORGANICS													
*1,2-dichloroethylenes (cis And Trans)		3.6				1.8				< .5			
1,1,1-trichloroethane		< .5				< .5				< .5			
Acetone		< 13				< 13				< 13			
Carbon Tetrachloride		< .58				< .58				< .58			
Chloroform		< .5				< .5				< .5			
Dichloromethane		< 2.3				< 2.3				< 2.3			
Ethylbenzene		< .5				< .5				< .5			
Styrene		< .5				< .5				< .5			
Tetrachloroethene		1.7				16				< 1.6			
Toluene		< .5				.6				< .5			
Trichloroethylene		1				1.9				< .5			
Xylenes		< .84				< .84				< .84			
WET CHEMISTRY													
Alkalinity		32000				14000				18000			
Chloride		8340				6040				44000			
Nitrite, Nitrate-non Specific		32.3				148				1800			
Nitrogen By Kjeldahl Method		514				333				< 183			
Phosphate		26.6				13.8				< 13.3			
Sulfate		16000				16000				25000			
Total Dissolved Solids		69000				72000				112000			
Total Hardness		12000				18400				< 1000			
Total Suspended Solids		15000				6000				20000			
OTHER													
Total Petroleum Hydrocarbons		< 181				< 187				< 170			

TABLE 7-15
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Sample Date:	Devens Background Concentrations	57M-95-04B	57M-95-05X	57M-95-05X	57M-95-05X	57M-95-05X	57M-95-06X
Field Sample Number:		MX5704B2	MX5705X1	MX5705X1	MX5705X2	MX5705X2	MX5706X1
Lab Sample Number:		DV4W*459	DV4F*175	DV4W*175	DV4F*176	DV4W*176	DV4F*177
Sample Date:		02/14/96	11/02/95	11/02/95	02/13/96	02/13/96	11/02/95
Depth:		23.5	15	15	15	15	16.9
Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
METALS							
Aluminum	6870	< 141	< 141 F	< 141	< 141 F	< 141	< 141 F
Arsenic	10.5	< 2.54	< 2.54 F	< 2.54	< 2.54 F	< 2.54	< 2.54 F
Barium	39.6	10.4	16.4 F	16	13.9 F	13	21.6 F
Cadmium	4.01	< 4.01	< 4.01 F	< 4.01	< 4.01 F	< 4.01	< 4.01 F
Calcium	14700	12700	5320 F	5290	5320 F	5010	8760 F
Copper	8.09	< 8.09	< 8.09 F	< 8.09	< 8.09 F	< 8.09	< 8.09 F
Iron	9100	< 38.8	47.4 F	< 38.8	< 38.8 F	< 38.8	< 38.8 F
Lead	4.25	< 1.26	< 1.26 F	< 1.26	< 1.26 F	< 1.26	< 1.26 F
Magnesium	3480	1390	< 500 F	522	507 F	< 500	668 F
Manganese	291	530	9.3 F	10	5.95 F	5.79	319 F
Potassium	2370	2800	1330 F	1560	1660 F	1560	2170 F
Sodium	10800	34900	11300 F	10700	10100 F	9000	7680 F
Zinc	21.1	< 21.1	< 21.1 F	< 21.1	< 21.1 F	< 21.1	< 21.1 F
PESTICIDES/PCBS							
Endosulfan Ii		< .023		< .023		< .023	
SEMIVOLATILE ORGANICS							
1,2-dichlorobenzene		< 1.7		< 1.7		< 1.7	
1,4-dichlorobenzene		< 1.7		< 1.7		< 1.7	
2-methylnaphthalene		< 1.7		< 1.7		< 1.7	
4-methylphenol		< .52		< .52		< .52	
Diethyl Phthalate		< 2		< 2		2.7	
Naphthalene		< .5		< .5		< .5	
Bis(2-ethylhexyl) Phthalate		400		7.7		< 4.8	
VOLATILE ORGANICS							
*1,2-dichloroethylenes (cis And Trans)		< .5		< .5		< .5	
1,1,1-trichloroethane		< .5		< .5		< .5	
Acetone		< 13		< 13		< 13	
Carbon Tetrachloride		< .58		< .58		< .58	
Chloroform		< .5		< .5		< .5	
Dichloromethane		< 2.3		< 2.3		< 2.3	
Ethylbenzene		< .5		< .5		< .5	
Styrene		< .5		< .5		< .5	
Tetrachloroethene		< 1.6		< 1.6		< 1.6	
Toluene		.9		< .5		1.2	
Trichloroethylene		< .5		< .5		< .5	
Xylenes		< .84		< .84		< .84	
WET CHEMISTRY							
Alkalinity		5330		12000		224000	
Chloride		63000		12100		13200	
Nitrite, Nitrate-non Specific		1700		950		870	
Nitrogen By Kjeldahl Method		< 183		< 183		< 183	
Phosphate		15		17.7		< 13.3	
Sulfate		21000		11000		< 10000	
Total Dissolved Solids		174000		42000		62000	
Total Hardness		41200		16000		17600	
Total Suspended Solids		< 4000		14000		< 4000	
OTHER							
Total Petroleum Hydrocarbons		< 191		< 176		< 179	

TABLE 7-15
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Sample Date:		57M-95-06X		57M-95-06X		57M-95-06X		57M-95-07X		57M-95-07X		57M-95-07X	
Field Sample Number:		MX5706X1		MX5706X2		MX5706X2		MX5707X1		MX5707X1		MX5707X2	
Lab Sample Number:	Devens	DV4W*177		DV4F*178		DV4W*178		DV4F*179		DV4W*179		DV4F*180	
Sample Date:	Background	11/02/95		02/15/96		02/15/96		10/31/95		10/31/95		02/14/96	
Depth:	Concentrations	16.9		16.9		16.9		8		8		8	
Units:	µg/L	µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
METALS													
Aluminum	6870	2480		167	F	204		< 141	F	< 141		< 141	F
Arsenic	10.5	6.93		< 2.54	F	< 2.54		< 2.54	F	< 2.54		< 2.54	F
Barium	39.6	34.3		17.2	F	18.6		23.1	F	23		9.06	F
Cadmium	4.01	< 4.01		< 4.01	F	< 4.01		< 4.01	F	< 4.01		< 4.01	F
Calcium	14700	9540		4660	F	4790		4450	F	4410		2590	F
Copper	8.09	< 8.09		< 8.09	F	< 8.09		< 8.09	F	< 8.09		< 8.09	F
Iron	9100	2790		< 38.8	F	< 38.8		< 38.8	F	< 38.8		< 38.8	F
Lead	4.25	2.17		< 1.26	F	< 1.26		9	F	9.65		< 1.26	F
Magnesium	3480	1380		< 500	F	< 500		< 500	F	< 500		< 500	F
Manganese	291	355		173	F	177		18.2	F	19.2		20.9	F
Potassium	2370	2700		1350	F	1320		1050	F	917		775	F
Sodium	10800	7670		2760	F	2800		23700	F	22700		10400	F
Zinc	21.1	31		< 21.1	F	< 21.1		< 21.1	F	< 21.1		< 21.1	F
PESTICIDES/PCBS													
Endosulfan Ii		.0271	C			< .023				< .023			
SEMIVOLATILE ORGANICS													
1,2-dichlorobenzene		< 1.7				< 1.7				< 1.7	N		
1,4-dichlorobenzene		< 1.7				< 1.7				< 1.7	N		
2-methylnaphthalene		< 1.7				< 1.7				< 1.7	N		
4-methylphenol		< .52				< .52				< .52	N		
Diethyl Phthalate		< 2				< 2				< 2	N		
Naphthalene		< .5				< .5				< .5	N		
Bis(2-ethylhexyl) Phthalate		< 4.8				< 4.8				< 4.8	N		
VOLATILE ORGANICS													
*1,2-dichloroethylenes (cis And Trans)		< .5				< .5				< .5			
1,1,1-trichloroethane		< .5				< .5				< .5			
Acetone		< 13				< 13				< 13			
Carbon Tetrachloride		< .58				< .58				< .58			
Chloroform		< .5				< .5				< .5			
Dichloromethane		< 2.3				< 2.3				< 2.3			
Ethylbenzene		< .5				< .5				< .5			
Styrene		< .5				< .5				< .5			
Tetrachloroethene		< 1.6				< 1.6				4			
Toluene		< .5				< .5				< .5			
Trichloroethylene		< .5				< .5				< .5			
Xylenes		< .84				< .84				< .84			
WET CHEMISTRY													
Alkalinity		10000				< 5000				7000			
Chloride		7570				< 2120				28500			
Nitrite, Nitrate-non Specific		1600				2000				570			
Nitrogen By Kjeldahl Method		< 183				< 183				< 183			
Phosphate		< 13.3				< 13.3				< 13.3			
Sulfate		19000				< 10000				< 10000			
Total Dissolved Solids		42000				55000				74000			
Total Hardness		2000				13200				16000			
Total Suspended Solids		19000				< 4000				5000			
OTHER													
Total Petroleum Hydrocarbons		< 172				< 177				< 167			

TABLE 7-15
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID Sample Date:		57M-95-07X	57M-95-08A	57M-95-08A	57M-95-08A	57M-95-08A	57M-95-08B
Field Sample Number:		MX5707X2	MX5708A1	MX5708A1	MX5708A2	MX5708A2	MX5708B1
Lab Sample Number:	Devens	DV4W*180	DV4F*181	DV4W*181	DV4R*182	DV4W*182	DV4F*183
Sample Date:	Background	02/14/96	11/01/95	11/01/95	02/15/96	02/15/96	11/01/95
Depth:	Concentrations	8	8	8	8	8	23
Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
METALS							
Aluminum	6870	< 141	< 141 F	< 141	< 141 F	< 141	< 141 F
Arsenic	10.5	< 2.54	< 2.54 F	< 2.54	< 2.54 F	< 2.54	< 2.54 F
Barium	39.6	9.19	16.8 F	13.7	16.8 F	15.2	9.35 F
Cadmium	4.01	< 4.01	< 4.01 F	< 4.01	< 4.01 F	< 4.01	< 4.01 F
Calcium	14700	2660	8320 F	7040	7480 F	6940	14100 F
Copper	8.09	< 8.09	< 8.09 F	< 8.09	< 8.09 F	< 8.09	< 8.09 F
Iron	9100	< 38.8	< 38.8 F	146	413 F	712	< 38.8 F
Lead	4.25	< 1.26	< 1.26 F	< 1.26	< 1.26 F	< 1.26	< 1.26 F
Magnesium	3480	< 500	843 F	779	842 F	765	1500 F
Manganese	291	21.4	2420 F	1740	819 F	724	30 F
Potassium	2370	809	1450 F	1350	1380 F	704	2360 F
Sodium	10800	10500	4440 F	3880	4310 F	4010	28900 F
Zinc	21.1	< 21.1	< 21.1 F	< 21.1	< 21.1 F	< 21.1	< 21.1 F
PESTICIDES/PCBS							
Endosulfan Ii		< .023		< .023		< .023	
SEMIVOLATILE ORGANICS							
1,2-dichlorobenzene		< 1.7		< 1.7		< 1.7	
1,4-dichlorobenzene		< 1.7		< 1.7		< 1.7	
2-methylnaphthalene		< 1.7		< 1.7		< 1.7	
4-methylphenol		< .52		< .52		< .52	
Diethyl Phthalate		< 2		< 2		< 2	
Naphthalene		< .5		< .5		< .5	
Bis(2-ethylhexyl) Phthalate		< 4.8		< 4.8		< 4.8	
VOLATILE ORGANICS							
*1,2-dichloroethylenes (cis And Trans)		< .5		< .5		< .5	
1,1,1-trichloroethane		< .5		< .5		< .5	
Acetone		< 13		19		< 13	
Carbon Tetrachloride		< .58		< .58		< .58	
Chloroform		< .5		< .5		< .5	
Dichloromethane		< 2.3		< 2.3		< 2.3	
Ethylbenzene		< .5		< .5		< .5	
Styrene		< .5		< .5		< .5	
Tetrachloroethene		3.9		< 1.6		< 1.6	
Toluene		.58		< .5		< .5	
Trichloroethylene		< .5		< .5		< .5	
Xylenes		< .84		< .84		< .84	
WET CHEMISTRY							
Alkalinity		6000		15000		14000	
Chloride		11000		4060		5160	
Nitrite, Nitrate-non Specific		1400		360		290	
Nitrogen By Kjeldahl Method		< 183		181		< 183	
Phosphate		< 13.3		19		< 13.3	
Sulfate		< 10000		11000		10000	
Total Dissolved Solids		51000		25000		70000	
Total Hardness		10800		2000		2000	
Total Suspended Solids		8000		4000		4000	
OTHER							
Total Petroleum Hydrocarbons		< 195		< 180		< 183	

TABLE 7-15
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/L	57M-95-08B MX5708B1 DV4W*183 11/01/95 23 µg/L	57M-95-08B MX5708B2 DV4F*462 02/15/96 23 µg/L		57M-95-08B MX5708B2 DV4W*462 02/15/96 23 µg/L	57M-95-03X MD5703X2 DV4F*458 02/14/96 12 µg/L		57M-95-03X MD5703X2 DV4W*458 02/14/96 12 µg/L	
METALS									
Aluminum	6870	1770	< 141	F	< 141	< 141	DF	263	D
Arsenic	10.5	< 2.54	< 2.54	F	< 2.54	36.6	DF	27.5	D
Barium	39.6	11.4	7.56	F	7.31	37.4	DF	47.6	D
Cadmium	4.01	< 4.01	< 4.01	F	< 4.01	< 4.01	DF	< 4.01	D
Calcium	14700	17400	12700	F	13600	10100	DF	8890	D
Copper	8.09	39.1	< 8.09	F	< 8.09	< 8.09	DF	< 8.09	D
Iron	9100	2150	< 38.8	F	< 38.8	10600	DF	7400	D
Lead	4.25	9.76	< 1.26	F	< 1.26	< 1.26	DF	< 1.26	D
Magnesium	3480	1910	1340	F	1460	775	DF	758	D
Manganese	291	81.3	9.97	F	10.9	351	DF	277	D
Potassium	2370	1930	1260	F	1410	1860	DF	1830	D
Sodium	10800	30000	29800	F	30700	1950	DF	1650	D
Zinc	21.1	< 21.1	< 21.1	F	< 21.1	46.3	DF	63.6	D
PESTICIDES/PCBS									
Endosulfan Ii		< .023			< .023			< .023	D
SEMIVOLATILE ORGANICS									
1,2-dichlorobenzene		< 1.7			< 1.7			< 1.7	D
1,4-dichlorobenzene		< 1.7			< 1.7			< 1.7	D
2-methylnaphthalene		< 1.7			< 1.7			< 1.7	D
4-methylphenol		< .52			< .52			< .52	D
Diethyl Phthalate		< 2			< 2			< 2	D
Naphthalene		< .5			< .5			2.6	D
Bis(2-ethylhexyl) Phthalate		6.9			300			300	D
VOLATILE ORGANICS									
*1,2-dichloroethylenes (cis And Trans)		< .5			< .5			< .5	D
1,1,1-trichloroethane		< .5			< .5			< .5	D
Acetone		< 13			< 13			< 13	D
Carbon Tetrachloride		< .58			< .58			< .58	D
Chloroform		< .5			< .5			< .5	D
Dichloromethane		< 2.3			< 2.3			< 2.3	D
Ethylbenzene		< .5			< .5			1.9	D
Styrene		< .5			< .5			< .5	D
Tetrachloroethene		< 1.6			< 1.6			< 1.6	D
Toluene		< .5			.53			1.8	D
Trichloroethylene		1.5			1.8			< .5	D
Xylenes		< .84			< .84			8.3	D
WET CHEMISTRY									
Alkalinity		15000			6000			38000	D
Chloride		53000			46000			< 2120	D
Nitrite, Nitrate-non Specific		1600			1800			270	D
Nitrogen By Kjeldahl Method		276			< 183			419	D
Phosphate		28.5			< 13.3			< 13.3	D
Sulfate		22000			21000			< 10000	D
Total Dissolved Solids		120000			160000			81000	D
Total Hardness		52000			51200			28400	D
Total Suspended Solids		19000			< 4000			12000	D
OTHER									
Total Petroleum Hydrocarbons		< 178			< 183			< 187	D

TABLE 7-15
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID Sample Date:		57M-95-03X	57M-95-03X	57M-95-03X	57M-95-03X	57M-95-03X	57M-96-09X
Field Sample Number:		MX5703X1	MX5703X1	MX5703X2	MX5703X2	MX5703X3	MX5709X1
Lab Sample Number:	Devens	DV4F*171	DV4W*171	DV4F*172	DV4W*172	DV4W*537	DV4W*533
Sample Date:	Background	11/02/95	11/02/95	02/14/96	02/14/96	10/02/96	10/01/96
Depth:	Concentrations	12	12	12	12	12	0
Units:	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
METALS							
Aluminum	6870	< 141 F	< 141	< 141 F	< 141	85	190
Arsenic	10.5	71 F	74	40.1 F	42.3	33.2	< 2.54
Barium	39.6	26.4 F	25.1	36.4 F	37.4	87.2	17.6
Cadmium	4.01	< 4.01 F	< 4.01	< 4.01 F	< 4.01	8.67	< 3.01
Calcium	14700	18600 F	18200	9820 F	9740	7940	8150
Copper	8.09	< 8.09 F	< 8.09	< 8.09 F	< 8.09	< 5	< 5
Iron	9100	17500 F	17800	11300 F	11700	12400	191
Lead	4.25	2.39 F	< 1.26	< 1.26 F	< 1.26	< 1.26	< 1.26
Magnesium	3480	846 F	880	712 F	715	< 1000	1110
Manganese	291	699 F	687	343 F	348	466	19.6
Potassium	2370	2970 F	2500	2370 F	2130	2400	1550
Sodium	10800	2190 F	2130	1910 F	1840	< 2290	< 2290
Zinc	21.1	< 21.1 F	< 21.1	43.3 F	42.8	192	< 35.8
PESTICIDES/PCBS							
Endosulfan Ii			< .023		< .023	< .023	< .023
SEMIVOLATILE ORGANICS							
1,2-dichlorobenzene			7		< 1.7	9.8	< 1.7
1,4-dichlorobenzene			5		< 1.7	5.6	< 1.7
2-methylnaphthalene			< 3		< 1.7	4.4	< 1.7
4-methylphenol			< 1		< .52	1.5	< .52
Diethyl Phthalate			< 4		< 2	< 2	< 2
Naphthalene			20		2.8	20	< .5
Bis(2-ethylhexyl) Phthalate			< 10		< 4.8	< 4.8	< 4.8
VOLATILE ORGANICS							
*1,2-dichloroethylenes (cis And Trans)			< .5		< .5	< .5	< .5
1,1,1-trichloroethane			< .5		< .5	< .5	< .5
Acetone			< 13		< 13	< 13	< 13
Carbon Tetrachloride			< .58		< .58	4.5	< .58
Chloroform			< .5		< .5	10	< .5
Dichloromethane			< 2.3		< 2.3	2.9	< 2.3
Ethylbenzene			47		1.9	46	< .5
Styrene			< .5		< .5	< .5	< .5
Tetrachloroethene			3.7		< 1.6	2.6	< 1.6
Toluene			49		1.9	19	< .5
Trichloroethylene			< .5		< .5	.59	< .5
Xylenes			200 X		9.3	200	< .84
WET CHEMISTRY							
Alkalinity			*56000*		38200		
Chloride			3510		< 2120		
Nitrite, Nitrate-non Specific			1100		260	158	
Nitrogen By Kjeldahl Method			733		495	324	< 183
Phosphate			240		21.9	16.2	28.6
Sulfate			< 10000		< 10000		
Total Dissolved Solids			72000		78000	86000	40000
Total Hardness			14000		26800	1660000000	33600000
Total Suspended Solids			162000		12000	8000	19000
OTHER							
Total Petroleum Hydrocarbons			337		< 197	< 167000	< 167

TABLE 7-15
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID Sample Date: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/L	57M-96-10X MX5710X1 DV4W*534 10/02/96 0 µg/L	57M-96-11X MD5711X1 DV4W*305 10/02/96 0 µg/L	57M-96-11X MX5711X1 DV4W*535 10/02/96 0 µg/L	57M-96-12X MX5712X1 DV4W*306 10/02/96 0 µg/L	57M-96-13X MX5713X1 DV4W*307 10/02/96 0 µg/L	G3M-92-02X MXG302X1 DV4F*163 10/31/95 26 µg/L
METALS							
Aluminum	6870	183	200 D	161	2 2450	65.2	< 141 F
Arsenic	10.5	< 2.54	170 D	170	3.73	8.96	< 2.54 F
Barium	39.6	36.1	11.6 D	11	41.8	12.1	12.3 F
Cadmium	4.01	< 3.01	< 3.01 D	< 3.01	< 3.01	< 3.01	< 4.01 F
Calcium	14700	2020	9730 D	9310	9110	16900	6780 F
Copper	8.09	< 5	< 5 D	< 5	< 5	< 5	< 8.09 F
Iron	9100	105	26500 D	25900	1540	1910	< 38.8 F
Lead	4.25	< 1.26	< 1.26 D	< 1.26	< 1.26	< 1.26	< 1.26 F
Magnesium	3480	< 1000	1190 D	1190	1080	< 1000	584 F
Manganese	291	206	2100 D	1990	126	346	6.68 F
Potassium	2370	< 1000	1920 D	1680	1730	1650	1110 F
Sodium	10800	< 2290	4050 D	3990	5050	2850	20300 F
Zinc	21.1	37.2	< 35.8 D	< 35.8	< 35.8	< 35.8	< 21.1 F
PESTICIDES/PCBS							
Endosulfan Ii		< .023 K	< .023 D	< .023	< .023	< .023	
SEMIVOLATILE ORGANICS							
1,2-dichlorobenzene		< 1.7 V K	3.4 D	2.6	< 1.7	< 1.7	
1,4-dichlorobenzene		< 1.7 V K	< 1.7 D	< 1.7	< 1.7	< 1.7	
2-methylnaphthalene		< 1.7 V K	< 1.7 D	< 1.7	< 1.7	< 1.7	
4-methylphenol		< .52 V K	< .52 D	< .52	< 0.52	5	
Diethyl Phthalate		< 2 V K	< 2 D	< 2	< 0.2	< 2	
Naphthalene		< .5 V K	3.3 D	2.5	< 0.5	< .5	
Bis(2-ethylhexyl) Phthalate		< 4.8 V K	6.7 D	< 4.8	< 4.8	< 4.8	
VOLATILE ORGANICS							
*1,2-dichloroethylenes (cis And Trans)		< .5	.89 D	.74	< .5	< .5	
1,1,1-trichloroethane		< .5	< .5 D	< .5	< .5	< .5	
Acetone		< 13	< 13 D	< 13	< 13	< 13	
Carbon Tetrachloride		< .58	< .58 D	< .58	< .58	< .58	
Chloroform		< .5	< .5 D	< .5	< .5	< .5	
Dichloromethane		< 2.3	< 2.3 D	< 2.3	< 2.3	< 2.3	
Ethylbenzene		< .5	4.6 D	4.2	< .5	2.8	
Styrene		< .5	< .5 D	< .5	< .5	8	
Tetrachloroethene		< 1.6	4.8 D	4.7	< 1.6	< 1.6	
Toluene		< .5	.67 D	.86	1.1	2.9	
Trichloroethylene		< .5	1.1 D	1.1	< .5	< .5	
Xylenes		< .84	6.5 D	6.8	< .84	< .84	
WET CHEMISTRY							
Alkalinity							
Chloride							
Nitrite, Nitrate-non Specific		54		< 10	17.1	132	
Nitrogen By Kjeldahl Method		< 183	390 D	448	< 183	< 183	
Phosphate		< 13.3	70.8 D	65.6	55.2	< 13.3	
Sulfate							
Total Dissolved Solids		26000	93000 D	86000	58000	67000	
Total Hardness		10800000	1140000000 D	1610000000	35200000	104000000	
Total Suspended Solids		< 4000	25000 D	26000	101000	4000	
OTHER							
Total Petroleum Hydrocarbons		< 167	< 169 D	< 167	< 167	< 167	

TABLE 7-15
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID Sample Date:		G3M-92-02X		G3M-92-02X		G3M-92-02X		G3M-92-07X		G3M-92-07X		G3M-92-07X	
Field Sample Number:		MXG302X1		MXG302X2		MXG302X2		MDG307X1		MDG307X1		MXG307X1	
Lab Sample Number:	Devens	DV4W*163		DV4F*164		DV4W*164		DV4F*448		DV4W*448		DV4F*165	
Sample Date:	Background	10/31/95		02/12/96		02/12/96		10/31/95		10/31/95		10/31/95	
Depth:	Concentrations	26		26		26		27		27		27	
Units:	µg/L	µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
METALS													
Aluminum	6870	< 141		< 141	F	< 141		< 141	D	168	D	< 141	F
Arsenic	10.5	< 2.54		< 2.54	F	< 2.54		< 2.54	DF	< 2.54	D	< 2.54	F
Barium	39.6	12.3		34.6	F	33		15.4	D	15.9	D	15.6	F
Cadmium	4.01	< 4.01		< 4.01	F	< 4.01		< 4.01	D	< 4.01	D	< 4.01	F
Calcium	14700	6860		10100	F	10200		11700	D	11900	D	11900	F
Copper	8.09	< 8.09		< 8.09	F	< 8.09		< 8.09	D	< 8.09	D	< 8.09	F
Iron	9100	93.5		< 38.8	F	< 38.8		< 38.8	D	247	D	< 38.8	F
Lead	4.25	< 1.26		< 1.26	F	< 1.26		< 1.26	DF	< 1.26	D	< 1.26	F
Magnesium	3480	588		895	F	883		652	D	664	D	652	F
Manganese	291	7.54		9.16	F	7.82		< 2.75	D	6.88	D	< 2.75	F
Potassium	2370	1280		2490	F	1700		2210	D	2110	D	2090	F
Sodium	10800	21700		49100	F	50800		39100	D	39100	D	38700	F
Zinc	21.1	< 21.1		< 21.1	F	< 21.1		< 21.1	D	< 21.1	D	< 21.1	F
PESTICIDES/PCBS													
Endosulfan Ii		< .023				< .023				< .023	D		
SEMIVOLATILE ORGANICS													
1,2-dichlorobenzene		< 1.7	N			< 1.7				< 1.7	D N		
1,4-dichlorobenzene		< 1.7	N			< 1.7				< 1.7	D N		
2-methylnaphthalene		< 1.7	N			< 1.7				< 1.7	D N		
4-methylphenol		< .52	N			< .52				< .52	D N		
Diethyl Phthalate		< 2	N			3.4				< 2	D N		
Naphthalene		< .5	N			< .5				< .5	D N		
Bis(2-ethylhexyl) Phthalate		< 4.8	N			< 4.8				< 4.8	D N		
VOLATILE ORGANICS													
*1,2-dichloroethylenes (cis And Trans)		< .5				< .5				< .5	D		
1,1,1-trichloroethane		< .5				< .5				< .5	D		
Acetone		< 13				< 13				< 13	D		
Carbon Tetrachloride		< .58				< .58				< .58	D		
Chloroform		< .5				< .5				< .5	D		
Dichloromethane		< 2.3				< 2.3				< 2.3	D		
Ethylbenzene		< .5				< .5				< .5	D		
Styrene		< .5				< .5				< .5	D		
Tetrachloroethene		< 1.6				< 1.6				< 1.6	D		
Toluene		< .5				< .5				< .5	D		
Trichloroethylene		< .5				< .5				< .5	D		
Xylenes		< .84				< .84				< .84	D		
WET CHEMISTRY													
Alkalinity		10000				5000				13000	D		
Chloride		35000				93000				66000	D		
Nitrite, Nitrate-non Specific		1500				1300				1000	D		
Nitrogen By Kjeldahl Method		< 183				< 183				181	D		
Phosphate		< 13.3				< 13.3				< 13.3	D		
Sulfate		< 10000				11000				15000	D		
Total Dissolved Solids		93000				195000				169000	D		
Total Hardness		20000				30400				36000	D		
Total Suspended Solids		< 4000				< 4000				< 4000	D		
OTHER													
Total Petroleum Hydrocarbons		< 183				< 181				< 181	D		

TABLE 7-15
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Sample Date: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations µg/L	G3M-92-07X MXG307X1 DV4W*165 10/31/95 27 µg/L		G3M-92-07X MXG307X2 DV4F*166 02/13/96 27 µg/L		G3M-92-07X MXG307X2 DV4W*166 02/13/96 27 µg/L	G3M-92-07X MXG307X3 DV4W*536 10/01/96 0 µg/L
METALS							
Aluminum	6870	< 141		< 141	F	< 141	41.4
Arsenic	10.5	< 2.54		< 2.54	F	< 2.54	< 2.54
Barium	39.6	15.4		16.4	F	15.9	28.3
Cadmium	4.01	< 4.01		< 4.01	F	< 4.01	< 3.01
Calcium	14700	11800		9580	F	9480	15200
Copper	8.09	< 8.09		< 8.09	F	< 8.09	5.14
Iron	9100	135		< 38.8	F	< 38.8	< 36.8
Lead	4.25	< 1.26		< 1.26	F	< 1.26	< 1.26
Magnesium	3480	668		591	F	541	< 1000
Manganese	291	2.99		< 2.75	F	< 2.75	< 2.5
Potassium	2370	2240		2430	F	1740	2440
Sodium	10800	38400		42300	F	42900	52000
Zinc	21.1	< 21.1		< 21.1	F	< 21.1	43
PESTICIDES/PCBS							
Endosulfan Ii		< .023				< .023	< .023
SEMIVOLATILE ORGANICS							
1,2-dichlorobenzene		< 1.7	N			< 1.7	< 1.7
1,4-dichlorobenzene		< 1.7	N			< 1.7	< 1.7
2-methylnaphthalene		< 1.7	N			< 1.7	< 1.7
4-methylphenol		< .52	N			< .52	< .52
Diethyl Phthalate		2.4	N			< 2	< 2
Naphthalene		< .5	N			< .5	< .5
Bis(2-ethylhexyl) Phthalate		< 4.8	N			< 4.8	12
VOLATILE ORGANICS							
*1,2-dichloroethylenes (cis And Trans)		< .5				< .5	< .5
1,1,1-trichloroethane		< .5				< .5	< .5
Acetone		< 13				< 13	< 13
Carbon Tetrachloride		< .58				< .58	< .58
Chloroform		.53				< .5	< .5
Dichloromethane		< 2.3				< 2.3	< 2.3
Ethylbenzene		< .5				< .5	< .5
Styrene		< .5				< .5	< .5
Tetrachloroethene		< 1.6				< 1.6	< 1.6
Toluene		< .5				.89	< .5
Trichloroethylene		< .5				< .5	< .5
Xylenes		< .84				< .84	< .84
WET CHEMISTRY							
Alkalinity		12000				320000	
Chloride		66000				71000	
Nitrite, Nitrate-non Specific		1300				1900	
Nitrogen By Kjeldahl Method		< 183				343	< 183
Phosphate		18.2				< 13.3	< 13.3
Sulfate		15000				13000	
Total Dissolved Solids		172000				174000	216000
Total Hardness		34000				27200	48800000
Total Suspended Solids		< 4000				9000	< 4000
OTHER							
Total Petroleum Hydrocarbons		< 181				< 189	< 167000

Notes:
< = Concentration was less than the certified reporting limit
D = Duplicate Sample
T = Non-target compound analyzed for and not detected (non-GC/MS method)
I = Interferences in the sample caused the quantitation and/or identification to be suspect
M = High duplicate spike not within control limits
J = Value is estimated
F = Filtered Sample
X =Analyte concentration above reporting limit

TABLE 7-16
1998 GROUNDWATER FIELD AND OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

		Area 2		Area 3							
Parameter	Units	57P-98-02X MX5702XX 5/26/98	57P-98-02X MX5702XX 5/26/98	57M-96-11X MX5711XX 5/27/98	57M-96-11X MX5711XX 5/27/98	57M-96-11X MD5711XX 5/27/98	57M-96-11X MD5711XX 5/27/98	57P-98-03X MX5703XX 5/26/98	57P-98-03X MX5703XX 5/26/98	57P-98-04X MX5704XX 5/26/98	57P-98-04X MX5704XX 5/26/98
Volatile Organics GC/MS											
*1,2-dichloroethylenes (cis And Trans)	µg/L	13		LT 0.5		LT 0.5 d		LT 0.5		LT 0.5	
Chlorobenzene	µg/L	LT 0.5		LT 0.5		LT 0.5 d		LT 0.5		0.88	
Ethylbenzene	µg/L	LT 0.5		20		20 d		3.2		LT 0.5	
Toluene	µg/L	0.54		LT 0.5		LT 0.5 d		LT 0.5		LT 0.5	
Methylcyclohexane	µg/L										
Tetrachloroethene	µg/L	LT 1.6		5.4		5.5 d		LT 1.6		LT 1.6	
Trichloroethylene	µg/L	0.71		3.7		3.8 d		LT 0.5		LT 0.5	
Xylenes	µg/L	LT 0.84		5.9		5.8 d		5 s		LT 0.84	
Semivolatile Organics by GC/MS											
1,2-dichlorobenzene	µg/L	LT 1.7		6.4		3.9 d		4.9		LT 1.7	
1,4-dichlorobenzene	µg/L	LT 1.7		2.7		LT 1.7 d		LT 1.7		LT 1.7	
2-methylnaphthalene	µg/L	LT 1.7		LT 1.7		LT 1.7 d		2		LT 1.7	
bis(2-ethylhexyl) Phthalate	µg/L	6.4		LT 4.8		LT 4.8 d		52		5.8	
Naphthalene	µg/L	LT 0.5		6.2		3.3 d		8 s		LT 0.5	
Metals											
Arsenic	µg/L	54.4	73f	84.4	133f	83.6 d	138 df	13.4	20.9f	7.68	12.7f
Barium	µg/L	16.4	16f	18	9.2f	41.8 d	8.8 df	10.2	7.2f	8.4	6.4f
Copper	µg/L	LT 5	LT 5f	LT 5	LT 5f	8.54 d	LT 5 df	LT 5	LT 5f	LT 5	LT 5f
Lead	µg/L	16.0	4.40f	LT 1.00	LT 1.00f	8.07	LT 1.00f	1.85	LT 1.00f	3.76	LT 1.00f
Manganese	µg/L	439 RJ	434 RJf	2640 RJ	2660 RJf	2460 d RJ	2380 d RJf	690 RJ	754 RJf	1480 RJ	1420 RJf
Total Suspended Solids	µg/L	110000		2120000		46700 d		312000		633000	
VPH Ranges (µg/L)											
n-C5 to n-C8 Aliphatic	µg/L	<20		91		88		<20		<20	
n-C9 to n-C12 Aliphatic	µg/L	<20		75j		<20j		<20		<20	
n-C9 to n-C10 Aromatic	µg/L	<20		93j		250j		310		<20	
EPH Ranges (µg/L)											
n-C9 to n-C18 Aliphatic	µg/L	<500j		<500j		<500j		<500j		<500j	
n-C19 to n-C36 Aliphatic	µg/L	<500		<500		<500		<500		<500	
n-C11 to n-C22 Aromatic	µg/L	<200		<200j		<200j		<200		<200	
On-Site TPH (mg/L)	mg/L	<50		<50		<50		<50		<50	

Notes:

Flag codes are in small case letters following result
d = duplicate sample result
f = filtered result
Data qualifiers are in capital letters following result
R = Rejected data, J = low blank spike recovery in this lot was low
j = estimated
▨ = exceeds established Devens background concentrations

TABLE 7 - 17
RI SEDIMENT OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations UGG		57D-95-03X DD570300 DV4S*431 09/13/95 0 UGG			57D-95-03X DX570300 DV4S*187 09/13/95 0 UGG			57D-95-03X DX570302 DV4S*188 09/13/95 2 UGG			57D-95-04X DX570401 DV4S*189 09/14/95 1 UGG			57D-95-04X DX570402 DV4S*190 09/14/95 2 UGG	
METALS																
Aluminum	18000		14700	D		11300			3980			7210			7910	
Arsenic	19		120	D		180			75			17.5			10.2	
Barium	54		121	D		67.1			25		<	5.18			14.8	
Beryllium	0.81	<	.5	D	<	.5		<	.5		<	.5			2.8	
Cadmium	1.28	<	.7	D	<	.7		<	.7		<	.7		<	.7	
Calcium	810		10300	D		8670			3110			11100			2610	
Chromium	33		45.2	D		39.1			13.8		<	4.05			71.6	
Cobalt	4.7		29.9	D		11.5			3.9		<	1.42		<	1.42	
Copper	13.5		42.6	D		13.5			5.39			201			14.6	
Iron	18000		31500	D		26700			8880			5280			4030	
Lead	48		320	D		66			23			410			13.7	
Magnesium	5500		4130	D		3500			1170			1380			1060	
Manganese	380		2070	D		695			262			53.3			86.4	
Mercury	14.6		.273	D	<	.05		<	.05		<	.05		<	.05	
Nickel	2400		46.8	D		18.7			6.35		<	1.71			5.85	
Potassium	-		1060	D		696			253		<	100			284	
Selenium	0.086		3.15	D		3.24			.81		<	.25			.864	
Sodium	131		1780	D	<	100			510			3610			710	
Vanadium	32.3		46.4	D		21.7		<	3.39		<	3.39		<	3.39	
Zinc	43.9		457	D		125			46.6			129		<	8.03	
PESTICIDES/PCBS																
4,4'-ddd			.78	CD		.34	C		.058	C	<	.00826		<	.00826	
4,4'-dde			.26	CD		.0974	C		.0139	C	<	.00765		<	.00765	
4,4'-ddt			.125	CD	<	.00707		<	.00707		<	.00707	M	<	.00707	M
Dieldrin		<	.00629	D	<	.00629		<	.00629		<	.00629		<	.00629	
Pcb 1260		<	.0804	D	<	.0804		<	.0804		<	.0804		<	.0804	
SEMIVOLATILE ORGANICS																
Benzo[k]fluoranthene			3	D	<	.7		<	.3		<	.066		<	.066	
Chrysene		<	.6	D	<	1		<	.6		<	.12		<	.12	
Fluoranthene			7	D		5			2			1.2		<	.068	
Phenanthrene			3	D		2			.7			.53		<	.033	
Pyrene			6	D		5			1			.98			.11	
TPH BY GC																
Diesel			75.5	D	<	8			17.8			169		<	8	
Tphgas			81.5	D	<	8		<	8		<	8		<	8	
VOLATILE ORGANICS																
Acetone			2	D	<	.017			.086			.31		<	.017	
Chlorobenzene		<	.004	D	<	.00086			.0016		<	.00086		<	.00086	
Dichloromethane		<	.06	D	<	.012		<	.012			.15		<	.012	
Tetrachloroethene		<	.004	D	<	.00081			.0046		<	.00081		<	.00081	
Toluene		<	.004	D	<	.00078			.0028			.02		<	.00078	
Trichlorofluoromethane		<	.03	D	<	.0059			.015		<	.0059		<	.0059	
OTHER																
Total Organic Carbon			293000	D		283000			76900			602000			109000	
Total Petroleum Hydrocarbons			212	D		186		<	27.6			1860			355	

TABLE 7 - 17
RI SEDIMENT OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations UGG	57D-95-05X DX570500 DV4S*191 09/13/95 0 UGG	57D-95-05X DX570502 DV4S*192 09/13/95 2 UGG	57D-95-06X DX570600 DV4S*193 09/12/95 0 UGG	57D-95-06X DX570602 DV4S*194 09/12/95 2 UGG	57D-95-07X DX570700 DV4S*195 09/12/95 0 UGG
METALS						
Aluminum	18000	15000	4770	15900	2300	9640
Arsenic	19	28	12.1	80	6.2	110
Barium	54	70	30.6	124	< 5.18	159
Beryllium	0.81	< .5	< .5	< .5	< .5	< .5
Cadmium	1.28	2.33	< .7	< .7	< .7	< .7
Calcium	810	2170	2470	10800	894	18400
Chromium	33	43.2	98.8	48.9	10.9	< 4.05
Cobalt	4.7	6.91	3.11	20.9	< 1.42	20.4
Copper	13.5	33.8	8.31	42.3	2.17	36.1
Iron	18000	18900	5440	27800	3180	29700
Lead	48	188	27	281	18	170
Magnesium	5500	3880	1170	4480	778	2990
Manganese	380	123	247	1240	38.9	3940
Mercury	14.6	< .05	< .05	.36	< .05	< .05
Nickel	2400	25.7	10.3	42.2	3.72	36.3
Potassium	--	1240	351	1190	173	< 100
Selenium	0.086	[illegible]	.776	2.41	649	< 25
Sodium	131	[illegible]	688	2090	434	2380
Vanadium	32.3	28.4	< 3.39	40.3	< 3.39	< 3.39
Zinc	43.9	129	19.6	432	20.5	434
PESTICIDES/PCBS						
4,4'-ddd		.0258 C	< .00826	.44 C	.089 C	.21 C
4,4'-dde		< .00765	< .00765	.162 C	.0222 C	.086 C
4,4'-ddt		.0363 C	< .00707	.0759 C	< .00707	< .00707
Dieldrin		.0183 C	< .00629	< .00629	< .00629	< .00629
Pcb 1260		.301 C	< .0804	< .0804	< .0804	< .0804
SEMIVOLATILE ORGANICS						
Benzo[k]fluoranthene		< 1	< .3	< .7	< .3	3
Chrysene		< 2	< .6	< 1	< .6	< .6
Fluoranthene		< 1	< .3	5	< .3	6
Phenanthrene		< .7	< .2	< .3	< .2	3
Pyrene		< .7	< .2	5	.4	6
TPH BY GC						
Diesel		52.5	< 8	62.1	< 8	114
Tphgas		< 8	< 8	< 8	< 8	150
VOLATILE ORGANICS						
Acetone		.071	.041	.2	< .017	< .017
Chlorobenzene		< .00086	< .00086	< .00086	< .00086	< .00086
Dichloromethane		< .012	< .012	< .012	< .012	< .012
Tetrachloroethene		< .00081	< .00081	< .00081	< .00081	< .00081
Toluene		.0065	.0019	.0098	< .00078	< .00078
Trichlorofluoromethane		.02	< .0059	< .0059	.011	.076
OTHER						
Total Organic Carbon		84900	60900	304000	9820	187000
Total Petroleum Hydrocarbons		3170	153	1070	< 27.5	< 27.5

TABLE 7 - 17
RI SEDIMENT OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations UGG	57D-95-07X DX570702 DV4S*196 09/12/95 2 UGG	57D-95-08X DX570800 DV4S*197 09/13/95 0 UGG	57D-95-09X DX570900 DV4S*198 09/12/95 0 UGG	57D-95-10X DX571000 DV4S*199 09/13/95 0 UGG
METALS					
Aluminum	18000	3470	11800	13700	8130
Arsenic	19	▨ 77	▨ 69	▨ 88	▨ 66.2
Barium	54	28.4	▨ 107	▨ 138	▨ 99.8
Beryllium	0.81	< .5	< .5	< .5	< .5
Cadmium	1.28	< .7	< .7	< .7	< .7
Calcium	810	▨ 6400	▨ 10300	▨ 13700	▨ 13400
Chromium	33	< 4.05	▨ 39.1	▨ 40.9	< 4.05
Cobalt	4.7	< 1.42	▨ 21.7	▨ 25.8	▨ 15.1
Copper	13.5	5.25	▨ 33.4	▨ 48.6	▨ 34.2
Iron	18000	5890	▨ 24700	▨ 30400	15500
Lead	48	20.2	▨ 223	▨ 215	▨ 170
Magnesium	5500	1120	3610	3830	2240
Manganese	380	▨ 470	▨ 1640	▨ 3000	▨ 2040
Mercury	14.6	< .05	▨ .241	< .05	< .05
Nickel	2400	< 1.71	▨ 36.8	▨ 42.9	▨ 27.7
Potassium	–	< 100	989	1010	769
Selenium	0.086	▨ 1.19	▨ 2.43	▨ 3.1	< .25
Sodium	131	▨ 856	▨ 1390	▨ 2010	▨ 2110
Vanadium	32.3	< 3.39	▨ 35.3	▨ 35.9	29.5
Zinc	43.9	39.2	▨ 339	▨ 468	▨ 251
PESTICIDES/PCBS					
4,4'-ddd		< .00826	.49 C	.29 C	.22 C
4,4'-dde		< .00765	.18 C	.14 C	.1 C
4,4'-ddt		< .00707	.12 C	.0667 C	.053 C
Dieldrin		< .00629	< .00629	< .00629	< .00629
Pcb 1260		< .0804	< .0804	< .0804	< .0804
SEMIVOLATILE ORGANICS					
Benzo[k]fluoranthene		.35	2	< .3	< .3
Chrysene		.46	< .6	< .6	< .6
Fluoranthene		.83	4	3	< .3
Phenanthrene		.38	2	1	< .2
Pyrene		.74	4	3	2
TPH BY GC					
Diesel		< 8	51.4	68	< 8
Tphgas		46.6	71.4	107	117
VOLATILE ORGANICS					
Acetone		.12	.1 X	< .017	.1 X
Chlorobenzene		< .00086	< .00086	< .00086	< .00086
Dichloromethane		< .012	< .012	< .012	< .012
Tetrachloroethene		< .00081	< .00081	< .00081	< .00081
Toluene		< .00078	< .00078	< .00078	.0066
Trichlorofluoromethane		< .0059	< .0059	< .0059	< .0059
OTHER					
Total Organic Carbon		92900	265000	226000	462000
Total Petroleum Hydrocarbons		106	277	< 27.6	273

Notes:

C = Detection confirmed
D = Duplicate analysis
M = The high spike recovery is high

▨ = Exceeds background concentrations
X = Analyte exceeds upper reporting limit

TABLE 7-18
1998 SEDIMENT FIELD AND OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Parm	Method	Analyte	Units	Area 2 57D-98-01X DX570100 5/21/98	Area 2 57D-98-02X DX570200 5/21/98	Area 2 57D-98-03X DX570300 5/21/98	Area 3 57D-98-04X DX570400 5/21/98	Area 3 57D-98-05X DX570500 5/21/98	Area 3 57D-98-06X DX570600 5/21/98	Area 3 57D-98-07X DX570700 5/21/98	Area 3 57D-98-08X DX570800 5/21/98
Volatile Organics											
	LM19	Acetone	µg/g	LT .017	LT .017	LT .017	.21	.057	.13	.17	.19
	LM19	Benzene	µg/g	LT .0015	LT .0015	LT .0015	LT .0015	LT .0015	.007	LT .0015	.037
	LM19	Chlorobenzene	µg/g	LT .00086	LT .00086	LT .00086	LT .00086	.019	.013	LT .00086	.0031
	LM19	Toluene	µg/g	LT .00078	LT .00078	LT .00078	LT .00078	.0018	.0047	LT .00078	.0048
	LM19	Tetrachloroethene	µg/g	.078	.01	LT .00081	LT .00081	LT .00081	LT .00081	LT .00081	LT .00081
	LM19	Trichloroethylene	µg/g	LT .0028	.027	LT .0028	LT .0028	LT .0028	LT .0028	LT .0028	LT .0028
	LM19	Xylenes	µg/g	LT .0015	LT .0015	LT .0015	LT .0015	LT .0015	LT .0015	LT .0015	.011
Semivolatile Organics											
	LM18	1,2-dichlorobenzene	µg/g	LT .11	LT .11	LT .11	LT .11	LT .11	.39	LT .11	LT .11
	LM18	1,4-dichlorobenzene	µg/g	LT .098	LT .098	LT .098	LT .098	1	.43	LT .098	LT .098
	LM18	Benzo[b]fluoranthene	µg/g	LT .21	LT .21	LT .21	LT .21	.49	LT .21	LT .21	LT .21
	LM18	Benzo[k]fluoranthene	µg/g	.35	.65	LT .066	LT .066	.19	.2	.28	LT .066
	LM18	Chrysene	µg/g	.53	1.2	LT .12	LT .12	.34	LT .12	LT .12	LT .12
	LM18	Fluoranthene	µg/g	.86	2	.82	LT .068	.47	.47	.65	.17
	LM18	Naphthalene	µg/g	LT .037	LT .037	LT .037	LT .037	.13	.53	LT .037	LT .037
	LM18	Phenanthrene	µg/g	.52	1.1	.48	LT .033	.19	.27	.37	.085
	LM18	Pyrene	µg/g	.79	1.7	.72	.2	.46	.4	.56	.16
Pesticides/PCBs											
	LH10	Dieldrin	µg/g	LT .00629	LT .00629	.046 c	LT .00629	LT .00629	LT .00629	LT .00629	LT .00629
	LH10	4,4'-DDD	µg/g	LT .00826	.091 c	.0418 c	LT .00826	.048 c	.15 c	.0586 c	LT .00826
	LH16	Pcb 1260	µg/g	LT .0804	LT .0804	LT .0804	LT .0804	.84 c	LT .0804	LT .0804	LT .0804
Other											
	9060	Total Organic Carbon	µg/g	121000	177000	149000	210000	41200	97600	97000	38400
	9071	Total Petroleum Hydrocarbons	µg/g	103	452	185	246	3540	160	200	109
Metals											
	JS16	Barium	µg/g	30	LT 5.18	LT 5.18	▨ 59.8	37.7	25.2	26.4	16.1
	JS16	Copper	µg/g	▨ 14.3	8.69	LT .965	4.97	11.2	2.72	LT .965	LT .965
	JS16	Manganese	µg/g	269	40.1	48.6	▨ 459	140	156	29	155
	JS16	Lead	µg/g	43.9	▨ 88.9	LT 10.5	LT 10.5	▨ 64.6	33.6	LT 10.5	LT 10.5
	JS16	Zinc	µg/g	LT 8.03	LT 8.03	LT 8.03	LT 8.03	▨ 90.8	LT 8.03	LT 8.03	LT 8.03
	J301	Arsenic	µg/g	▨ 220	12.1	10.4	6.76	▨ 37.1	▨ 37	15.8	3.19
	J301	Selenium	µg/g	2.98	7.74	3.44	1.82	0.716	1.8	1.27	LT 0.250
VPH Ranges (µg/g)											
		n-C5 to n-C8 Aliphatic	µg/g	<5.2	<9.3 j	<7.6 j	<8.0	<2.7	3.3	<2.2 j	<1.8
		n-C9 to n-C12 Aliphatic	µg/g	<5.2	<9.3	<7.6	<8.0	4.2	5.6	<2.2 j	<1.8
		n-C9 to n-C10 Aromatic	µg/g	<5.2	<9.3	<7.6	<8.0	<2.7	4.3	<2.2 j	<1.8
EPH Ranges (µg/g)											
		n-C9 to n-C18 Aliphatic	µg/g	<130 j	<200 j	<140 j	<160	<70 j	<63 j	<69 j	<50 j
		n-C19 to n-C36 Aliphatic	µg/g	<130	<200	<140	<160	630	<63	<69	<50
		n-C11 to n-C22 Aromatic	µg/g	<130	<200	<140	<160	280	<63	<69	<50
On-Site TPH (µg/g-dry)			µg/g	2500	<31000	<1800	<1500	5500	<380	5500	<390

Notes:
j = estimated
LT = less than
C = analysis confirmed
▨ = exceeds established Devens background concentration

TABLE 7-19
RI SURFACE WATER OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations UGG	57D-95-03X WD5703XX DV4W*432 09/13/95 0 UGL		57D-95-03X WX5703XX DV4W*202 09/13/95 0 UGL	57D-95-04X WX5704XX DV4F*203 09/14/95 0 UGL		57D-95-04X WX5704XX DV4W*203 09/14/95 0 UGL	57D-95-05X WX5705XX DV4F*204 09/13/95 0 UGL	
METALS									
Aluminum	18000	< 141	D	< 141	< 141	F	15100	< 141	F
Arsenic	19	4.69	D	5.12	< 2.54	F	41.6	8.85	F
Barium	54	12.5	D	13.7	20.9	F	169	43.1	F
Cadmium	1.28	< 4.01	D	< 4.01	< 4.01	F	24.6	< 4.01	F
Calcium	810	23300	D	25400	11800	F	28700	19100	F
Chromium	33	< 6.02	D	< 6.02	< 6.02	F	35.8	< 6.02	F
Copper	13.5	< 8.09	D	24	< 8.09	F	375	< 8.09	F
Iron	18000	687	D	512	549	F	17600	17200	F
Lead	48	< 1.26	D	< 1.26	2.28	F	690	< 1.26	F
Magnesium	5500	3470	D	3760	1050	F	4930	1180	F
Manganese	380	119	D	123	64.2	F	252	483	F
Mercury	14.6	< .243	D	< .243	< .243	F	.242	< .243	F
Potassium	--	1870	D	1410	2430	F	3840	1710	F
Sodium	131	18700	D	20000	56900	F	60900	15800	F
Vanadium	32.3	< 11	D	< 11	< 11	F	72.3	< 11	F
Zinc	43.9	< 21.1	D	< 21.1	< 21.1	F	712	58.4	F
SEMIVOLATILE ORGANICS									
Phenanthrene		< .5	D	< .5			.52		
Bis(2-ethylhexyl) Phthalate		< 4.8	D	< 4.8			24		
VOLATILE ORGANICS									
*1,2-dichloroethylenes (cis And Trans)		< .5	D	< .5			< .5		
Dichloromethane		< 2.3	D	2.4			< 2.3		
Tetrachloroethene		< 1.6	D	< 1.6			< 1.6		
Toluene		< .5	D	< .5			< .5		
Trichloroethylene		< .5	D	< .5			< .5		
WET CHEMISTRY									
Alkalinity		35000	D	34000			13000		
Chloride		44000	D	44000			100000		
Nitrite, Nitrate-non Specific		129	D	137			< 10		
Nitrogen By Kjeldahl Method		1430	D	229			16000		
Phosphate		118	D	24.8			1000		
Sulfate		13000	D	13000			13000		
Total Dissolved Solids		153000	D	159000			234000		
Total Hardness		95000	D	132000			104000		
Total Suspended Solids		108000	D	47000			504000		
OTHER									
Total Petroleum Hydrocarbons		< 169	D	< 168			924		

TABLE 7-19
RI SURFACE WATER OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations UGG	57D-95-05X WX5705XX DV4W*204 09/13/95 0 UGL	57D-95-06X WX5706XX DV4F*205 09/12/95 0 UGL	57D-95-06X WX5706XX DV4W*205 09/12/95 0 UGL	57D-95-07X WX5707XX DV4W*206 09/12/95 0 UGL	57D-95-08X WX5708XX DV4F*207 09/13/95 0 UGL
METALS						
Aluminum	18000	185	< 141 F	< 141	244	< 141 F
Arsenic	19	9.17	3.52 F	4.8	6.29	4.37 F
Barium	54	41.3	12.6 F	14.4	16.7	11.9 F
Cadmium	1.28	< 4.01	< 4.01 F	< 4.01	< 4.01	< 4.01 F
Calcium	810	18400	24000 F	25700	23700	24100 F
Chromium	33	< 6.02	< 6.02 F	< 6.02	< 6.02	< 6.02 F
Copper	13.5	< 8.09	< 8.09 F	< 8.09	< 8.09	< 8.09 F
Iron	18000	14600	194 F	592	1040	254 F
Lead	48	< 1.26	< 1.26 F	< 1.26	2.93	< 1.26 F
Magnesium	5500	1290	3550 F	3770	3500	3610 F
Manganese	380	433	156 F	177	289	107 F
Mercury	14.6	< .243	< .243 F	< .243	< .243	< .243 F
Potassium	–	1610	1490 F	1490	1320	1700 F
Sodium	131	17800	19100 F	20000	20500	19000 F
Vanadium	32.3	< 11	< 11 F	< 11	< 11	< 11 F
Zinc	43.9	109	< 21.1 F	< 21.1	< 21.1	< 21.1 F
SEMIVOLATILE ORGANICS						
Phenanthrene		< .5		< .5	< .5	
Bis(2-ethylhexyl) Phthalate		< 4.8		< 4.8	< 4.8	
VOLATILE ORGANICS						
*1,2-dichloroethylenes (cis And Trans)		26		< .5	< .5	
Dichloromethane		< 2.3		2.7	4.1	
Tetrachloroethene		1.8		< 1.6	< 1.6	
Toluene		< .5		< .5	< .5	
Trichloroethylene		3.5		< .5	< .5	
WET CHEMISTRY						
Alkalinity		33000		36000	32000	
Chloride		25200		44000	44000	
Nitrite, Nitrate-non Specific		< 10		142	130	
Nitrogen By Kjeldahl Method		714		352	886	
Phosphate		70		24.8	79.1	
Sulfate		11000		13000	13000	
Total Dissolved Solids		125000		160000	156000	
Total Hardness		106000		110000	104000	
Total Suspended Solids		47000		9000	151000	
OTHER						
Total Petroleum Hydrocarbons		247		< 168	< 173	

TABLE 7-19
RI SURFACE WATER OFF-SITE ANALYTICAL RESULTS
AOC 57
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Units:	Devens Background Concentrations UGG	57D-95-08X WX5708XX DV4W*207 09/13/95 0 UGL	57D-95-09X WX5709XX DV4W*208 09/12/95 0 UGL	57D-95-10X WX5710XX DV4F*209 09/13/95 0 UGL	57D-95-10X WX5710XX DV4W*209 09/13/95 0 UGL
METALS					
Aluminum	18000	< 141	156	< 141 F	158
Arsenic	19	5.86	5.01	3.41 F	4.05
Barium	54	12.1	13.2	11.7 F	12.9
Cadmium	1.28	< 4.01	< 4.01	< 4.01 F	< 4.01
Calcium	810	▨ 24200	▨ 21600	▨ 22300 F	▨ 22000
Chromium	33	< 6.02	< 6.02	< 6.02 F	< 6.02
Copper	13.5	< 8.09	< 8.09	< 8.09 F	< 8.09
Iron	18000	691	607	230 F	620
Lead	48	< 1.26	1.52	< 1.26 F	2.49
Magnesium	5500	▨ 3640	3130	3260 F	3220
Manganese	380	141	182	83.4 F	123
Mercury	14.6	< .243	< .243	< .243 F	< .243
Potassium	–	1620	1570	1750 F	1490
Sodium	131	▨ 19000	▨ 19000	▨ 19600 F	▨ 19300
Vanadium	32.3	< 11	< 11	< 11 F	< 11
Zinc	43.9	< 21.1	< 21.1	< 21.1 F	< 21.1
SEMIVOLATILE ORGANICS					
Phenanthrene		< .5	< .5		< .5
Bis(2-ethylhexyl) Phthalate		< 4.8	< 4.8		< 4.8
VOLATILE ORGANICS					
*1,2-dichloroethylenes (cis And Trans)		< .5	< .5		< .5
Dichloromethane		4.2	2.3		< 2.3
Tetrachloroethene		< 1.6	< 1.6		< 1.6
Toluene		.58	< .5		< .5
Trichloroethylene		< .5	< .5		< .5
WET CHEMISTRY					
Alkalinity		36000	33000		31000
Chloride		44000	44000		44000
Nitrite, Nitrate-non Specific		122	152		146
Nitrogen By Kjeldahl Method		448	276		< 183
Phosphate		26.9	29.5		18.8
Sulfate		13000	13000		13000
Total Dissolved Solids		163000	150000		150000
			149000 D		
Total Hardness		101000	85000		93000
Total Suspended Solids		< 4000	8000		4000
			11000 D		
OTHER					
Total Petroleum Hydrocarbons		< 191	< 169		< 178

Notes:
D = Duplicate analysis
F = Filtered sample
▨ = Exceeds background concentrations

TABLE 7-20
1998 SURFACE WATER AND FIELD OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

				Area 2						Area 3	
Parm	Method	Analyte	Units	57W-98-01X WX570100 5/21/98	57W-98-01X WX570100 5/21/98	57W-98-02X WX570200 5/21/98	57W-98-02X WX570200 5/21/98	57W-98-03X WX570300 5/21/98	57W-98-03X WX570300 5/21/98	57W-98-04X WX570400 5/21/98	57W-98-04X WX570400 5/21/98
Wet Chemistry											
	1602	Total Suspended Solids	µg/L	4000		10500000		2430000			15800000
Volatile Organics											
	UM20	Chloroform	µg/L	LT .5		.72		LT .5			LT .5
	UM20	Tetrachloroethene	µg/L	2.6		LT 1.6		LT 1.6			LT 1.6
	UM20	Trichloroethene	µg/L	0.6		LT .5		LT .5			LT .5
	UM20	Chlorobenzene	µg/L	LT .5		LT .5		LT .5			LT .5
	UM20	Carbon Disulfide	µg/L	LT .5		1.1		LT .5			LT .5
	UM20	Toluene	µg/L	LT .5		LT .5		1.1			LT .5
Semivolatile Organics											
	UM18	Benzo[k]fluoranthene	µg/L	LT .87		LT .87		LT .87			LT .87
Metals											
	S303	Arsenic	µg/L	96.2	5.14 f	198	6.86 f	90.1	4.91 f	24 f	70.8
	S303	Antimony	µg/L	LT 1.00	LT 1.00 f	LT 1.00	LT 1.00 f	LT 1.00	LT 1.00 f	LT 1.00 f	LT 1.00
	SS18	Barium	µg/L	254	20 f	553	9.6 f	323	10.2 f	10 f	267
	SS18	Copper	µg/L	62.2	LT 5 f	156	LT 5 f	60.4	LT 5 f	LT 5 f	44.1
	S303	Lead	µg/L	37	1.96 f	71.4	1.43 f	35.5	2.06 f	1.95 f	32.9
	SS18	Manganese	µg/L	2690 RJ	540 f RJ	3680 RJ	97.7 f	1640 RJ	69.2 f	282 f RJ	1650 RJ
	S303	Selenium	µg/L	LT 2.00	LT 2.00 f	2.35	LT 2.00 f	LT 2.00	LT 2.00 f	LT 2.00 f	LT 2.00
	SS18	Zinc	µg/L	138	LT 35.8 f	363	LT 35.8 f	256	LT 35.8 f	LT 35.8 f	340
VPH Ranges (µg/L)											
		n-C5 to n-C8 Aliphatic	µg/L	<20		<20		<20			<20
		n-C9 to n-C12 Aliphatic	µg/L	<20		<20		<20			<20
		n-C9 to n-C10 Aromatic	µg/L	<20 j		<20 j		<20 j			<20 j
EPH Ranges (µg/L)											
		n-C9 to n-C18 Aliphatic	µg/L	<500		<500		<500			<500
		n-C19 to n-C36 Aliphatic	µg/L	750		1700		1400			1000
		n-C11 to n-C22 Aromatic	µg/L	380		1400		610			430
On-Site TPH (mg/L)											
			mg/L	<50		<50		<50			<50

Notes:
f = filtered sample

j = estimated
LT = less than
J = low spike recovery was low
R = rejected
▨ = exceeds established Devens background concentration

TABLE 7-20
1998 SURFACE WATER AND FIELD OFF-SITE ANALYTICAL RESULTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

				Area 3							
Parm	Method	Analyte	Units	57W-98-05X WX570500 5/21/98	57W-98-05X WX570500 5/21/98	57W-98-06X WX570600 5/21/98	57W-98-06X WX570600 5/21/98	57W-98-07X WX570700 5/21/98	57W-98-07X WX570700 5/21/98	57W-98-08X WX570800 5/21/98	57W-98-08X WX570800 5/21/98
Wet Chemistry											
	1602	Total Suspended Solids	µg/L	3240000		3330000		4540000		6170000	
Volatile Organics											
	UM20	Chloroform	µg/L	LT .5		LT .5		LT .5		LT .5	
	UM20	Tetrachloroethene	µg/L	LT 1.6		LT 1.6		LT 1.6		LT 1.6	
	UM20	Trichloroethene	µg/L	LT .5		LT .5		LT .5		LT .5	
	UM20	Chlorobenzene	µg/L	4.6		LT .5		LT .5		LT .5	
	UM20	Carbon Disulfide	µg/L	.58		LT .5		LT .5		LT .5	
	UM20	Toluene	µg/L	1.6		LT .5		LT .5		.59	
Semivolatile Organics											
	UM18	Benzo[k]fluoranthene	µg/L	LT .87				LT .87		.94	
Metals											
	S303	Arsenic	µg/L	153	53.4 f	25.3	6.53 f	5.55	3.7 f	12.5	12.5 f
	S303	Antimony	µg/L	5.62	LT 1.00 f	2.07	LT 1.00 f	LT 1.00	LT 1.00 f	1.98	LT 1.00 f
	SS18	Barium	µg/L	278	22.8 f	180	7.6 f	42.8	5.2 f	110	21.6 f
	SS18	Copper	µg/L	27.6	LT 5 f	26	LT 5 f	LT 5	LT 5 f	19.2	LT 5 f
	S303	Lead	µg/L	97.4	LT 1.00 f	185	LT 1.00 f	27.8	LT 1.00 f	120	1.73 f
	SS18	Manganese	µg/L	1370 RJ	892 f RJ	1350 RJ	155 f	92.8	37.6 f	2600 RJ	2050 f RJ
	S303	Selenium	µg/L	2.05	LT 2.00 f	2.53	LT 2.00 f	LT 2.00	LT 2.00 f	LT 2.00	LT 2.00 f
	SS18	Zinc	µg/L	445	LT 35.8 f	171	LT 35.8 f	LT 35.8	LT 35.8 f	80.6	LT 35.8 f
VPH Ranges (µg/L)											
		n-C5 to n-C8 Aliphatic	µg/L	<20		<20		<20		<20	
		n-C9 to n-C12 Aliphatic	µg/L	<20		<20		<20		<20	
		n-C9 to n-C10 Aromatic	µg/L	25 j		<20 j		<20 j		<20 j	
EPH Ranges (µg/L)											
		n-C9 to n-C18 Aliphatic	µg/L	<530		<500		<500		<500	
		n-C19 to n-C36 Aliphatic	µg/L	<530		<500		<500		1100	
		n-C11 to n-C22 Aromatic	µg/L	400		300		360		650	
On-Site TPH (mg/L)											
			mg/L	<50		<50		<50		<50	

Notes:
f = filtered sample

j = estimated
LT = less than
J = low spike recovery was low
R = rejected
▨ = exceeds established Devens background concentration

TA 21
CONFIRMATOR PLING RESULTS
AOC 57 AREA 3 MOVAL ACTION
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID DATE COLLECTED	MCP S-1/GW-1 (µg/g)	MCP S-2/GW-3 (µg/g)	RISK BASED SURFACE (µg/g)	RISK BASED SUBSURFACE (µg/g)	EX57W01X 2.5 ft bgs 25-Mar-99	EX57W02X 3 ft bgs 25-Mar-99	ED57W02X 3 ft bgs 25-Mar-99	EX57W03X 3 ft bgs 25-Mar-99	EX57W04X 3 ft bgs 25-Mar-99	EX57W05X 3 ft bgs 25-Mar-99	EX57W06X 5 ft bgs 25-Mar-99	EX57W07X 5 ft bgs 25-Mar-99	EX57W08X 5 ft bgs 25-Mar-99	EX57W09X 4 ft bgs 16-Apr-99	EX57W10X 3 ft bgs 16-Apr-99
VPH (µg/g)															
n-C5 to n-C8 Aliphatic	100	500			<20	<23	<20	<19	<20	<19	<18	<18	<18	<15	<15
n-C9 to n-C12 Aliphatic	1000	2500			<4.9	<<5.8	<4.9	<4.8	<4.9	<4.7	<4.6	<4.5	<4.5	<3.7	<3.8
n-C9 to n-C10 Aromatic	100	500			<4.9	<5.8J	6.8J	<4.8	<4.9	<4.7	<4.6	<4.5	<4.5	<3.7	<3.8
Benzene	10	60			<2.5	<2.9	<2.4	<2.4	<2.4	<2.4	<2.3	<2.3	<2.2	<1.8	<1.9
Ethylbenzene	80	80			<2.5	<2.9	<2.4	<2.4	<2.4	<2.4	<2.3	<2.3	<2.2	<1.8	<1.9
m,p-Xylene	500*	1000*			<9.9	<12	<9.8	<9.5	<9.8	<9.5	<9.3	<9.1	<8.9	<7.4	<7.6
MTBE	0.3	200			<7.4	<8.8	<7.4	<7.1	<7.3	<7.1	<7.0	<6.8	<6.7	<5.6	<5.7
Naphthalene	4	1000			<4.9	<5.8	<4.9	<4.8	<4.9	<4.7	<4.6	<4.5	<4.5	<3.7	<3.8
o-Xylene	500*	1000*			<4.9	<5.8	<4.9	<4.8	<4.9	<4.7	<4.6	<4.5	<4.5	<3.7	<3.8
Toluene	90	1000			<7.4	<8.8	<7.4	<7.1	<7.3	<7.1	<7.0	<6.8	<6.7	<5.6	<5.7
EPH (µg/g)															
n-C9 to n-C18 Aliphatic	1000	2500	NA	NA	50	<7.1	<7.4	11	61	<6.4	<6.4	9	<6.3	<6.3	<6.9
n-C19 to n-C36 Aliphatic	2500	5000	20000	20000	660	<7.1	<11	420	1700	<6.4	<20	440	<10	<6.3	<6.9
n-C11 to n-C22 Aromatic	200	2000	5000	10000	64	<19	<20	200	380	<17	<17	37	<17	<17	<18
2-Methylnaphthalene	4	1000			<1.8	<1.8	<1.8	<1.7	<1.8	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Acenaphthene	20	2000			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Acenaphthylene	100	1000			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Anthracene	1000	2500			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Benzo(a)anthracene	0.7	1			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Benzo(a)pyrene	0.7	0.7			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Benzo(b)fluoranthene	0.7	1			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Benzo(g,h,I)perylene	1000	2500			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Benzo(k)fluoranthene	7	10			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Chrysene	7	10			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Dibenzo(a,h)anthracene	0.7	0.7			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Fluoranthene	1000	600			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Fluorene	400	1000			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Indeno(1,2,3-cd)pyrene	0.7	1			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Naphthalene	4	1000			<1.8J	<1.8J	<1.8J	<1.7J	<1.6J	<1.6J	<1.6J	<1.6J	<1.6J	<1.6J	<1.7
Phenanthrene	700	100			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Pyrene	700	2000			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
PCBs (µg/g)															
PCB-1016	2	2	2	4	<0.020	<0.020	<0.020	<0.020	<0.019	<0.019	<0.019	<0.019	<0.017	<0.017	<0.020
PCB-1221	2	2	2	4	<0.040	<0.040	<0.040	<0.040	<0.036	<0.036	<0.036	<0.036	<0.033	<0.033	<0.040
PCB-1232	2	2	2	4	<0.020	<0.020	<0.020	<0.020	<0.019	<0.019	<0.019	<0.019	<0.017	<0.017	<0.020
PCB-1242	2	2	2	4	<0.020	<0.020	<0.020	<0.020	<0.019	<0.019	<0.019	<0.019	<0.017	<0.017	<0.020
PCB-1248	2	2	2	4	<0.020	<0.020	<0.020	<0.020	<0.019	<0.019	<0.019	<0.019	<0.017	<0.017	<0.020
PCB-1254	2	2	2	4	<0.020	<0.020	<0.020	<0.020	<0.019	<0.019	<0.019	<0.019	<0.017	<0.017	<0.020
PCB-1260	2	2	2	4	1.3	<0.020	<0.020	2.8	0.43	<0.019	0.039	0.88	<0.017	0.025	<0.020
PESTICIDES (µg/g)															
alpha-BHC					<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017	<0.002
gamma-BHC (Lindane)					<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017J	<0.002J
Heptachlor	0.1	0.2			<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017	<0.002
Aldrin	0.03	0.04			<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017	<0.002
beta-BHC					<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017J	<0.002J
delta-BHC					<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017	<0.002
Heptachlor epoxide	0.06	0.09			<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017J	<0.002J
Endosulfan I	20	0.05			<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017J	<0.002J
gamma-Chlordane	1	2			<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017J	<0.002J
alpha-Chlordane	1	2			<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017J	<0.002J
4,4'-DDE	2	2			<0.040	<0.004	<0.004	<0.040	<0.140	<0.0036	<0.0036	<0.0036	<0.0033	<0.0033	<0.004
Dieldrin	0.03	0.04			0.042J	<0.004	<0.004	<0.040	<0.140	<0.0036	<0.0036	<0.0036	<0.0033	<0.0033J	<0.004J
Endrin	0.6	1			<0.040	<0.004	<0.004	<0.040	<0.140	<0.0036	<0.0036	<0.0036	<0.0033	<0.0033J	<0.004J
4,4'-DDD	2	3			0.2J	<0.004	<0.004	<0.040	1.8J	<0.0036	<0.0036	<0.0036	<0.0033	<0.0033J	<0.004J
Endosulfan II					<0.040	<0.004	<0.004	<0.040	<0.140	<0.0036	<0.0036	<0.0036	<0.0033	<0.0033J	<0.004J
4,4'-DDT	2	2			<0.040	<0.004	<0.004	<0.040	<0.140	<0.0036	<0.0036	<0.0036	<0.0033	<0.0033J	<0.004J
Endrin aldehyde					<0.040	<0.004	<0.004	<0.040	<0.140	<0.0036	<0.0036	<0.0036	<0.0033	<0.0033	<0.004
Endosulfan sulfate					<0.040	<0.004	<0.004	<0.040	<0.140	<0.0036	<0.0036	<0.0036	<0.0033	<0.0033J	<0.004J
Methoxychlor	100	30			<0.200	<0.020	<0.020	<0.200	<0.730	<0.019	<0.019	<0.019	<0.017	R	R
Endrin ketone					<0.040	<0.004	<0.004	<0.040	<0.140	<0.0036	<0.0036	<0.0036	<0.0033	<0.0033	<0.004
Toxaphene					<0.400	<0.040	<0.040	<0.400	<1.400	<0.036	<0.036	<0.036	<0.033	R	R

Notes:

MCP S-2/GW-3 Standards identified as cleanup goals in Action Memorandum

* = standard is for mixed isomers

J = estimated

R = rejected

< = less than

▨ = sample locations removed during subsequent excavation

TA 1
CONFIRMATOR LING RESULTS
AOC 57 AREA 3 R OVAL ACTION
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SAMPLE ID DATE COLLECTED	MCP S-1/GW-1 (µg/g)	MCP S-2/GW-3 (µg/g)	RISK BASED SURFACE (µg/g)	RISK BASED SUBSURFACE (µg/g)	ED57W10X 3 ft bgs 16-Apr-99	EX57W11X 4 ft bgs 16-Apr-99	EX57W12X 1 ft bgs 16-Apr-99	EX57W13X 2 ft bgs 16-Apr-99	EX57W14X 2 ft bgs 11-Jun-99	EX57W15X 1 ft bgs 11-Jun-99	ED57W15X 1 ft bgs 11-Jun-99	EX57W16X 2 ft bgs 11-Jun-99	EX57W17X 2 ft bgs 11-Jun-99	EX57F01X 6 ft bgs 25-Mar-99	EX57F02X 8 ft bgs 25-Mar-99	EX57F03X 3 ft bgs 15-Apr-99
VPH (µg/g)																
n-C5 to n-C8 Aliphatic	100	500			<16	<1200	<22	<18J	<16	<20	<22	<140	<15	<18	<18	<15
n-C9 to n-C12 Aliphatic	1000	2500			<3.9	2500	<5.5	<4.4J	52	<5	<5.4	870	16	<4.6	<4.6	47
n-C9 to n-C10 Aromatic	100	500			<3.9	1900	<5.5	<4.4J	55	<5J	<5.4J	600	<3.7J	<4.6	<4.6	37
Benzene	10	60			<2.0	<140	<2.7	<2.2J	<110	<140J	<160J	<1000	<110J	<2.3	<2.3	<1.9
Ethylbenzene	80	80			<2.0	<140	<2.7	<2.2J	<110	<140J	<160J	<1000	<110J	<2.3	<2.3	<1.9
m,p-Xylene	500*	1000*			<7.9	<580	<11	<8.8J	<7.9	<10J	<11J	<72	<7.4J	<9.3	<9.1	<7.4
MTBE	0.3	200			<5.9	<440	<8.2	<6.6J	<5.9	<7.5	<8.2	<54	<5.6	<7.0	<6.8	<5.6
Naphthalene	4	1000			<3.9	<290	<5.5	<4.4J	<230	<290J	<310J	<2100	<210J	<4.6	<4.6	<3.7
o-Xylene	500*	1000*			<3.9	<290	<5.5	<4.4J	<110	<140J	<160J	<1000	<110J	<4.6	<4.6	<3.7
Toluene	90	1000			<5.9	<440	<8.2	<6.6J	<230	<290J	<310J	<2100	<210J	<7.0	<6.8	<5.6
EPH (µg/g)																
n-C9 to n-C18 Aliphatic	1000	2500	NA	NA	<7.0	1900	210J	67	920	880	650	1300	<3.6	78	<7.6	<7.5
n-C19 to n-C36 Aliphatic	2500	5000	20000	20000	<7.0	10000	6000J	1500	20000	7700	6700	8600	<4.8	990	<12	<7.5
n-C11 to n-C22 Aromatic	200	2000	5000	10000	<19	2300	930	100J	3100	1300	1100	1400	<19	110	<20	<20
2-Methylnaphthalene	4	1000			<1.8	13	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Acenaphthene	20	2000			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Acenaphthylene	100	1000			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Anthracene	1000	2500			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Benzo(a)anthracene	0.7	1			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Benzo(a)pyrene	0.7	0.7			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Benzo(b)fluoranthene	0.7	1			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Benzo(g,h,i)perylene	1000	2500			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Benzo(k)fluoranthene	7	10			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Chrysene	7	10			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Dibenzo(a,h)anthracene	0.7	0.7			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Fluoranthene	1000	600			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Fluorene	400	1000			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Indeno(1,2,3-cd)pyrene	0.7	1			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Naphthalene	4	1000			<1.8	10	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0]	<1.9J	<1.9
Phenanthrene	700	100			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
Pyrene	700	2000			<1.8	<3.8	<2.4	<2.1J	<6.4	<2.2	<2.3	<3.9	<1.8	<2.0	<1.9	<1.9
PCBs (µg/g)																
PCB-1016	2	2	2	4	<0.020	<0.200	<0.540	<0.480	<0.240	<0.025	<0.026	<0.022	<0.020	<0.024	<0.022	<0.020
PCB-1221	2	2	2	4	<0.040	<0.400	<1.100	<0.920	<0.470	<0.049	<0.050	<0.043	<0.040	<0.046	<0.043	<0.040
PCB-1232	2	2	2	4	<0.020	<0.200	<0.540	<0.480	<0.240	<0.025	<0.026	<0.022	<0.020	<0.024	<0.022	<0.020
PCB-1242	2	2	2	4	<0.020	2.4	<0.540	<0.480	<0.240	<0.025	<0.026	<0.022	<0.020	<0.024	<0.022	<0.020
PCB-1248	2	2	2	4	<0.020	<0.200	<0.540	4	<0.240	<0.025	<0.026	<0.022	<0.020	<0.024	<0.022	<0.020
PCB-1254	2	2	2	4	<0.020	<0.200	<0.540	<0.480	<0.240	<0.025	<0.026	<0.022	<0.020	<0.024	<0.022	<0.020
PCB-1260	2	2	2	4	<0.020	3.5	14	9.6	4.3	<0.025	<0.026	<0.022	<0.020	2.6	<0.022	0.056
PESTICIDES (µg/g)																
alpha-BHC					<0.002	<0.020	<0.054	<0.048	<0.024	<0.026	<0.026	<0.022	<0.020	<0.024	<0.0022	<0.002
gamma-BHC (Lindane)					<0.002J	<0.020J	<0.054J	<0.048J	<0.024	<0.026	<0.026	<0.022	<0.020	<0.024	<0.0022	<0.002J
Heptachlor	0.1	0.2			<0.002	0.046	<0.054	<0.048	<0.024	<0.026	<0.026	<0.022	<0.020	<0.024	<0.0022	<0.002
Aldrin	0.03	0.04			<0.002	<0.020	<0.054	<0.048	<0.024	<0.026	<0.026	<0.022	<0.020	<0.024	<0.0022	<0.002
beta-BHC					<0.002J	<0.020J	<0.054J	<0.048J	<0.024	<0.026	<0.026	<0.022	<0.020	<0.024	<0.0022	<0.002J
delta-BHC					<0.002	<0.020	<0.054	<0.048	<0.024	<0.026	<0.026	<0.022	<0.020	<0.024	<0.0022	<0.002
Heptachlor epoxide	0.06	0.09			<0.002J	<0.020J	<0.054J	<0.048J	<0.024	<0.026	<0.026	<0.022	<0.020	<0.024	<0.0022	<0.002J
Endosulfan I	20	0.05			<0.002J	<0.020J	<0.054J	<0.048J	<0.024	<0.026	<0.026	<0.022	<0.020	<0.024	<0.0022	<0.002J
gamma-Chlordane	1	2			<0.002J	<0.020J	<0.054J	<0.048J	<0.024	<0.026	<0.026	<0.022	<0.020	<0.024	<0.0022	<0.002
alpha-Chlordane	1	2			<0.002J	<0.020J	<0.054J	<0.048J	<0.024	<0.026	<0.026	<0.022	<0.020	<0.024	<0.0022	<0.002J
4,4'-DDE	2	2			<0.004	<0.040	0.12	<0.092	<0.046	<0.050	<0.050	<0.043	<0.040	<0.046	<0.0043	<0.004
Dieldrin	0.03	0.04			<0.004J	0.06J	0.26J	0.15J	0.14	<0.050	<0.050	0.086	<0.040	<0.046	<0.0043	<0.004J
Endrin	0.6	1			<0.004J	<0.040J	<0.110J	<0.092J	0.054	<0.050	<0.050	0.07	<0.040	<0.046	<0.0043	<0.004J
4,4'-DDD	2	3			<0.004J	<0.040J	<0.110J	<0.092J	<0.046	0.27	0.24	0.29	<0.040	0.24	<0.0043	<0.004J
Endosulfan II					<0.004J	<0.040J	<0.110J	<0.092J	<0.046	<0.050	<0.050	<0.043	<0.040	<0.046	<0.0043	<0.004J
4,4'-DDT	2	2			<0.004J	<0.040J	1.1J	<0.092J	<0.046	<0.050	<0.050	<0.043	<0.040	<0.046	<0.0043	<0.004J
Endrin aldehyde					<0.004	<0.040	<0.110	<0.092	<0.046	<0.050	<0.050	<0.043	<0.040	<0.046	<0.0043	<0.004
Endosulfan sulfate					<0.004J	<0.040J	<0.110J	<0.092J	<0.046	<0.050	<0.050	<0.043	<0.040	<0.046	<0.0043	<0.004J
Methoxychlor	100	30			R	R	R	R	<0.240	<0.260	<0.260	<0.220	<0.200	<0.24	<0.022	R
Endrin ketone					<0.004	<0.040	<0.110	<0.092	<0.046	<0.050	<0.050	<0.043	<0.040	<0.046	<0.0043	<0.004
Toxaphene					R	R	R	R	<0.460	<0.500	<0.500	<0.430	<0.400	<.46	<0.043	R

Notes:

MCP S-2/GW-3 Standards identified as cleanup goals in Action Memorandum

* = standard is for mixed isomers

J = estimated

R = rejected

< = less than

▨ = sample locations removed during subsequent excava

TABLE 9-1
SOIL SAMPLES USED IN HHRA
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

MEDIA	AREA	SAMPLE LOCATION	DEPTH (Ft bgs)	ANALYSES
Surface Soil	Area 2 - Industrial	57B-95-01X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57B-95-02X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-02X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-10X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-25X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
	Area 2 - Recreational	57E-95-12X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-16X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-17X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57S-98-01F	1 - 2	TPH, VPH, EPH
		57S-98-01X	1 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs
		57S-98-02F	0 - 1	TPH, VPH, EPH
		57S-98-02X	0 - 1	Inorganics, Pest/PCBs, SVOCs, VOCs
		57S-98-04F	1 - 2	TPH, VPH, EPH
		57S-98-04X	1 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs
		57S-98-06F	1 - 2	TPH, VPH, EPH
		57S-98-06X	1 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs
		57S-98-07F and Dup	0 - 1	TPH, VPH, EPH
		57S-98-07X and Dup	0 - 1	Inorganics, Pest/PCBs, SVOCs, VOCs
		57S-98-07F	1 - 2	TPH, VPH, EPH
		57S-98-07X	1 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs
		57S-98-08F	0 - 1	TPH, VPH, EPH
		57S-98-08X	0 - 1	Inorganics, Pest/PCBs, SVOCs, VOCs
		57S-98-09F	0 - 1	TPH, VPH, EPH
		57S-98-09X	0 - 1	Inorganics, Pest/PCBs, SVOCs, VOCs
	Area 3 - Industrial	57B-96-08X	0 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		EX57W05X	3	Pest/PCBs, VPH, EPH
		EX57W10X and Dup	3	Pest/PCBs, VPH, EPH
		EX57W02X and Dup	3	Pest/PCBs, VPH, EPH
		EX57W17X	2	Pest/PCBs, VPH, EPH
		57B-96-09X	0 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
	Area 3 - Recreational	57S-98-13F	1 - 2	TPH, VPH, EPH
		57S-98-14F	1 - 2	TPH, VPH, EPH
		57S-98-13X	1 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs
		57S-98-14X	1 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs
		EX57F03X	3	Pest/PCBs, VPH, EPH
		EX57W14X	2	Pest/PCBs, VPH, EPH
		EX57W15X	1	Pest/PCBs, VPH, EPH
		EX57W16X	2	Pest/PCBs, VPH, EPH

TABLE 9-1
SOIL SAMPLES USED IN HHRA
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

MEDIA	AREA	SAMPLE LOCATION	DEPTH (Ft bgs)	ANALYSES
Subsurface Soil	Area 2 - Industrial	57B-95-01X	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-01X	6 - 8	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57B-95-02X	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-04X and Dup	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
	Area 2 - Recreational	57E-95-07X	4 - 6	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-08X	4 - 6	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-09X	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-13X	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-14X	6 - 8	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-15X	2 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-16X	2 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-18X	2 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-19X	2 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-20X	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57S-98-03F	2 - 3	TPH, VPH, EPH
		57S-98-03X	2 - 3	Inorganics, Pest/PCBs, SVOCs, VOCs
		57S-98-05F	3 - 4	TPH, VPH, EPH
		57S-98-05X	3 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs
	Area 3 - Recreational	57S-98-15F	3 - 4	TPH, VPH, EPH
		57S-98-15X	3 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs
	Area 3 - Industrial	57B-96-08X	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57B-96-09X	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-01X	6 - 8	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57B-96-11X and Dup	10 - 12	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		EX57W06X	5	Pest/PCBs, VPH, EPH
		EX57W07X	5	Pest/PCBs, VPH, EPH
		EX57W08X	5	Pest/PCBs, VPH, EPH
		EX57W09X	4	Pest/PCBs, VPH, EPH
		EX57F01X	6	Pest/PCBs, VPH, EPH
		EX57F02X	8	Pest/PCBs, VPH, EPH

TABLE 9-2
EXCAVATED SOIL SAMPLES
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

MEDIA	AREA	SAMPLE LOCATION
Soil	Area 3 - Recreational	57B-96-12X
	Area 3 - Industrial	EX57W01X
		EX57W03X
		57B-96-07X
		57R-96-14X
		57R-95-04X
		57R-95-06X
		57E-96-30X
		57E-96-31X
		57R-95-03X
		57R-96-18X
		57B-96-10X
		57E-96-28X
		57R-96-12X
		57R-96-19X
		57E-95-24X
		57B-98-11X
		57E-96-29X
		57R-95-02X
		57R-96-13X
		57R-96-15X
		57R-96-16X
		EX57W01X
		EX57W03X
		EX57W04X
		EX57W11X
		EX57W12X
		EX57W13X

TABLE 9-3
GROUNDWATER SAMPLES USED IN HHRA
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

MEDIA	AREA	SAMPLE LOCATION	SAMPLE #	DATE	U/F	ANALYSES
Groundwater	Area 2 - Upgradient	57M-95-01X	DV4F168	2/13/96	F	Inorganics
		57M-95-01X	DV4W168	2/13/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-01X Dup	DV4F455	2/13/96	F	Inorganics
		57M-95-01X Dup	DV4W455	2/13/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-02X	DV4F170	2/13/96	F	Inorganics
		57M-95-02X	DV4W170	2/13/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-98-02X		5/26/98		TPH, VPH, EPH
		G3M-92-02X	DV4F164	2/12/96	F	Inorganics
	Area 2 - Industrial	57M-95-05X	DV4F176	2/13/96	F	Inorganics
		57M-95-05X	DV4W176	2/13/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-06X	DV4F178	2/15/96	F	Inorganics
		57M-95-06X	DV4W178	2/15/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
	Area 2 - Recreational	57M-95-04A	DV4F174	2/14/96	F	Inorganics
		57M-95-04A	DV4W174	2/14/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-04B	DV4F459	2/14/96	F	Inorganics
		57M-95-04B	DV4W459	2/14/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-98-04X		5/27/98		TPH, VPH, EPH
		57M-98-04X - Dup		5/27/98		TPH
		57M-95-07X	DV4F180	2/14/96	F	Inorganics
		57M-95-07X	DV4W180	2/14/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-08A	DV4F182	2/15/96	F	Inorganics
		57M-95-08A	DV4W182	2/15/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-08B	DV4F462	2/15/96	F	Inorganics
		57M-95-08B	DV4W462	2/15/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57P-98-02X	ADV1W20	5/26/98	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem
		57P-98-02X	ADV1W21	5/26/98	F	Inorganics
	Area 3 - Industrial	57M-95-03X	DV4F172	2/14/96	F	Inorganics
		57M-95-03X	DV4W537	10/2/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-03X - Dup	DV4F458	2/14/96	F	Inorganics
		57M-98-03X		5/26/98		TPH, VPH, EPH
		57M-96-09X	DV4W533	10/1/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
	Area 3 - Recreational	57M-96-10X	DV4W534	10/2/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-96-11X	ADV1W26	5/27/98	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem
		57M-96-11X	ADV1W27	5/27/98	F	Inorganics
		57M-96-11X - Dup	ADV1W28	5/27/98	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem
		57M-96-11X - Dup	ADV1W29	5/27/98	F	Inorganics
		57M-98-11X		5/27/98		TPH, VPH, EPH
		57M-98-11X - Dup		5/27/98		TPH, VPH, EPH
		57M-96-12X	DV4W306	10/2/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-96-13X	DV4W307	10/2/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57P-98-03X	ADV1W22	5/26/98	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem
		57P-98-03X	ADV1W23	5/26/98	F	Inorganics
		57P-98-04X	ADV1W24	5/26/98	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem
		57P-98-04X	ADV1W25	5/26/98	F	Inorganics

TABLE 9-4
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 INDUSTRIAL USE
SURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*				
SURFACE SOIL (0 - 2 feet bgs) (mg/kg)[a]										
PAL METALS										
Aluminum		5 / 5	7530	6700	NC	18000	7800	NA	No	[1] Less than RBC, [2] Background
Arsenic		5 / 5	21	14.5	NC	19	0.43	NA	Yes	[3] Exceeds RBC
Barium		5 / 5	40.9	26.3	NC	54	550	NA	No	[1] Less than RBC, [2] Background
Beryllium	0.50 - 0.50	1 / 5	0.705	0.341	NC	0.81	16	NA	No	[1] Less than RBC, [2] Background
Calcium		5 / 5	889	492	NC	810	NA	NA	No	[4] Essential Nutrient
Chromium		5 / 5	27	15.9	NC	33	23	NA	Yes	[3] Exceeds RBC,[2] Background
Cobalt		5 / 5	7.53	4.64	NC	4.7	470	NA	No	[1] Less than RBC
Copper		5 / 5	15.6	11	NC	13.5	310	NA	No	[1] Less than RBC
Iron		5 / 5	16400	11700	NC	18000	2300	NA	Yes	[3] Exceeds RBC,[2] Background
Lead		5 / 5	22.9	14	NC	48	NA	400[b]	No	[5] Less than ARAR, [2] Background
Magnesium		5 / 5	4020	2370	NC	5500	NA	NA	No	[4] Essential Nutrient, [2] Background
Manganese		5 / 5	481	282	NC	380	160	NA	Yes	[3] Exceeds RBC
Nickel		5 / 5	30.7	16.8	NC	14.6	160	NA	No	[1] Less than RBC
Potassium		5 / 5	1170	654	NC	2400	NA	NA	No	[2] Background, [4] Essential Nutrient
Selenium	0.25 - 0.25	1 / 5	0.883	0.277	NC	ND	39	NA	No	[1] Less than RBC
Sodium		5 / 5	436	327	NC	131	NA	NA	No	[4] Essential Nutrient
Vanadium		5 / 5	15.5	12	NC	32.3	55	NA	No	[1] Less than RBC, [2] Background
Zinc		5 / 5	38.1	24.2	NC	43.9	2300	NA	No	[1] Less than RBC, [2] Background
PESTICIDES/PCBs										
4,4-DDE	0.0077 - 0.0077	1 / 5	0.0199	0.007	NC	--	1.9	NA	No	[1] Less than RBC
4,4-DDT	0.0071 - 0.0071	1 / 5	0.0257	0.008	NC	--	1.9	NA	No	[1] Less than RBC
PAL SEMIVOLATILE ORGANICS										
2-methylnaphthalene	0.049 - 0.2	2 / 5	0.43	0.201	NC	--	160	NA	No	[1] Less than RBC
Bis(2-ethylhexyl) Phthalate	0.62 - 3	2 / 5	2.7	1.6	NC	--	46	NA	No	[1] Less than RBC
Dibenzofuran	0.035 - 0.2	1 / 5	0.16	0.0825	NC	--	31	NA	No	[1] Less than RBC
Fluoranthene	0.3 - 0.3	3 / 5	0.3	0.161	NC	--	310	NA	No	[1] Less than RBC
Naphthalene	0.037 - 0.2	3 / 5	0.42	0.208	NC	--	160	NA	No	[1] Less than RBC
Phenanthrene	0.2 - 0.2	4 / 5	0.28	0.145	NC	--	230[c]	NA	No	[1] Less than RBC
Pyrene	0.2 - 0.2	4 / 5	0.4	0.181	NC	--	230	NA	No	[1] Less than RBC
PAL VOLATILE ORGANICS										
Chloroform	0.00087 - 0.00087	1 / 5	0.00089	0.00053	NC	--	100	NA	No	[1] Less than RBC
Ethylbenzene	0.0017 - 0.0017	1 / 5	0.0024	0.0012	NC	--	780	NA	No	[1] Less than RBC
Tetrachloroethylene	0.00081 - 0.00081	1 / 5	0.003	0.00092	NC	--	12	NA	No	[1] Less than RBC
Toluene	0.00078 - 0.00078	3 / 5	0.0037	0.0017	NC	--	1600	NA	No	[1] Less than RBC
Trichlorofluoromethane	0.0059 - 0.0059	3 / 5	0.017	0.0075	NC	--	2300	NA	No	[1] Less than RBC
Xylenes	0.0015 - 0.0015	1 / 5	0.029	0.0064	NC	--	16000	NA	No	[1] Less than RBC

TABLE 9-4
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 INDUSTRIAL USE
SURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*				
OTHER										
Total Petroleum Hydrocarbons[d]		5 / 5	7970	1720	NC	--	NA	NA	Yes	[7] No standard available

NOTES:

[a] Based on samples from 57B-95-01X, 57B-95-02X, 57E-95-02X, 57E-95-10X, 57E-95-25X

[b] USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)

[c] *Value for pyrene used as surrogate*

[d] For calculation of the CPC for TPH see Table@.

*Background: Maximum concentration in Fort Devens background listed;
See Appendix F for development of background.

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for surface soil evaluation.
RBCs based on carcinogenic effects are associated with a $1x10^{-6}$ cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.
RBC - Risk-based concentration
mg - milligram
kg - kilogram
bgs - below ground surface
SQL - Sample Quantitation Limit
NA - No value available
ND - Not detected
NC - Not calculated because there are fewer than 10 samples.
-- Not applicable
PAL - project analyte list
UCL - upper confidence limit
ARARs - Applicable or Relevant and Appropriate Requirements
CPC - Contaminate of concern
DDE - dichlorodiphenyldichloroethylene
DDT - dichlorodiphenyltrichlorothylene

TABLE 9-5
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 RECREATIONAL USE
SURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration			Back-ground*	Region III RBC**	ARARs	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL					
SURFACE SOIL (0 - 2 feet bgs) (mg/kg) [a]										
PAL METALS										
Aluminum		3 / 3	6180	4930	NC	18000	7800	NA	No	[1] Less than RBC, [2] Background
Antimony	1.09 - 7.14	1 / 11	1.62	2.84	5.87	0.5	3.1	NA	No	[1] Less than RBC
Arsenic		11 / 11	61.2	24.1	47.9	19	0.43	NA	Yes	[3] Exceeds RBC
Barium		11 / 11	113	47.9	106	54	550	NA	No	[1] Less than RBC,
Beryllium	0.50 - 0.50	1 / 3	0.708	0.403	NC	0.81	16	NA	No	[1] Less than RBC, [2] Background
Calcium		3 / 3	528	399	NC	810	NA	NA	No	[2] Background, [4] Essential Nutrient
Chromium		3 / 3	15.4	12.7	NC	33	23	NA	No	[1] Less than RBC, [2] Background
Cobalt		3 / 3	2.31	2.11	NC	4.7	470	NA	No	[1] Less than RBC, [2] Background
Copper		11 / 11	41.3	15.6	39.3	13.5	310	NA	No	[1] Less than RBC
Iron		3 / 3	7920	6830	NC	18000	2300	NA	Yes	[3] Exceeds RBC, [2] Background
Lead		11 / 11	320	143	459	48	NA	400 [b]	No	[5] Less than ARARs
Magnesium		3 / 3	1390	1220	NC	5500	NA	NA	No	[2] Background, [4] Essential Nutrient
Manganese		11 / 11	679	149	273	380	160	NA	Yes	[3] Exceeds RBC
Nickel		3 / 3	10.4	7.95	NC	14.6	160	NA	No	[1] Less than RBC, [2] Background
Potassium		3 / 3	460	377	NC	2400	NA	NA	No	[2] Background, [4] Essential Nutrient
Selenium	0.25 - 2.42	7 / 11	27.9	7.84	437	ND	39	NA	No	[1] Less than RBC
Sodium		3 / 3	446	362	NC	131	NA	NA	No	[4] Essential Nutrient
Vanadium		3 / 3	14	10.7	NC	32.3	55	NA	No	[1] Less than RBC, [2] Background
Zinc	8.03 - 8.03	10 / 11	150	55.1	183	43.9	2300	NA	No	[1] Less than RBC, [2] Background
PESTICIDES/PCBs										
4,4'-DDD	0.0083 - 0.0083	1 / 11	0.0372	0.0071	0.0104	--	2.7	NA	No	[1] Less than RBC
4,4'- DDE	0.0077 - 0.0077	4 / 11	0.0524	0.0131	0.034	--	1.9	NA	No	[1] Less than RBC
4,4'-DDT	0.0071 - 0.0071	4 / 11	0.18	0.0388	0.427	--	1.9	NA	No	[1] Less than RBC
Dieldrin	0.0063 - 0.0063	4 / 11	0.032	0.0099	0.0245	--	0.04	NA	No	[1] Less than RBC
Aroclor-1260	0.0804 - 0.0804	8 / 11	4.2	0.625	3.6	--	0.32	NA	Yes	[3] Exceeds RBC
PAL SEMIVOLATILE ORGANICS										
2-Methylnaphthalene	0.049 - 0.5	1 / 11	0.6	0.176	0.383	--	160	NA	No	[1] Less than RBC
Acenapthylene	0.033 - 0.3	1 / 11	0.4	0.13	0.259	--	160 [c]	NA	No	[1] Less than RBC
Benzo(k)fluoranthene	0.066 - 0.7	1 / 11	1	0.266	0.601	--	8.7	NA	No	[1] Less than RBC
Chrysene	0.12 - 1	1 / 11	1	0.386	0.712	--	87	NA	No	[1] Less than RBC
Fluoranthene	0.068 - 0.7	3 / 11	2	0.584	2.75	--	310	NA	No	[1] Less than RBC
Naphthalene	0.037 - 0.4	1 / 11	0.4	0.143	0.301	--	160	NA	No	[1] Less than RBC
Phenanthrene	0.033 - 0.3	5 / 11	1	0.389	2.32	--	160 [c]	NA	No	[1] Less than RBC
Pyrene	0.033 - 0.3	5 / 11	2	0.625	6.62	--	230	NA	No	[1] Less than RBC
Di-n-butyl Phthalate	0.061 - 0.6	1 / 11	2.0	0.329	0.771	--	780	NA	No	[1] Less than RBC

TABLE 9-5
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 RECREATIONAL USE
SURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*				
PAL VOLATILE ORGANICS										
1,2-Dichloroethylenes (Total)	0.003 - 0.003	2 / 11	0.016	0.0036	0.0069	--	70	NA	No	[1] Less than RBC
Acetone	0.017 - 0.017	2 / 11	0.33	0.029	0.0672	--	780	NA	No	[1] Less than RBC
Methylene Chloride	0.012 - 0.012	1 / 11	0.015	0.0068	0.0081	--	85	NA	No	[1] Less than RBC
Ethylbenzene	0.0017 - 0.0017	2 / 11	0.022	0.003	0.0059	--	780	NA	No	[1] Less than RBC
Tetrachloroethylene	0.00081 - 0.00081	2 / 11	0.0047	0.0009	0.0014	--	12	NA	No	[1] Less than RBC
Toluene	0.00078 - 0.00078	2 / 11	0.0083	0.0017	0.0051	--	1600	NA	No	[1] Less than RBC
Trichlorofluoromethane	0.0059 - 0.0059	3 / 11	0.014	0.0048	0.0072	--	2300	NA	No	[1] Less than RBC
OTHER										
Total Petroleum Hydrocarbons[e]		11 / 11	17,000	3500	NC[a]	--	NA	NA	Yes	[7] No standard available
VPH Ranges										
C9-C12 Aliphatics[d]		7 / 8	15	6.1	NC	--	NA	NA	Yes	[7] No standard available
C9-C10 Aromatics[d]		2 / 8	16.5	4.6	NC	--	NA	NA	Yes	[7] No standard available
EPH Ranges										
C9-C18 Aliphatics[d]		2 / 8	270	79	NC	--	NA	NA	Yes	[7] No standard available
C19-C36 Aliphatics[d]		7 / 8	1,950	670	NC	--	NA	NA	Yes	[7] No standard available
C11-C22 Aromatics[d]		6 / 8	550	247	NC	--	NA	NA	Yes	[7] No standard available

NOTES:

[a] Based on samples from 57E-95-12X, 57E-95-16X, 57E-95-17X, 57S-98-01X (1 ft), 57S-98-02X, 57S-98-04X (1 ft), 57S-98-06X (1 ft), 57S-98-07X and its duplicate, 57S-98-07X (1 ft), 57S-98-08X, 57S-98-09X

[b] USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)

[c] Value for naphthalene used as surrogate.

[d] For calculation of the CPC for TPH and EPH/VPH fractions see Table@.

[e] Exposures to petroleum are evaluated using EPH/VPH data. See appendix @.

*Background: Maximum concentration in Fort Devens background listed;
See Appendix F for development of background.

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for surface soil evaluation
RBCs based on carcinogenic effects are associated with a $1x10^{-6}$ cancer risk level;
RBCs based on noncarcinogenic effects are associated with an adjusted HQ of 0.1 (USEPA, 1999).

[1] Less than RBC - Maximum detected concentration less than risk-based concentration

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.
RBC - Risk-based concentration
mg - milligrams
kg - kilograms
ARARs - Applicable or Relevant and Appropriate Requirements
bgs - below ground surface
SQL - Sample Quantitation Limit
NA - No value available
-- Not applicable
NC - Not calculated because there are fewer than 10 samples.
PAL - project analyte list
UCL - upper confidence limit
CPC - Contaminant of concern
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethene
DDT - dichlorodiphenyltrichloroethane

TABLE 9-6
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 INDUSTRIAL USE
SURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration			Background*	Region III RBC**	ARARs	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL					
SURFACE SOIL (0 - 2 feet bgs) (mg/kg) [a]										
PAL METALS										
Aluminum		2 / 2	7100	6735	NC	18000	7800	NA	No	[1] Less than RBC, [2] Background
Arsenic		2 / 2	41	23.1	NC	19	0.43	NA	Yes	[3] Exceeds RBC
Barium		2 / 2	29.3	20.2	NC	54	550	NA	No	[1] Less than RBC, [2] Background
Cadmium	0.7 - 0.7	1 / 2	1.5	0.925	NC	1.28	3.9	NA	No	[1] Less than RBC
Calcium	100 - 100	1 / 2	283	167	NC	810	NA	NA	No	[2] Background, [4] Essential Nutrient
Chromium		2 / 2	11.7	11.2	NC	33	23	NA	No	[1] Less than RBC, [2] Background
Cobalt		2 / 2	3.23	2.8	NC	4.7	470	NA	No	[1] Less than RBC, [3] Background
Copper		2 / 2	6.83	6.06	NC	13.5	310	NA	No	[1] Less than RBC, [2] Background
Iron		2 / 2	8040	7740	NC	18000	2300	NA	Yes	[3] Exceeds RBC, [2] Background
Lead		2 / 2	32.7	20.3	NC	48	NA	400 [b]	No	[5] Less than ARARs
Magnesium		2 / 2	1650	1600	NC	5500	NA	NA	No	[2] Background, [4] Essential Nutrient
Manganese		2 / 2	548	318	NC	380	160	NA	Yes	[3] Exceeds RBC
Nickel		2 / 2	11.1	10.8	NC	14.6	160	NA	No	[1] Less than RBC, [2] Background
Potassium		2 / 2	683	446	NC	2400	NA	NA	No	[2] Background, [4] Essential Nutrient
Sodium		2 / 2	435	418	NC	131	NA	NA	No	[4] Essential Nutrient
Vanadium		2 / 2	9.41	9.29	NC	32.3	55	NA	No	[1] Less than RBC, [2] Background
Zinc		2 / 2	28.5	22.6	NC	43.9	2300	NA	No	[1] Less than RBC, [2] Background
PESTICIDES/PCBs										
4,4'- DDE	0.0004 - 0.04	1 / 6	0.0081	0.006	NC	--	1.9	NA	No	[1] Less than RBC
4,4'-DDT	0.0004 - 0.04	1 / 6	0.0121	0.0066	NC	--	1.9	NA	No	[1] Less than RBC
PAL SEMIVOLATILE ORGANICS										
Fluoranthene	0.068 - 1.8	1 / 6	0.14	0.61	NC	--	310	NA	No	[1] Less than RBC
Naphthalene	0.037 - 230	1 / 10	0.048	12.5	NC	--	160	NA	No	[1] Less than RBC
Phenanthrene	0.033 - 1.8	1 / 6	0.11	0.604	NC	--	160 [c]	NA	No	[1] Less than RBC
Pyrene	0.033 - 1.8	1 / 6	0.15	0.61	NC	--	230	NA	No	[1] Less than RBC
PAL VOLATILE ORGANICS										
Toluene	5.9 - 230	2 / 6	0.003	0.0017	NC	--	1600	NA	No	[1] Less than RBC
OTHER										
Total Petroleum Hydrocarbons[d]		2 / 2	50	44.5	NC	--	NA	NA	Yes	[7] No standard available
VPH Ranges										
C9-C12 Aliphatics[d]	3.8 - 5.4	1 / 4	16	5.74	NC	--	NA	NA	Yes	[7] No standard available
C9-C10 Aromatics[d]	3.8 - 4.7	1 / 4	4.85	2.78	NC	--	NA	NA	Yes	[7] No standard available

TABLE 9-6
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 INDUSTRIAL USE
SURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*				
EPH Ranges										
C19-C36 Aliphatics[d]	4.8 -7.0	1 / 4	7.28	4.09	NC	--	NA	NA	Yes	[7] No standard available

NOTES:

[a] Based on samples from 57B-96-08X, 57B-96-09X, EX57W02X and Dup, EX57W10X and Dup, EX57W05X, and EX57W17X

[b] USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)

[c] Value for naphthalene used as surrogate.

[d] For calculation of the CPC for TPH and EPH/VPH fractions see Table@.

*Background: Maximum concentration in Fort Devens background listed;

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for subsurface soil evaluation
RBCs based on carcinogenic effects are associated with a 1×10^{-6} cancer risk level;

RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration.

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration.

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.

RBC - Risk-based Concentration
mg - milligram
kg - kilogram
-- Not applicable
ARARs - Applicable or Relevant and Appropriate Requirements
SQL - Sample Quantitation Limit
NA - No value available
ND - Not detected
NC - Not calculated
PAL = protject analyte list
UCL - upper confidence limit
CPC - contaminant of concern

TABLE 9-7
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 RECREATIONAL USE
SURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*				
SURFACE SOIL (0 - 2 feet bgs) (mg/kg) [a]										
PAL METALS										
Arsenic		2 / 2	28	26.8	NC	19	0.43	NA	Yes	[3] Exceeds RBC
Barium		2 / 2	17.1	15.9	NC	54	550	NA	No	[1] Less than RBC, [2] Background
Copper		2 / 2	3.46	3.2	NC	13.5	310	NA	No	[1] Less than RBC, [2] Background
Lead	10.5 - 10.5	1 / 2	22	13.6	NC	48	NA	400 [b]	No	[5] Less than ARAR, [2] Background
Manganese		2 / 2	170	120	NC	380	160	NA	Yes	[3] Exceeds RBC, [2] Background
Selenium		2 / 2	8.29	8.21	NC	ND	39	NA	No	[1] Less than RBC
Zinc		2 / 2	27.5	21.7	NC	43.9	2300	NA	No	[1] Less than RBC, [2] Background
PESTICIDES/PCBs										
4,4'- DDD	0.004 - 0.046	3 / 6	0.29	0.102	NC	--	2.7	NA	No	[1] Less than RBC
4,4'-DDT	0.004 - 0.05	1 / 6	0.0248	0.0166	NC	--	1.9	NA	No	[1] Less than RBC
Chlordane - Alpha	0.0013 - 0.0013	1 / 2	0.0028	0.0017	NC	--	1.8 [c]	NA	No	[1] Less than RBC
Chlordane - Gamma	0.0013 - 0.0013	1 / 2	0.0028	0.0017	NC	--	1.8 [c]	NA	No	[1] Less than RBC
Dieldrin	0.004 - 0.05	2 / 6	0.14	0.0432	NC	--	0.04	NA	Yes	[3] Exceeds RBC
Endrin	0.004 - 0.05	2 / 6	0.07	0.0263	NC	--	2.3	NA	No	[1] Less than RBC
Aroclor 1260	0.022 - 0.0804	3 / 6	4.3	0.816	NC	--	0.32	NA	No	[1] Less than RBC
PAL SEMIVOLATILE ORGANICS										
1,2-Dichlorobenzene	0.11 - 0.11	1 / 2	0.35	0.203	NC	--	700	NA	No	[1] Less than RBC
1,4-Dichlorobenzene	0.098 - 0.098	1 / 2	0.48	0.265	NC	--	27	NA	No	[1] Less than RBC
Fluoranthene	0.068 - 6.4	1 / 6	0.13	1.23	NC	--	310	NA	No	[1] Less than RBC
Phenanthrene	0.033 - 6.4	1 / 6	0.067	1.21	NC	--	160 [d]	NA	No	[1] Less than RBC
Pyrene	0.033 - 6.4	1 / 6	0.096	1.22	NC	--	230	NA	No	[1] Less than RBC
PAL VOLATILE ORGANICS										
Chlorobenzene	0.0009 - 0.0009	1 / 2	0.012	0.0062	NC	--	160	NA	No	[1] Less than RBC
Trichloroethylene	0.0028 - 0.0028	1 / 2	0.0042	0.0028	NC	--	58	NA	No	[1] Less than RBC
OTHER										
Total Petroleum Hydrocarbons [e]		2 / 2	951	923	NC	--	NA	NA	Yes	[7] No standard available
VPH Ranges										
C9-C12 Aliphatics [e]		4 / 6	1500	277	NC	--	NA	NA	Yes	[7] No standard available
C9-C10 Aromatics [e]		3 / 6	600	116	NC	--	NA	NA	Yes	[7] No standard available

TABLE 9-7
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 RECREATIONAL USE
SURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration							
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*	Region III RBC**	ARARs	CPC?	Notes
EPH Ranges										
C9-C18 Aliphatics[e]		3 / 6	1300	505	NC	–	NA	NA	Yes	[7] No standard available
C19-C36 Aliphatics[e]		5 / 6	20,000	6020	NC	–	NA	NA	Yes	[7] No standard available
C11-C22 Aromatics[e]		5 / 6	3100	974	NC	–	NA	NA	Yes	[7] No standard available

NOTES:

[a] Based on samples from 57S-98-13F, 57S-98-14F, 57S-98-13X, 57S-98-14X , EX57F03X, EX57W14X, EX57W15X, and EX57W16X

[b] USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)

[c] Value for chlordane used as a surrogate.

[d] Value for naphthalene used as surrogate.

[e] For calculation of the CPC for TPH and EPH/VPH fractions see Table@.

*Background: Maximum concentration in Fort Devens background listed;
See Appendix F for development of background.

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for surface soil evaluation
RBCs based on carcinogenic effects are associated with a 1x10^{-6} cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration.

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration.

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.

RBC - Risk-based Concentration
mg - milligram
kg - kilogram
\- Not applicable
ARARs - Applicable or Relevant and Appropriate Requirements
MCL - Maximum Contaminant Level
SQL - Sample Quantitation Limit
NA - No value available
ND - Not detected
NC - Not calculated because there are fewer than 10 samples.
PAL = protject analyte list
UCL - upper confidence limit
CPC - contaminant of concern

TABLE 9-8
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 INDUSTRIAL USE
SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*				
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg) [a]										
PAL METALS										
Aluminum		4 / 4	4620	3440	NC	18000	7800	NA	No	[1] Less than RBC, [2] Background
Arsenic		4 / 4	9.87	9.7	NC	19	0.43	NA	Yes	[3] Exceeds RBC, [2] Background
Barium		4 / 4	17.6	11.5	NC	54	550	NA	No	[1] Less than RBC, [2] Background
Calcium		4 / 4	477	337	NC	810	NA	NA	No	[2] Background, [4] Essential Nutrient
Chromium	4.05 - 4.05	2 / 4	14	6.61	NC	33	23	NA	No	[1] Less than RBC, [2] Background
Cobalt		4 / 4	3.79	2.68	NC	4.7	470	NA	No	[1] Less than RBC, [2] Background
Copper		4 / 4	8.42	5.41	NC	13.5	310	NA	No	[1] Less than RBC, [2] Background
Iron		4 / 4	8080	6050	NC	18000	2300	NA	Yes	[3] Exceeds RBC, [2] Background
Lead		4 / 4	2.96	2.39	NC	48	NA	400 [b]	No	[5] Less than ARARs [2] Background
Magnesium		4 / 4	1930	1350	NC	5500	NA	NA	No	[2] Background, [4] Essential Nutrient
Manganese		4 / 4	231	151	NC	380	160	NA	Yes	[3] Exceeds RBC, [2] Background
Nickel		4 / 4	12	7.74	NC	14.6	160	NA	No	[1] Less than RBC, [2] Background
Potassium		4 / 4	742	488	NC	2400	NA	NA	No	[2] Background, [4] Essential Nutrient
Sodium		4 / 4	309	260	NC	131	NA	NA	No	[4] Essential Nutrient
Vanadium	3.39 - 3.39	3 / 4	8.5	5.11	NC	32.3	55	NA	No	[1] Less than RBC, [2] Background
Zinc	8.03 - 8.03	3 / 4	19.8	12.5	NC	43.9	2300	NA	No	[1] Less than RBC, [2] Background
PAL VOLATILE ORGANICS										
Trichlorofluoromethane	0.0059 - 0.0059	3 / 4	0.013	0.0075	NC	–	2300	NA	No	[1] Less than RBC
OTHER										
Total Petroleum Hydrocarbons[c]		4 / 4	141	68	NC	–	NA	NA	Yes	[7] No standard available

NOTES:

[a] Based on samples from 57B-95-01X, 57B-95-02X, 57E-95-01X, 57E-95-04X.

[b] USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)

[c] For calculation of the CPC for TPH see Table@.

*Background: Maximum concentration in Fort Devens background listed;
See Appendix F for development of background.

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for subsurface soil evaluation.
RBCs based on carcinogenic effects are associated with a $1x10^{-6}$cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.

RBC - Risk-based concentration
mg - milligram
kg - kilogram
bgs - below ground surface
SQL - Sample Quantitation Limit
NA - No value available
ND - Not detected
NC - Not calculated because there are fewer than 10 samples.
-- Not applicable
PAL - project analyte list
UCL - upper confidence limit
ARARs - Applicable or Relevant and Appropriate Requirements
CPC - Contaminate of concern

TABLE 9-9
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 RECREATIONAL USE
SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*				
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg) [b]										
PAL METALS										
Aluminum		10 / 10	9940	5110	6970	18000	7800	NA	Yes	[3] Exceeds RBC, [2] Background
Arsenic		10 / 10	21.0	9.46	24	19	0.43	NA	Yes	[3] Exceeds RBC
Barium	5.18 - 5.18	9 / 12	116	30.8	156	54	550	NA	No	[1] Less than RBC
Calcium	100 - 100	8 / 10	1190	513	2620	810	NA	NA	No	[4] Essential Nutrient
Chromium	4.05 - 4.05	5 / 10	2410	248	8350	33	23	NA	Yes	[3] Exceeds RBC
Cobalt	1.42 - 1.42	4 / 10	4.7	1.59	3	4.7	470	NA	No	[1] Less than RBC, [2] Background
Copper	0.965 - 0.965	11 / 12	17.6	6.83	17.8	13.5	310	NA	No	[1] Less than RBC
Iron		10 / 10	6880	4780	9900	18000	2300	NA	Yes	[3] Exceeds RBC, [2] Background
Lead		12 / 12	5060	484	30,600	48	NA	400 [b]	Yes	[6] Exceeds ARARs
Magnesium	100 - 100	9 / 10	1560	716	2720	5500	NA	NA	No	[4] Essential Nutrient, [2] Background
Manganese		12 / 12	175	62.3	169	380	160	NA	Yes	[3] Exceeds RBC, [2] Background
Nickel	1.71 - 1.71	8 / 10	8.26	4.98	12.2	14.6	160	NA	No	[1] Less than RBC, [2] Background
Potassium	100 - 100	9 / 10	386	250	424	2400	NA	NA	No	[4] Essential Nutrient, [2] Background
Selenium	0.25 - 0.25	6 / 10	1.22	0.536	1.58	ND	39	NA	No	[1] Less than RBC
Silver	0.589 - 0.589	1 / 10	0.959	0.361	0.458	0.086	39	NA	No	[1] Less than RBC
Sodium		10 / 10	726	503	626	131	NA	NA	No	[4] Essential Nutrient
Vanadium	3.39 - 3.39	6 / 10	11.9	6.25	16	32.3	55	NA	No	[1] Less than RBC, [2] Background
Zinc	8.03 - 8.03	8 / 12	753	87.5	550	43.9	23000	NA	No	[1] Less than RBC
PESTICIDES/PCBS										
4,4'-DDD	0.0083 - 0.0083	2 / 12	0.044	0.0094	0.0159	--	2.7	NA	No	[1] Less than RBC
4,4'-DDT	0.0071 - 0.0071	1 / 12	0.0352	0.0062	0.0086	--	1.9	NA	No	[1] Less than RBC
Endosulfan I	0.006 - 0.006	1 / 12	0.081	0.0095	0.0141	--	47	NA	No	[1] Less than RBC
Dieldrin	0.0063 - 0.0063	2 / 12	0.043	0.0072	0.0113	--	0.04	NA	Yes	[3] Exceeds RBC
Aroclor - 1248	0.082 - 0.082	1 / 12	3.2	0.304	0.482	--	0.32	NA	Yes	[3] Exceeds RBC
Aroclor - 1260	0.0804 - 0.0804	4 / 12	12	2.09	156	--	0.32	NA	Yes	[3] Exceeds RBC
PAL SEMIVOLATILE ORGANICS										
2-Methylnaphthalene	0.049 - 2	1 / 12	6	0.696	9.49	--	160	NA	No	[1] Less than RBC
Fluoranthene	0.068 - 3	1 / 12	0.7	0.325	2.23	--	310	NA	No	[1] Less than RBC
Naphthalene	0.037 - 1	1 / 12	6	0.626	7.61	--	160	NA	No	[1] Less than RBC
Pheneanthrene	0.033 - 1	1 / 12	0.3	0.154	1.13	--	160 [c]	NA	No	[1] Less than RBC
Pyrene	0.033 - 1	1 / 12	0.6	0.179	1.54	--	230	NA	No	[1] Less than RBC
PAL VOLATILE ORGANICS										
1,2-Dichloroethylene (Total)	0.003 - 0.003	1 / 12	0.0039	0.0017	0.002	--	70	NA	No	[1] Less than RBC
Acetone	0.017 - 0.017	4 / 12	0.067	0.0197	0.0354	--	780	NA	No	[1] Less than RBC
Ethylbenzene	0.0017 - 0.0017	2 / 12	0.051	0.0054	0.0114	--	780	NA	No	[1] Less than RBC
Tetrachloroethylene	0.00078 - 0.00078	2 / 12	0.0059	0.001	0.0018	--	12	NA	No	[1] Less than RBC
Toluene	0.00081 - 0.00081	3 / 12	0.023	0.0033	0.0128	--	1600	NA	No	[1] Less than RBC
Trichloroethylene	0.0028 - 0.0028	1 / 12	0.011	0.0022	0.003	--	58	NA	No	[1] Less than RBC
Xylenes	0.0015 - 0.0015	1 / 12	0.27	0.0232	0.0488	--	16,000	NA	No	[1] Less than RBC

TABLE 9-9
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 RECREATIONAL USE
SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration Maximum Detected	Concentration Arithmetic Mean	Concentration 95% UCL	Back-ground*	Region III RBC**	ARARs	CPC?	Notes
OTHER										
Total Petroleum Hydrocarbons[d]	28 - 28	11 / 12	31,800	8740	NC	--	NA	NA	Yes	[7]No standard available
VPH Ranges										
C9-C12 Aliphatics[d]		2 / 2	2.1	2	NC	--	NA	NA	Yes	[7]No standard available
EPH Ranges										
C9-C18 Aliphatics[d]	33 - 33	1 / 2	110	63.2	NC	--	NA	NA	Yes	[7]No standard available
C19-C36 Aliphatics[d]		2 / 2	3,300	1960	NC	--	NA	NA	Yes	[7]No standard available
C11-C22 Aromatics[d]		2 / 2	990	565	NC	--	NA	NA	Yes	[7]No standard available

NOTES:

[a] Based on samples from 57E-95-13X (5ft), 57E-95-14X (6ft), 57E-95-15X (2ft), 57E-95-16X (2ft), 57E-95-18X (2ft), 57E-95-19X (2ft), 57E-95-20X (5ft), 57S-98-03X (2ft), 57S-98-05X (3ft), 57E-95-07X (4ft), 57E-95-08X 9 (4ft), and 57E-95-09X (5ft).

[b] USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)

[c] Value for naphthalene used as surrogate.

[d] For calculation of the CPC for TPH and EPH/VPH fractions see Table@.

[e] Exposures to petroleum are evaluated using EPH/VPH data. See appendix @.

*Background: Maximum concentration in Fort Devens background listed;
See Appendix F for development of background.

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for subsurface soil evaluation.
RBCs based on carcinogenic effects are associated with a $1x10^{-6}$ cancer risk level;
RBCs based on noncarcinogenic effects are associated with an adjusted HQ of 0.1 (USEPA, 1999).

[1] Less than RBC - Maximum detected concentration less than risk-based concentration

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.
RBC - Risk-based concentration
mg - milligrams
kg - kilograms
ARARs - Applicable or Relevant and Appropriate Requirements
bgs - below ground surface
SQL - Sample Quantitation Limit
NA - No value available
- - Not applicable
PAL - project analyte list
UCL - upper confidence limit
CPC - Contaminant of concern
DDD - dichlorodiphenyldichloroethane
DDT - dichlorodiphenyltrichloroethane

TABLE 9-10
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 INDUSTRIAL USE
SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration Maximum Detected	Arithmetic Mean	95% UCL	Background*	Region III RBC**	ARARs	CPC?	Notes
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg) [a]										
PAL METALS										
Aluminum		3 / 3	5610	4665	NC	18000	7800	NA	No	[1] Less than RBC, [2] Background
Arsenic		3 / 3	9.67	7.68	NC	19	0.43	NA	Yes	[3] Exceeds RBC
Barium		3 / 3	16	14.6	NC	54	550	NA	No	[1] Less than RBC, [2] Background
Calcium		3 / 3	1380	747	NC	810	NA	NA	No	[4] Essential Nutrient
Chromium		3 / 3	7.57	6.12	NC	33	23	NA	No	[1] Less than RBC, [2] Background
Cobalt	1.4 - 1.4	2 / 3	2.7	1.58	NC	4.7	470	NA	No	[1] Less than RBC, [2] Background
Copper		3 / 3	5.48	5.19	NC	13.5	310	NA	No	[1] Less than RBC, [2] Background
Iron		3 / 3	6410	5760	NC	18000	2300	NA	Yes	[3] Exceeds RBC, [2] Background
Magnesium		3 / 3	1340	1200	NC	5500	NA	NA	No	[2] Background, [4] Essential Nutrient
Manganese		3 / 3	65.2	60.6	NC	380	160	NA	No	[1] Less than RBC, [2] Background
Nickel		3 / 3	7.3	6.81	NC	14.6	160	NA	No	[1] Less than RBC, [2] Background
Potassium		3 / 3	742	611	NC	24000	NA	NA	No	[2] Background, [4] Essential Nutrient
Silver	0.59 - 0.59	2 / 3	4.46	1.96	NC	0.086	39	NA	No	[1] Less than RBC
Sodium		3 / 3	555	533	NC	131	NA	NA	No	[4] Essential Nutrient
Vanadium		3 / 3	7.99	7.01	NC	32.3	55	NA	No	[1] Less than RBC, [2] Background
Zinc		3 / 3	18.3	17.2	NC	43.9	2300	NA	No	[1] Less than RBC, [2] Background
PESTICIDES/PCBs										
4,4-DDD	0.0003 - 0.0083	1 / 9	0.024	0.0041	NC	--	2.7	NA	No	[1] Less than RBC
Aroclor - 1260	0.0017 - 0.0804	4 / 9	0.26	0.053	NC	--	0.32	NA	No	[1] Less than RBC
PAL VOLATILE ORGANICS										
Toluene	0.0008 - 7	2 / 9	0.0018	2.22	NC	--	1600	NA	No	[1] Less than RBC
Xylenes	0.0015 - 9.3	1 / 9	0.0069	2.95	NC	--	16000	NA	No	[1] Less than RBC
OTHER										
Total Petroleum Hydrocarbons[b]	28 - 28	1 / 3	25	17.7	NC	--	NA	NA	Yes	[7] No standard available
EPH Ranges										
C9-C18 Aliphatics[b]	6.3 - 7.6	2 / 6	78	16.7	NC	--	NA	NA	Yes	[7] No standard available
C19-C36 Aliphatics[b]	6.3 - 6.3	5 / 6	990	246	NC	--	NA	NA	Yes	[7] No standard available
C11-C22 Aromatics[b]	17 - 20	2 / 6	110	30.4	NC	--	NA	NA	Yes	[7] No standard available

TABLE 9-10
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 INDUSTRIAL USE
SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*				

NOTES:

[a] Based on samples from 57B-96-08X (5 ft), 57B-96-09X (5 ft), 57B-96-11X and Dup (10 ft) , EX57W06X (5 ft), EX57W07X (5 ft),

EX57W08X (5 ft), EX57W09X (4 ft), EX57F01X (6 ft), and EX57F02X (8 ft).

[b] For calculation of the CPC for TPH and EPH/VPH fractions see Table@.

*Background: Maximum concentration in Fort Devens background listed;

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for subsurface soil evaluation

RBCs based on carcinogenic effects are associated with a $1x10^{-6}$ cancer risk level;

RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration.

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration.

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.

RBC - Risk-based Concentration

mg - milligram

kg - kilogram

\- Not applicable

ARARs - Applicable or Relevant and Appropriate Requirements

SQL - Sample Quantitation Limit

NA - No value available

ND - Not detected

NC - Not calculated because there are fewer than 10 samples.

PAL = protject analyte list

UCL - upper confidence limit

CPC - contaminant of concern

TABLE 9-11
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 RECREATIONAL USE
SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration Maximum Detected	Concentration Arithmetic Mean	Concentration 95% UCL	Background*	Region III RBC**	ARARs	CPC?	Notes
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg) [a]										
PAL METALS										
Arsenic		1 / 1	28.2	28.2	NC	19	0.43	NA	Yes	Exceeds RBC
Barium		1 / 1	13.1	13.1	NC	54	550	NA	No	[1] Less than RBC, [2] Background
Copper		1 / 1	2.2	2.2	NC	13.5	310	NA	No	[1] Less than RBC, [2] Background
Manganese		1 / 1	70.8	70.8	NC	380	160	NA	No	[1] Less than RBC, [2] Background
Selenium		1 / 1	5.89	5.89	NC	ND	39	NA	No	[1] Less than RBC
Zinc		1 / 1	13.3	13.3	NC	43.9	2300	NA	No	[1] Less than RBC, [2] Background
PAL SEMIVOLATILE ORGANICS										
Bis(2-ethylhexyl)phthalate		1 / 1	14	14	NC	--	46	NA	No	[1] Less than RBC
PAL VOLATILE ORGANICS										
1,1,1-Trichloroethane		1 / 1	0.013	0.013	NC	--	160	NA	No	[1] Less than RBC
Toluene		1 / 1	0.0013	0.0013	NC	--	1600	NA	No	[1] Less than RBC
Xylenes		1 / 1	0.0041	0.0041	NC	--	16,000	NA	No	[1] Less than RBC

NOTES:

[a] Based on samples from 57S-98-15F and 57S-98-15X.

*Background: Maximum concentration in Fort Devens background listed;
See Appendix F for development of background.

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for subsurface soil evaluation
RBCs based on carcinogenic effects are associated with a $1x10^{-6}$ cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration.
[2] Background - Sample concentrations detected are at or below background concentrations.
[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration.
[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.
[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.
[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.
[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.
RBC - Risk-based Concentration
mg - milligram
kg - kilogram
- Not applicable
ARARs - Applicable or Relevant and Appropriate Requirements
MCL - Maximum Contaminant Level
SQL - Sample Quantitation Limit
NA - No value available
ND - Not detected
NC - Not calculated because there are fewer than 10 samples.
PAL = protject analyte list
UCL - upper confidence limit
CPC - contaminant of concern

TABLE 9-12
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 INDUSTRIAL USE
GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs***	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Background*				
GROUNDWATER - UNFILTERED (µg/L) ^{a}										
PAL METALS										
Aluminum	141 - 141	1 / 2	204	137	NC	6870	3700	50 ^{d}	Yes	^{6} Exceeds ARAR, ^{1} Less than RBC, ^{2} Background
Barium		2 / 2	18.6	15.8	NC	39.6	260	2000 ^{c}	No	^{1} Less than RBC· ^{5} Less than ARAR· ^{2} Background
Calcium		2 / 2	5010	4900	NC	14700	NA	NA	No	^{4} Essential Nutrient, ^{2} Background
Manganese		2 / 2	177	91.4	NC	291	73	50 ^{d}	Yes	^{3} Exceeds RBC· ^{6} Exceeds ARAR
Potassium		2 / 2	1560	1440	NC	2370	NA	NA	No	^{4} Essential Nutrient, ^{2} Background
Sodium		2 / 2	9000	5900	NC	10800	NA	NA	No	^{4} Essential Nutrient, ^{2} Background
PAL SEMIVOLATILE ORGANICS										
Diethyl Phthalate	2 - 2	1 / 2	2.7	1.85	NC	--	2900	NA	No	^{1} Less than RBC
PAL VOLATILE ORGANICS										
Toluene	0.5 - 0.5	1 / 2	1.2	0.73	NC	--	75	1000	No	^{1} Less than RBC· ^{5} Less than ARAR
OTHER										
Nitrite/Nitrate		2 / 2	2000	1435	NC	--	NA	10000 ^{c}	No	^{5} Less than ARAR
Chloride	2120 - 2120	1 / 2	13200	7130	NC	--	NA	250000 ^{d}	No	^{5} Less than ARAR
GROUNDWATER - FILTERED (µg/L) ^{b}										
PAL METALS										
Aluminum	141 - 141	1 / 2	167	118.8	NC	6870	3700	50 ^{d}	Yes	^{1} Less than RBC ^{6} Exceeds ARAR ^{2} Background
Barium		2 / 2	17.2	15.6	NC	39.6	260	2000 ^{c}	No	^{1} Less than RBC· ^{5} Less than ARAR· ^{2} Background
Calcium		2 / 2	5320	4990	NC	14700	NA	NA	No	^{4} Essential Nutrient, ^{2} Background
Magnesium	500 - 500	1 / 2	507	379	NC	3480	NA	NA	No	^{4} Essential Nutrient, ^{2} Background
Manganese		2 / 2	173	89.5	NC	291	73	50 ^{d}	Yes	^{3} Exceeds RBC, ^{6} Exceeds ARAR, ^{2} Background
Potassium		2 / 2	1660	1505	NC	2370	NA	NA	No	^{4} Essential Nutrient, ^{2} Background
Sodium		2 / 2	10100	6430	NC	10800	NA	NA	No	^{4} Essential Nutrient, ^{2} Background

TABLE 9-12
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 INDUSTRIAL USE
GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs***	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*				

NOTES:

[a] Based on unfiltered samples taken in 1995 from 57M-95-05X, 57M-95-06X.

[b] Based on filtered samples taken in 1995 from 57M-95-05X, 57M-95-06X.

[c] MCL (USEPA, 1998)

[d] Secondary MCL (USEPA, 1998)

*Background: Maximum concentration in Fort Devens background listed;
95 percent UCL of Fort Devens background groundwater. See Appendix F for development of background.

**Region III RBCs (USEPA, 1997a): Tapwater RBCs used for groundwater evaluation.
RBCs based on carcinogenic effects are associated with a $1x10^{-6}$ cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1997a).

*** ARARs are primary or secondary MCLs.

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.

RBC - Risk-based concentration

µg - micrograms

L - liter

SQL - Sample Quantitation Limit

NA - No value available

NC - Not calculated because there are fewer than 10 samples.

-- Not applicable

PAL - project analyte list

UCL - upper confidence limit

ARARs - Applicable or Relevant and Appropriate Requirements

CPC - Contaminate of concern

TABLE 9-13
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 RECREATIONAL USE
GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration Maximum Detected	Concentration Arithmetic Mean	Concentration 95% UCL	Concentration Back-ground*	Region III RBC**	ARARs***	CPC?	Notes
GROUNDWATER - UNFILTERED (µg/L) [a]										
PAL METALS										
Arsenic	2.54 - 2.54	2 / 6	54.4	10.73	NC	10.5	0.045	50	Yes	[3] Exceeds RBC, [6] Exceeds ARAR
Barium		6 / 6	27.6	14.4	NC	39.6	260	2000 [c]	No	[1] Less than RBC, [2] Background, [5] Less than ARAR
Calcium		5 / 5	13600	8720	NC	14700	NA	NA	No	[2] Background, [4] Essential Nutrient
Iron	38.8 - 38.8	2 / 5	3610	876	NC	9100	1100	300 [e]	Yes	[3] Exceeds RBC, [2] Background, [6] Exceeds ARAR
Magnesium	500 - 500	4 / 5	1460	946	NC	3480	NA	NA	No	[2] Background, [4] Essential Nutrient
Manganese		5 / 5	724	368	NC	291	730	50 [d]	Yes	[1] Less than RBC, [6] Exceeds ARAR
Potassium		5 / 5	2800	1350	NC	2370	NA	NA	No	[4] Essential Nutrient
Sodium		5 / 5	34900	17200	NC	10800	NA	NA	No	[4] Essential Nutrient
PESTICIDES/PCBs										
Aroclor-1260	0.19 - 0.19	1 / 6	0.22	0.116	NC	--	0.033	0.5	Yes	[3] Exceeds RBC, [5] Less than ARAR
PAL SEMIVOLATILE ORGANICS										
Bis(2-ethylhexyl)phthalate	4.8 - 4.8	3 / 6	400	119	NC	--	4.8	6	Yes	[3] Exceeds RBC, [6] Exceeds ARAR
PAL VOLATILE ORGANICS										
1,2-dichloroethylene (total)	0.5 - 0.5	2 / 6	13	2.63	NC	--	5.5	70	Yes	[3] Exceeds RBC, [5] Less than ARAR
Tetrachloroethylene	1.6 - 1.6	2 / 6	16	3.85	NC	--	1.1	5	Yes	[3] Exceeds RBC, [6] Exceeds ARAR
Toluene	0.5 - 0.5	5 / 6	0.9	0.567	NC	- -	75	NA	No	[1] Less than RBC
Trichloroethylene	0.5 - 0.5	3 / 6	1.9	0.86	NC	--	1.6	5	Yes	[3] Exceeds RBC, [5] Less than ARAR
OTHER										
Nitrate/Nitrite		5 / 5	1800	1070	NC	--	NA	10000 [c]	No	[5] Less than ARAR
Nitrogen	183 - 183	1 / 5	333	140	NC	--	NA	NA	Yes	[7] No standard available
Phosphate	13.3 - 13.3	2 / 5	15	9.75	NC	--	NA	NA	Yes	[7] No standard available
Chloride		5 / 5	63000	26200	NC	--	NA	250000 [d]	No	[5] Less than ARAR
Sulfate	10,000 - 10,000	4 / 5	21000	14600	NC	--	NA	250000 [d]	No	[5] Less than ARAR
GROUNDWATER - FILTERED (µg/L) [b]										
PAL METALS										
Arsenic	2.54 - 2.54	2 / 6	73	13.7	NC	10.5	0.045	NA	Yes	[3] Exceeds RBC
Barium		6 / 6	27.7	14.6	NC	39.6	260	NA	No	[1] Less than RBC, [2] Background
Calcium		5 / 5	12700	8610	NC	14700	NA	NA	No	[4] Essential Nutrient, [2] Background
Iron	38.8 - 38.8	2 / 5	3530	800	NC	9100	1100	NA	Yes	[3] Exceeds RBC, [2] Background
Magnesium	500 - 500	4 / 5	1370	941	NC	3480	NA	NA	No	[4] Essential Nutrient, [2] Background
Manganese		5 / 5	819	380	NC	291	73	NA	Yes	[3] Exceeds RBC
Potassium		5 / 5	2990	1550	NC	2370	NA	NA	No	[4] Essential Nutrient
Sodium		5 / 5	34500	17000	NC	10800	NA	NA	No	[4] Essential Nutrient

TABLE 9-13
CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 RECREATIONAL USE GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs***	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*				

NOTES:

[a] Based on unfiltered samples taken in 1995 and 1998 from 57M-95-04A, 57M-95-04B, 57M-95-07X, 57M-95-08A, 57M-95-08B, 57P-98-02X.

[b] Based on filtered samples taken in 1995 and 1998 from 57M-95-04A, 57M-95-04B, 57M-95-07X, 57M-95-08A, 57M-95-08B, 57P-98-02X.

[c] MCL (USEPA, 1998)

[d] Secondary MCL (USEPA, 1998)

[e] The value for cis-1,2-dichloroethylene was used because it is the most conservative value.

*Background: Maximum concentration in Fort Devens background listed;

95 percent UCL of Fort Devens background groundwater. See Appendix F for development of background.

**Region III RBCs (USEPA, 1997a): Tapwater RBCs used for groundwater evaluation.

RBCs based on carcinogenic effects are associated with a 1×10^{-6} cancer risk level;

RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1997a).

*** ARARs are primary or secondary MCLs.

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

[8] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.

RBC - Risk-based concentration

ARARs - Applicable or Relevant and Appropriate Requirements

µg - micrograms

L - liter

SQL - Sample Quantitation Limit

NA - No value available

- - Not applicable

NC - Not calculated because there are fewer than 10 samples.

PAL - project analyte list

UCL - upper confidence limit

CPC - Contaminant of concern

TABLE 9-14
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 INDUSTRIAL USE
GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration Maximum Detected	Concentration Arithmetic Mean	Concentration 95% UCL	Concentration Background*	Region III RBC**	ARARs***	CPC?	Notes
GROUNDWATER - UNFILTERED (µg/L) [a]										
PAL METALS										
Aluminum		2 / 2	190	138	NC	6870	3700	50 [d]	Yes	[1] Less than RBC, [6] Exceeds ARARs, [2] Background
Arsenic	2.54 - 2.54	1 / 2	33.2	17.2	NC	3.03	0.045	50 [e]	Yes	[3] Exceeds RBC, [5] Less than ARARs
Barium		2 / 2	87.2	52.4	NC	39.6	260	2000 [e]	No	[1] Less than RBC, [5] Less than ARARs
Cadmium	3.01 - 3.01	1 / 2	8.67	5.09	NC	4.01	1.8	5 [e]	Yes	[3] Exceeds RBC, [6] Exceeds ARARs
Calcium		2 / 2	8150	8050	NC	14700	NA	NA	No	[4] Essential nutrient, [2] Background
Iron		2 / 2	12400	6300	NC	9100	1100	300 [d]	Yes	[3] Exceeds RBC, [6] Exceeds ARARs
Magnesium	1000 - 1000	1 / 2	1110	805	NC	3480	NA	NA	No	[4] Essential nutrient, [2] Background
Manganese		2 / 2	466	243	NC	291	73	50 [d]	Yes	[3] Exceeds RBC, [6] Exceeds ARARs
Potassium		2 / 2	2400	1980	NC	2370	NA	NA	No	[4] *Essential nutrient*
Zinc	35.8 - 35.8	1 / 2	192	105	NC	21.1	1100	500 [d]	No	[1] Less than RBC, [5] Less than ARARs
PAL SEMIVOLATILE ORGANICS										
1,2-Dichlorobenzene	1.7 - 1.7	1 / 2	9.8	5.33	NC	--	6.4	600	Yes	[3] Exceeds RBC, [5] *Less than ARARs*
1,4-Dichlorobenzene	1.7 - 1.7	1 / 2	5.6	3.23	NC	--	0.47	5 [e]	Yes	[3] Exceeds RBC, [6] Exceeds ARARs
2-Methylnaphthalene	1.7 - 1.7	1 / 2	4.4	2.63	NC	--	12	NA	No	[1] Less than RBC
4-Methylphenol	0.52 - 0.52	1 / 2	1.5	0.88	NC	--	18	NA	No	[1] Less than RBC
Naphthalene	0.5 - 0.5	1 / 2	20	10.1	NC	--	0.65	NA	Yes	[3] Exceeds RBC
PAL VOLATILE ORGANICS										
Carbon Tetrachloride	0.58 - 0.58	1 / 2	4.5	2.4	NC	--	0.16	5 [e]	Yes	[3] Exceeds RBC
Chloroform	0.5 - 0.5	1 / 2	10	5.13	NC	--	0.15	5 [e]	Yes	[3] Exceeds RBC, [6] Exceeds ARARs
Dichloromethane	2.3 - 2.3	1 / 2	2.9	2.03	NC	--	4.1	NA	No	[1] Less than RBC
Ethylbenzene	0.5 - 0.5	1 / 2	46	23.1	NC	--	130	700 [e]	No	[1] Less than RBC, [5] Less than ARARs
Tetrachloroethene	1.6 - 1.6	1 / 2	2.6	1.7	NC	--	1.1	5 [e]	Yes	[3] Exceeds RBC, [5] Less than ARARs
Toluene	0.5 - 0.5	1 / 2	19	9.63	NC	--	75	1000 [e]	No	[1] Less than RBC, [5] Less than ARARs
Trichloroethene	0.5 - 0.5	1 / 2	0.59	0.42	NC	--	1.6	5 [e]	No	[1] Less than RBC, [5] Less than ARARs
Xylenes	0.84 - 0.84	1 / 2	200	100	NC	--	1200	10000 [e]	No	[1] Less than RBC, [5] Less than ARARs
OTHER										
Nitrite/Nitrate		1 / 1	158	158	NC	--	NA	10000 [d]	No	[5] Less than ARARs
Nitrogen	183 - 183	1 / 2	324	208	NC	--	NA	NA	Yes	[7] No Standard
Phosphate		2 / 2	28.6	22.4	NC	--	NA	NA	Yes	[7] No Standard
VPH Ranges										
C9-C10 Aromatics		1 / 1	310	310	NC	--	NA	NA	Yes	[7] No Standard

TABLE 9-14
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 INDUSTRIAL USE
GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration Maximum Detected	Concentration Arithmetic Mean	Concentration 95% UCL	Concentration Background*	Region III RBC**	ARARs***	CPC?	Notes
GROUNDWATER - FILTERED (µg/L) [b]										
PAL METALS										
Arsenic		1 / 1	40.1	38.4	NC	10.5	0.045	50 [c]	Yes	[3] Exceeds RBC, [5] Less than ARARs
Barium		1 / 1	37.4	36.9	NC	39.6	260	2000 [c]	No	[1] Less than RBC, [5] Less than ARARs, [2] Background
Calcium		1 / 1	10100	9960	NC	14700	NA	NA	No	[2] Background, [4] Essential Nutrient
Iron		1 / 1	11300	11000	NC	9100	1100	300 [d]	Yes	[3] Exceeds RBC, [6] Exceeds ARARs
Magnesium		1 / 1	775	744	NC	3480	NA	NA	No	[2] Background, [4] Essential Nutrient
Manganese		1 / 1	351	347	NC	291	73	50 [d]	Yes	[3] Exceeds RBC, [6] Exceeds ARARs
Potassium		1 / 1	2370	2120	NC	2370	NA	NA	No	[2] Background, [4] Essential Nutrient
Sodium		1 / 1	1950	1930	NC	10800	NA	NA	No	[2] Background, [4] Essential Nutrient
Zinc		1 / 1	46.3	44.8	NC	21.1	1100	5000 [d]	No	[1] Less than RBC, [5] Less than ARARs

NOTES:

[a] Based on unfiltered samples taken in 1995 and 1996 from 57M-95-03X and 57M-96-09X.

[b] Based on filtered samples taken in 1995 from 57M-95-03X and its duplicate.

[c] MCL (USEPA, 1998)

[d] Secondary MCL (USEPA, 1998)

*Background: Maximum concentration in Fort Devens background listed;
95 percent UCL of Fort Devens background groundwater. See Appendix F for development of background.

**Region III RBCs (USEPA, 1997a): Tapwater RBCs used for groundwater evaluation.
RBCs based on carcinogenic effects are associated with a 1×10^{-6} cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1997a).

*** ARARs are primary or secondary MCLs.

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration.

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration.

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.

RBC - Risk-based Concentration
µg - microgram
L - liter
\- Not applicable
ARARs - Applicable or Relevant and Appropriate Requirements
MCL - Maximum Contaminant Level
SQL - Sample Quantitation Limit
NA - No value available
ND - Not detected
NC - Not calculated because there are fewer than 10 samples.
PAL = protject analyte list
UCL - upper confidence limit
CPC - contaminant of concern

TABLE 9-15
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 RECREATIONAL USE
GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration				Region III RBC**	ARARs****	CPC?	Notes
			Maximum Detected	Arithmetic Mean	95% UCL	Back-ground*				
GROUNDWATER - UNFILTERED (µg/L) ^{a}										
PAL METALS										
Aluminum		3 / 3	2450	899	NC	6870	3700	50 ^{d}	Yes	^{1} Less than RBC, ^{6} Exceeds ARAR, ^{2} Background
Arsenic	2.54 - 2.54	5 / 6	84.4	19.8	NC	10.5	0.045	50 ^{c}	Yes	^{3} Exceeds RBC, ^{6} Exceeds ARAR
Barium		6 / 6	41.8	23.1	NC	39.6	260	2000 ^{c}	No	^{1} Less than RBC, ^{5} Less than ARAR
Calcium		3 / 3	16,900	9340	NC	14,700	NA	NA	No	^{4} Essential Nutrient
Copper	5.0 - 5.0	1 / 6	8.54	3	NC	8.09	150	1300 ^{c}	No	^{1} Less than RBC, ^{5} Less than ARAR
Iron		3 / 3	1910	1190	NC	9100	1100	300 ^{d}	Yes	^{3} Exceeds RBC, ^{6} Exceeds ARAR, ^{2} Background
Magnesium	1000 - 1000	1 / 3	1080	693	NC	3480	NA	NA	No	^{4} Essential Nutrient
Manganese		3 / 3	346	226	NC	291	73	50 ^{d}	Yes	^{3} Exceeds RBC, ^{6} Exceeds ARAR
Potassium	1000 - 1000	2 / 3	1730	1290	NC	2370	NA	NA	No	^{4} Essential Nutrient
Sodium	2290 - 2290	2 / 3	5050	3020	NC	10,800	NA	NA	No	^{4} Essential Nutrient
Zinc	35.8 - 35.8	1 / 6	37.2	21.1	NC	21.1	1100	5000 ^{d}	No	^{1} Less than RBC, ^{5} Less than ARAR
PAL SEMIVOLATILE ORGANICS										
1,2-dichlorobenzene	1.7 - 1.7	2 / 6	6.4	2.24	NC	--	6.4	600 ^{c}	No	^{5} Less than ARAR
1,4-dichlorobenzene	1.7 - 1.7	1 / 6	2.7	1	NC	--	0.47	5 ^{c}	Yes	^{3} Exceeds RBC, ^{5} Less than ARAR
2-methylnaphthalene	1.7 - 1.7	1 / 6	2	1.04	NC	--	12	NA	No	^{1} Less than RBC
4-methylphenol	0.52 - 0.52	1 / 6	5	1.05	NC	--	18	NA	No	^{1} Less than RBC
Bis(2-ethylhexyl)phthalate	4.8 - 4.8	2 / 6	52	11.2	NC	--	4.8	6 ^{c}	Yes	^{3} Exceeds RBC, ^{6} Exceeds ARAR
Naphthalene	0.5 - 0.5	2 / 6	13	3.13	NC	--	0.65	NA	Yes	^{3} Exceeds RBC
PAL VOLATILE ORGANICS										
Chlorobenzene	0.5 - 0.5	1 / 6	0.88	0.355	NC	--	11	100 ^{c}	No	^{1} Less than RBC, ^{5} Less than ARAR
Ethylbenzene	0.5 - 0.5	3 / 6	20	4.46	NC	--	130	700 ^{c}	No	^{1} Less than RBC, ^{5} Less than ARAR
Styrene	0.5 - 0.5	1 / 6	8	1.54	NC	--	160	100 ^{c}	No	^{1} Less than RBC, ^{5} Less than ARAR
Tetrachloroethene	1.6 - 1.6	1 / 6	5.5	1.58	NC	--	1.1	5 ^{c}	Yes	^{3} Exceeds RBC, ^{6} Exceeds ARAR
Toluene	0.5 - 0.5	2 / 6	2.9	0.833	NC	--	75	1000 ^{c}	No	^{1} Less than RBC, ^{5} Less than ARAR
Trichloroethylene	0.5 - 0.5	1 / 6	3.8	0.833	NC	--	1.6	5 ^{c}	Yes	^{3} Exceeds RBC, ^{5} Less than ARAR
Xylenes	0.84 - 0.84	2 / 6	5.9	2.21	NC	--	1200	10,000 ^{c}	No	^{1} Less than RBC, ^{5} Less than ARAR
OTHER										
Nitrate/Nitrite		3 / 3	132	67.7	NC	--	NA	10,000 ^{c}	No	^{5} Less than ARAR
Phosphate	13.3 - 13.3	1 / 3	55.2	22.8	NC	--	NA	NA	Yes	^{7} No standard available
VPH Ranges										
C5-C8 Aliphatics		1 / 1	89.5	89.5	NC	--	NA	NA	Yes	^{7} No standard available
C9-C12 Aliphatics		1 / 1	42.5	42.5	NC	--	NA	NA	Yes	^{7} No standard available
C9-C10 Aromatics		1 / 1	172	172	NC	--	NA	NA	Yes	^{7} No standard available

TABLE 9-15
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 RECREATIONAL USE
GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Concentration Maximum Detected	Concentration Arithmetic Mean	Concentration 95% UCL	Concentration Back-ground*	Region III RBC**	ARARs***	CPC?	Notes
GROUNDWATER - FILTERED (µg/L) [b]										
PAL METALS										
Arsenic		3 / 3	138	56.4	NC		0.045	50 [c]	Yes	[3] Exceeds RBC, [6] Exceeds ARARs
Barium		3 / 3	9.2	7.53	NC		260	2000 [c]	No	[1] Less than RBC, [5] Less than ARARs, [2] Background

NOTES:

[a] Based on unfiltered samples taken in 1996 and 1998 from 57M-96-10X, 57M-96-11X and its duplicate, 57M-96-12X, 57M-96-13X, 57P-98-03X, and 57P-98-04X.

[b] Based on filtered samples taken in 1996 and 1998 from 57M-96-11X and its duplicate, 57P-98-03X, and 57P-98-04X.

[c] MCL (USEPA, 1996a)

[d] Secondary MCL (USEPA, 1996a)

*Background: Maximum concentration in Fort Devens background listed;
95 percent UCL of Fort Devens background groundwater. See Appendix F for development of background.

**Region III RBCs (USEPA, 1997a): Tapwater RBCs used for groundwater evaluation.
RBCs based on carcinogenic effects are associated with a $1x10^{-6}$ cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1997a).

*** ARARs are primary and secondary MCLs.

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration.

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration.

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.

RBC - Risk-based Concentration
µg - microgram
L - liter
-- Not applicable
ARARs - Applicable or Relevant and Appropriate Requirements
MCL - Maximum Contaminant Level
SQL - Sample Quantitation Limit
NA - No value available
NC - Not calculated because there are fewer than 10,samples.
PAL = protject analyte list
UCL - upper confidence limit
CPC - contaminant of concern

TABLE 9-16
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 RECREATIONAL USE
SEDIMENT

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean	95% UCL	Upgradient Sediment Concentration *	Region III RBC ***	ARARS ****	CPC?	NOTES
SEDIMENT (mg/kg) [a]										
PAL METALS										
Aluminum		6/6	15,900	11,600	NC	12,400	7800	NA	YES	[3] Exceeds RBC
Arsenic		9/9	220	70.2	NC	110	0.43	NA	YES	[3] Exceeds RBC
Barium	5.2 - 5.2	6/9	159	69.8	NC	101	550	NA	NO	[1] Less than RBC
Cadmium	0.70 - 0.70	1/6	2.3	0.68	NC	NA	39	NA	NO	[1] Less than RBC
Calcium		6/6	18,400	11,600	NC	9,890	NA	NA	NO	[4] Essential Nutrient
Chromium	4.1 - 4.1	3/6	48.9	23.2	NC	40.6	23	NA	YES	[3] Exceeds RBC
Cobalt	1.4 - 1.4	5/6	25.8	15.0	NC	21.2	470	NA	NO	[1] Less than RBC
Copper	0.97 - 0.97	8/9	201	46.6	NC	30.7	310	NA	NO	[1] Less than RBC
Iron		6/6	30,400	21,300	NC	26,900	2300	NA	YES	[3] Exceeds RBC
Lead	10.5 - 10.5	8/9	410	175	NC	208	NA	400 [b]	YES	[6] Exceeds ARARs
Magnesium		6/6	4,480	3,133	NC	3,710	NA	NA	NO	[4] Essential Nutrient
Manganese		9/9	3,940	1,200	NC	1,510	160	NA	YES	[3] Exceeds RBC
Mercury	0.05 - 0.05	1/6	0.36	0.081	NC	0.20	2.3	NA	NO	[1] Less than RBC
Nickel	1.7 - 1.7	5/6	42.9	29.3	NC	34.8	160	NA	NO	[1] Less than RBC
Potassium	100 - 100	4/6	1,240	718	NC	934	NA	NA	NO	[4] Essential Nutrient
Selenium	0.25 - 2.4	5/9	21.9	5.7	NC	2.8	39	NA	NO	[1] Less than RBC
Sodium		6/6	3,610	2,157	NC	1,150	NA	NA	NO	[4] Essential Nutrient
Vanadium	3.4 - 3.4	4/6	40.3	22.9	NC	34.7	55	NA	NO	[1] Less than RBC
Zinc	8 - 8	6/9	468	206	NC	315	2300	NA	NO	[1] Less than RBC
PESTICIDES/PCBs										
4,4'-DDD	0.0083 - 0.0083	7/9	0.44	0.15	NC	0.53	2.7	NA	NO	[1] Less than RBC, [2] Background
4,4'-DDE	0.0077 - 0.0077	4/9	0.16	0.056	NC	0.18	1.9	NA	NO	[1] Less than RBC, [2] Background
4,4'-DDT	0.0071 - 0.0071	4/6	0.076	0.040	NC	0.092	1.9	NA	NO	[1] Less than RBC, [2] Background
Aroclor-1260	0.0804 - 0.0804	1/9	0.30	0.069	NC	NA	0.32	NA	NO	[1] Less than RBC
Dieldrin	0.0063 - 0.0063	2/9	0.046	0.0096	NC	NA	0.04	NA	YES	[3] Exceeds RBC
PAL SEMIVOLATILE ORGANICS										
Benzo[k]fluoranthene	0.066 - 1.0	3/9	3.0	0.58	NC	1.8	8.7	NA	NO	[1] Less than RBC
Chrysene	0.12 - 2.0	2/9	1.2	0.47	NC	NA	87	NA	NO	[1] Less than RBC
Fluoranthene	0.30 - 1.0	7/9	6.0	2.2	NC	5	310	NA	NO	[1] Less than RBC
Phenanthrene	0.20 - 0.70	6/9	3.0	0.80	NC	2.3	160 [c]	NA	NO	[1] Less than RBC
Pyrene	0.70 - 0.70	8/9	6.0	2.3	NC	4.8	230	NA	NO	[1] Less than RBC
PAL VOLATILE ORGANICS										
Acetone	0.017 - 0.017	4/9	0.31	0.080	NC	0.55	780	NA	NO	[1] Less than RBC, [2] Background
Methylene chloride	0.012 - 0.012	1/9	0.15	0.022	NC	NA	85	NA	NO	[1] Less than RBC
Tetrachloroethene	0.0008 - 0.0008	2/9	0.078	0.010	NC	NA	12	NA	NO	[1] Less than RBC
Toluene	0.0008 - 0.0008	4/9	0.020	0.0050	NC	NA	1600	NA	NO	[1] Less than RBC
Trichloroethylene	0.0028 - 0.0028	1/9	0.027	0.0042	NC	NA	58	NA	NO	[1] Less than RBC

TABLE 9-16
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 RECREATIONAL USE
SEDIMENT

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean	95% UCL	Upgradient Sediment Concentration *	Region III RBC ***	ARARS ****	CPC?	NOTES
Trichlorofluoromethane	0.0059 - 0.0059	2/9	0.076	0.013	NC	NA	2300	NA	NO	[1] Less than RBC
TPH BY GC										
Diesel Fuel	8 - 8	5/6	170	78	NC	46	NA	NA	YES	No Standard
Total Petroleum Hydrocarbons, Gas Fraction	8 - 8	3/6	150	64	NC	57	NA	NA	YES	No Standard
OTHER										
Total Petroleum Hydrocarbons (418.1)	28 - 28	7/9	3,200	790	NC	240	NA	NA	YES	No Standard
Total Petroleum Hydrocarbons (IR)	1800 - 31000	1/3	2,500	6,300	NC	NA	NA	NA	YES	No Standard

Notes:

[a] Based on samples from 57D-95-04X through 57D-95-07X, 57D-95-09X, 57D-95-10X, and 57D-98-01X through 57D-98-03X.
[b] USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)
[c] The value for naphthalene used as a surrogate
* The arithmetic mean of concentrations detected in upgradient samples was used for background (inorganics only).
Upgradient sample locations include 57D-95-03X and -08X.
*** Region III RBCs (USEPA, 1999): Residential RBC for soil used for sediment evaluation.
RBCs based on carcinogenic effects are associated with a $1x10^{-6}$ cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).
**** ARARs are primary or secondary MCLs.

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration
[2] Background - Sample concentrations detected are at or below background concentrations.
[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration
[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.
[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.
[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.
[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.
RBC - Risk-based concentration

mg - milligram
kg - kilogram
SQL - Sample Quantitation Limit
NA - No value available
ND - Not detected
NC - Not calculated because there are fewer than 10 samples.
-- Not applicable
PAL - project analyte list
UCL - upper confidence limit
ARARs - Applicable or Relevant and Appropriate Requirements
CPC - Contaminant of concern

TABLE 9-17
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 RECREATIONAL USE
SEDIMENT

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean	95% UCL	Upgradient Sediment Concentration **	Region III RBC ***	ARARS ****	CPC?	NOTES
SEDIMENT (mg/kg) [a]										
PAL METALS										
Arsenic		5/5	37	20	NC	110	0.43	NA	YES	[3] Exceeds RBC, [2] Background
Barium		5/5	60	33	NC	101	550	NA	NO	[1] Less than RBC, [2] Background
Copper	0.97 - 0.97	3/5	11	4	NC	31	310	NA	NO	[1] Less than RBC, [2] Background
Lead	10.5 - 10.5	2/5	65	23	NC	208	NA	400 [b]	NO	[5] Less than ARAR, [2] Background
Manganese		5/5	459	188	NC	1,510	160	NA	YES	[3] Exceeds RBC, [2] Background
Selenium	2.42 - 2.42	1/5	9.0	2.8	NC	2.8	39	NA	NO	[1] Less than RBC
Zinc	8.03 - 8.03	1/5	91	21	NC	315	2300	NA	NO	[1] Less than RBC, [2] Background
PESTICIDES/PCBs										
4,4'-DDD	0.0083 - 0.0083	3/5	0.15	0.053	NC	0.53	2.7	NA	NO	[1] Less than RBC, [2] Background
Aroclor-1260	0.08 - 0.08	1/5	1	0.20	NC	NA	0.32	NA	YES	[3] Exceeds RBC
PAL SEMIVOLATILE ORGANICS										
1,2-Dichlorobenzene	0.11 - 0.11	1/5	0.39	0.12	NC	NA	700	NA	NO	[1] Less than RBC
1,4-Dichlorobenzene	0.098 - 0.098	2/5	1	0.32	NC	NA	27	NA	NO	[1] Less than RBC
Benzo[b]fluoranthene	0.21 - 0.21	1/5	0.49	0.18	NC	NA	0.87	NA	NO	[1] Less than RBC
Benzo[k]fluoranthene	0.066 - 0.066	3/5	0.28	0.15	NC	1.8	8.7	NA	NO	[1] Less than RBC
Chrysene	0.12 - 0.12	1/5	0.34	0.12	NC	NA	87	NA	NO	[1] Less than RBC
Fluoranthene	0.068 - 0.068	4/5	0.65	0.36	NC	5.0	310	NA	NO	[1] Less than RBC
Naphthalene	0.037 - 0.037	2/5	0.53	0.14	NC	NA	160	NA	NO	[1] Less than RBC
Phenanthrene	0.033 - 0.033	4/5	0.37	0.19	NC	2.3	160 [c]	NA	NO	[1] Less than RBC
Pyrene		5/5	0.56	0.36	NC	4.8	230	NA	NO	[1] Less than RBC
PAL VOLATILE ORGANICS (µg/g)										
Acetone		5/5	0.21	0.15	NC	0.55	780	NA	NO	[1] Less than RBC
Benzene	0.0015 - 0.0015	2/5	0.037	0.0093	NC	NA	22	NA	NO	[1] Less than RBC
Chlorobenzene	0.0009 - 0.0009	3/5	0.019	0.0072	NC	NA	160	NA	NO	[1] Less than RBC
Toluene	0.0008 - 0.0008	3/5	0.0048	0.0024	NC	NA	1600	NA	NO	[1] Less than RBC
Xylenes	0.0015 - 0.0015	1/5	0.011	0.0028	NC	NA	16,000	NA	NO	[1] Less than RBC
OTHER										
Total Petroleum Hydrocarbons	NA	5/5	3,500	850	NC	238	NA	NA	YES	[7] No Standard
EPH Fractions										
C11-C22 Aromatics	50 - 160	1/5	280	90	NC	NA	NA	NA	YES	[7] No Standard
C19-C36 Aliphatics	50 - 160	1/5	630	160	NC	NA	NA	NA	YES	[7] No Standard

TABLE 9-17
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 RECREATIONAL USE
SEDIMENT

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean	95% UCL	Upgradient Sediment Concentration *	Region III RBC ***	ARARS ****	CPC?	NOTES
VPH Fractions										
C5-C8 Aliphatics	1.8 - 8	1/5	3.3	2.1	NC	NA	NA	NA	YES	No Standard
C9-C10 Aromatics	1.8 - 8	1/5	4.3	2.3	NC	NA	NA	NA	YES	No Standard
C9-C10 Aliphatics	1.8 - 8	2/5	5.6	3.2	NC	NA	NA	NA	YES	No Standard

Notes:

[a] Based on samples 57D-98-04X through 57D-98-08X.

[b] USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)

[c] The value for naphthalene used as a surrogate

* The arithmetic mean of concentrations detected in upgradient samples was used for background (inorganics only).
Upgradient sample locations include 57D-95-03X and -08X.

*** Region III RBCs (USEPA, 1999): Residential RBC for soil used for sediment evaluation.
RBCs based on carcinogenic effects are associated with a 1x10^{-6}cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

**** ARARs are primary or secondary MCLs.

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.
RBC - Risk-based concentration
mg - milligram
kg - kilogram
SQL - Sample Quantitation Limit
NA - No value available
ND - Not detected
NC - Not calculated because there are fewer than 10 samples.
-- Not applicable
PAL - project analyte list
UCL - upper confidence limit
ARARs - Applicable or Relevant and Appropriate Requirements
CPC - Contaminant of concern

TABLE 9-18
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 RECREATIONAL USE
SURFACE WATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean	95% UCL	Upgradient Surface Water Concentration *	Region III RBC **	ARARS ***	CPC?	NOTES
SURFACE WATER - UNFILTERED (ug/L) [a]										
PAL METALS										
Aluminum	141 - 141	5/6	15,100	2,650	NC	ND	3700	NA	YES	[3] Exceeds RBC
Arsenic		9/9	198	51	NC	5.4	0.045	NA	YES	[3] Exceeds RBC
Barium		9/9	553	155	NC	12.6	260	NA	YES	[3] Exceeds RBC
Cadmium	4.0 - 4.0	1/6	25	5.8	NC	ND	1.8	NA	YES	[3] Exceeds RBC
Calcium		6/6	28,700	23,350	NC	24,300	NA	NA	NO	[4] Essential Nutrient
Chromium	6.0 - 6.0	1/6	36	8.5	NC	ND	11	NA	YES	[3] Exceeds RBC
Copper	8.1 - 8.1	4/9	375	749	NC	9	150	NA	YES	[3] Exceeds RBC
Iron		6/6	17,600	5840	NC	645	1100	NA	YES	[3] Exceeds RBC
Lead	1.3 - 1.3	7/9	967	243	NC	ND	NA	15[e]	YES	[6] Exceeds ARARs
Magnesium		6/6	4930	3307	NC	3630	NA	NA	NO	[4] Essential Nutrient
Manganese		6/6	433	243	NC	131	73	NA	YES	[3] Exceeds RBC
Mercury	0.24 - 0.24	1/6	0.24	0.14	NC	ND	1.1	NA	NO	[1] Less than RBC
Potassium		6/6	3,840	1,887	NC	1,630	NA	NA	NO	[4] Essential Nutrient
Selenium	2 - 3.02	1/9	2.4	1.5	NC	ND	18	NA	NO	[1] Less than RBC
Sodium		6/6	60,900	26,250	NC	19,200	NA	NA	NO	[4] Essential Nutrient
Vanadium	11 - 11	1/6	72	17	NC	ND	26	NA	YES	[3] Exceeds RBC
Zinc	21.1 - 21.1	5/9	712	180	NC	ND	1100	NA	NO	[1] Less than RBC
PAL SEMIVOLATILE ORGANICS										
Bis(2-ethylhexyl)phthalate	4.8 - 4.8	1/9	24	4.8	NC	NA	4.8	NA	YES	[3] Exceeds RBC
Phenanthrene	0.5 - 0.5	1/9	0.52	0.28	NC	NA	6.5[d]	NA	NO	[1] Less than RBC
PAL VOLATILE ORGANICS										
1,2-Dichloroethylenes (total)	0.5 - 0.5	1/9	26	3.1	NC	ND	5.5	NA	YES	[3] Exceeds RBC
Carbon disulfide	0.5 - 0.5	1/9	1.1	0.34	NC	ND	100	NA	NO	[1] Less than RBC
Chloroform	0.5 - 0.5	1/9	0.72	0.30	NC	ND	0.15	NA	YES	[3] Exceeds RBC
Methylene chloride	2.3 - 2.3	3/9	4.1	1.8	NC	3	4.1	NA	NO	[1] Less than RBC
Tetrachloroethylene	1.6 - 1.6	2/9	2.6	1.1	NC	ND	1.1	NA	YES	[3] Exceeds RBC
Toluene	0.5 - 0.5	1/9	1.1	0.34	NC	0.42	75	NA	NO	[1] Less than RBC
Trichloroethylene	0.5 - 0.5	2/9	3.5	0.65	NC	ND	1.6	NA	YES	[3] Exceeds RBC

TABLE 9-18
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 2 RECREATIONAL USE
SURFACE WATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean	95% UCL	Upgradient Surface Water Concentration *	Region III RBC **	ARARS ***	CPC?	NOTES
OTHER										
Total Petroleum Hydrocarbons	168 - 176	2/6	924	252	NC	NA	NA	NA	YES[7]	No Standard
EPH Fractions										
C11-C22 Aromatics		3/3	1,400	797	NC	NA	NA	NA	YES	No Standard
C19-C36 Aliphatics		3/3	1,700	1,280	NC	NA	NA	NA	YES	No Standard
SURFACE WATER - FILTERED (ug/L) [b]										
PAL METALS										
Arsenic	2.5 - 2.5	4/5	9	4	NC	4.4	0.045	NA	YES	[3] Exceeds RBC
Barium		5/5	43	22	NC	12	260	NA	NO	[1] Less than RBC
Calcium		4/4	24,000	19,300	NC	24,100	NA	NA	NO	[4] Essential Nutrient, [2] Background
Iron		4/4	17,200	4,540	NC	254	1100	NA	YES	[3] Exceeds RBC
Lead	1.3 - 50	1/5	2	6	NC	NA	NA	15 [c]	NO	[5] Less than ARAR
Magnesium		4/4	3,550	2,260	NC	3,610	NA	NA	NO	[4] Essential Nutrient, [2] Background
Manganese		4/4	483	197	NC	107	73	NA	YES	[3] Exceeds RBC
Potassium		4/4	2,430	1,850	NC	1,700	NA	NA	NO	[4] Essential Nutrient
Sodium		4/4	56,900	27,800	NC	19,000	NA	NA	NO	[4] Essential Nutrient
Zinc	21.1 - 35.8	1/5	58	22	NC	NA	1100	NA	NO	[1] Less than RBC

Notes:

[a] Sample locations include: 57D-95-04X through 57D-95-07X, 57D-95-09X, 57D-95-10X, and 57W-98-01X through 57W-98-03X.

[b] Filtered samples were collected at 57W-95-04X

[c] Massachusetts Drinking Water Standard (MADEP, 1998).

[d] The value for naphthalene used as a surrogate

* The arithmetic mean of concentrations detected in upgradient samples was used for background (inorganics only). Upgradient sample locations include 57D-95-03X and -08X.

** Region III RBCs (USEPA, 1999): Tap Water RBCs used for surface water evaluation.
RBCs based on carcinogenic effects are associated with a $1x10^{-6}$ cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

*** ARARs are primary or secondary MCLs.

Chemicals selected as CPCs are shaded.
RBC - Risk-based concentration
ug - microgram
L - liter
SQL - Sample Quantitation Limit
NA - No value available
ND - Not detected
NC - Not calculated because there are fewer than 10 samples.
-- Not applicable
PAL - project analyte list
UCL - upper confidence limit
ARARs - Applicable or Relevant and Appropriate Requirements
CPC - Contaminant of concern

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration

[2] Background - Sample concentrations detected are at or below background concentrations.

[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

TABLE 9-19
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 RECREATIONAL USE
SURFACE WATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean	95% UCL	Upgradient Surface Water Concentration *	Region III RBC **	ARARS ***	CPC?	NOTES
SURFACE WATER - UNFILTERED (ug/L) [a]										
PAL METALS										
Antimony	1 - 1	3/5	5.6	2.1	NC	NA	1.5	NA	YES	[3]Exceeds RBC
Arsenic		4/4	153	49	NC	5.4	0.045	NA	YES	[3]Exceeds RBC
Barium		5/5	278	176	NC	13	260	NA	YES	[3]Exceeds RBC
Copper	5 - 5	4/5	44	24	NC	9.0	150	NA	NO	[1]Less than RBC
Lead		5/5	184	92	NC	NA	NA	15[c]	YES	[6] Exceeds ARAR
Manganese		1/1	93	93.0	NC	131	73	NA	YES	[3]Exceeds RBC, [4]Background
Selenium	2 - 2	2/5	2.5	1.5	NC	NA	18	NA	NO	[1]Less than RBC
Zinc	36 - 36	4/5	445	211	NC	NA	1100	NA	NO	[1]Less than RBC
PAL SEMIVOLATILE ORGANICS										
Benzo[k]fluoranthene	0.87 - 0.87	1/4	0.94	0.56	NC	NA	0.92	NA	YES	[3]Exceeds RBC
PAL VOLATILE ORGANICS										
Carbon Disulfide	0.5 - 0.5	1/5	0.58	0.32	NC	NA	100	NA	NO	[1]Less than RBC
Chlorobenzene	0.5 - 0.5	1/5	4.6	1.1	NC	NA	11	NA	NO	[1]Less than RBC
Toluene	0.5 - 0.5	2/5	1.6	0.59	NC	NA	75	NA	NO	[1]Less than RBC
OTHER										
EPH Fractions										
C11-C22 Aromatics		5/5	650	430	NC	NA	NA	NA	YES	No Standard
C19-C36 Aliphatics	500 - 530	2/5	1100	570	NC	NA	NA	NA	YES	No Standard
VPH Fractions										
C9-C10 Aromatics	20	1/5	25	13	NC	NA	NA	NA	YES	No Standard

TABLE 9-19
CHEMICALS OF POTENTIAL CONCERN
AOC 57 AREA 3 RECREATIONAL USE
SURFACE WATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Range of SQLs	Frequency of Detection	Maximum Detected Concentration	Arithmetic Mean	95% UCL	Upgradient Surface Water Concentration *	Region III RBC **	ARARS ***	CPC?	NOTES
SURFACE WATER - FILTERED (ug/L) [b]										
PAL METALS										
Arsenic		5/5	53	20	NC	4.4	0.045	NA	YES	[3] Exceeds RBC
Barium		5/5	23	13	NC	12	260	NA	NO	[1] Less than RBC
Manganese		2/2	155	96	NC	107	73	NA	YES	[3] Exceeds RBC

Notes:
[a] Sample locations include: 57W-98-04X through 57W-98-08X (duplicate at 57W-98-07X).
[b] Filtered samples were collected at 57W-98-04X through 57W-98-08X.
[c] Massachusetts Drinking Water Standard (MADEP, 1998).
* The arithmetic mean of concentrations detected in upgradient samples was used for background (inorganics only).
Upgradient sample locations include 57W-95-03X and -08X.
** Region III RBCs (USEPA, 1999): Tap water RBCs used for surface water evaluation.
RBCs based on carcinogenic effects are associated with a $1x10^{-6}$ cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).
*** ARARs are primary or secondary MCLs.

[1] Less than RBC - Maximum detected concentration is less than risk-based concentration
[2] Background - Sample concentrations detected are at or below background concentrations.
[3] Exceeds RBC - Maximum detected concentration exceeds risk-based concentration
[4] Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.
[5] Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.
[6] Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.
[7] No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded.
RBC - Risk-based concentration
ug - micrograms
L - Liter
SQL - Sample Quantitation Limit
NA - No value available
ND - Not detected
NC - Not calculated because there are fewer than 10 samples.
-- Not applicable
PAL - project analyte list
UCL - upper confidence limit
ARARs - Applicable or Relevant and Appropriate Requirements
CPC - Contaminant of concern

TABLE 9-20
SUMMARY OF POTENTIAL PATHWAYS FOR HUMAN HEALTH RISK ASSESSMENT
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM, AND POINT	EVALUATED?	REASON FOR SELECTION OR EXCLUSION
AREA 2 INDUSTRIAL			
Current/Future Land Use			
Maintenance Worker	Incidental ingestion of surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via ingestion.
	Dermal contact with surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via dermal contact.
	Inhalation of particulates from surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via dust inhalation.
	Inhalation of VOCs from surface soil	No	No VOCs were selected as CPCs.
	Incidental ingestion and dermal contact with groundwater	No	Workers are unlikely to come in contact with groundwater.
	Inhalation of VOCs from groundwater	No	Workers are unlikely to come in contact with groundwater and migration of vapors to ambient air is not considered a significant source of exposure (a).
Possible Future Land Use			
Construction Worker	Incidental ingestion of surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soils via ingestion.
	Dermal contact with surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soils via dermal contact.
	Inhalation of particulates from surface and subsurface soil	Yes	Excavation work is likely to generate dust.
	Inhalation of VOCs from surface and subsurface soil	No	No VOCs were selected as CPCs.
	Incidental ingestion and dermal contact with groundwater	No	Workers would probably wear protective clothing, which would mitigate exposure from these routes.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air is not considered a significant source of exposure (a)
Commercial Worker	Incidental ingestion of surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas via ingestion.
	Dermal contact with surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas via dermal contact.
	Inhalation of particulates from surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas via dust inhalation.
Commercial Worker	Ingestion of drinking water	Yes	Groundwater is considered a possible source of potable water at the site.
	Inhalation of VOCs volatilizing from shallow groundwater or volatilizing from process water.	No	Volatiles could migrate to indoor air or be released from industrial process water, however maximum detected VOCs in groundwater are below the MCP GW-2 Standards.

TABLE 9-20
SUMMARY OF POTENTIAL PATHWAYS FOR HUMAN HEALTH RISK ASSESSMENT
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM, AND POINT	EVALUATED?	REASON FOR SELECTION OR EXCLUSION
Unrestricted Future Land Use			
Adult and Child Resident	Incidental ingestion of surface soil	Yes	Residents may be exposed to contaminated soils via ingestion.
	Dermal contact with surface soil	Yes	Residents may be exposed to contaminated soils via dermal contact.
	Inhalation of particulates from surface soil	Yes	Residents may be exposed to contaminated soils via dust inhalation.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air not considered a significant source of exposure (a).
	Ingestion of groundwater	Yes	Although groundwater is not considered a source of potable water at the site, consumption of groundwater is assessed to evaluate risk management obligations for unrestricted land use.
AREA 2 - RECREATIONAL			
Current/Future Land Use			
Recreational Child	Incidental ingestion of surface soil, sediment and surface water	Yes	Children playing in the recreational area may be exposed to contaminants in these media via ingestion.
	Dermal contact with surface soil, sediment and surface water	Yes	Children playing in the recreational area may be exposed to contaminants in soil via dermal contact.
	Inhalation of particulates from surface soil	No	Considered insignificant due to saturated soils.
	Inhalation of VOCs from surface soil	No	No VOCs selected as CPCs.
Possible Future Land Use			
Construction Worker	Incidental ingestion of surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soils via ingestion.
	Dermal contact with surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soils via dermal contact.
	Inhalation of particulates from surface and subsurface soil	Yes	Excavation work is likely to generate dust.
	Inhalation of VOCs from surface and subsurface soil	No	No VOCs were selected as CPCs.
	Incidental ingestion and dermal contact with groundwater	No	Workers would probably wear protective clothing, which would mitigate exposure from these routes.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air is not considered a significant source of exposure (a)

TABLE 9-20
SUMMARY OF POTENTIAL PATHWAYS FOR HUMAN HEALTH RISK ASSESSMENT
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM, AND POINT	EVALUATED?	REASON FOR SELECTION OR EXCLUSION
Unrestricted Future Land Use			
Adult and Child Resident	Incidental ingestion of surface soil	Yes	Residents may be exposed to contaminated soils via ingestion.
	Dermal contact with surface soil	Yes	Residents may be exposed to contaminated soils via dermal contact.
	Inhalation of particulates from surface soil	Yes	Residents may be exposed to contaminated soils via dust inhalation.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air not considered a significant source of exposure (a).
	Ingestion of groundwater	Yes	Although groundwater is not considered a source of potable water at the site, consumption of groundwater is assessed to evaluate risk management obligations for unrestricted land use.
AREA 3 - INDUSTRIAL			
Current/Future Land Use			
Maintenance Worker	Incidental ingestion of surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via ingestion.
	Dermal contact with surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via dermal contact.
	Inhalation of particulates from surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via dust inhalation.
	Inhalation of VOCs from surface soil	No	No VOCs selected as CPCs.
	Incidental ingestion and dermal contact with groundwater	No	Workers are unlikely to come in contact with groundwater.
	Inhalation of VOCs from groundwater	No	Workers are unlikely to come in contact with groundwater and migration of vapors to ambient air is not considered a significant source of exposure.
Possible Future Land Use			
Construction Worker	Incidental ingestion of surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soils via ingestion.
	Dermal contact with surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soil through dermal contact
	Inhalation of particulates from surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soil through dust inhalation.
	Inhalation of VOCs from surface and subsurface soil	No	No VOCs selected as CPCs .
	Incidental ingestion and dermal contact with groundwater	No	Workers would be wearing protective clothing, which would mitigate exposure from these routes.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air not considered a significant source of exposure (a).

TABLE 9-20
SUMMARY OF POTENTIAL PATHWAYS FOR HUMAN HEALTH RISK ASSESSMENT
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM, AND POINT	EVALUATED?	REASON FOR SELECTION OR EXCLUSION
Commercial Worker	Incidental ingestion of surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas soils via ingestion.
	Dermal contact with surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas soils via dermal contact.
	Inhalation of particulates from surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas soils via dust inhalation.
	Ingestion of drinking water	Yes	Groundwater is considered a possible source of potable water at the site.
	Inhalation of VOCs volatilizing from shallow groundwater or volatilizing from process water.	No	Volatiles could migrate to indoor air or be released from industrial process water, however maximum detected VOCs in groundwater are below the MCP GW-2 Standards.
Unrestricted Future Land Use			
Adult and Child Resident	Incidental ingestion of surface soil	Yes	Residents may be exposed to contaminated soils via ingestion.
	Dermal contact with surface soil	Yes	Residents may be exposed to contaminated soils via dermal contact.
	Inhalation of particulates from surface soil	Yes	Residents may be exposed to contaminated soils via dust inhalation.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air not considered a significant source of exposure (a).
	Ingestion of groundwater	Yes	Although groundwater is not considered a source of potable water at the site, consumption of groundwater is assessed to evaluate risk management obligations for unrestricted land use.
AREA 3 - RECREATIONAL			
Current/Future Land Use			
Recreational Child	Incidental ingestion of surface soil, sediment and surface water	Yes	Children playing in the recreational area may be exposed to contaminants in surface soil via ingestion.
	Dermal contact with surface soil, sediment and surface water	Yes	Children playing in the recreational area may be exposed to contaminants in soil via dermal contact.
	Inhalation of particulates from surface soil	No	Considered insignificant due to saturated soils.
	Inhalation of VOCs from surface soil	No	No VOCs selected as CPCs.

TABLE 9-20
SUMMARY OF POTENTIAL PATHWAYS FOR HUMAN HEALTH RISK ASSESSMENT
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM, AND POINT	EVALUATED?	REASON FOR SELECTION OR EXCLUSION
Possible Future Land Use			
Construction Worker	Incidental ingestion of surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soils via ingestion.
	Dermal contact with surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soil through dermal contact
	Inhalation of particulates from surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soil through dust inhalation.
	Inhalation of VOCs from surface and subsurface soil	No	No VOCs selected as CPCs .
	Incidental ingestion and dermal contact with groundwater	No	Workers would be wearing protective clothing, which would mitigate exposure from these routes.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air not considered a significant source of exposure (a).
Unrestricted Future Land Use			
Adult and Child Resident	Incidental ingestion of surface soil	Yes	Residents may be exposed to contaminated soils via ingestion.
	Dermal contact with surface soil	Yes	Residents may be exposed to contaminated soils via dermal contact.
	Inhalation of particulates from surface soil	Yes	Residents may be exposed to contaminated soils via dust inhalation.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air not considered a significant source of exposure (a).
	Ingestion of groundwater	Yes	Although groundwater is not considered a source of potable water at the site, consumption of groundwater is assessed to evaluate risk management obligations for unrestricted land use.

Notes:

VOC - Volatile Organic Compound
CPC - Chemical of Potential Concern
GW - Groundwater
(a) Maximum concentrations of VOCs in groundwater do not exceed the MCP GW-2 Standard.

MADEP - Massachusetts Department of Environmental Protection
MCP - Massachusetts Contingency Plan

TABLE 9-21
COMPARISON OF GW-2 STANDARDS TO VOLATILE CPCs
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Site Area	Analyte	Maximum Detected Concentration (ug/L)	GW-2 Standard (ug/L)[1]	Maximum Exceed GW-2 Standard?
Area 2 - Industrial	NA			
Area 2 - Recreational	Bis(2-ethylhexyl)phthalate	400	50,000	No
	1,2-Dichloroethylene (Total)	13	20,000	No
	Tetrachloroethylene	16	3000	No
	Trichloroethylene	1.9	300	No
Area 3 - Industrial	1,2-Dichlorobenzene	9.8	10,000	No
	1,4-Dichlorobenzene	5.6	30,000	No
	Naphthalene	20	6000	No
	Carbon Tetrachloride	4.5	20	No
	Chloroform	10	400	No
	Tetrachloroethylene	2.6	3000	No
Area 3 - Recreational	1,4-Dichlorobenzene	2.7	30,000	No
	Bis(2-ethylhexyl)phthalate	52	50,000	No
	Naphthalene	13	6000	No
	Tetrachloroethylene	5.5	3000	No
	Trichloroethylene	3.8	300	No

NOTES:

NA - Not applicable because there were no volatile CPCs selected therefore no GW-2 comparison.

[1] GW-2 Standard is from MADEP (310 CMR 40.097), October, 1997.

CPC - chemicals of concern

ug/L - micrograms per liter

TABLE 9-22
EXPOSURE POINT CONCENTRATIONS
AOC 57 AREA 2 INDUSTRIAL USE
SURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL	EPC
SURFACE SOIL (0 - 2 feet bgs) (mg/kg)				
PAL METALS				
Arsenic	5 / 5	21	NC	21
Chromium	5 / 5	27	NC	27
Iron	5 / 5	16,400	NC	16,400
Manganese	5 / 5	481	NC	481
OTHER				
VPH Ranges[c]				
C9-C12 Aliphatics	5 / 5	32	NC	32
C9-C10 Aromatics	5 / 5	23	NC	23
EPH Ranges[c]				
C9-C18 Aliphatics	5 / 5	465	NC	465
C19-C36 Aliphatics	5 / 5	5680	NC	5680
C11-C22 Aromatics	5 / 5	1770	NC	1770

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the lesser of the 95% UCL and the maximum concentration.

[c] See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligram
Kg - kilogram
bgs - below ground surface
NC - Not calculated because there are fewer than 10 samples.
PAL - project analyte list
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-23
EXPOSURE POINT CONCENTRATIONS
AOC 57 AREA 2 INDUSTRIAL USE
SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL[a]	EPC[b]
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg)				
PAL METALS				
Arsenic	4 / 4	9.87	NC	9.87
Iron	4 / 4	8080	NC	8080
Manganese	4 / 4	231	NC	231
OTHER				
VPH RANGES[c]				
C9-C12 Aliphatics	4 / 4	0.57	NC	0.57
C9-C10 Aromatics	4 / 4	0.41	NC	0.41
EPH RANGES[c]				
C9-C18 Aliphatics	4 / 4	8.2	NC	8.2
C19-C36 Aliphatics	4 / 4	101	NC	101
C11-C22 Aromatics	4 / 4	31	NC	31

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the lesser of the 95% UCL and the maximum concentration.

[c] See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligram
kg - kilogram
bgs - below ground surface
NC - Not calculated because there are fewer than 10 samples.
PAL - project analyte list
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-24
EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER
AOC 57 AREA 2 INDUSTRIAL USE
GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL[a]	EPC[b]
GROUNDWATER - UNFILTERED (µg/L)				
PAL METALS				
Aluminum	1 / 2	204	NA	204
Manganese	2 / 2	177	NA	177
GROUNDWATER - FILTERED (µg/L)				
PAL METALS				
Aluminum	1 / 2	167	NA	167
Manganese	2 / 2	173	NA	173

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the maximum concentration.

µg - micrograms
L - liter
NA - 95% UCL not applicable to groundwater
PAL - project analyte list
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-25
EXPOSURE POINT CONCENTRATIONS
AOC 57 AREA 2 RECREATIONAL USE
SURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL [a]	EPC [b]
SURFACE SOIL (0 - 2 feet bgs) (mg/kg)				
PAL METALS				
Arsenic	11 / 11	61.2	47.9	47.9
Iron	3 / 3	7920	NC	7920
Manganese	11 / 11	679	273	273
PESTICIDES/PCBs				
Aroclor-1260	8 / 11	4.2	3.6	3.6
OTHER				
VPH Ranges[c]				
C9-C12 Aliphatics	11 / 11	21	29	21
C9-C10 Aromatics	11 / 11	17	24	17
EPH Ranges[c]				
C9-C18 Aliphatics	11 / 11	298	343	298
C19-C36 Aliphatics	11 / 11	3640	5760	3640
C11-C22 Aromatics	11 / 11	1130	1360	1130

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the lesser of the maximum concentration and the 95% UCL.

[c] See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams
Kg - kilogram
bgs - below ground surface
NC - Not calculated because there are fewer than 10 samples.
PAL - project analyte list
UCL - upper confidence limit

TABLE 9-26
EXPOSURE POINT CONCENTRATIONS
AOC 57 AREA 2 RECREATIONAL USE
SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL[a]	EPC[b]
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg)[b]				
PAL METALS				
Aluminum	10 / 10	9940	6970	6970
Arsenic	10 / 10	21	24	21
Chromium	5 / 10	2410	8350	2410
Iron	10 / 10	6880	9900	6880
Lead	12 / 12	5060	30,600	5060
Manganese	12 / 12	175	169	169
PESTICIDES/PCBS				
Dieldrin	2 / 12	0.043	0.0113	0.0113
Aroclor - 1248	1 / 12	3.2	0.482	0.482
Aroclor - 1260	4 / 12	12	156	12
OTHER				
VPH Ranges				
C9-C12 Aliphatics[d]	12 / 12	130	33,200	130
C9-C10 Aromatics[d]	10 / 12	93	22,200	93
EPH Ranges				
C9-C18 Aliphatics[d]	11 / 12	1860	625,000	1860
C19-C36 Aliphatics[d]	12 / 12	22,700	12,200,000	22,700
C11-C22 Aromatics[d]	12 / 12	7050	3,510,000	7050

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the lesser of the maximum concentration and the 95% UCL.

[d] See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams
Kg - kilogram
bgs - below ground surface
NC - Not calculated because there are fewer than 10 samples.
PAL - project analyte list
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-27
EXPOSURE POINT CONCENTRATIONS
AOC 57 AREA 2 RECREATIONAL USE
GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL[a]	EPC[b]
GROUNDWATER - UNFILTERED (µg/L)[a]				
PAL METALS				
Arsenic	2 / 6	54.4	NA	54.4
Iron	2 / 5	3610	NA	3610
Manganese	5 / 5	724	NA	724
PESTICIDES/PCBs				
Aroclor-1260	1 / 6	0.22	NA	0.22
PAL SEMIVOLATILE ORGANICS				
Bis(2-ethylhexyl)phthalate	3 / 6	400	NA	400
PAL VOLATILE ORGANICS				
1,2-dichloroethylene (total)	2 / 6	13	NA	13
Tetrachloroethylene	2 / 6	16	NA	16
Trichloroethylene	3 / 6	1.9	NA	1.9
GROUNDWATER - FILTERED (µg/L)[b]				
PAL METALS				
Arsenic	2 / 6	73	NA	73
Iron	2 / 5	3530	NA	3530
Manganese	5 / 5	819	NA	819

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the maximum concentration.

µg - micrograms
L - liter
NA - 95% UCL not applicable to groundwater
PAL - project analyte list
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-28
EXPOSURE POINT CONCENTRATIONS IN SEDIMENT
AOC 57 AREA 2 RECREATIONAL USE
SEDIMENT

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Maximum Detected Concentration	95% UCL [a]	EPC [b]
SEDIMENT (mg/kg)				
PAL METALS				
Aluminum	6/6	15,900	NC	15,900
Arsenic	9/9	220	NC	220
Chromium	3/6	49	NC	49
Iron	6/6	30,400	NC	30,400
Lead	8/9	410	NC	410
Manganese	9/9	3,940	NC	3,940
PESTICIDES/PCBs				
Dieldrin	2/9	0.046	NC	0.046
OTHER				
Total Petroleum Hydrocarbons	7/9	3200 [c]	NC	3,200

NOTES:

[a] *The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data.* Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the lesser of the maximum concentration and the 95% UCL.

[c] Maximum detected values among all TPH analytical methods.

mg - milligrams
Kg - kilogram
bgs - below ground surface
NC - Not calculated because there are fewer than 10 samples.
PAL - *project analyte list*
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-29
EXPOSURE POINT CONCENTRATIONS IN SURFACE WATER
AOC 57 AREA 2 RECREATIONAL USE
SURFACE WATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Maximum Detected Concentration	95% UCL[a]	EPC[b]
SURFACE WATER - UNFILTERED (ug/L)				
PAL METALS				
Aluminum	5/6	15,100	NA	15,100
Arsenic	9/9	198	NA	198
Barium	9/9	553	NA	553
Cadmium	1/6	25	NA	25
Chromium	1/6	36	NA	36
Copper	4/9	375	NA	375
Iron	6/6	17,600	NA	17,600
Lead	7/9	967	NA	967
Manganese	6/6	433	NA	433
Vanadium	1/6	72	NA	72
PAL SEMIVOLATILE ORGANICS				
Bis(2-ethylhexyl)phthalate	1/9	24	NA	24
PAL VOLATILE ORGANICS				
1,2-Dichloroethylenes (total)	1/9	26	NA	26
Chloroform	1/9	0.72	NA	0.72
Tetrachloroethylene	2/9	2.6	NA	2.6
Trichloroethylene	2/9	3.5	NA	3.5
OTHER				
EPH Fractions				

TABLE 9-29
EXPOSURE POINT CONCENTRATIONS IN SURFACE WATER
AOC 57 AREA 2 RECREATIONAL USE
SURFACE WATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Maximum Detected Concentration	95% UCL [a]	EPC [b]
C11-C22 Aromatics	3/3	1,400	NA	1,400
C19-C36 Aliphatics	3/3	1,700	NA	1,700
SURFACE WATER - FILTERED (ug/L)				
PAL METALS				
Arsenic	4/5	9	NA	9
Iron	4/4	17,200	NA	17,200
Manganese	4/4	483	NA	483

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccuracy of the calculation for small data sets, UCLs are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the maximum detected concentration.

ug - micrograms
L - liter
NA - 95% UCL not applicable to surface water
PAL - project analyte list
UCL - upper confidence limit
EPC - Exposure point concentration

TABLE 9-30
EXPOSURE POINT CONCENTRATIONS
AOC 57 AREA 3 INDUSTRIAL USE
SURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL[a]	EPC[b]
SURFACE SOIL (0 - 2 feet bgs) (mg/kg)[a]				
PAL METALS				
Arsenic	2 / 2	41	NC	41
Iron	2 / 2	8040	NC	8040
Manganese	2 / 2	548	NC	548
OTHER				
VPH Ranges[c]				
C9-C12 Aliphatics	3 / 6	16	NC	16
C9-C10 Aromatics	3 / 6	4.85	NC	4.85
EPH Ranges[c]				
C9-C18 Aliphatics	2 / 6	3.63	NC	3.63
C19-C36 Aliphatics	3 / 6	38	NC	38
C11-C22 Aromatics	2 / 6	9.75	NC	9.75

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the lesser of the 95% UCL and the maximum concentration.

[c] See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams
kg - kilograms
NC - Not calculated because there are fewer than 10 samples.
PAL - project analyte list
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-31
EXPOSURE POINT CONCENTRATIONS
AOC 57 AREA 3 INDUSTRIAL USE
SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL[a]	EPC[b]
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg)				
PAL METALS				
Arsenic	3 / 3	9.67	NC	9.67
Iron	3 / 3	6410	NC	6410
OTHER				
VPH Ranges				
C9-C12 Aliphatics	1 / 9	0.84	NC	0.84
C9-C10 Aromatics	1 / 9	0.35	NC	0.35
EPH Ranges				
C9-C18 Aliphatics	3 / 9	78	NC	78
C19-C36 Aliphatics	6 / 9	990	NC	990
C11-C22 Aromatics	3 / 9	110	NC	110

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the lesser of the 95% UCL and the maximum concentration.

[c] See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams
kg - kilograms
NC - Not calculated because there are fewer than 10 samples.
PAL - project analyte list
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-32
EXPOSURE POINT CONCENTRATIONS
AOC 57 AREA 3 INDUSTRIAL USE
GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL [a]	EPC [c]
GROUNDWATER - UNFILTERED (µg/L)				
PAL METALS				
Aluminum	2 / 2	190	NA	190
Arsenic	1 / 2	33.2	NA	33.2
Cadmium	1 / 2	8.67	NA	8.67
Iron	2 / 2	12400	NA	12400
Manganese	2 / 2	466	NA	466
PAL SEMIVOLATILE ORGANICS				
1,2-Dichlorobenzene	1 / 2	9.8	NA	9.8
1,4-Dichlorobenzene	1 / 2	5.6	NA	5.6
Naphthalene	1 / 2	20	NA	20
PAL VOLATILE ORGANICS				
Carbon Tetrachloride	1 / 2	4.5	NA	4.5
Chloroform	1 / 2	10	NA	10
Tetrachloroethene	1 / 2	2.6	NA	2.6
OTHER				
C9-C10 Aromatics	1 / 1	310	NA	310
GROUNDWATER - FILTERED (µg/L)				
PAL METALS				
Arsenic	1 / 1	40.1	NA	40.1
Iron	1 / 1	11300	NA	11300
Manganese	1 / 1	351	NA	351

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[c] The EPC is the maximum concentration.

µg - micrograms
L - liter
NA - 95% UCL not applicable to groundwater
PAL - project analyte list
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-33
EXPOSURE POINT CONCENTRATIONS AOC 57 AREA 3 RECREATIONAL USE SURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL[a]	EPC[b]
SURFACE SOIL (0 - 2 feet bgs) (mg/kg)[a]				
PAL METALS				
Arsenic	2 / 2	28	NC	28
Manganese	2 / 2	170	NC	170
PESTICIDES/PCBs				
Dieldrin	2 / 6	0.14	NC	0.14
OTHER				
VPH Ranges[c]				
C9-C12 Aliphatics[c]	4 / 6	1500	NC	1500
C9-C10 Aromatics[c]	3 / 6	600	NC	600
EPH Ranges[c]				
C9-C18 Aliphatics[c]	3 / 6	1300	NC	1300
C19-C36 Aliphatics[c]	5 / 6	20,000	NC	20,000
C11-C22 Aromatics[c]	5 / 6	3100	NC	3100

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the lesser of the maximum concentration and the 95% UCL.

[c] See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams
Kg - kilogram
bgs - below ground surface
NC - Not calculated because there are fewer than 10 samples.
PAL - project analyte list
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-34
EXPOSURE POINT CONCENTRATIONS
AOC 57 AREA 3 RECREATIONAL USE
SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL[a]	EPC[b]
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg)[a]				
PAL METALS				
Arsenic	1 / 1	28.2	NC	28.2

NOTES:
[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.
[b] The EPC is the lesser of the maximum concentration and the 95% UCL.
[c] See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams
Kg - kilogram
bgs - below ground surface
NC - Not calculated because there are fewer than 10 samples.
PAL - project analyte list
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-35
EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER
AOC 57 AREA 3 RECREATIONAL USE
GROUNDWATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Concentration		
		Maximum Detected	95% UCL [a]	EPC [b]
GROUNDWATER - UNFILTERED (µg/L)				
PAL METALS				
Aluminum	3 / 3	2450	NA	2450
Arsenic	5 / 6	84.4	NA	84.4
Iron	3 / 3	1910	NA	1910
Manganese	3 / 3	346	NA	346
PAL SEMIVOLATILE ORGANICS				
1,4-Dichlorobenzene	1 / 6	2.7	NA	2.7
Bis(2-ethylhexyl)phthalate	2 / 6	52	NA	52
Naphthalene	2 / 6	13	NA	13
PAL VOLATILE ORGANICS				
Tetrachloroethene	1 / 6	5.5	NA	5.5
Trichloroethene	1 / 6	3.8	NA	3.8
OTHER				
VPH Ranges				
C5-C8 Aliphatics	1 / 1	89.5	NA	89.5
C9-C12 Aliphatics	1 / 1	42.5	NA	42.5
C9-C10 Aromatics	1 / 1	172	NA	172
GROUNDWATER - FILTERED (µg/L)				
PAL METALS				
Arsenic	3 / 3	138	NA	138

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the maximum concentration.

µg - micrograms
L - liter
NA - 95% UCL not applicable to groundwater
PAL - project analyte list
UCL - upper confidence limit
EPC exposure point concentration

TABLE 9-36
EXPOSURE POINT CONCENTRATIONS IN SEDIMENT
AOC 57 AREA 3 RECREATIONAL USE
SEDIMENT

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Maximum Detected Concentration	95% UCL[a]	EPC[b]
SEDIMENT (mg/kg)				
PAL METALS				
Arsenic	5/5	37	NC	37
Manganese	5/5	459	NC	459
PESTICIDES/PCBs				
Aroclor-1260	1/5	0.84	NC	0.84
EPH Fractions				
C11-C22 Aromatics	1/5	280	NC	280
C19-C36 Aliphatics	1/5	630	NC	630
VPH Fractions				
C5-C8 Aliphatics	1/5	3.3	NC	3.3
C9-C10 Aromatics	1/5	4.3	NC	4.3
C9-C12 Aliphatics	2/5	5.6	NC	5.6

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccuracy of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the lesser of the maximum concentration and the 95% UCL.

mg - milligrams
Kg - kilogram
bgs - below ground surface
NC - Not calculated because there are fewer than 10 samples.
PAL - project analyte list

TABLE 9-37
EXPOSURE POINT CONCENTRATIONS IN SURFACE WATER
AOC 57 AREA 3 RECREATIONAL USE
SURFACE WATER

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	Frequency of Detection	Maximum Detected Concentration	95% UCL [a]	EPC [b]
SURFACE WATER - UNFILTERED (ug/L)				
PAL METALS				
Antimony	3/5	5.6	NA	5.6
Arsenic	4/4	153	NA	153
Barium	5/5	278	NA	278
Manganese	1/1	93	NA	93
PAL SEMIVOLATILE ORGANICS				
Benzo[k]fluoranthene	1/4	0.94	NA	0.94
OTHER				
EPH Fractions				
C11-C22 Aromatics	5/5	650	NA	650
C19-C36 Aliphatics	2/5	1100	NA	1100
VPH Fractions				
C9-C10 Aromatics	1/5	25	NA	25
SURFACE WATER - FILTERED (ug/L)				
PAL METALS				
Arsenic	5/5	53	NA	53
Manganese	2/2	155	NA	155

Notes:

NOTES:

[a] The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccuracy of the calculation for small data sets, UCLs are not calculated if the data set contains fewer than 10 samples.

[b] The EPC is the maximum detected concentration.

ug - micrograms
L - liter
NA - 95% UCL not applicable to surface water
PAL - project analyte list
UCL - upper confidence limit
EPC - Exposure point concentration

TABLE 9-38
EXPOSURE PARAMETERS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	POSSIBLE FUTURE LAND USE			
PARAMETER	COMMERCIAL/INDUSTRIAL WORKER	CONSTRUCTION WORKER	UNITS	SOURCE
Soil Ingestion Rate				
RME	100	480	mg/day	USEPA, 1994a
Central Tendency	50	--	mg/day	USEPA, 1994a
Fraction Ingested From Site	100%	100%		Assumption
Relative Absorption Factor	100%	100%		Assumption
Inhalation Rate [2]	1.6	3.3	m^3/hour	USEPA, 1997
Exposure Time	8	8	hours/day	USEPA, 1994a;
Exposure Frequency [3]	150	250	days/year	USEPA, 1994a;
Exposure Duration				
RME	25	0.5	years	USEPA, 1994a
Central Tendency	6.6	0.25	years	USEPA, 1997
Body Weight	70	70	kg	USEPA, 1991a
Averaging Time				
Cancer	70	70	years	USEPA, 1989b
Noncancer [4]				
RME	25	0.5	years	USEPA, 1994a
Central Tendency	6.6	0.25	years	Assumption [7]
Surface Area Exposed [5]				
RME	9350	5200	cm^2/day	USEPA, 1989a
Central Tendency	9350	5200	cm^2/day	USEPA, 1989a
Soil Adherence Factor [5]	0.0087	0.28	mg/cm^2	USEPA, 1997
Particulate Emission Factor	1.32E+09	1.32E+09	m^3/kg	USEPA, 1996b
Drinking Water Ingestion Rate	1	--	liters/day	USEPA, 1991a

Notes:
1 - RME exposure parameters are used for RME and central tendency scenarios unless separate central tendency exposure parameters are provided.
2 - Inhalation rates are obtained from the Exposure Factors Handbook (USEPA, 1997)
Commercial/Industrial Worker inhalation rates are based on short-term exposures for moderate activities.
Construction Worker inhalation rate is based on upper-percentile hourly average for outdoor workers.
3 - 5 days per week for 50 weeks for the commercial/industrial worker and 5 days per week for 26 weeks for the construction worker.
4 - The AT for noncarcinogenic effects is equal to the exposure duration; for durations less than one year it is equal to the 18 week period of construction activity expressed as a fraction of a year
5 - SA and AF values based on highest dermal loading among utility workers, construction workers, and equipment operators. Value conservatively applied to surface area of upper extremeties and head.
6 - Exposure variables with source listed as "assumption" are site specific; the remainder are default values.
7 - Central tendency assumptions are 1/2 the RME value.
mg - milligrams
m3 - cubic meters
kg - kilograms
RME - Reasonable maximum exposure
-- Not Applicable

TABLE 9-39
ORAL DOSE-RESPONSE DATA FOR CARCINOGENIC EFFECTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	WEIGHT OF EVIDENCE	ORAL SLOPE FACTOR (mg/kg/day)⁻¹		TEST SPECIES	STUDY TYPE	TUMOR TYPE	SOURCE
METALS							
Aluminum	Not Listed						HEAST
Antimony	Not Listed						
Arsenic	A	1.5E+00		Human	Oral-DW	Skin	IRIS
Barium	Not Listed						
Cadmium	B1	ND					IRIS
Chromium	Not Listed						
Copper	D						
Iron	Not Listed						
Lead	B2	ND					IRIS
Manganese	D						IRIS
Vanadium	Not Listed						
PESTICIDES/PCBs							
Dieldrin	B2	1.6E+01		Mouse	Oral-diet	Liver	IRIS
Polychlorinated Biphenyls (PCBs)	B2	See Below	*	Rat	Oral-diet	Liver	IRIS
high risk and persistence-upper bound		2.0E+00					
high risk and persistence-central estimate		1.0E+00					
low risk and persistence-upper bound		4.0E-01					
low risk and persistence-central estimate		3.0E-01					
lowest risk and persistence-upper bound		7.0E-02					
lowest risk and persistence-central estimate		4.0E-02					
SEMIVOLATILES							
1,2-Dichlorobenzene	D						IRIS
1,4-Dichlorobenzene	C	2.4E-02		Mouse	Oral-gavage	Liver	HEAST
Bis(2-ethylhexyl)phthalate	B2	1.4E-02		Mouse	Oral-diet	Liver	IRIS
Benzo(k)fluoranthene	B2	7.3E-02	**				NCEA
Naphthalene	C	ND					IRIS
VOLATILES							
1,2-Dichloroethene (Total)	Not Listed	ND					
Carbon Tetrachloride	B2	1.3E-01		Several	Oral-gavage	Liver	IRIS
Chloroform	B2	6.1E-03		Rat	Oral-DW	Kidney	IRIS
Tetrachloroethene	B2	5.2E-02	W2 N1				NCEA, 1992
Trichloroethene	B2	1.1E-02	W2 N1				HEAST
OTHER							
Total Petroleum Hydrocarbon	D	ND					
EPH							
C9-C18 Aliphatics	D	ND					
C19-C36 Aliphatics	D	ND					

TABLE 9-39
ORAL DOSE-RESPONSE DATA FOR CARCINOGENIC EFFECTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	WEIGHT OF EVIDENCE	ORAL SLOPE FACTOR (mg/kg/day)⁻¹	TEST SPECIES	STUDY TYPE	TUMOR TYPE	SOURCE
C10-C22 Aromatics	D	ND				
VPH						
C5-C8 Aliphatics	D	ND				
C9-C12 Aliphatics	D	ND				
C9-C10 Aromatics	D	ND				

NOTES:
ND - Not Determined
W - Withdrawn from IRIS
DW - Drinking water
mg - milligrams
kg - kilograms

IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
NCEA - National Center for Environmental Assessment

Sources:
IRIS as of 8/99
HEAST, 1997
NCEA 1992

W1 - Value withdrawn from IRIS 4/98.
W2 - Value was withdrawn from HEAST in FY 1992 update.
N1 - An NCEA provisional regional value has been published in the USEPA Region III Rsick Based Concentration Table (April 12, 1999)
* *Applicable to Aroclors 1016, 1248, 1254, and 1260*
** Slope factor for benzo(a)pyrene used for other carcinogenic PAHs, adjusted by a relative potency factor for benzo(K)fluoranthene of 0.01
Weight of Evidence (Route-Specific):
A - Human carcinogen
B - Probable human carcinogen (B1 - limited evidence of cancer in humans;
B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
C - Possible human carcinogen
D - Not classifiable as to human carcinogenicity
E - Evidence of lack of carcinogenicity to humans

TABLE 9-40
INHALATION DOSE/RESPONSE DATA FOR CARCINOGENIC EFFECTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	WEIGHT OF EVIDENCE	INHALATION SLOPE FACTOR * (mg/kg/day)		UNIT RISK ($\mu g/m^3$)		TEST SPECIES	STUDY TYPE	TUMOR TYPE	SOURCE
METALS									
Aluminum	Not Listed								
Antimony	Not Listed								
Arsenic	A	15	W1	0.0043		Human	Inhalation	Lung	IRIS
Barium	Not Listed								
Cadmium	B1	6.3	c	0.0018		Human	Inhalation	Lung	IRIS
Chromium	A	41		0.012		Human	Inhalation	Lung	IRIS
Copper	D								
Iron	Not Listed								
Lead	B2	ND		ND					IRIS
Manganese	D								IRIS
Vanadium	Not Listed								
PESTICIDES/PCBs									
Dieldrin	B2	16		0.0046		Mouse	Oral-diet	Liver	IRIS
Polychlorinated Biphenyls (PCBs)	B2	See Below	**			Rat	Oral-diet	Liver	IRIS
high risk and persistence-upper bound		2							
high risk and persistence-central estimate		1							
low risk and persistence-upper bound		0.4							
low risk and persistence-central estimate		0.3							
lowest risk and persistence-upper bound		0.07							
lowest risk and persistence-central estimate		0.04							
SEMIVOLATILES									
1,2-Dichlorobenzene	D								IRIS
1,4-Dichlorobenzene	C	0.022	N1	ND					NCEA
Bis(2-ethylhexyl)phthalate (BEHP)	B2	0.014	N2	ND					NCEA
Naphthalene	C			ND					IRIS
VOLATILES									
1,2-Dichloroethene (Total)	Not Listed								
Carbon Tetrachloride	B2	0.053		0.000015		Several	Oral-gavage	Liver	IRIS
Chloroform	B2	0.081		0.000023		Mouse	Oral-gavage	Liver	IRIS
Tetrachloroethene	B2	0.002	N3	0.0000059	W3				NCEA/HEAST
Trichloroethene	B2	0.006	N4	0.0000017	W4				NCEA/HEAST

TABLE 9-40
INHALATION DOSE/RESPONSE DATA FOR CARCINOGENIC EFFECTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	WEIGHT OF EVIDENCE	INHALATION SLOPE FACTOR * (mg/kg/day)	UNIT RISK ($\mu g/m^3$)	TEST SPECIES	STUDY TYPE	TUMOR TYPE	SOURCE
OTHER							
Total Petroleum Hydrocarbons	D						
EPH							
C9-C18 Aliphatics	D						
C19-C36 Aliphatics	D						
C10-C22 Aromatics	D						
VPH							
C5-C8	D						
C9-C12 Aliphatics	D						
C9-C10 Aromatics	D						

ND - Not Determined
W - Withdrawn from IRIS
mg - milligrams
kg - kilograms
µg - micrograms
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
NCEA - National Center for Environmental Assessment

Sources:
IRIS as of 8/99
HEAST, 1997
NCEA

* - Source of slope factor is HEAST, 1997 unless otherwise noted.
W1 - Value withdrawn from HEAST in FY 1997 update.
W2 - Value withdrawn from HEAST in FY 1992 update.
N1 - An NCEA provisional value of 2.2 E-02 has been provided in the USEPA Region III RBC Table (April, 1999).
N2 - An NCEA provisional value of 1.4 E-02 has been provided in the USEPA Region III RBC Table (April, 1999)
N3 - An NCEA provisional value of 2.0 E-03 has been published in the USEPA Region III RBC Table (April, 1999).
N4 - An NCEA provisional value of 6.0 E-03 has been published in the USEPA Region III RBC Table (April, 1999).
c - Calculated from unit risk [slope = (unit risk x 70 kg)/20 m^3/day x 0.001 mg/ug]
** - Slope factors are applicable to Aroclors 1016, 1248, 1254, and 1260.

Weight of Evidence (Route-Specific):
A - Human carcinogen
B - Probable human carcinogen (B1 - limited evidence of cancer in humans;
B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
C - Possible human carcinogen
D - Not classifiable as to human carcinogenicity
E - Evidence of lack of carcinogenicity to humans

TAB[illegible]
ORAL DOSE-RESPONSE DATA F[illegible]NCARCINOGENIC EFFECTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	CHRONIC ORAL RfD (mg/kg-day)		SUBCHRONIC ORAL RfD (mg/kg-day)		STUDY TYPE	CONFIDENCE LEVEL	CRITICAL EFFECT	TEST ANIMAL	UNCERTAINTY FACTOR	SOURCE
METALS										
Aluminum	1E+00	N1	ND							NCEA, 1994a
Antimony	4E-04		0.0004		Oral-DW	Low	Reduced Lifespan	Rat	1000 H,A,L	IRIS
Arsenic	3E-04		3E-04		Oral-DW	Medium	Keratosis and hyperpigmentation	Human	3 H	IRIS
Barium	7E-02		7E-02		Oral-DW	Medium	Increased Blood Pressure	Human	3 H	IRIS
Cadmium (food)	1E-03		ND		Oral-diet	High	Proteinuria	Human	10 H	IRIS
Cadmium (water)	5E-04		ND		Oral-DW	High	Proteinuria	Human	10 H	IRIS
Chromium	3E-03		2E-02		Oral-DW	Low	No effects observed	Rat	300 H,A,S	IRIS
Copper	(H1)		ND							HEAST
Iron	ND		ND							NCEA, 1994c
Lead	ND		ND							IRIS
Manganese (soil)	7.1E-02	+	ND		Oral-diet	Medium	No effects observed	Human	2, 1M	USEPA, 1996
Manganese (drinking water)	2.4E-02	++	ND						2, 3M	USEPA, 1996
Vanadium	7.0E-03		7E-03		Oral-DW	Low	No effects observed	Rat	100 H,A	HEAST
PESTICIDES/PCBs										
Dieldrin	5E-05		5E-05		Oral-diet	Medium	Liver lesions	Rat	100 H,A	IRIS
Aroclor-1248	2E-05	*	5E-05	*						
Aroclor-1260	2E-05	*	5E-05	*	Oral-diet	Medium	Immunotoxicity	Monkey	300 H,A,S	IRIS
SEMIVOLATILES										
1,2-Dichlorobenzene	9.0E-02		ND		Oral-diet	Low	No adverse effects observed	Rat	1,000 H,A,D	IRIS
1,4-Dichlorobenzene	3E-02	N2	ND							HEAST
Benzo(k)fluoranthene	ND		ND							
Bis(2-ethylhexyl)phthalate	2E-02		2E-02	W1	Oral-diet	Medium	Increased liver weight	Guinea Pig	1,000 H,A,S	IRIS
Naphthalene	2E-02		2E-02		Oral-gavage	Low	Decreased body weight	Rat	3000 H,A,S,D	IRIS
VOLATILES										
1,2-Dichloroethylene	9E-03		9E-03		Oral-DW	ND	Liver lesions	Rat	1000	HEAST
Carbon Tetrachloride	7E-04		ND		Oral-gavage	Medium	Liver lesions	Rat	1,000 H,A,S	IRIS
Chloroform	1E-02		1E-02		Oral-capsule	Medium	Fatty cyst formation in liver	Dog	1,000 H,A,S	IRIS
Tetrachloroethene	1E-02		1E-01		Oral-gavage	Medium	Hepatotoxicity	Mouse	1,000 H,A,S	IRIS
Trichloroethene	6E-03	N3	ND							NCEA, 1995
OTHER										
Total Petroleum Hydrocarbons *	3E-02		3E-01							
EPH										
C9-C18 Aliphatics	6E-01		6E+00							MADEP[2]
C19-C36 Aliphatics	6E+00		6E+01							MADEP[2]
C10-C22 Aromatics	3E-02		3E-01							MADEP[2]
VPH										
C5-C8 Aliphatics	6E-02		6E-01							MADEP[2]
C9-C12 Aliphatics	6E-01		6E+00							MADEP[2]
C9-C10 Aromatics	3E-02		3E-01							MADEP[2]

N1 - An NCEA provisional value of 1.0 E +01 has been published in the USEPA Region III RBC Table (April, 1999)

N2 - An NCEA provisional value of 3.0 E-02 has been published in the USEPA Region III RBC Table (April, 1999).

N3 - An NCEA provisional value of 6.0 E-03 has been published in the USEPA Region III RBC Table (April, 1999).

W1 - Value of 9.0 E-01 was withdrawn from HEAST in FY 1993 update.

H1 - Value is the drinking water value (1.3 mg/L) converted to a dose (2 L/day x 1.3 mg/L / 70 kg); not a health-based value.

[1] Source for all subchronic RfDs is HEAST, 1995

[2] Interim Final Petroleum Report: Development of Health-Based Alternative to the Total Petroleum Hydrocarbon Parameter and Revisions to the MCP 10/31/97.

+ RfD based on NOAEL for chronic consumption of manganese divided by 2 to account for dietary exposures.

++ RfD for nondietary exposures adjusted by modifying factor of 3 recommended by IRIS.

* - Value for Aroclor 1254 used as a surrogate.

Uncertainty factors:
H - variation in human sensitivity
A - animal to human extrapolation
S - extrapolation from subchronic to chronic NOAEL
L - extrapolation from LOAEL to NOAEL
D - Lack of supporting data
M - additional modifying factor

SOURCES:
IRIS as of 1/97
NCEA, 1994a,b,c, 1995
HEAST, 1995 (including July update)
USEPA Region 1 Risk Update, 1996

ND - No data available
W - RfD withdrawn from IRIS/HEAST
mg - milligrams
kg - kilograms
DW = Drinking Water
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
USEPA - United States Environmental Protection Agency
NCEA - National Center for Environmental Assessment

TA[illegible]-42
INHALATION DOSE/RESPONSE DA[illegible]OR NONCARCINOGENIC EFFECTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	CHRONIC INHALATION RfC (mg/m^3)	SUBCHRONIC[1] INHALATION RfC (mg/m^3)	CHRONIC INHALATION RfD[2] (mg/kg-day)	SUBCHRONIC INHALATION RfD[2] (mg/kg-day)	STUDY TYPE	CONFIDENCE LEVEL	CRITICAL EFFECT	TEST ANIMAL	UNCERTAINTY FACTOR	SOURCE
METALS										
Aluminum	ND	ND	1.0E-03 N1	ND						NCEA
Antimony	ND	ND	ND	ND						
Arsenic	ND	ND	ND	ND						
Barium	5.0E-04	5.0E-03	1.0E-04	1.0E-03	Inhalation	Low	Fetotoxicity	Rat	1000 H,A,S	HEAST
Cadmium	ND	ND	ND	ND						
Chromium	1.0E-04 [1]	ND	2.9E-05	ND	Inhalation	Medium	Increase in Lactase Dehydrogenase	Rat	300 H,A,S	IRIS
Copper	ND	ND	ND	ND						
Iron	ND	ND	ND	ND						
Lead	ND [2]	ND	ND	ND						IRIS
Manganese	5.0E-05	ND	1.4E-05	ND	Inhalation	Medium	Impaired neurobehavioral function	Human	1,000 H,L,D	IRIS
Vanadium	ND	ND	ND	ND						
PESTICIDES/PCBs										
Dieldrin	ND	ND	ND	ND						
Aroclor-1248	ND	ND	ND	ND						
Aroclor-1260	ND	ND	ND	ND						
SEMIVOLATILES										
1,2-Dichlorobenzene	2.0E-01	2.0E+00	5.7E-02 [3]	5.7E-01	Inhalation	Low	Decreased weight gain	Rat	1,000 H,A,S	HEAST
1,4-Dichlorobenzene	8.0E-01	2.5E+00	2.3E-01	7.1E-01	Inhalation	Medium	Increased liver weight	Rat	100 H,A,S	IRIS
Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND						
Naphthalene	3.0E-03	3.0E-03	8.5E-04	8.5E-04	Inhalation	Medium	Hyperplasia and metaplasis in respiratory and olfacotry epithelium	Rat	3,000 H,A,S,D	IRIS
VOLATILES										
1,2-Dichloroethylene (Total)	ND	ND	ND	ND						
Carbon Tetrachloride	ND	ND	5.7E-04 N2	ND						NCEA
Chloroform	ND	ND	8.6E-05 N3	ND						NCEA
Tetrachloroethene	ND	ND	1.4E-01 N4	ND						NCEA
Trichloroethene	ND	ND	ND	ND						IRIS
OTHER										
Total Petroleum Hydrocarbons	ND	ND	ND	ND						
EPH										
C9-C18 Aliphatics	2.0E+00	2.0E+01	5.7E-01	5.7E+00						MADEP[4]
C19-C36 Aliphatics	ND	ND	ND	ND						MADEP[4]
C11-C22 Aromatics	7.1E-02	7.1E-01	2.0E-02	2.0E-01						MADEP[4]
VPH										
C5-C8 Aliphatics	2.0E-01	2.0E+00	5.7E-02	5.7E-01						MADEP[4]
C9-C12 Aliphatics	2.0E+00	2.0E+01	5.7E-01	5.7E+00						MADEP[4]
C9-C10 Aromatics	6.0E-02	6.0E-01	1.7E-02	1.7E-01						MADEP[4]

ND - No data available
mg - milligram
kg - kilogram
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
USEPA - United States Environmental Protection Agency

SOURCES:
IRIS as of 8/99
HEAST, 1997

[1] - Source for all subchronic RfCs is HEAST, 1997

[2] - RfD calculated from RfC as follows:
RfD (mg/kg-d) = RfC (mg/m^3)/ 70 kg x 20 m^3/d

[3] - HEAST Table 1: Subchronic and Chronic Toxicity

[4] - Interim Final Petroleum Report:Development of Health-Based Alternative to the Total Petroleum Hydrocarbon Parameter (1994). and revisions to the MCP 10/31/97.

N1 - An NCEA provisional support value of 1.0 E-3 has been published in the USEPA Region III RBC Table (April, 1999).
N2 - An NCEA provisional support value of 5.7 E-4 has been published in the USEPA Region III RBC Table (April 1999).
N3 - An NCEA provisional support value of 8.6 E-5 has been published in the USEPA Region III RBC Table (April, 1999).
N4 - An NCEA provisional support value of 1.4 E-1 has been published in the USEPA Region III RBC Table (April 1999).
[1] Value is for chromium particulates; value for Chromium VI as dissolved Chromium VI aerosols or chromic acid mists is 8E-6 mg/m^3
[2] - There is a National Ambient Air Quality Standard for lead of 1.5 $\mu g/m^3$ averaged over three months
[3] Rfd calculated from RfC - HEAST Table 2

Uncertainty factors:
H - variation in human sensitivity
A - animal to human extrapolation
S - extrapolation from subchronic to chronic NOAEL
L - extrapolation from LOAEL to NOAEL
D - Lack of supporting data

TABLE 9-43
DERMAL DOSE-RESPONSE DATA FOR CARCINOGENIC AND NONCARCINOGENIC EFFECTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	ORAL ABSORPTION EFFICIENCY[1]	CHRONIC ORAL RfD[2] (mg/kg-day)	CHRONIC DERMAL RfD[3] (mg/kg-day)	SUBCHRONIC ORAL RfD[2] (mg/kg-day)	SUBCHRONIC DERMAL RfD[3] (mg/kg-day)	ORAL CSF[2] (mg/kg-day)	ADJUSTED DERMAL CSF[4] (mg/kg-day)
METALS							
Aluminum	ND	1.0E+00	--	ND	--	ND	--
Antimony	0.15	4.0E-04	6.0E-05	4.0E-04	6.0E-05	ND	--
Arsenic	0.95	3.0E-04	2.9E-04	3.0E-04	2.9E-04	1.5E+00	1.6E+00
Barium	0.07	7.0E-02	4.9E-03	7.0E-02	4.9E-03	ND	--
Cadmium (food)	0.03	1.0E-03	3.0E-05	ND	--	ND	--
Cadmium (water)	0.05	5.0E-04	2.5E-05	ND	--	ND	--
Chromium	0.025	3.0E-03	7.5E-05	2.0E-02	5.0E-04	ND	--
Copper	0.57	ND	--	ND	--	ND	--
Iron	ND	ND	--	ND	--	ND	--
Lead	ND	ND	--	ND	--	ND	--
Manganese (soil)	0.06	7.1E-02	4.3E-03	ND	--	ND	--
Manganese (drinking water)	0.06	2.4E-02	1.4E-03	ND	--	ND	--
Vanadium	0.026	7.0E-03	1.8E-04	7.0E-03	1.8E-04	ND	--
PESTICIDES/PCBs							
Dieldrin	ND	5.0E-05	--	5.0E-05	--	1.6E+01	--
Polychlorinated Biphenyls (PCBs)	0.8	2.0E-05	1.6E-05	5.0E-05	4.0E-05	2.0E+00	2.5E+00
SEMIVOLATILES							
Bis(2-ethylhexyl)phthalate	ND	2.0E-02	--	2.0E-02	--	1.4E-02	--
Polyaromatic Hydrocarbons (PAHs)	0.89						
Benzo(k)fluoranthene		ND	--	ND	--	7.3E-02	8.2E-02
Naphthalene		2.0E-02	1.8E-02	2.0E-02	1.8E-02	ND	--
VOLATILES							
1,2-Dichloroethylenes	ND	9.0E-03	--	9.0E-03	--	ND	--
Chloroform	ND	1.0E-02	--	1.0E-02	--	6.1E-03	--
Tetrachloroethylene	ND	1.0E-02	--	1.0E-01	--	5.2E-02	--
Trichloroethylene	ND	6.0E-03	--	ND	--	1.1E-02	--
OTHER							
VPH							
C5-C8 Aliphatics	0.91	6.0E-02	5.5E-02	6.0E-01	5.5E-01	ND	--
C9-C12 Aliphatics	0.91	6.0E-01	5.5E-01	6.0E+00	5.5E+00	ND	--
C9-C10 Aromatics	0.91	3.0E-02	2.7E-02	3.0E-01	2.7E-01	ND	--

TABLE 9-43
DERMAL DOSE-RESPONSE DATA FOR CARCINOGENIC AND NONCARCINOGENIC EFFECTS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	ORAL ABSORPTION EFFICIENCY[1]	CHRONIC ORAL RfD[2] (mg/kg-day)	CHRONIC DERMAL RfD[3] (mg/kg-day)	SUBCHRONIC ORAL RfD[2] (mg/kg-day)	SUBCHRONIC DERMAL RfD[3] (mg/kg-day)	ORAL CSF[2] (mg/kg-day)	ADJUSTED DERMAL CSF[4] (mg/kg-day)
EPH							
C9-C18 Aliphatics	0.91	6.0E-01	5.5E-01	6.0E+00	5.5E+00	ND	--
C19-C36 Aliphatics	0.91	6.0E+00	5.5E+00	6.0E+01	5.5E+01	ND	--
C11-C22 Aromatics	0.91	3.0E-02	2.7E-02	3.0E-01	2.7E-01	ND	--

NOTES:

[1] Values based on Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance Dermal Risk Assessment Interim Guidance, May 7, 1998. Values for EPH/VPH derived from relative absorption factor (MADEP, 1997).

[2] See Dose-Response Tables; Chronic RfD used if no subchronic RfD available.

[3] Dermal RfD = Oral RfD x Oral Absorption Efficiency

[4] Dermal CSF = Oral CSF / Oral Absorption Efficiency

RfD - Reference Dose

CSF - Cancer Slope Factor

TABLE 9-45
POTENTIAL SOURCES OF UNCERTAINTY
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

UNCERTAINTY	EFFECT	JUSTIFICATION
Likelihood of exposure pathways	Overestimate	Future exposures may not actually occur
Degradation of chemicals not considered	Overestimate	Risk estimates are based on recent chemical concentrations. Concentrations will tend to decrease over time as a result of degradation, so future exposures may be to lower concentrations.
Extrapolation of animal toxicity data to humans	Unknown, probably overestimate	Animals and humans differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical. Animal studies typically involve high-dose exposures, whereas humans are exposed to low doses in the environment.
Use of linearized, multistage model to derive cancer slope factors	Overestimate	Model assumes a non-threshold, linear-at-low-dose relationship for carcinogens. Many compounds induce cancer by non-genotoxic mechanisms. Model results in a 95% upper confidence limit of the cancer risk. The true risk is unlikely to be higher and may be as low as zero.
Summation of effects (cancer risks and hazard indices) from multiple substances	Unknown	The assumption that effects are additive ignores potential synergistic and/or antagnonistic effects. Assumes similarity in mechanism of action, which is not the case for many substances. Compounds may induce tumors or other toxic effects in different organs or systems.
Use of uncertainty factors in the derivation of reference doses.	Unknown	Ten-fold uncertainty factors are incorporated to account for various sources of uncertainty. Although some data seem to support the ten-fold factor, its selection is somewhat arbitrary.
The use of an oral absorption factor of 1	Overestimate	The assumption of 100% gastrointestinal absorption of chemicals on soil is conservative.

TABLE 9-46
ENDPOINTS FOR ECOLOGICAL ASSESSMENT
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

MEDIUM	RECEPTOR	ASSESSMENT ENDPOINT	MEASUREMENT ENDPOINT
Surface Soil (upland and floodplain)	Wildlife	Survival and propagation of wildlife populations.	Oral contaminant doses (mg/kg BW-day) based on measured adverse effects on growth, reproduction, or survival (e.g., LD_{50} studies, LOAELs, and NOAELs) of mammalian or avian laboratory test populations.
	Terrestrial invertebrates	Survival and propagation of terrestrial invertebrate populations.	Contaminant concentrations in surface soil (µg/g) that measure adverse effects on survival (e.g., LC_{50} studies) of terrestrial invertebrates. When no survival studies are available, measured adverse effects on reproduction and growth are used.
	Terrestrial plants	Survival and propagation of plant populations.	Contaminant concentrations in surface soil (µg/g) that measure adverse effects on growth, reproduction, or survival of terrestrial plants.
Surface Water and Sediment	Wildlife	Survival and propagation of wildlife populations.	Oral contaminant doses (mg/kg BW-day) based on measured adverse effects on growth, reproduction, or survival (e.g., LD_{50} studies, LOAELs, or NOAELs) of mammalian or avian laboratory test populations.
Surface Water	Aquatic organisms (small fish, invertebrates, plants, and amphibians)	Survival and propagation of small fish, invertebrate, amphibian, and aquatic plant populations.	Chemical concentrations in surface water (µg/l) associated with adverse effects to growth, reproduction, survival, and biodiversity of aquatic organisms.
Sediment	Aquatic organisms (small fish, invertebrates, plants, and amphibians)	Survival and propagation of small fish, invertebrate, amphibian, and aquatic plant populations.	Chemical concentrations in sediment (µg/g) associated with adverse effects to growth, reproduction, and survival of aquatic organisms.
	Aquatic invertebrates	Survival and propagation of benthic macroinvertebrate populations.	Direct measurement of survival and growth of the midge (*Chironomus tentans*) and amphipod (*Hyalella azteca*) in laboratory toxicity tests.
Groundwater discharge to the surface	Aquatic organisms (small fish, invertebrates, plants, and amphibians)	Future survival and propagation of small fish, invertebrate, amphibian, and aquatic plant populations.	Current chemical concentrations in surface water (µg/l) and sediment (mg/kg) in Cold Spring Brook in the vicinity of the Bower's Brook junction

NOTES:

µg/g = micrograms per gram
µg/l = micrograms per liter
mg/kg BW-day= milligrams per kilogram of body weight per day
LD_{50} = lethal dose to 50 percent of a test population
LC_{50} = lethal concentration to 50 percent of a test population
LOAEL = Lowest Observed Adverse Effect Concentration.
NOAEL = No Observed Adverse Effect Concentration.

TABLE 9-47
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 UPLAND SURFACE SOIL[1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection[2]	Range of SQLs[3]	Range of Detected Concentrations	Background Surface Soil Concentrations[4]	Analyte a CPC?[5]	Average of all Concentrations[6]	Exposure Point Concentrations	
							RME[7]	Average[8]
PAL METALS (µg/g)								
Aluminum	5/5	NA	3,920 to 7,530	18,000	NO[9]			
Arsenic	5/5	NA	7.9 to 21	19	YES	14.5	21	14.5
Barium	5/5	NA	18.8 to 40.9	54	NO[9]			
Beryllium	1/5	0.5	0.71	0.81	NO[9]			
Calcium	5/5	NA	134 to 889	810	NO[10]			
Chromium	5/5	NA	7.7 to 27	33	NO[9]			
Cobalt	5/5	NA	1.9 to 7.5	4.7	YES	4.6	7.5	4.6
Copper	5/5	NA	4.1 to 15.6	13.5	YES	11	15.6	11
Iron	5/5	NA	7,030 to 16,400	18,000	NO[9,10]			
Lead	5/5	NA	8.1 to 22.9	48	NO[9]			
Magnesium	5/5	NA	926 to 4,020	5,500	NO[9,10]			
Manganese	5/5	NA	79.2 to 481	380	YES	282	481	282
Nickel	5/5	NA	6.6 to 30.7	14.6	YES	16.8	30.7	16.8
Potassium	5/5	NA	144 to 1,170	2,400	NO[9,10]			
Selenium	1/5	0.25	0.88	NA	YES	0.28	0.88	0.28
Sodium	5/5	NA	260 to 436	131	NO[10]			
Vanadium	5/5	NA	7.6 to 15.5	32.3	NO[9]			
Zinc	5/5	NA	13.7 to 38.1	43.9	NO[9]			
PESTICIDES/PCBs (µg/g)								
4,4'-DDE	1/5	0.0077	0.020	NA	YES	0.0070	0.020	0.0070
4,4'-DDT	1/5	0.0071	0.026	NA	YES	0.0080	0.026	0.0080
PAL SEMIVOLATILE ORGANICS (µg/g)								
2-Methylnaphthalene	2/5	0.05 to 0.20	0.40 to 0.43	NA	YES	0.20	0.43	0.20
Bis(2-ethylhexyl)phthalate	2/5	0.62 to 3.0	2.0 to 2.7	NA	YES	1.6	2.7	1.6
Dibenzofuran	1/5	0.04 to 0.20	0.16	NA	YES	0.083	0.16	0.083
Fluoranthene	3/5	0.30	0.097 to 0.30	NA	YES	0.16	0.30	0.16
Naphthalene	3/5	0.04 to 0.20	0.1 to 0.42	NA	YES	0.21	0.42	0.21
Phenanthrene	4/5	0.20	0.045 to 0.28	NA	YES	0.15	0.28	0.15
Pyrene	4/5	0.20	0.087 to 0.40	NA	YES	0.18	0.40	0.18
PAL VOLATILE ORGANICS (µg/g								
Chloroform	1/5	0.00087	0.00089	NA	YES	0.00053	0.00089	0.00053
Ethylbenzene	1/5	0.0017	0.0024	NA	YES	0.0012	0.0024	0.0012

TABLE 9-4
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 UPLAND SURFACE SOIL[1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection[2]	Range of SQLs[3]	Range of Detected Concentrations	Background Surface Soil Concentrations[4]	Analyte a CPC?[5]	Average of all Concentrations[6]	Exposure Point Concentrations	
							RME[7]	Average[8]
Tetrachloroethylene	1/5	0.00081	0.0030	NA	YES	0.00092	0.0030	0.00092
Toluene	3/5	0.00078	0.0016 to 0.0037	NA	YES	0.0017	0.0037	0.0017
Trichlorofluoromethane	3/5	0.0059	0.0073 to 0.017	NA	YES	0.0075	0.017	0.0075
Xylenes	1/5	0.0015	0.029	NA	YES	0.0064	0.029	0.0064
OTHER (µg/g)								
Total Petroleum Hydrocarbons	5/5	NA	25 to 8,000	NA	YES	1,700	8,000	1,700

Notes:

[1] Sample locations include: 57B-95-01X, 57B-95-02X, 57E-95-02X, 57E-95-10X, and 57E-95-25X (all collected from 0 to 2 feet below ground surface).

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

[3] Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

[4] Inorganic background concentrations from the Ft. Devens background surface soil database (developed in 1993) were used to screen CPCs.

[5] Contaminant of Potential Concern (CPC) for wildlife receptors.

[6] The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

[7] Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calculated because there are fewer than 10 samples in the data set.

[8] Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.

[9] Maximum concentration is less than the background concentration.

[10] Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

µg/g = micrograms per gram
AOC = Area of contamination.
CPC = Contaminant of potential concern.
NA = Not available.
PAL = Project analyte list.
RME = Reasonable maximum exposure.
SQL = Sample quantitation limit.

TABLE 9-48
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 FLOODPLAIN SURFACE SOIL
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection[2]	Range of SQLs[3]	Range of Detected Concentrations	Background Surface Soil Concentration[4]	Analyte a CPC?[5]	Average of all Concentrations[6]	95th % UCL[7]	Exposure Point Concentrations	
								RME[8]	Average[9]
PAL METALS (µg/g)									
Aluminum	3/3	NA	3,140 to 6,180	18,000	NO[10]				
Antimony	1/11	1.1 to 7.1	1.6	0.5	YES	2.8	5.9	1.6	1.6
Arsenic	11/11	NA	7.0 to 61.2	19	YES	24.1	47.9	47.9	24.1
Barium	11/11	NA	10.7 to 113	54	YES	47.9	106	106	47.9
Beryllium	1/3	0.5	0.71	0.81	NO[10]				
Calcium	3/3	NA	255 to 528	810	NO[10,11]				
Chromium	3/3	NA	9.0 to 15.4	33	NO[10]				
Cobalt	3/3	NA	1.9 to 2.3	4.7	NO[10]				
Copper	11/11	NA	2.5 to 41.3	13.5	YES	15.6	39.3	39.3	15.6
Iron	3/3	NA	5,390 to 7,920	18,000	NO[10, 11]				
Lead	11/11	NA	18.7 to 320	48	YES	143	459	320	143
Magnesium	3/3	NA	1,120 to 1,390	5,500	NO[10,11]				
Manganese	11/11	NA	36.7 to 679	380	YES	149	273	273	149
Nickel	3/3	NA	6.1 to 10.4	14.6	NO[10]				
Potassium	3/3	NA	327 to 460	2,400	NO[10,11]				
Selenium	9/11	0.25	0.39 to 4.4	NA	YES	1.9	12.1	4.4	1.9
Sodium	3/3	NA	294 to 446	131	NO[11]				
Vanadium	3/3	NA	5.7 to 14	32.3	NO[10]				
Zinc	10/11	8.0	14.9 to 150	43.9	YES	55.1	183	150	55.1
PESTICIDES/PCBs (µg/g)									
4,4'-DDD	1/11	0.0083	0.037	NA	YES	0.0071	0.010	0.010	0.0071
4,4'-DDE	4/11	0.0077	0.0093 to 0.052	NA	YES	0.013	0.034	0.034	0.013
4,4'-DDT	4/11	0.0071	0.035 to 0.18	NA	YES	0.039	0.43	0.18	0.039
Aroclor-1260	8/11	0.080	0.19 to 4.2	NA	YES	0.63	3.6	3.6	0.63
Dieldrin	4/11	0.0063	0.013 to 0.032	NA	YES	0.0099	0.025	0.025	0.0099
PAL SEMIVOLATILE ORGANICS (µg/g)									
2-Methylnaphthalene	1/11	0.049 to 0.50	0.60	NA	YES	0.18	0.38	0.38	0.18
Acenaphthylene	1/11	0.033 to 0.30	0.40	NA	YES	0.13	0.26	0.26	0.13
Benzo[k]fluoranthene	1/11	0.066 to 0.70	1.0	NA	YES	0.27	0.60	0.60	0.27
Chrysene	1/11	0.12 to 1.0	1.0	NA	YES	0.39	0.71	0.71	0.39
Di-n-butylphthalate	1/11	0.061 to 0.60	2.0	NA	YES	0.33	0.77	0.77	0.33
Fluoranthene	3/11	0.068 to 0.70	1.0 to 2.0	NA	YES	0.58	2.7	2.0	0.58
Naphthalene	1/11	0.037 to 0.40	0.40	NA	YES	0.14	0.30	0.30	0.14
Phenanthrene	5/11	0.033 to 0.30	0.30 to 1.0	NA	YES	0.39	2.3	1.0	0.39
Pyrene	5/11	0.033 to 0.30	0.40 to 2.0	NA	YES	0.63	6.6	2.0	0.63

TABLE 9-48
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 FLOODPLAIN SURFACE SOIL
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection[2]	Range of SQLs[3]	Range of Detected Concentrations	Background Surface Soil Concentration[4]	Analyte a CPC?[5]	Average of all Concentrations[6]	95th % UCL[7]	Exposure Point Concentrations	
								RME[8]	Average[9]
PAL VOLATILE ORGANICS (µg/g)									
1,2-Dichloroethylene (cis and trans)	2/11	0.0030	0.01 to 0.016	NA	YES	0.0036	0.0069	0.0069	0.0036
Acetone	2/11	0.017	0.073 to 0.33	NA	YES	0.029	0.067	0.067	0.029
Ethylbenzene	2/11	0.0017	0.0033 to 0.022	NA	YES	0.003	0.0059	0.0059	0.003
Methylene Chloride	1/11	0.012	0.015	NA	YES	0.0068	0.0081	0.0081	0.0068
Tetrachloroethylene	2/11	0.0008	0.0011 to 0.0047	NA	YES	0.0009	0.0014	0.0014	0.0009
Toluene	2/11	0.0008	0.0072 to 0.0083	NA	YES	0.0017	0.0051	0.0051	0.0017
Trichlorofluoromethane	3/11	0.0059	0.0073 to 0.014	NA	YES	0.0048	0.0072	0.0072	0.0048
OTHER (µg/g)									
Total Petroleum Hydrocarbons	11/11	NA	169 to 17,000	NA	YES	3,500	20,000	17,000	3,500

Notes:

1 Sample locations include: 57E-95-12X, 57E-95-16X, 57E-95-17X (all collected from 0 to 2 feet below ground surface), 57S-98-01X, 57S-98-02X, 57S-98-04X, and 57S-98-06X through 57S-98-09X (all collected from 0-1 feet below the ground surface). 57S-98-07X also includes a sample collected from 1-2 feet below ground surface.
2 Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.
3 Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).
4 Inorganic background concentrations from the Ft. Devens background surface soil database (developed in 1993) were used to screen CPCs.
5 Contaminant of Potential Concern (CPC) for wildlife receptors.
6 The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.
7 The 95th percent UCL was calculated for data sets with 10 or more samples, and is calculated using the log-transformed average of all concentrations (assuming a log normal distribution).
8 Reasonable Maximum Exposure (RME) concentrations are equal to the lesser of the maximum detected concentration and the 95th percent UCL, when more than 10 samples were collected. The RME is equal to the maximum detected concentration when less than 10 samples were collected.
9 Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.
10 Maximum concentration is less than the background concentration.
11 Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

µg/g = micrograms per gram
AOC = Area of contamination.
CPC = Contaminant of potential concern.
NA = Not available.
PAL = Project analyte list.
RME = Reasonable maximum exposure.
SQL = Sample quantitation limit.

TABLE 9-49
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SURFACE SOIL[1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection[2]	Range of SQLs[3]	Range of Detected Concentrations	Background Surface Soil Concentration[4]	Analyte a CPC?[5]	Average of all Concentrations[6]	Exposure Point Concentrations	
							RME[7]	Average[8]
PAL METALS (µg/g)								
Aluminum	2/2	NA	6,370 to 7,100	18,000	NO[9]			
Arsenic	4/4	NA	5.2 to 41	19	YES	25.0	41	25.0
Barium	4/4	NA	11.1 to 29.3	54	NO[9]			
Cadmium	1/2	0.7	1.5	1.28	YES	0.93	1.5	0.93
Calcium	1/2	100	283	810	NO[9,10]			
Chromium	2/2	NA	10.6 to 11.7	33	NO[9]			
Cobalt	2/2	NA	2.4 to 3.2	4.7	NO[9]			
Copper	4/4	NA	2.9 to 6.8	13.5	NO[9]			
Iron	2/2	NA	7,430 to 8,040	18,000	NO[9,10]			
Lead	3/4	10.5	7.8 to 32.7	48	NO[9]			
Magnesium	2/2	NA	1,540 to 1,650	5,500	NO[9,10]			
Manganese	4/4	NA	69.5 to 548	380	YES	219	548	2.19
Nickel	2/2	NA	10.5 to 11.1	14.6	NO[9]			
Potassium	2/2	NA	209 to 683	2,400	NO[9,10]			
Selenium	1/4	0.25	1.6	NA	YES	0.48	1.6	0.48
Sodium	2/2	NA	400 to 435	131	NO[10]			
Vanadium	2/2	NA	9.2 to 9.4	32.3	NO[9]			
Zinc	4/4	NA	15.8 to 28.5	43.9	NO[9]			
PESTICIDES/PCBs (µg/g)								
4,4'-DDD	2/5	0.0083	0.0234 to 0.27	NA	YES	0.061	0.27	0.061
4,4'-DDE	1/5	0.0077 to 0.05	0.0081	NA	YES	0.0089	0.0081	0.0081
4,4'-DDT	2/5	0.0071 to 0.05	0.0121 to 0.025	NA	YES	0.014	0.025	0.014
Chlordane - Alpha	1/4	0.0013 to 0.005	0.0028	NA	YES	0.0021	0.0028	0.0021
Chlordane - Gamma	1/4	0.0013 to 0.005	0.0028	NA	YES	0.0021	0.0028	0.0021
Aroclor-1260	1/5	0.025 to 0.0804	0.47	NA	YES	0.12	0.47	0.12
PAL SEMIVOLATILE ORGANICS (µg/g)								
1,2-Dichlorobenzene	1/4	0.11	0.35	NA	YES	0.13	0.35	0.13
1,4-Dichlorobenzene	1/4	0.098	0.48	NA	YES	0.16	0.48	0.16
Fluoranthene	2/5	0.068 to 2.2	0.13 to 0.14	NA	YES	0.29	0.14	0.14
Naphthalene	1/5	0.037 to 2.2	0.048	NA	YES	0.89	0.048	0.048

TABLE 9-49
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SURFACE SOIL[1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection [2]	Range of SQLs [3]	Range of Detected Concentrations	Background Surface Soil Concentration [4]	Analyte a CPC? [5]	Average of all Concentrations [6]	Exposure Point Concentrations	
							RME [7]	Average [8]
Phenanthrene	2/5	0.033 to 2.2	0.067 to 0.11	NA	YES	0.26	0.11	0.11
Pyrene	2/5	0.033 to 2.2	0.096 to 0.15	NA	YES	0.28	0.15	0.15
PAL VOLATILE ORGANICS (µg/g)								
Chlorobenzene	1/4	0.0009	0.012	NA	YES	0.0033	0.012	0.0033
Toluene	2/4	0.0008 to 310	0.0017 to 0.0030	NA	YES	0.0014	0.0030	0.0014
Trichloroethylene	1/4	0.0028	0.0042	NA	YES	0.0021	0.0042	0.0021
EPH/VPH (µg/g)								
Eph C11-C22 Aromatics	2/2	NA	60 to 75	NA	YES	70	75	70
Eph C19-C36 Aliphatics	2/2	NA	150 to 180	NA	YES	170	180	170
Vph C9-C10 Aromatics	1/2	NA	3.7	NA	YES	2.2	3.7	2.2
OTHER (µg/g)								
Total Petroleum Hydrocarbons	10/11	1,400	39 to 2,900	NA	YES	850	2,900	850

Notes:

1 Sample locations include: EX57W15X, 57B-95-08X, 57B-95-09X, 57S-98-11X through 57S-98-16X (all collected from 0 to 1 feet below ground surface), and 57S-98-12X, through 57S-98-14X (collected 1 to 2 feet below ground surface).

2 Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

3 Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

4 Inorganic background concentrations from the Ft. Devens background surface soil database (developed in 1993) were used to screen CPCs.

5 Contaminant of Potential Concern (CPC) for wildlife receptors.

6 The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

7 Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; except for TPHC the 95th percent UCL was not calculated because there are fewer than 10 samples in the data set. The 95% UCL for TPHC is greater than the maximum detected concentration.

8 Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.

9 Maximum concentration is less than the background concentration.

10 Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

µg/g = micrograms per gram
AOC = Area of contamination.
CPC = Contaminant of potential concern.
NA = Not available.
PAL = Project analyte list.
RME = Reasonable maximum exposure.
SQL = Sample quantitation limit.

TABLE 9-50
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 SURFACE WATER [1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection [2]	Range of SQLs [3]	Range of Detected Concentrations	Upgradient Surface Water Concentration [4]	Analyte a CPC? [5]	Average of all Concentrations [6]	Exposure Point Concentrations	
							RME [7]	Average [8]
PAL UNFILTERED METALS (µg/L)								
Aluminum	5/6	141	156 to 15,100	ND	YES	2,650	15,100	2,650
Arsenic	9/9	NA	4.1 to 198	5.4	YES	50.6	198	50.6
Barium	9/9	NA	12.2 to 553	12.6	YES	155	553	155
Cadmium	1/6	4.0	24.6	ND	YES	5.8	24.6	5.8
Calcium	6/6	NA	18,400 to 28,700	24,300	NO[9]			
Chromium	1/6	6.0	35.8	ND	YES	8.5	35.8	8.5
Copper	4/9	8.1	60.4 to 375	9.0	YES	74.9	375	74.9
Iron	6/6	NA	592 to 17,600	645	YES	5,840	17,600	5,840
Lead	7/9	1.3	1.5 to 967	ND	YES	243	967	243
Magnesium	6/6	NA	1,290 to 4,930	3,630	NO[9]			
Manganese	6/6	NA	123 to 433	131	YES	243	433	243
Mercury	1/6	0.24	0.24	ND	YES	0.14	0.24	0.14
Potassium	6/6	NA	1,320 to 3,840	1,630	NO[9]			
Selenium	1/9	2 to 3.02	2.4	ND	YES	1.5	2.4	1.5
Sodium	6/6	NA	17,800 to 60,900	19,200	NO[9]			
Vanadium	1/6	11	72.3	ND	YES	16.6	72.3	16.6
Zinc	5/9	21.1	109 to 712	ND	YES	180	712	180
PAL FILTERED METALS (µg/L)								
Arsenic	4/5	2.5	3.4 to 8.9	4.4	YES	4.4	8.9	4.4
Barium	5/5	NA	11.7 to 43.1	11.9	YES	21.7	43.1	21.7
Calcium	4/4	NA	11,800 to 24,000	24,100	NO[9,10]			
Iron	4/4	NA	194 to 17,200	254	YES	4,540	17,200	4,540
Lead	1/5	1.3 to 50	2.3	ND	YES	5.8	2.3	5.8
Magnesium	4/4	NA	1,050 to 3,550	3,610	NO[9,10]			
Manganese	4/4	NA	64.2 to 483	107	YES	197	483	197
Potassium	4/4	NA	1,490 to 2,430	1,700	NO[9]			
Sodium	4/4	NA	15,800 to 56,900	19,000	NO[9]			
Zinc	1/5	21.1 to 35.8	58.4	NA	YES	21.6	58.4	21.6

TABLE 9-50
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 SURFACE WATER [1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection [2]	Range of SQLs [3]	Range of Detected Concentrations	Upgradient Surface Water Concentration [4]	Analyte a CPC? [5]	Average of all Concentrations [6]	Exposure Point Concentrations	
							RME [7]	Average [8]
PAL SEMIVOLATILE ORGANICS (µg/L)								
Bis(2-ethylhexyl)phthalate	1/9	4.8	24	ND	YES	4.8	24	4.8
Phenanthrene	1/9	0.5	0.52	ND	YES	0.28	0.52	0.28
PAL VOLATILE ORGANICS (µg/L)								
1,2-Dichloroethylenes (cis and trans)	1/9	0.5	26	ND	YES	3.1	26	3.1
Carbon disulfide	1/9	0.5	1.1	ND	YES	0.34	1.1	0.34
Chloroform	1/9	0.5	0.72	ND	YES	0.30	0.72	0.30
Methylene chloride	3/9	2.3	2.3 to 4.1	3.0	YES	1.8	4.1	1.8
Tetrachloroethylene	2/9	1.6	1.8 to 2.6	ND	YES	1.11	1.8	1.11
Toluene	1/9	0.5	1.1	0.42	YES	0.34	1.1	0.34
Trichloroethylene	2/9	0.5	0.6 to 3.5	ND	YES	0.65	3.5	0.65
WET CHEMISTRY (µg/L)								
Alkalinity	6/6	NA	13,000 to 36,000	35,300	YES	29,700	36,000	29,700
Chloride	6/6	NA	25,200 to 100,000	44,000	YES	50,200	100,000	50,200
Nitrite, Nitrate-non Specific	4/6	10	130 to 152	128	NA			
Nitrogen By Kjeldahl Method	5/6	183	276 to 16,000	639	NA			
Phosphate	6/6	NA	18.8 to 1,000	49.2	NA			
Sulfate	6/6	NA	11,000 to 13,000	13,000	NA			
Total Dissolved Solids	6/6	NA	125,000 to 234,000	160,000	NA	162,000		
Total Hardness	6/6	NA	85,000 to 110,000	107,000	NA	100,000		
Total Suspended Solids	8/8	NA	4,000 to 10,500,000	39,800	YES	1,700,000	10,500,000	1,700,000
OTHER (µg/L)								
Total Petroleum Hydrocarbons	2/6	168 to 176	247 to 924	ND	YES	252	924	252
EPH								
C11-C22 Aromatics	3/3	NA	380 to 1,400	NA	YES	797	1,400	797
C19-C36 Aliphatics	3/3	NA	750 to 1,700	NA	YES	1,280	1,700	1,280

TABLE 9-50

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 SURFACE WATER [1]

AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection [2]	Range of SQLs [3]	Range of Detected Concentrations	Upgradient Surface Water Concentration [4]	Analyte a CPC? [5]	Average of all Concentrations [6]	Exposure Point Concentrations	
							RME [7]	Average [8]

Notes:

[1] Sample locations include: 57D-95-04X through 57D-95-07X, 57D-95-09X, 57D-95-10X, and 57W-98-01X through 57W-98-03X. Filtered samples were collected at 57W-95-04X through 57W-95-06X, 57W-95-10X, and 57W-98-01X.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

[3] Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

[4] The arithmetic mean of inorganic concentrations detected in upgradient samples was used to screen surface water CPCs. Upgradient sample locations include 57W-95-03X and -08X.

[5] Contaminant of Potential Concern (CPC) for aquatic and wildlife receptors.

[6] The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

[7] Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calculated because there are fewer than 10 samples in the data set.

[8] Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.

[9] Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

[10] Maximum concentration is less than the average upgradient concentration.

µg/L = micrograms per liter
AOC = Area of contamination.
CPC = Contaminant of potential concern.
NA = Not available.
ND = Not detected.
PAL = Project analyte list.
RME = Reasonable maximum exposure.
SQL = Sample quantitation limit.

TABLE 9-51
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SURFACE WATER[1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection[2]	Range of SQLs[3]	Range of Detected Concentrations	Upgradient Surface Water Concentration[4]	Analyte a CPC?[5]	Average of all Concentrations[6]	Exposure Point Concentrations RME[7]	Exposure Point Concentrations Average[8]
PAL UNFILTERED METALS (µg/L)								
Antimony	3/5	1	2.0 to 5.6	NA	YES	2.1	5.6	2.1
Arsenic	4/4	NA	5.6 to 153	5.4	YES	49.1	153	49.1
Barium	5/5	NA	42.8 to 278	12.6	YES	176	278	176
Copper	4/5	5	19.2 to 44.1	9.0	YES	23.9	44.1	23.9
Lead	5/5	NA	27.8 to 184	NA	YES	92.4	184	92.4
Manganese	1/1	NA	92.8	131	NO[10]			
Selenium	2/5	2	2.1 to 2.5	NA	YES	1.5	2.5	1.5
Zinc	4/5	35.8	80.6 to 445	NA	YES	211	445	211
PAL FILTERED METALS (µg/L)								
Arsenic	5/5	NA	3.7 to 53.4	4.4	YES	20.0	53.4	20.0
Barium	5/5	NA	5.2 to 22.8	11.9	YES	13.4	22.8	13.4
Manganese	2/2	NA	37.6 to 155	107	YES	96.3	155	96.3
PAL SEMIVOLATILE ORGANICS (µg/L)								
Benzo[k]fluoranthene	1/4	0.87	0.94	NA	YES	0.56	0.94	0.56
PAL VOLATILE ORGANICS (µg/L)								
Carbon Disulfide	1/5	0.50	0.58	NA	YES	0.32	0.58	0.32
Chlorobenzene	1/5	0.50	4.6	NA	YES	1.1	4.6	1.1
Toluene	2/5	0.50	0.59 to 1.6	NA	YES	0.59	1.6	0.59
EPH/VPH (µg/L)								
Eph C11-C22 Aromatics	5/5	NA	300 to 650	NA	NA	430		
Eph C19-C36 Aliphatics	2/5	500 to 530	1,000 to 1,100	NA	NA	570		
Vph C9-C10 Aromatics	1/5	20	25	NA	NA	13		
OTHER (µg/L)								
Total Suspended Solids	5/5	NA	3,240,000 to 15,800,000	39,800	NA	6,620,000		

Notes:
1 Sample locations include: 57W-98-04X through 57W-98-08X (duplicate at 57W-98-07X). Filtered samples were collected at 57W-98-04X through 57W-98-08X.
2 Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.
3 Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).
4 The arithmetic mean of inorganic concentrations detected in upgradient samples was used to screen surface water CPCs. Upgradient sample locations include

TABLE 9-51
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SURFACE WATER[1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection[2]	Range of SQLs[3]	Range of Detected Concentrations	Upgradient Surface Water Concentration[4]	Analyte a CPC?[5]	Average of all Concentrations[6]	Exposure Point Concentrations	
							RME[7]	Average[8]

57W-95-03X and -08X.

[5] Contaminant of Potential Concern (CPC) for aquatic and wildlife receptors.

[6] The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

[7] Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calculated because there are fewer than *10 samples in the data set.*

[8] Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.

[9] Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

[10] Maximum concentration is less than the average upgradient concentration.

µg/L = micrograms per liter
AOC = Area of contamination.
CPC = Contaminant of potential concern.
NA = Not available.
PAL = Project analyte list.
RME = Reasonable maximum exposure.
SQL = Sample quantitation limit.

TABLE 9-52
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 SEDIMENT[1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection [2]	Range of SQLs [3]	Range of Detected Concentrations	Upgradient Sediment Concentration [4]	Elevated Sediment Concentration [5]	Analyte a CPC? [6]	Average of all Concentrations [7]	Exposure Point Concentrations RME [8]	Exposure Point Concentrations Average [9]
PAL METALS (µg/g)									
Aluminum	6/6	NA	7,210 to 15,900	12,400	NA	YES	11,600	15,900	11,600
Arsenic	9/9	NA	10.4 to 220	110	25-50	YES	70.2	220	70.2
Barium	6/9	5.2	30 to 159	101	NA	YES	69.8	159	69.8
Cadmium	1/6	0.70	2.3	NA	5-14	NO [10]			
Calcium	6/6	NA	2,170 to 18,400	9,890	NA	NO [11]			
Chromium	3/6	4.1	40.9 to 48.9	40.6	30-70	YES	23.2	48.9	23.2
Cobalt	5/6	1.4	6.9 to 25.8	21.2	NA	YES	15.0	25.8	15.0
Copper	8/9	0.97	8.7 to 201	30.7	70-130	YES	46.6	201	46.6
Iron	6/6	NA	5,280 to 30,400	26,900	30,000-60,000	YES	21,300	30,400	21,300
Lead	8/9	10.5	43.9 to 410	208	200-410	YES	175	410	175
Magnesium	6/6	NA	1,380 to 4,480	3,710	NA	NO [11]			
Manganese	9/9	NA	40.1 to 3,940	1,510	350-850	YES	1,200	3,940	1,200
Mercury	1/6	0.050	0.36	0.20	0.35-0.75	YES	0.081	0.36	0.081
Nickel	5/6	1.7	25.7 to 42.9	34.8	35-75	YES	29.3	42.9	29.3
Potassium	4/6	100	769 to 1,240	934	NA	NO [11]			
Selenium	6/9	0.25	0.93 to 7.7	2.8	NA	YES	2.3	7.7	2.3
Sodium	6/6	NA	741 to 3,610	1,150	NA	NO [11]			
Vanadium	4/6	3.4	28.4 to 40.3	34.7	60-100	NO [10]			
Zinc	6/9	8.0	129 to 468	315	250-450	YES	206	468	206
PESTICIDES/PCBs (µg/g)									
4,4'-DDD	7/9	0.0083	0.0258 to 0.44	0.53	NA	YES	0.15	0.44	0.15
4,4'-DDE	4/9	0.0077	0.086 to 0.16	0.18	NA	YES	0.056	0.16	0.056
4,4'-DDT	4/6	0.0071	0.0363 to 0.076	0.092	NA	YES	0.040	0.076	0.040
Aroclor-1260	1/9	0.0804	0.30	NA	NA	YES	0.069	0.30	0.069
Dieldrin	2/9	0.0063	0.0183 to 0.046	NA	NA	YES	0.0096	0.046	0.0096
PAL SEMIVOLATILE ORGANICS (µg/g)									
Benzo[k]fluoranthene	3/9	0.066 to 1.0	0.35 to 3.0	1.8	NA	YES	0.58	3.0	0.58
Chrysene	2/9	0.12 to 2.0	0.53 to 1.2	NA	NA	YES	0.47	1.2	0.47
Fluoranthene	7/9	0.30 to 1.0	0.82 to 6.0	5	NA	YES	2.2	6.0	2.2
Phenanthrene	6/9	0.20 to 0.70	0.48 to 3.0	2.3	NA	YES	0.80	3.0	0.80
Pyrene	8/9	0.70	0.72 to 6.0	4.8	NA	YES	2.3	6.0	2.3
PAL VOLATILE ORGANICS (µg/g)									
Acetone	4/9	0.017	0.071 to 0.31	0.55	NA	YES	0.080	0.31	0.080
Methylene chloride	1/9	0.012	0.15	NA	NA	YES	0.022	0.15	0.022
Tetrachloroethene	2/9	0.00080	0.010 to 0.078	NA	NA	YES	0.010	0.078	0.010
Toluene	4/9	0.00080	0.0065 to 0.020	NA	NA	YES	0.0050	0.020	0.0050
Trichloroethylene	1/9	0.0028	0.027	NA	NA	YES	0.0042	0.027	0.0042
Trichlorofluoromethane	2/9	0.0059	0.020 to 0.076	NA	NA	YES	0.013	0.076	0.013

TABLE 9-52
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 SEDIMENT[1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection[2]	Range of SQLs[3]	Range of Detected Concentrations	Upgradient Sediment Concentration[4]	Elevated Sediment Concentration[5]	Analyte a CPC?[6]	Average of all Concentrations[7]	Exposure Point Concentrations	
								RME[8]	Average[9]
TPH BY GC (µg/g)									
Diesel Fuel	5/6	8	53 to 170	46	NA	YES	78	170	78
Total Petroleum Hydrocarbons, Gas Fraction	3/6	8	107 to 150	57	NA	YES	64	150	64
OTHER (µg/g)									
Total Organic Carbon	9/9	NA	84,900 to 602,000	277,000	NA	NA	257,000		
Total Petroleum Hydrocarbons (418.1)	7/9	28	103 to 3,200	240	NA	YES	790	3,200	790
Total Petroleum Hydrocarbons (IR)	1/3	1,800 to 31,000	2,500	NA	NA	YES	6,300	2,500	2,500

Notes:

[1] Sample locations include: 57D-95-04X through 57D-95-07X, 57D-95-09X, 57D-95-10X, and 57D-98-01X through 57D-98-03X.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

[3] Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

[4] The arithmetic mean of concentrations detected in upgradient samples was used to screen sediment CPCs (inorganics only). Upgradient sample locations include 57D-95-03X and -08X.

[5] Rojko, 1990. "Proposed Classification Scheme for Sediments in Massachusetts Lakes and Ponds". Values less than the provided range are classified as "normal", and values greater than the provided range are classified as "highly elevated".

[6] Contaminant of Potential Concern (CPC) for aquatic and wildlife receptors.

[7] The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

[8] Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calucated because there are fewer than 10 samples in the data set.

[9] Average Exposure Point Concentrations (EPCs) are equal to the lesser of the average of all concentrations and RME.

[10] Maximum concentration corresponds to a level classified as "normal" for lake sediment concentrations for this analyte (Rojko, 1990).

[11] Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

µg/g = micrograms per gram
AOC = Area of contamination.
CPC = Contaminant of potential concern.
NA = Not available.
PAL = Project analyte list.
RME = Reasonable maximum exposure.
SQL = Sample quantitation limit.

TABLE 9-53
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SEDIMENT[1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection [2]	Range of SQLs [3]	Range of Detected Concentrations	Upgradient Sediment Concentration [4]	Elevated Sediment Concentration [5]	Analyte a CPC? [6]	Average of all Concentrations [7]	Exposure Point Concentrations	
								RME [8]	Average [9]
PAL METALS (µg/g)									
Arsenic	5/5	NA	3.2 to 37.1	110	25-50	NO [10]			
Barium	5/5	NA	16.1 to 59.8	101	NA	NO [10]			
Copper	3/5	0.97	2.7 to 11.2	30.7	70-130	NO [10,11]			
Lead	2/5	10.5	33.6 to 64.6	208	200-410	NO [10,11]			
Manganese	5/5	NA	29 to 459	1,510	350-850	NO [10]			
Selenium	4/5	0.25	0.72 to 1.8	2.8	NA	NO [10]			
Zinc	1/5	8.0	90.8	315	250-450	NO [10,11]			
PESTICIDES/PCBs (µg/g)									
4,4'-DDD	3/5	0.0083	0.048 to 0.15	0.53	NA	YES	0.053	0.15	0.053
Aroclor-1260	1/5	0.080	0.84	NA	NA	YES	0.20	0.84	0.20
PAL SEMIVOLATILE ORGANICS (µg/g)									
1,2-Dichlorobenzene	1/5	0.11	0.39	NA	NA	YES	0.12	0.39	0.12
1,4-Dichlorobenzene	2/5	0.098	0.43 to 1.0	NA	NA	YES	0.32	1.0	0.32
Benzo[b]fluoranthene	1/5	0.21	0.49	NA	NA	YES	0.18	0.49	0.18
Benzo[k]fluoranthene	3/5	0.066	0.19 to 0.28	1.8	NA	YES	0.15	0.28	0.15
Chrysene	1/5	0.12	0.34	NA	NA	YES	0.12	0.34	0.12
Fluoranthene	4/5	0.068	0.17 to 0.65	5	NA	YES	0.36	0.65	0.36
Naphthalene	2/5	0.037	0.13 to 0.53	NA	NA	YES	0.14	0.53	0.14
Phenanthrene	4/5	0.033	0.085 to 0.37	2.3	NA	YES	0.19	0.37	0.19
Pyrene	5/5	NA	0.16 to 0.56	4.8	NA	YES	0.36	0.56	0.36
PAL VOLATILE ORGANICS (µg/g)									
Acetone	5/5	NA	0.057 to 0.21	0.55	NA	YES	0.15	0.21	0.15
Benzene	2/5	0.0015	0.007 to 0.037	NA	NA	YES	0.0093	0.037	0.0093
Chlorobenzene	3/5	0.0009	0.0031 to 0.019	NA	NA	YES	0.0072	0.019	0.0072
Toluene	3/5	0.0008	0.0018 to 0.0048	NA	NA	YES	0.0024	0.0048	0.0024
Xylenes	1/5	0.0015	0.011	NA	NA	YES	0.0028	0.011	0.0028
EPH/VPH (µg/g)									
EPH C11-C22 Aromatics	1/5	50 to 160	280	NA	NA	NA	90	280	90
EPH C19-C36 Aliphatics	1/5	50 to 160	630	NA	NA	NA	160	630	160
Total Petroleum Hydrocarbons	2/5	380 to 1,500	5,500	NA	NA	NA	2,400	5,500	2400
VPH C5-C8 Aliphatics	1/5	1.8 to 8.0	3.3	NA	NA	NA	2.1	3.3	2.1
VPH C9-C10 Aromatics	1/5	1.8 to 8.0	4.3	NA	NA	NA	2.3	4.3	2.3
VPH C9-C10 Aliphatics	2/5	1.8 to 8.0	4.2 to 5.6	NA	NA	NA	3.2	5.6	3.2
OTHER (µg/g)									
Total Organic Carbon	5/5	NA	38,400 to 210,000	NA	NA	NA	97,000		

TABLE 9-53
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SEDIMENT[1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection[2]	Range of SQLs[3]	Range of Detected Concentrations	Upgradient Sediment Concentration[4]	Elevated Sediment Concentration[5]	Analyte a CPC?[6]	Average of all Concentrations[7]	Exposure Point Concentrations	
								RME[8]	Average[9]
Total Petroleum Hydrocarbons	5/5	NA	109 to 3,500	238	NA	YES	850	3,500	850

Notes:
1 Sample locations include: 57D-98-04X through 57D-98-08X.
2 Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.
3 Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).
4 The arithmetic mean of inorganic concentrations detected in upgradient samples was used to screen sediment CPCs. Upgradient sample locations include 57D-95-03X and -08X.
5 Rojko, 1990. "Proposed Classification Scheme for Sediments in Massachusetts Lakes and Ponds". Values less than the provided range are classified as "normal", and values greater than the provided range are classified as "highly elevated".
6 Contaminant of Potential Concern (CPC) for aquatic and wildlife receptors.
7 The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.
8 Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calucated because there are fewer than 10 samples in the data set.
9 Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.
10 Maximum concentration is less than upgradient concentration.
11 Maximum concentration corresponds to a level classified as "normal" for lake sediment concentrations for this analyte (Rojko, 1990).
12 Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

µg/g = micrograms per gram
AOC = Area of contamination.
CPC = Contaminant of potential concern.
NA = Not available.
PAL = Project analyte list.
RME = Reasonable maximum exposure.
SQL = Sample quantitation limit.

TABLE 9-54
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 GROUNDWATER [1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection [2]	Range of SQLs [3]	Range of Detected Concentrations	Background Groundwater Concentration [4]	Upgradient Groundwater Concentration [5]	Analyte a CPC? [6]	Average of all Concentrations [7]	Exposure Point Concentrations	
								RME [8]	Average [9]
PAL UNFILTERED METALS (µg/L)									
Aluminum	3/7	141	204 to 2,480	6,870	507	NO [10]			
Arsenic	3/8	2.5	4.9 to 54.4	10.5	3.6	YES	9.3	54.4	9.3
Barium	8/8	NA	7.3 to 63.5	39.6	21.3	YES	18.3	63.5	18.3
Calcium	7/7	NA	2,660 to 17,400	14,700	10,000	NO [11]			
Copper	2/8	5 to 8.1	10.3 to 39.1	8.09	5.6	YES	6.4	39.1	6.4
Iron	5/7	38.8	87.4 to 6,310	9,100	665	NO [10]			
Lead	6/8	1.3	1.8 to 16.0	4.25	1.9	YES	4.0	16.0	4.0
Magnesium	6/7	500	522 to 1,910	3,480	880	NO [10,11]			
Manganese	7/7	NA	5.8 to 3,700	291	61.9	YES	593	3,700	593
Potassium	7/7	NA	704 to 4,140	2,370	1,830	NO [11]			
Sodium	7/7	NA	2,800 to 34,900	10,800	27,000	NO [11]			
Zinc	2/8	21.1 to 35.8	25.3 to 31.0	21.1	15.3	YES	13.7	31.0	13.7
PAL FILTERED METALS (µg/L)									
Aluminum	1/7	141	167	6,870	ND	NO [10]			
Arsenic	2/8	2.5	2.8 to 73.0	10.5	ND	YES	10.5	73.0	10.5
Barium	8/8	NA	7.6 to 45.6	39.6	21.6	YES	17.4	45.6	17.4
Calcium	7/7	NA	2,590 to 14,100	14,700	11,300	NO [10,11]			
Iron	3/7	38.8	47.4 to 3,530	9,100	22.7	NO [10]			
Lead	2/8	1.3	4.4 to 9.0	4.25	0.68	YES	1.6	9.0	1.6
Magnesium	6/7	500	507 to 1,500	3,480	887	NO [10,11]			
Manganese	7/7	NA	6.0 to 2,420	291	10.8	YES	474	2,420	474
Potassium	7/7	NA	775 to 2,990	2,370	1,900	NO [11]			
Sodium	7/7	NA	2,760 to 34,500	10,800	33,400	NO [11]			
PESTICIDES (µg/L)									
Endosulfan II	1/8	0.023	0.027	NA	ND	YES	0.013	0.027	0.013
PAL SEMIVOLATILE ORGANICS (µg/L)									
Bis(2-ethylhexyl)phthalate	4/8	4.8	5 to 400	NA	3.4	YES	47	400	47
Diethylphthalate	1/8	2	2.7	NA	1.6	YES	1.1	2.7	1.1
PAL VOLATILE ORGANICS (µg/L)									
1,2-Dichloroethylenes (cis and trans)	2/8	0.5	1.8 to 13	NA	ND	YES	2.2	13	2.2
Acetone	1/8	13	19	NA	ND	YES	7.3	19	7.3
Tetrachloroethylene	2/8	1.6	1.7 to 16	NA	ND	YES	2.2	16	2.2
Toluene	6/8	0.5	0.53 to 1.2	NA	0.34	YES	0.45	1.2	0.45

TABLE 9-54
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 GROUNDWATER [1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection [2]	Range of SQLs [3]	Range of Detected Concentrations	Background Groundwater Concentration [4]	Upgradient Groundwater Concentration [5]	Analyte a CPC? [6]	Average of all Concentrations [7]	Exposure Point Concentrations RME [8]	Exposure Point Concentrations Average [9]
Trichloroethylene	3/8	0.5	0.71 to 1.9	NA	0.28	YES	0.63	1.9	0.63
WET CHEMISTRY (µg/L)									
Alkalinity	7/7	NA	5,330 to 224,000	NA	11,700	NA			
Chloride	7/7	NA	4,060 to 63,000	NA	53,100	NA			
Nitrite, Nitrate-non Specific	7/7	NA	32.3 to 2,000	NA	1,460	NA			
Nitrogen By Kjeldahl Method	3/7	183	181 to 514	NA	121	NA			
Phosphate	5/7	13.3	13.8 to 28.5	NA	39.3	NA			
Sulfate	6/7	10,000	10,000 to 25,000	NA	11,400	NA			
Total Dissolved Solids	7/7	NA	25,000 to 174,000	NA	123,000	NA	80,600		
Total Hardness	7/7	NA	2,000 to 52,000	NA	31,900	NA	18,200		
Total Suspended Solids	8/8	NA	4,000 to 110,000	NA	30,300	NA	21,400		

Notes:

[1] Sample locations include: 57M-95-04A, 57M-95-04B, 57M-95-05X through -07X, 57M-95-08A, 57M-95-08B, and 57P-98-02X. Two rounds of samples were collected from all wells except 57P-98-02X.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

[3] Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

[4] 95th percentiles of inorganic background concentrations from the Ft. Devens background groundwater database (developed in 1993) were used to screen CPCs.

[5] Average upgradient groundwater concentration from monitoring wells 57M-95-01X, 57M-95-02X, G3M-92-02X, and G3M-92-07X.

[6] Contaminant of Potential Concern (CPC) for aquatic receptors.

[7] The average of all concentrations assigns a value of 1/2 the SQL to all non-detects. A temporal average was calculated for each well with more than one round of samples prior to calculating the average of all concentrations.

[8] Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calculated because there are fewer than 10 samples in the data set.

[9] Average Exposure Point Concentrations (EPCs) are equal to the lesser of the average of all concentrations and the RME.

[10] Maximum concentration is less than the background concentration.

[11] Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

µg/L = micrograms per liter
AOC = Area of contamination.
CPC = Contaminant of potential concern.
NA = Not available.
ND = Not detected.
PAL = Project analyte list.
RME = Reasonable maximum exposure.
SQL = Sample quantitation limit.

TABLE 9-55
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 GROUNDWATER [1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection [2]	Range of SQLs [3]	Range of Detected Concentrations	Background Groundwater Concentration [4]	Upgradient Groundwater Concentration [5]	Analyte a CPC? [6]	Average of all Concentrations [7]	Exposure Point Concentrations RME [8]	Exposure Point Concentrations Average [9]
PAL UNFILTERED METALS (µg/L)									
Aluminum	5/5	141	65.2 to 2,450	6,870	507	NO[10]			
Arsenic	6/7	2.54	3.73 to 170	10.5	3.6	YES	33.7	170	33.7
Barium	7/7	NA	8.4 to 87.2	39.6	21.3	YES	27.1	87.2	27.1
Cadmium	1/5	3.01 to 4.01	8.7	4.01	ND	YES	2.0	8.7	2.0
Calcium	5/5	NA	2,020 to 18,200	14,700	10,000	NO[11]			
Copper	1/7	5 to 8.09	8.5	8.09	5.6	YES	3.2	8.5	3.2
Iron	5/5	NA	105 to 26,500	9,100	665	YES	8,550	26,500	8,550
Lead	3/7	1 to 1.26	1.85 to 8.1	4.25	ND	YES	1.5	8.1	1.5
Magnesium	3/5	1,000	715 to 1,190	3,480	880	NO[10,11]			
Manganese	5/5	NA	126 to 2,100	291	61.9	YES	638	2,100	638
Potassium	4/5	1,000	1,650 to 2,500	2,370	1,830	NO[11]			
Sodium	4/5	2,290	1,650 to 5,050	10,800	27,000	NO[10,11,12]			
Zinc	2/7	21.1 to 35.8	37.2 to 192	21.1	15.3	YES	26.7	192	26.7
PAL FILTERED METALS (µg/L)									
Arsenic	4/4	NA	12.7 to 133	10.5	NA	YES	55.3	133	55.3
Barium	4/4	NA	6.4 to 37.4	39.6	21.6	NO[10]			
Calcium	1/1	NA	9,820 to 18,600	14,700	11,300	NO[10]			
Iron	1/1	NA	10,600 to 17,500	9,100	NA	YES	14,200	17,500	14,200
Lead	1/4	1.26 to 50	2.4	4.25	NA	NO[10]			
Magnesium	1/1	NA	712 to 846	3,480	724	NO[10,11]			
Manganese	1/1	NA	343 to 699	291	10.7	YES	523	699	523
Potassium	1/1	NA	1,860 to 2,970	2,370	2,030	NO[10]			
Sodium	1/1	NA	1,910 to 2,190	10,800	30,300	NO[10,11,12]			
Zinc	1/4	21.1 to 35.8	43.3 to 46.3	21.1	NA	YES	20.3	46.3	20.3
PAL SEMIVOLATILE ORGANICS (µg/L)									
1,2-Dichlorobenzene	3/7	1.7	2.6 to 9.8	NA	NA	YES	2.6	9.8	2.6
1,4-Dichlorobenzene	2/7	1.7	2.7 to 5.6	NA	NA	YES	1.4	5.6	1.4
2-Methylnaphthalene	2/7	1.7 to 3	2 to 4.4	NA	NA	YES	1.2	4.4	1.2
4-Methylphenol	2/7	0.52 to 1	1.5 to 5	NA	NA	YES	1.0	5	1.0
Bis(2-ethylhexyl)phthalate	4/7	4.8 to 10	5.8 to 300	NA	3.36	YES	17	300	17
Naphthalene	3/7	0.5	2.5 to 20	NA	NA	YES	4.5	20	4.5
PAL VOLATILE ORGANICS (µg/L)									
1,2-Dichloroethylenes (cis and trans)	1/7	0.5	0.74 to 0.89	NA	NA	YES	0.29	0.89	0.29
Carbon tetrachloride	1/7	0.58	4.5	NA	NA	YES	0.52	4.5	0.52
Chlorobenzene	1/7	0.5	0.88	NA	NA	YES	0.34	0.88	0.34
Chloroform	1/7	0.5	10	NA	0.26	YES	0.64	10	0.64
Ethylbenzene	4/7	0.5	1.9 to 47	NA	NA	YES	7.3	47	7.3

TABLE [illegible]-55
SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 GROUNDWATER [1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	Frequency of Detection [2]	Range of SQLs [3]	Range of Detected Concentrations	Background Groundwater Concentration [4]	Upgradient Groundwater Concentration [5]	Analyte a CPC? [6]	Average of all Concentrations [7]	Exposure Point Concentrations RME [8]	Exposure Point Concentrations Average [9]
Methylene chloride	1/7	2.3	2.9	NA	NA	YES	1.4	2.9	1.4
Styrene	1/7	0.5	8	NA	NA	YES	1.4	8	1.4
Tetrachloroethylene	2/7	1.6	2.6 to 5.5	NA	NA	YES	1.7	5.5	1.7
Toluene	4/7	0.5	0.67 to 49	NA	0.34	YES	3.5	49	3.5
Trichloroethylene	2/7	0.5	0.59 to 3.8	NA	0.28	YES	0.61	3.8	0.61
Xylenes	3/7	0.84	5.7 to 200	NA	NA	YES	21	200	21
WET CHEMISTRY (µg/L)									
Alkalinity	1/1	NA	38,000 to 56,000	NA	11,700	NA	47,100		
Chloride	1/1	NA	3,510	NA	53,100	NA	2,290		
Nitrite, Nitrate-non Specific	4/5	10	17.1 to 1,100	NA	1,460	NA	142		
Nitrogen By Kjeldahl Method	2/5	183	324 to 733	NA	121	NA	230		
Phosphate	3/5	13.3	16.2 to 240	NA	39.3	NA	45.3		
Total Dissolved Solids	5/5	NA	26,000 to 93,000	NA	123,000	NA	65,300		
Total Hardness	5/5	NA	10,800 to 1,660,000	NA	31,900	NA	321,000		
Total Petroleum Hydrocarbons	1/5	192 to 169,000	337	NA	16,800	NA	67,100		
Total Suspended Solids	6/7	4,000	4,000 to 2,120,000	NA	30,300	NA	238,000		

Notes:

[1] Sample locations include: 57M-95-03X (three rounds of data, plus one duplicate), 57M-96-10X through 57M-96-13X (two rounds of data for 57M-96-11X, plus two duplicates), 57P-98-03X, and 57P-98-04X. Filtered samples were collected at 57M-95-03X (two rounds, plus one duplicate), 57M-96-11X, 57P-98-03X, and 57P-98-04X.

[2] Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

[3] Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

[4] 95th percentiles of inorganic background concentrations from the Ft. Devens background groundwater database (developed in 1993) were used to screen CPCs.

[5] Average upgradient groundwater concentration from monitoring wells 57M-95-01X, 57M-95-02X, 57M-96-09X, G3M-92-02X, and G3M-92-07X.

[6] Contaminant of Potential Concern (CPC) for aquatic receptors.

[7] The average of all concentrations assigns a value of 1/2 the SQL to all non-detects. A temporal average was calculated for each well with more than one round of samples prior to calculating the average of all concentrations.

[8] Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calculated because there are fewer than 10 samples in the data set.

[9] Average Exposure Point Concentrations (EPCs) are equal to the lesser of the average of all concentrations and the RME.

[10] Maximum concentration is less than the background concentration.

[11] Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

[12] Maximum detected concentration is less than the upgradient concentration.

µg/L = micrograms per liter
AOC = Area of contamination.
CPC = Contaminant of potential concern.
NA = Not available.
ND = Not detected.
PAL = Project analyte list.
RME = Reasonable maximum exposure.
SQL = Sample quantitation limit.

TABLE 9-56
ECOLOGICAL RECEPTORS EVALUATED AT AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Method of Evaluation	Receptor Evaluated		Media				
	Common Name	Scientific Name	Surface Soil			Surface Water	Sediment
			Upland	Floodplain	Area 3		
Food-web modeling	White-footed mouse	*Peromyscus leucopus*	√	√	√		
	Short-tailed shrew	*Blarina brevicauda*		√			
	Muskrat	*Ondatra zibethicus*				√	√
	American robin	*Turdus migratorius*	√	√	√		
	Mallard	*Anas platyrhynchos*				√	√
	Red fox	*Vulpes vulpes*	√		√		
	Raccoon	*Procyon lotor*		√		√	√
	Barred owl	*Strix varia*	√	√	√		
	Great blue heron	*Ardea herodias*				√	√
Benchmark Comparison	Terrestrial Plants		√	√	√		
	Soil Invertebrates		√	√	√		
	Aquatic Plants					√	√
	Benthic Invertebrates					√	√
	Amphibians					√	√
	Small Fish					√	√
Toxicity Testing	Midge	*Chironomus tentans*					√
	Amphipod	*Hyalella azteca*					√

TABLE 9-58
ESTIMATION OF BIOACCUMULATION AND BIOCONCENTRATION FACTORS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Receptor Group	Nature of Approach	General Approach
Terrestrial Receptors		
Plants Unit: mg/kg wet tissue per mg/kg dry soil	Literature Values	When available, literature values were used to estimate plant BAFs.
	SAR	When literature values were not available, plant BAFs for semivolatile organic compounds (SVOCs) were calculated using a regression equation based on the uptake of organic chemicals into plant tissue from Travis and Arms (1988).[1]
	Extrapolation and Empirical Data	When literature values were not available, plant BAFs for inorganic compounds were obtained from Baes et al. (1984).[2]
	Assumption	Although evidence suggests that plants may transport organic analytes with log K_{ow}s < 5 (i.e., volatile organic compounds [VOCs]) from the roots into leafy portions (Briggs *et al.*, 1982; Briggs *et al.*, 1983), bioaccumulation data for VOCs is generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log K_{ow}s < 3.5 are not bioaccumulated into animal tissue. Therefore, it was assumed that transfer of VOCs from plant tissue to animal tissue does not occur.
Terrestrial Invertebrates Unit: mg/kg wet tissue per mg/kg dry soil	Site-specific Data and Literature Values	Invertebrate BAFs were calculated based on tissue concentrations of freshwater oligochaetes (*Lumbriculus variegatus*) exposed to AOC 57 sediment (Appendix O-1, Table O-1.3). Because of uncertainties associated with the results, these calculated BAFs were not used to quantitatively evaluate wildlife exposures to invertebrate tissue. Literature values were the primary means for evaluating invertebrate bioaccumulation from soil at AOC 57.
	Assumption	Literature-derived earthworm data were used to represent all invertebrates.
	Empirical Data and Assumption	A single BAF for PAHs was calculated using data presented in Beyer (1990); dry weight was converted to wet weight assuming earthworms are 80 percent water.
	Surrogate Values	When no literature values for invertebrates were available, mammals values were used as a surrogate.
	Assumption	Bioaccumulation data for VOCs is generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log K_{ow}s < 3.5 are not bioaccumulated into animal tissue. Therefore, it was assumed that soil invertebrates do not bioaccumulate VOCs.

See notes at end of table

TABLE 9-58
ESTIMATION OF BIOACCUMULATION AND BIOCONCENTRATION FACTORS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Receptor Group	Nature of Approach	General Approach
Small Mammals Unit: mg/kg wet tissue per mg/kg wet food	Literature Values	When available, literature values were used to estimate BAFs for small mammals.
	SAR	When literature values were not available for SVOCs, BAFs for small mammals were estimated using a regression equation based on the uptake of organic chemicals into beef tissue from Travis and Arms (1988) [3].
	Extrapolation/ Empirical Data	When literature values were not available, BAFs for small mammals for inorganics were derived from ingestion-to-beef biotransfer factors (BTFs) presented in Baes et al. (1984) [4].
	Assumption	Bioaccumulation data for VOCs are generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log K_{ow}s < 3.5 are not bioaccumulated into animal tissue. Therefore, it was assumed that small mammals do not bioaccumulate VOCs.
Small Birds Unit: mg/kg wet tissue per mg/kg wet food	Literature Values	When available, literature values were used to estimate BAFs for small birds.
	Surrogate Values	BAFs were not available for many SVOCs or inorganic compounds as there is little bioaccumulation data available for birds. In these situations, mammal data were used as a surrogate. It was assumed that small birds do not accumulate VOCs.
Semi-aquatic Receptors		
Surface Water Unit: mg/kg tissue per mg/l water	Empirical Data	When available, BCF data were obtained from the AQUIRE database and from AWQC documents. BCF values were obtained by calculating the geometric mean of the combined BCF data (presented in Appendix O-1, Table O.1-4).
	Literature Values	When empirical data were not available, literature values for BCFs were obtained.
	SAR	When empirical or literature values were not available, BCFs were estimated using a regression equation based on the uptake of organic chemicals into fish tissue from Barnthouse et al., (1988) [5].
	Conservative Assumption	Analytes with BCFs <300 were not considered in the surface water ingestion model (USEPA, 1989).
Semi-aquatic Receptors (Cont.)		
Sediment Unit: mg/kg wet tissue per mg/kg wet sediment	Site-specific Data	As previously mentioned, aquatic invertebrate BAFs were calculated using tissue concentrations of freshwater oligochaetes (*Lumbriculus variegatus*) exposed to AOC 57 sediment (Appendix O-1, Table O.1-3). However, these data were not used in food web models due to uncertainties associated with the results. Site-specific crayfish and small fish tissue data were used directly in food web models to evaluate semi-aquatic wildlife exposures.
	Literature Values	When no site-specific information was available, literature values were used to estimate BAFs for aquatic plants and invertebrates. When literature values were not available, terrestrial plant and invertebrate BAFs were used instead.

TABLE 9-58
ESTIMATION OF BIOACCUMULATION AND BIOCONCENTRATION FACTORS
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

[1] Plant BAFs calculated using the following Travis and Arms (1988) regression:
$\log BAF = 1.588 - 0.578 \log K_{ow}$.

[2] BAFs derived from Baes et al. (1984). Values are based on analysis of literature references, correlations with other chemical and physical parameters, or comparisons of observed and predicted elemental concentrations in vegetative and reproductive plant material and soil. Data are based on dry weight and were converted to a fresh weight basis assuming that plants are 80 percent water. This is generally consistent with the water content of berries (82 to 87 percent water) and leafy vegetables (87 to 95 percent water), presented in Suter (1993). Grains contain a much lower percentage of water (approximately 10 percent), therefore, this assumption likely underestimates exposure to graminivores.

[3] Small mammal BAFs calculated using the following Travis and Arms (1988) regression:
$\log BTF = \log K_{ow} - 7.6$
where BTF = biotransfer factor (mg/kg tissue divided by mg chemical ingested per day).

[4] BTFs were converted to a BAF (mg/kg tissue divided by mg/kg food) by multiplying by a food ingestion rate of 12 kg (dry weight) per day (average intake for lactating and non-lactating cattle reported in Travis and Arms, 1988).

[5] Aquatic organism BCFs were calculated using the following Barnthouse et al. (1988) regression:
$\log BCF = -0.56 + 0.96 \log K_{ow}$.

Notes:
mg/kg = milligrams per kilogram
AOC = Area of contamination.
BAF = Bioaccumulation factor.
BCF = Bioconcentration factor.
BTF = Biotransfer factor.
K_{ow} = Octanol-water partition coefficient.
PAH = Polycyclic aromatic hydrocarbon.
SAR = Structure Activity Relationship.

TABLE 9-59
RESULTS OF SEDIMENT TOXICITY TESTING[1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Sample location	Midge (*Chironomus tentans*) 10-day Subchronic Toxicity Test		Amphipod (*Hyalella azteca*) 10-day Acute Toxicity Test		Oligochaete (*Lumbriculus variegatus*) 28-day Exposure Test
	Mean % Survival	Mean Weight (mg dry weight)	Mean % Survival	Mean Weight (mg dry weight)	Mean Biomass (g) / Aquarium
Control	74 (19)	1.70 (0.32)	64[2] (18)	0.10 (0.05)	1.37 (0.09)
57D-95-04X	65 (29)	1.36[3] (0.30)	83 (7)	0.08 (0.01)	NA
57D-95-05X	64 (29)	2.00 (0.48)	70 (19)	0.16 (0.05)	1.43 (0.11)
57D-95-06X	90 (8)	1.80 (0.19)	84 (9)	0.08 (0.03)	1.52 (0.41)
57D-95-07X	71 (24)	2.27 (0.67)	74 (7)	0.11 (0.04)	NA
57D-95-08X (Reference)	84 (12)	1.81 (0.30)	80 (21)	0.10 (0.03)	1.18 (0.25)
57D-95-10X	83 (12)	1.75 (0.33)	71 (18)	0.11 (0.06)	NA

[1] Toxicity testing methods and results (including controls and references) are described in Appendix Q. The numbers in parentheses are the standard deviations.

[2] The control survival did not meet the acceptance criteria of 80%.

[3] Midge growth in this sample was statistically significantly less than the reference sample (57D-95).

Notes:
% = percent
mg = milligrams

TABLE 9-60
RESULTS OF FOOD-WEB MODELING FOR SURFACE SOIL, SEDIMENT, AND SURFACE WATER [A]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Media Evaluated Ecological Receptor	Risk from Exposure to RME Concentrations	Risk from Exposure to Average Exposure Concentrations	Primary Risk Contributors
Area 2 Upland Surface Soil			
White-footed mouse	1.5	0.98	Arsenic
American robin	0.94	0.60	NA
Red fox	0.000077	0.000045	NA
Barred owl	0.00021	0.00013	NA
Area 2 Floodplain Surface Soil			
White-footed mouse	4.0	1.9	Arsenic
Short-tailed shrew	2.4	1.0	Selenium (HQ<1), lead (HQ <1)
American robin	1.8	0.71	Arsenic (HQ <1), Aroclor-1260 (HQ <1)
Raccoon	0.037	0.0069	NA
Barred owl	0.00028	0.00011	NA
Area 3 Surface Soil			
White-footed mouse	3.0	1.7	Arsenic
American robin	0.91	0.44	NA
Red fox	0.0011	0.00030	NA
Barred owl	0.00034	0.00017	NA
Area 2 Sediment and <u>Unfiltered</u> Surface Water			
Muskrat	13	4.6	Arsenic, lead, manganese
Mallard	0.015	0.0050	NA
Raccoon	0.028	0.014	NA
Great blue heron	12	6.8	Mercury
Area 2 Sediment and <u>Filtered</u> Surface Water			
Muskrat	13	4.5	Arsenic, lead, manganese
Mallard	0.015	0.0048	NA
Raccoon	0.020	0.0074	NA
Great blue heron	6.1	1.8	Mercury
Area 3 Sediment and <u>Unfiltered</u> Surface Water			
Raccoon	0.00054	Not evaluated	NA

[a] The information listed below is a summary of Tables O-2.1 through O-2.22 in Appendix O-2. These values are HIs calculated from all detected contaminants.
NA = Not applicable.

TABLE 9-61
SUMMARY OF ECOLOGICAL RISK FOR PLANTS AND INVERTEBRATES IN AREA 2 UPLAND SURFACE SOIL
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations[1]		RTV (µg/g)		RTV Exceeded?[3] (by Max./by Ave.)	
	RME	Average	Plant[2]	Invertebrate[2]	Plant	Invertebrate
PAL Metals (µg/g)						
Arsenic	21	14.5	10	100	Yes/Yes	No/No
Cobalt	7.5	4.6	20	NA	No/No	NA
Copper	15.6	11	100	30	No/No	No/No
Manganese	481	282	500	NA	No/No	NA
Nickel	30.7	16.8	30	400	Yes/No	No/No
Selenium	0.88	0.28	1	NA	No/No	NA
Pesticides/PCBs (µg/g)						
4,4'-DDE	0.020	0.0070	12.5	12	No/No	No/No
4,4'-DDT	0.026	0.0080	12.5	12	No/No	No/No
PAL Semivolatile Organics (µg/g)						
2-Methylnaphthalene	0.43	0.20	25	34	No/No	No/No
Bis(2-ethylhexyl)phthalate	2.7	1.6	1,000	478	No/No	No/No
Dibenzofuran	0.16	0.083	617	NA	No/No	NA
Fluoranthene	0.30	0.16	25	34	No/No	No/No
Naphthalene	0.42	0.21	100	34	No/No	No/No
Phenanthrene	0.28	0.15	25	34	No/No	No/No
Pyrene	0.40	0.18	25	34	No/No	No/No
PAL Volatile Organics (µg/g)						
Chloroform	0.00089	0.00053	1,000	150	No/No	No/No
Ethylbenzene	0.0024	0.0012	200	21	No/No	No/No
Tetrachloroethylene	0.0030	0.00092	1,000	150	No/No	No/No
Toluene	0.0037	0.0017	200	21	No/No	No/No
Trichlorofluoromethane	0.017	0.0075	NA	NA	NA	NA
Xylenes	0.029	0.0064	1,000	21	No/No	No/No
Other (µg/g)						
Total Petroleum Hydrocarbons	8,000	1,700	NA	NA	NA	NA

See notes at end of table

TABLE 9-61 (CONTINUED)
SUMMARY OF ECOLOGICAL RISK FOR PLANTS AND INVERTEBRATES IN AREA 2 UPLAND SURFACE SOIL
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations 1		RTV (µg/g)		RTV Exceeded? 3 (by Max./by Ave.)	
	RME	Average	Plant 2	Invertebrate 2	Plant	Invertebrate

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[1] Exposure Point Concentrations (EPCs) are presented in Table 9-47.

[2] Plant and invertebrate RTVs are presented in Appendix O-1, Tables O-1.7 and O-1.8 (respectively). Generally, the plant RTVs are the lowest LOEC from among plant growth studies on plants in solid media, and invertebrate RTVs are the lowest LC_{50} (14-day soil test on *Eisenia foetida*) from among chemicals in the same chemical class (applies to organic compounds). A conservative factor of 0.2 was applied to invertebrate RTVs; the resultant value should be protective of 99.9% of the population from lethal effects (USEPA, 1986).

[3] Comparison shown is maximum EPC to RTV/average EPC to RTV.

RTV = Reference toxicity value.
µg/g = micrograms per gram.
LC_{50} = concentration lethal to 50% of the test population.
LOEC = lowest observed effect concentration.
NA = Not available.
RME = Reasonable maximum exposure.
Shading indicates exceedances.

TABLE 9-62
SUMMARY OF ECOLOGICAL RISK FOR PLANTS AND INVERTEBRATES IN AREA 2 FLOODPLAIN SURFACE SOIL
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations[1]		RTV (µg/g)		RTV Exceeded?[3] (by RME / by Avg.)	
	RME	Average	Plant[2]	Invertebrate[2]	Plant	Invertebrate
PAL Metals (µg/g)						
Antimony	1.6	1.6	5	NA	No/No	NA
Arsenic	47.9	24.1	10	100	Yes/Yes	No/No
Barium	106	47.9	500	NA	No/No	NA
Copper	39.3	15.6	100	30	No/No	Yes/No
Lead	320	143	50	1,190	Yes/Yes	No/No
Manganese	273	149	500	NA	No/No	NA
Selenium	4.4	1.9	1	NA	Yes/Yes	NA
Zinc	150	55.1	50	130	Yes/Yes	Yes/No
Pesticides/PCBs (µg/g)						
4,4'-DDD	0.010	0.0071	12.5	12	No/No	No/No
4,4'-DDE	0.034	0.013	12.5	12	No/No	No/No
4,4'-DDT	0.18	0.039	12.5	12	No/No	No/No
Aroclor-1260	3.6	0.63	40	NA	No/No	NA
Dieldrin	0.025	0.0099	12.5	30	No/No	No/No
PAL Semivolatile Organics (µg/g)						
2-Methylnaphthalene	0.38	0.18	25	34	No/No	No/No
Acenaphthylene	0.26	0.13	25	34	No/No	No/No
Benzo[k]fluoranthene	0.60	0.27	25	34	No/No	No/No
Chrysene	0.71	0.39	25	34	No/No	No/No
Di-n-butylphthalate	0.77	0.33	200	478	No/No	No/No
Fluoranthene	2.0	0.58	25	34	No/No	No/No
Naphthalene	0.30	0.14	100	34	No/No	No/No
Phenanthrene	1.0	0.39	25	34	No/No	No/No
Pyrene	2.0	0.63	25	34	No/No	No/No
PAL Volatile Organics (µg/g)						
1,2-Dichloroethylene (cis and trans)	0.0069	0.0036	>1000	150	No/No	No/No
Acetone	0.067	0.029	NA	NA	NA	NA
Ethylbenzene	0.0059	0.003	200	21	No/No	No/No
Methylene chloride	0.0081	0.0068	>1,000	150	No/No	No/No
Tetrachloroethylene	0.0014	0.0009	>1,000	150	No/No	No/No
Toluene	0.0051	0.0017	200	21	No/No	No/No

TABLE 9-62
SUMMARY OF ECOLOGICAL RISK FOR PLANTS AND INVERTEBRATES IN AREA 2 FLOODPLAIN SURFACE SOIL
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations[1]		RTV (µg/g)		RTV Exceeded?[3] (by RME / by Avg.)	
	RME	Average	Plant[2]	Invertebrate[2]	Plant	Invertebrate
Trichlorofluoromethane	0.0072	0.0048	NA	NA	NA	NA
Other (µg/g)						
Total Petroleum Hydrocarbons	**17,000**	**3,500**	**NA**	**NA**	**NA**	**NA**

[1] Exposure Point Concentrations (EPCs) are presented in Table 9-20.

[2] Plant and invertebrate RTVs are presented in Appendix O-1, Tables O-1.7 and O-1.8 (respectively). Generally, the plant RTVs are the lowest LOEC from among plant growth studies on plants in solid media, and invertebrate RTVs are the lowest LC_{50} (14-day soil test on *Eisenia foetida*) from among chemicals in the same chemical class (applies to organic compounds). A conservative factor of 0.2 was applied to invertebrate RTVs; the resultant value should be protective of 99.9% of the population from lethal effects (USEPA, 1986).

[3] Comparison shown is maximum EPC to RTV/average EPC to RTV.

RTV = reference toxicity value.
µg/g = micrograms per gram.
LC_{50} = concentration lethal to 50% of the test population.
LOEC = lowest observed effect concentration.
NA = Not available.
RME = Reasonable maximum exposure.
Shading indicates exceedances.

TABLE 9-63
SUMMARY OF ECOLOGICAL RISK FOR PLANTS AND INVERTEBRATES IN AREA 3 SURFACE SOIL
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations[1]		RTV (µg/g)		RTV Exceeded?[3] (by RME / by Avg.)	
	RME	Average	Plant[2]	Invertebrate[2]	Plant	Invertebrate
PAL Metals (µg/g)						
Arsenic	41	25.0	10	100	Yes/Yes	No/No
Cadmium	1.5	0.93	3	50	No/No	No/No
Manganese	548	2.19	500	NA	Yes/No	NA
Selenium	1.6	0.48	1	NA	Yes/No	NA
Pesticides/PCBs (µg/g)						
4,4'-DDD	0.27	0.061	12.5	12	No/No	No/No
4,4'-DDE	0.0081	0.0081	12.5	12	No/No	No/No
4,4'-DDT	0.025	0.014	12.5	12	No/No	No/No
Chlordane-Alpha	0.0028	0.0021	12.5	NA	No/No	NA
Chlordane-Gamma	0.0028	0.0021	12.5	NA	No/No	NA
Aroclor-1260	0.47	0.12	40	NA	No/No	NA
PAL Semivolatile Organics (µg/g)						
1,2-Dichlorobenzene	0.35	0.13	248	NA	No/No	NA
1,4-Dichlorobenzene	0.48	0.16	248	NA	No/No	NA
Fluoranthene	0.14	0.14	25	34	No/No	No/No
Naphthalene	0.048	0.048	100	34	No/No	No/No
Phenanthrene	0.11	0.11	25	34	No/No	No/No
Pyrene	0.15	0.15	25	34	No/No	No/No
PAL Volatile Organics (µg/g)						
Chlorobenzene	0.012	0.0033	>1,000	21	No/No	No/No
Toluene	0.0030	0.0014	200	21	No/No	No/No
Trichloroethylene	0.0042	0.0021	>1,000	150	No/No	No/No
Other (µg/g)						
Total Petroleum Hydrocarbons	2,900	850	NA	NA	NA	NA

[1] Exposure Point Concentrations (EPCs) are presented in Table 9-49.

[2] Plant and invertebrate RTVs are presented in Appendix O-1, Tables O-1.7 and O-1.8 (respectively). Generally, the plant RTVs are the lowest LOEC from among plant growth studies on plants in solid media, and invertebrate RTVs are the lowest LC$_{50}$ (14-day soil test on *Eisenia foetida*) from among chemicals in the same chemical class (applies to organic compounds). A conservative factor of 0.2 was applied to invertebrate RTVs; the resultant value should be protective of 99.9% of the population from lethal effects (USEPA, 1986).

[3] Comparison shown is maximum EPC to RTV/average EPC to RTV.

RTV = reference toxicity value.
µg/g = micrograms per gram.
LC$_{50}$ = concentration lethal to 50% of the test population.
LOEC = lowest observed effect concentration.
NA = Not available.
RME = Reasonable maximum exposure.
Shading indicates exceedances.

TABLE 9-64
COMPARISON OF AREA 2 SURFACE WATER EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES [1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations		AWQC [2] (µg/l)	AQUIRE of Amphibian Lowest Reported Adverse Effect Concentration [3] (µg/l) / Test Species	Result
	RME	Average			
PAL Unfiltered Metals (µg/l)					
Aluminum	15,100	2,650	[4]87	50/narrow-mouthed frog LC_{50}	Exceeded
Arsenic	198	50.6	190	1,700/water flea LC_{50}	Exceeded
Barium	553	155	NA	8,900/water flea reproduction	Not exceeded
Cadmium	24.6	5.8	[5]1.1	0.32/water flea growth	Exceeded
Chromium	35.8	8.5	11	5/water flea growth, reproduction, and mortality	Exceeded
Copper	375	74.9	[5]12	1.5/water flea reproduction and mortality	Exceeded
Iron	17,600	5,840	1,000	3,700/duckweed growth	Exceeded
Lead	967	243	[5]3.2	40/narrow-mouthed toad$_{50}$	Exceeded
Manganese	433	243	NA	280/phytoplankton population endpoints	Exceeded
Mercury	0.24	0.14	[6]0.012	1.3/narrow-mouthed toad$_{50}$	Not exceeded
Selenium	2.4	1.5	5.0	70/scud LC_{50}	
Vanadium	72.3	16.6	NA	128/guppy LC_{50}	Not exceeded
Zinc	712	180	[5]110	10/narrow-mouthed toad LC_{50}	Exceeded
PAL Filtered Metals (µg/l)					
Arsenic	8.9	5.1	190	1,700/water flea LC_{50}	Not exceeded
Barium	43.1	18.3	NA	8,900/water flea reproduction	Not exceeded
Iron	17,200	4,540	1,000	3,700/duckweed growth	Exceeded
Lead	2.3	1.1	[5]2.5	40/narrow-mouthed toad$_{50}$	Not exceeded
Manganese	483	197	NA	280/photoplankton population endpoints	Exceeded
Zinc	58.4	21	[5]108	10/narrow-mouthed toad LC_{50}	Exceeded
PAL Semivolatile Organics (µg/l)					
Bis(2-ethylhexyl)phthalate	24	4.8	[7]160	0.89/moorfrog hatchability	Exceeded
Phenanthrene	0.52	0.28	[7]6.3	NA	Not Exceeded

See notes at end of table

TABLE 9-64
COMPARISON OF AREA 2 SURFACE WATER EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES [1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations		AWQC [2] (µg/l)	AQUIRE of Amphibian Lowest Reported Adverse Effect Concentration [3] (µg/l) / Test Species	Result
	RME	Average			
PAL Volatile Organics (µg/l)					
1,2-Dichloroethylenes (cis and trans)	26	3.1	NA	[10] 2,400/water flea lethality	Not exceeded
Carbon disulfide	1.1	0.34	NA	NA	No benchmark available
Chloroform	0.72	0.30	[8] 1,240	4,160/northern leopard frog LC_{50}	Not exceeded
Methylene chloride	4.1	1.8	NA	17,780/bullfrog teratogenesis	Not exceeded
Tetrachloroethylene	1.8	1.1	[8]840	510/water flea growth and reproduction	Not exceeded
Toluene	1.1	0.34	[9]17,500	390/northern leopard frog LC_{50}	Not exceeded
Trichloroethylene	3.5	0.65	[8]21,900	2,300/water flea LC_{50}	Not exceeded
Wet Chemistry (µg/l)					
Alkalinity	36,000	30,000	> 20,000	NA	Acceptable
Chloride	100,000	50,000	230,000	NA	Not exceeded
Other (µg/l)					
Total Petroleum Hydrocarbons	920	250	NA	NA	No benchmark available

[1] Results of analyses of surface water samples are included in Section 7. Only those analytes selected as aquatic CPCs in Table 9-50 are presented.

[2] Chronic Federal Ambient Water Quality Criteria (USEPA, 1991 and 1988).

[3] The lowest value reported in either Tables O-1.9 or 0.1-10 in Appendix O. Only growth, mortality, reproductive, and biomass effects to fish, plants, invertebrates, and amphibians were considered.

[4] Based on a pH of 6.5-9.

[5] Hardness dependent criterion based on an average site-specific hardness concentration of 100 mg $CaCO_3$. Hardness-adjusted values for unfiltered metals are from the AWQC (USEPA, 1991), and hardness-adjusted values for filtered metals are from the Ecotox Thresholds (USEPA, 1996).

[6] Value based on the marketability of fish, which is intended to be protective of human health. Therefore, this number was not used to evaluate risk to aquatic organisms.

[7] Proposed criterion.

[8] Insufficient data to derive criterion; value presented is the Lowest Observed Effect Level (LOEL).

[9] Chronic AWQC is not available; value shown is the acute AWQC.

[10] Value is for 1,1-Dichloroethylene.

Notes:

CPC = contaminant of potential concern
___ = concentration exceeds the most conservative toxicity benchmark
µg/l = micrograms per liter
AWQC = Ambient Water Quality Criteria (guidance criteria established under the Clean Water Act)
NA = Not available

TABLE 9-65

COMPARISON OF AREA 3 SURFACE WATER EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES [1]

AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations		AWQC [2] (µg/l)	AQUIRE Lowest Reported Adverse Effect Concentration [3] (µg/l) / Test Species	Result
	Maximum	Average			
PAL Unfiltered Metals (µg/l)					
Antimony	5.6	2.1	^{7}30.0	NA	Not exceeded
Arsenic	153	49.1	190	1,700/water flea LC_{50}	Not exceeded
Barium	278	176	NA	8,900/water flea reproduction	Not exceeded
Copper	44.1	23.9	^{5}12	1.5/water flea reproduction and mortality	Exceeded
Lead	184	92.4	^{5}3.2	40/narrow-mouthed toad LC_{50}	Exceeded
Selenium	2.5	1.5	5.0	70/scud LC_{50}	Not exceeded
Zinc	445	211	^{5}110	10/narrow-mouthed toad LC_{50}	Exceeded
PAL Filtered Metals (µg/l)					
Arsenic	53.4	20.0	190	1,700/water flea LC_{50}	Not exceeded
Barium	22.8	13.4	NA	8,900/water flea reproduction	Not exceeded
Manganese	155	96.3	NA	280/photoplankton population endpoints	Not exceeded
PAL Semivolatile Organics (µg/l)					
Benzo[k]fluoranthene	0.94	0.56	NA	NA	No benchmark available
PAL Volatile Organics (µg/l)					
Carbon disulfide	0.58	0.32	NA	NA	No benchmark available
Chlorobenzene	4.6	1.1	NA	880/Goldfish LC_{50}	Not exceeded
Toluene	1.6	0.59	^{7} 17,500	390/northern leopard frog LC_{50}	Not exceeded

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[1] Results of analyses of surface water samples are included in Section 7. Only those analytes selected as aquatic CPCs in Table 9-51 are presented.

[2] Chronic Federal Ambient Water Quality Criteria (USEPA, 1991 and 1988).

[3] From Appendix O-1, Table O-1.9. Only growth, mortality, reproductive, and biomass effects to fish, plants, invertebrates, and amphibians were considered.

[4] Based on a pH of 6.5-9.

[5] Hardness dependent criterion based on an average site-specific hardness concentration of 100 mg $CaCO_3$.

[6] Value based on the marketability of fish, which is intended to be protective of human health. Therefore, this number was not used to evaluate risk to aquatic organisms.

[7] Insufficient data to derive criterion; value presented is the Lowest Observed Effect Level (LOEL).

Notes:

CPC	= contaminant of potential concern
µg/l	= micrograms per liter
AWQC	= Ambient Water Quality Criteria (guidance criteria established under the Clean Water Act)
NA	= Not available

TABLE 9-66
COMPARISON OF AREA 2 SEDIMENT EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES [1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations		USEPA Sediment Quality Guidelines [2]	NOAA [3]		OME LEL [4]	NYSDEC LEL [5]	Result
	Maximum	Average		ER-L	ER-M			
PAL Metals (μg/g)								
Aluminum	15,900	11,600	NA	NA	NA	NA	NA	No benchmark available
Arsenic	220	70.2	NA	8.2	70	6.0	6.0	Exceeded
Barium	159	69.8	NA	NA	NA	NA	NA	[6]
Chromium	48.9	23.2	NA	81	370	26	26	Exceeded
Cobalt	25.8	15	NA	NA	NA	50	NA	Not exceeded
Copper	201	46.6	NA	34	270	16	16	Exceeded
Iron	30,400	21,300	NA	NA	NA	20,000	20,000	Exceeded
Lead	410	175	NA	46.7	218	31	31	Exceeded
Manganese	3,940	1,200	NA	NA	NA	460	460	Exceeded
Mercury	0.36	0.081	NA	0.15	0.71	0.2	0.15	Exceeded
Nickel	42.9	29.3	NA	20.9	51.6	16	16	Exceeded
Selenium	7.7	2.3	NA	NA	NA	NA	NA	No benchmark available
Zinc	468	206	NA	150	410	120	120	Exceeded
Pesticides/PCBs (μg/g)								
4,4'-DDD	0.44	0.15	[7]0.213	[7]0.00158	[7]0.0461	0.008	[7]0.257	Exceeded
4,4'-DDE	0.16	0.056	[7]0.213	0.0022	0.027	0.005	[7]0.257	Exceeded
4,4'-DDT	0.076	0.040	0.213	0.00158	0.0461	0.007	0.257	Exceeded
Pesticides/PCBs (μg/g) (Cont.)								
Aroclor-1260	0.30	0.069	[8]5.01	0.0227	0.180	0.005	4.96	Exceeded

TABLE 9-66

COMPARISON OF AREA 2 SEDIMENT EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES [1]
AOC 57

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DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations		USEPA Sediment Quality Guidelines [2]	NOAA [3]		OME LEL [4]	NYSDEC LEL [5]	Result
	Maximum	Average		ER-L	ER-M			
Dieldrin	0.046	0.0096	2.83	NA	NA	0.002	2.31	Exceeded
PAL Semivolatile Organics (µg/g)								
Benzo(k)fluoranthene	3.0	0.58	NA	NA	NA	0.240	NA	Exceeded
Chrysene	1.2	0.47	NA	0.384	2.8	0.34	NA	Exceeded
Fluoranthene	6.0	2.2	159.3	0.6	5.1	0.750	262	Exceeded
Phenanthrene	3.0	0.80	46.3	0.24	1.5	0.560	30.8	Exceeded
Pyrene	6.0	2.3	337	0.665	2.6	0.490	NA	Exceeded
PAL Volatile Organics (µg/g)								
Acetone	0.31	0.080	NA	NA	NA	NA	NA	[9]
Methylene chloride	0.15	0.022	NA	NA	NA	NA	NA	[10]
Tetrachloroethene	0.078	0.010	NA	NA	NA	NA	NA	[11]
Toluene	0.02	0.005	NA	NA	NA	NA	NA	[12]
Trichloroethylene	0.027	0.0042	NA	NA	NA	NA	NA	[13]
Trichlorofluoromethane	0.076	0.013	NA	NA	NA	NA	NA	No benchmark available
TPH by GC (µg/g)								
Diesel Fuel	170	78	NA	NA	NA	NA	NA	No benchmark available
TPH Gas Fraction	150	64	NA	NA	NA	NA	NA	No benchmark available
Other (mg/kg)								
TPH	3,200	790	NA	NA	NA	NA	NA	No benchmark available

TABLE 9-66

COMPARISON OF AREA 2 SEDIMENT EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES [1]

AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations		USEPA Sediment Quality Guidelines [2]	NOAA [3]		OME LEL [4]	NYSDEC LEL [5]	Result
	Maximum	Average		ER-L	ER-M			

[1] Results of analyses of sediment samples are included in Section 7. Only those analytes selected as aquatic CPCs in Table 9-52 are presented.

[2] U.S. Environmental Protection Agency (USEPA, 1988) mean Sediment Quality Criteria (SQCs) adjusted values using site-specific total organic carbon (TOC) of 25.7%. All values represent Final Chronic Values (FCVs); when no FCVs were available, Final Residue Values (FRVs) were used instead.

[3] National Oceanic and Atmospheric Administration (NOAA) Effects Range-Low (ER-L) and Effects Range-Median (ER-M) Sediment Guidelines correspond to the concentration that is protective of the 90th percentile and the 50th percentile of the test populations, respectively (Long et al., 1994).

[4] Ontario Ministry of the Environment (OME) Low Effects Level (LEL) Provincial Sediment Quality Guidelines (Persaud et al., 1996) correspond to a concentration that can be tolerated by the majority of benthic organisms.

[5] New York State Department of Environmental Conservation (NYSDEC) sediment criteria for evaluating chronic toxicity to benthic aquatic life (NYSDEC, 1994). These values are adjusted by the average site TOC content of 25.7%. The lowest effect levels (LELs) for metals are also presented.

[6] A sediment guideline of 20 mg/kg (provided by U.S. EPA Region V for the pollution classification of Great Lakes Harbor sediment [Fitchko, 1989]) is exceeded by the RME and average barium concentrations. These concentrations for barium fall within the range of "heavily polluted" sediments.

[7] Value for 4,4'-DDT used as a surrogate.

[8] Value for Aroclor-1254 used as a surrogate.

[9] A sediment guideline of 0.064 µg/g (provided by the Oak Ridge National Laboratory for screening sediment CPCs for effects to aquatic biota [ORNL, 1994]) is exceeded by the RME and average acetone concentrations.

[10] A sediment guideline of 0.427 µg/g (ORNL, 1994) is not exceeded by the RME and average concentrations of methylene chloride.

[11] A sediment guideline of 2.73 µg/g (ORNL, 1994) is not exceeded by the RME and average concentrations of tetrachloroethylene.

[12] A sediment guideline of 0.786 µg/g (ORNL, 1994) is not exceeded by the RME or average toluene concentration.

[13] A sediment guideline of 1.07 µg/g (ORNL, 1994) is not exceeded by the RME or average trichloroethylene concentration.

Notes:
µg/g = micrograms per gram
NA = Not available

TABLE 9-67
COMPARISON OF AREA 3 SEDIMENT EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES [1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations		USEPA Sediment Quality Guidelines [2]	NOAA [3]		OME L-EL [4]	NYSDEC LEL [5]	Result
	Maximum	Average		ER-L	ER-M			
Pesticides/PCBs (µg/g)								
4,4'-DDD	0.15	0.053	[7]0.0803	[7]0.00158	[7]0.0461	0.008	0.097	Exceeded
Aroclor-1260	0.84	0.20	[8]1.89	0.0227	0.180	0.005	1.87	Exceeded
PAL Semivolatile Organics (µg/g)								
1,2-Dichlorobenzene	0.39	0.12	NA	NA	NA	NA	1.16	Not exceeded
1,4-Dichlorobenzene	1.0	0.32	NA	NA	NA	NA	1.16	Not exceeded
Benzo(b)fluoranthene	0.49	0.18	NA	NA	NA	0.240	NA	Exceeded
Benzo(k)fluoranthene	0.28	0.15	NA	NA	NA	0.240	NA	Exceeded
Chrysene	0.34	0.12	NA	0.384	2.8	0.34	NA	Not exceeded
Fluoranthene	0.65	0.36	60.1	0.6	5.1	0.750	98.9	Exceeded
Naphthalene	0.53	0.14	NA	0.16	2.1	NA	NA	Exceeded
Phenanthrene	0.37	0.19	17.5	0.24	1.5	0.560	11.6	Exceeded
Pyrene	0.56	0.36	127	0.665	2.6	0.490	NA	Exceeded
PAL Volatile Organics (µg/g)								
Acetone	0.21	0.15	NA	NA	NA	NA	NA	[9]
Benzene	0.037	0.0093	NA	NA	NA	NA	NA	[10]
Chlorobenzene	0.019	0.0072	NA	NA	NA	NA	0.34	Not exceeded
Toluene	0.0048	0.0024	NA	NA	NA	NA	NA	[11]
Xylenes	0.011	0.0028	NA	NA	NA	NA	NA	[12]

See notes at end of table

TABLE 9-67
COMPARISON OF AREA 3 SEDIMENT EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES [1]
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations		USEPA Sediment Quality Guidelines [2]	NOAA [3]		OME L-EL [4]	NYSDEC LEL [5]	Result
	Maximum	Average		ER-L	ER-M			
Other (mg/kg)								
TPH	3,500	850	NA	NA	NA	NA	NA	No benchmark available

[1] Results of analyses of sediment samples are included in Section 7. Only those analytes selected as aquatic CPCs in Table 9-53 are presented.

[2] U.S. Environmental Protection Agency (USEPA, 1988) mean Sediment Quality Criteria (SQCs) adjusted values using site-specific total organic carbon (TOC) of 9.7%. All values represent Final Chronic Values (FCVs); when no FCVs were available, Final Residue Values (FRVs) were used instead.

[3] National Oceanic and Atmospheric Administration (NOAA) Effects Range-Low (ER-L) and Effects Range-Median (ER-M) Sediment Guidelines correspond to the concentration that is protective of the 90th percentile and the 50th percentile of the test populations, respectively (Long et al., 1994).

[4] Ontario Ministry of the Environment (OME) Low Effects Level (LEL) Provincial Sediment Quality Guidelines (Persaud et al., 1996) correspond to a concentration that can be tolerated by the majority of benthic organisms.

[5] New York State Department of Environmental Conservation (NYSDEC) sediment criteria for evaluating chronic toxicity to benthic aquatic life (NYSDEC, 1994). These values are adjusted by the average site TOC content of 9.7%. The lowest effect levels (LELs) for metals are also presented.

[6] A sediment guideline of 20 mg/kg (provided by U.S. EPA Region V for the pollution classification of Great Lakes Harbor sediment [Fitchko, 1989]) is exceeded by the RME and average barium concentrations. These concentrations for barium fall within the range of "heavily polluted" sediments.

[7] Value for 4,4'-DDT used as a surrogate.

[8] Value for Aroclor-1254 used as a surrogate.

[9] A sediment guideline of 0.064 µg/g (provided by the Oak Ridge National Laboratory for screening sediment CPCs for effects to aquatic biota [ORNL, 1994]) is exceeded by the RME and average acetone concentrations.

[10] A sediment guideline of 0.052 µg/g (ORNL, 1994) is not exceeded by the RME and average concentrations of benzene.

[11] A sediment guideline of 0.786 µg/g (ORNL, 1994) is not exceeded by the maximum or average toluene concentration.

[12] A sediment guideline of 1.21 µg/g (ORNL, 1994) is not exceeded by the maximum or average xylene concentration.

Notes:

µg/g = micrograms per gram
NA = Not available

TABLE 9-68
POTENTIAL SOURCES OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENT
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Potential source	Direction of Effect on Risk	Justification
Uncertainties Associated with CPC Selection Process		
Degradation of chemicals not considered	Overestimate	Risk estimates are based on recent chemical concentrations. Concentrations will tend to decrease over time from degradation and the formation of daughter products.
No evaluation of Tentatively Identified Compound (TIC) data	Underestimate	Risk was not calculated for potential exposure to TICs.
Use of estimated data	Unknown	Using estimated data in the risk assessment may over- or under-estimate the actual concentration of an analyte in site media.
Uncertainties Associated with Exposure Assessment		
Surface soil sampling depths	Underestimate	Most terrestrial receptors wil be exposed only within the first six inches of soil where contaminant concentrations are typically greatest. Sampling the upper two feet of soil provides a diluted soil exposure concentration.
Food chain model exposure parameter assumptions	Unknown	Some exposure parameters are from the literature and some are estimated. Efforts were made to select exposure parameters representative of a variety of species or feeding guilds, so that exposure estimates would be representative of more than a single species.
Assumption that receptor species will spend equal time at all habitats within home range	Unknown	Organisms will spend varying amounts of time in different habitats, thus affecting their overall exposures.
Extrapolation of literature values from test species to representative wildlife species	Unknown	Species differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical.
Organism-specific state variables	Underestimate	Surrogate laboratory animals are well-maintained and kept under controlled conditions. Field species must tolerate general environmental stressors that can exacerbate contaminant-induced stress.
Consumption of contaminated prey	Unknown	Toxicity to receptors may result in sickness or mortality, thus making fewer prey items available to predators. Predators may stop foraging in areas with reduced prey populations, or discriminate against, or, conversely, select contaminated prey. Furthermore, anthropogenic sources of contamination may not even have as great an impact on the predator-prey relationship as do climatic effects.
Use of surrogate values for invertebrate BAFs	Underestimate	Bioaccumulation data for earthworms are lacking for several metals (e.g., aluminum, antimony, barium, cobalt, manganese, and vanadium); therefore, mammal BAFs were used as surrogates. However, earthworms may actually bioaccumulate these metals to a greater degree than mammals.
Food chain assumed to occur at site	Unknown	Occurrence of the food chain used in the models at the sites is unknown.
Maximum exposure scenarios	Overestimate	It is unlikely any receptor would be exposed concurrently to maximum concentrations of all CPCs.

TABLE 9-68
POTENTIAL SOURCES OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENT
AOC 57

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Potential source	Direction of Effect on Risk	Justification
No evaluation of dermal or inhalation exposure pathways	Underestimate	The dermal and inhalation exposure pathways are generally considered insignificant due to protective fur, feathers, chitinous exoskeletons, and the low concentration of contaminants under natural atmospheric conditions. However, under certain conditions, these exposure pathways may occur.
Continuous uptake and bioaccumulation of CPCs by soil biota	Unknown	Tissue and organ responses to CPC uptake are represented by a linear function which is an oversimplification of a more complex system (i.e., trophic states and lipid concentrations may affect bioaccumulation, or contaminants may only be seasonally available).
Bioaccumulation of CPCs in leafy portions of plants	Overestimate	Ryan et al. (1988) states that compounds with log K_{ow}s > 5 are unavailable to plants due to soil sorption. Compounds with log K_{ow}s > 5 will be taken into the roots of plants, but are not easily transported into the leafy parts of plants (Briggs et al., 1982; 1983). The surface soil ingestion exposure model overestimates CPC exposure via plant ingestion to those receptors that only eat the leafy portions of plants.
Seasonal changes in receptor foraging habits	Unknown	The food-chain model does not consider variations in a receptor's foraging habits due to seasonal changes and breeding.
Relative uptake of inorganics by different plant species	Unknown	Estimated plant BAFs for certain inorganics were based on BAF data for leafy produce grown in sewage sludge. Variability in type of plant and substrate may make the chosen BAF values an overestimate or underestimate of actual uptake.
Uncertainties Associated with Effects		
Lack of ingestion toxicity information for reptile and amphibian species	Unknown	Information is not available on the toxicity of contaminants to reptiles or amphibians resulting from dietary exposures; as a result, dietary exposures to these receptors were not quantitatively evaluated in the AOC 57 ERA. Assuming the toxicities of analytes to mammals and birds are similar for these receptors, and to the extent that the dietary exposures for reptiles and amphibians are the same as for the tertiary consumers evaluated in the AOC 57 ERA, an assumption can be made that dietary exposures to reptiles and amphibians would result in similar risk-levels that were predicted for predatory mammals and birds. However, risks to reptiles and amphibians remain unknown.
Use of measurement endpoints	Overestimate	Although an attempt was made to have measurement endpoints reflect assessment endpoints, limited available ecotoxicological literature resulted in the selection of certain measurement endpoints that may overestimate assessment endpoints.
Failure to address potential community-level effects	Underestimate	Bulk toxicity studies to assess population risks to the midge (*Chironomus tentans*) and amphipod (*Hyalella azteca*) do not address the issue of effects on community structure and biodiversity.

TABLE 9-68
POTENTIAL SOURCES OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENT
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

Potential source	Direction of Effect on Risk	Justification
Uncertainties Associated with Risk Characterization		
Meta-population level risk vs. individual population level risk	Overestimate	Defining ecological significance for common site-related receptors with limited home ranges is often difficult. Impact to one or more isolated populations may not have a meaningful impact on the ecosystem, unless competing species recolonize the disturbed habitats. This assessment conservatively treats impacts to a single indicator species population as a potentially significant risk of harm to the environment.
Risk evaluated for individual terrestrial receptors only	Overestimate	Effects on individual terrestrial organisms may occur with little population-level effects. However, as the number of affected individuals and the extent of contamination increases, the likelihood of population-level effects increases.
Effect of decreased prey item populations on predatory receptors	Unknown	Adverse population effects to prey items may reduce the foraging population for predatory receptors, but may not necessarily adversely impact the population of predatory species.
Multiple conservative assumptions	Overestimate	Cumulative impact of multiple conservative assumptions yields high risk to ecological receptors, and may result in risk at background concentrations or the prediction of risks when there is no potential for adverse effects.
Summation of effects (HIs)	Unknown	The assumption that effects are additive ignores potential synergistic or antagonistic effects. It assumes similarity in mechanism of action, which is not the case for many substances. Compounds may induce toxic effects in different organs or systems.

Notes:

AOC = Area of contamination.
CPC = contaminant of potential concern.
TIC = tentatively identified compounds.
BAF = bioaccumulation factor.
HIs = hazard indices.

TA[illegible]0-1
SUMMARY OF HUMAN[illegible]TH RISK ASSESSMENT
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPOSURE MEDIUM	RECEPTOR	CENTRAL TENDENCY		REASONABLE MAXIMUM		ARE SITE RISKS UNACCEPTABLE?	
		Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index	Cancer Risk (greater than $1x10^{-4}$ - $1x10^{-6}$)	Non-Cancer Risk (greater than HI = 1)
CURRENT/FUTURE LAND USE							
AREA 2 INDUSTRIAL							
Maintenance Worker							
Surface Soil		2E-07	0.01	2E-06	0.04	NO	NO
	Total Maintenance Worker Risk	**2E-07**	**0.041**	**2E-06**	**0.04**	**NO**	**NO**
AREA 2 RECREATIONAL							
Recreational Child							
Surface Soil		5E-06	0.3	1E-05	0.7	NO	NO
Sediment		1E-05	0.3	3E-05	0.7	NO	NO
Surface Water		3E-06	0.07	6E-06	0.1	NO	NO
	Total Recreational Child Risk	**2E-05**	**0.7**	**5E-05**	**1**	**NO**	**NO**
AREA 3 INDUSTRIAL							
Maintenance Worker							
Surface Soil		3E-07	0.008	4E-06	0.03	NO	NO
	Total Maintenance Worker Risk	**3E-07**	**0.008**	**4E-06**	**0.03**	**NO**	**NO**
AREA 3 RECREATIONAL							
Recreational Child							
Surface Soil		3E-06	0.2	6E-06	0.5	NO	NO
Sediment		2E-06	0.07	6E-06	0.1	NO	NO
Surface Water		3E-06	0.04	5E-06	0.1	NO	NO
	Total Recreational Child Risk	**8E-06**	**0.3**	**2E-05**	**0.7**	**NO**	**NO**

TA[illegible]0-1
SUMMARY OF HUMAN[illegible]TH RISK ASSESSMENT
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPOSURE MEDIUM	RECEPTOR	CENTRAL TENDENCY		REASONABLE MAXIMUM		ARE SITE RISKS UNACCEPTABLE?	
		Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index	Cancer Risk (greater than 1×10^{-6} - 1×10^{-4})^1	Non-Cancer Risk (greater than HI = 1)^2
POSSIBLE FUTURE LAND USE							
AREA 2 INDUSTRIAL							
Commercial/Industrial Worker							
Surface Soil		1E-06	0.06	7E-06	0.1	NO	NO
Groundwater^3		NE	0.07	NE	0.07	NO	NO
	Total Commercial/Industrial Worker Risk	**1E-06**	**0.1**	**7E-06**	**0.2**	**NO**	**NO**
Construction Worker							
Surface Soil		6E-07	0.5	1E-06	0.5	NO	NO
Subsurface Soil		2E-07	0.2	6E-07	0.2	NO	NO
	Total Construction Worker Risk	**8E-07**	**0.7**	**2E-06**	**0.7**	**NO**	**NO**
AREA 2 RECREATIONAL							
Construction Worker							
Surface Soil		1E-06	1	3E-06	1	NO	NO
Subsurface Soil		1E-06	3	3E-06	3	NO	YES
	Total Construction Worker Risk	**2E-06**	**4**	**6E-06**	**4**	**NO**	**YES**
AREA 3 INDUSTRIAL							
Commercial/Industrial Worker							
Surface Soil		2E-06	0.04	1E-05	0.1	NO	NO
Groundwater^3		5E-05	2	2E-04	2	YES	NO^4
	Total Commercial/Industrial Worker Risk	**5E-05**	**2**	**2E-04**	**2**	**YES**	**NO^4**
Construction Worker							
Surface Soil		1E-06	0.8	2E-06	0.8	NO	NO
Subsurface Soil		3E-07	0.2	6E-07	0.2	NO	NO
	Total Construction Worker Risk	**1E-06**	**1**	**3E-06**	**1**	**NO**	**NO**
AREA 3 RECREATIONAL							
Construction Worker							
Surface Soil		8E-07	0.6	1E-06	0.6	NO	NO
Subsurface Soil		8E-07	0.4	1E-06	0.4	NO	NO
	Total Construction Worker Risk	2 **2E-06**	**1**	**2E-06**	**1**	**NO**	**NO**

TA[illegible]10-1
SUMMARY OF HUMAN[illegible]TH RISK ASSESSMENT
AOC 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPOSURE MEDIUM / RECEPTOR	CENTRAL TENDENCY		REASONABLE MAXIMUM		ARE SITE RISKS UNACCEPTABLE?	
	Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index	Cancer Risk (greater than $1x10^{-4}$ - $1x10^{-6}$)[1]	Non-Cancer Risk (greater than HI = 1)[2]
UNRESTRICTED FUTURE LAND USE						
AREA 2 INDUSTRIAL						
Adult Resident						
Surface Soil	--	--	7E-06	0.1	NO	NO
Subsurface Soil	--	--	3E-06	0.02	NO	NO
Groundwater [3]	--	--	--	0.2	--	NO
Child Resident						
Surface Soil	--	--	2E-05	2	NO	NO [4]
Subsurface Soil	--	--	9E-06	0.3	NO	NO
Total Resident Risk [5]	**--**	**--**	**4E-05**	**0.3 / 2**	**NO**	**NO / NO [4]**
AREA 2 RECREATIONAL						
Adult Resident						
Surface Soil	--	--	2E-05	0.3	NO	NO
Subsurface Soil	--	--	2E-05	1	NO	NO
Groundwater [3]	--	--	1E-03	7	YES	YES
Child Resident						
Surface Soil	--	--	6E-05	4	NO	YES
Subsurface Soil	--	--	6E-05	19	NO	YES
Total Resident Risk [5]	**--**	**--**	**1E-03**	**8 / 23**	**YES**	**YES / YES**
AREA 3 INDUSTRIAL						
Adult Resident						
Surface Soil	--	--	1E-05	0.1	NO	NO
Subsurface Soil	--	--	3E-06	0.03	NO	NO
Groundwater [3]	--	--	6E-04	5	YES	YES
Child Resident						
Surface Soil	--	--	4E-05	1	NO	NO
Subsurface Soil	--	--	9E-06	0.3	NO	NO
Total Resident Risk [5]	**--**	**--**	**7E-04**	**5 / 1**	**YES**	**YES / NO**

TA 0-1
SUMMARY OF HUMAN H RISK ASSESSMENT
AO 57

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPOSURE MEDIUM	RECEPTOR	CENTRAL TENDENCY		REASONABLE MAXIMUM		ARE SITE RISKS UNACCEPTABLE?	
		Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index	Cancer Risk (greater than $1x10^{-4}$ - $1x10^{-6}$)[1]	Non-Cancer Risk (greater than HI = 1)[2]
AREA 3 RECREATIONAL							
Adult Resident							
	Surface Soil	--	--	1E-05	0.2	NO	NO
	Subsurface Soil	--	--	1E-05	0.1	NO	NO
	Groundwater[3]	--	--	1E-03	8	YES	YES
Child Resident							
	Surface Soil	--	--	3E-05	3	NO	YES
	Subsurface Soil	--	--	3E-05	0.7	NO	NO
	Total Resident Risk[5]	**--**	**--**	**1E-03**	**8 / 4**	**YES**	**YES / YES**

NOTES:

1 According to the National Contigency Plan for Superfund Sites, the acceptable cancer risk range is within or below 1 in 10,000 ($1x10^{-4}$) to 1 in 1 million ($1x10^{-6}$).

2 According to the National Contigency Plan for Superfund Sites, the acceptable non-cancer risk is a chemical dose that will not result in adverse health effects to sensitive subpopulations; this is often interpreted by the USEPA to be a HI of not greater than 1.

3 Groundwater is not presently, nor will be in the future, used as a source of residential or industrial supply water. Therefore, this evaluation represents a theortical exposure which does not and will not occur.

4 The hazard index for effects to specific target organs or organ systems does not exceed 1 (see Appendix N).

5 The total cancer risk is the sum of cancer risks for surface soil and surface soil for the child and adult residents, plus the cancer risk for groundwater for the adult resident. Non-cancer risks are not additive between child and adult receptors. 'The total non-cancer risks are the sum of the risks for surface soil and subsurface soil for the child resident, and the sum of the surface soil, subsurface soil, and groundwater risks for the adult resident.

RME = Reasonable Maximum Exposure
bgs = below ground surface
HI = Hazard Index

NE = Not Evaluated; No potentially carcinogenic CPCs
-- = CT exposure not evaluated

DEVENS
FINAL REMEDIAL INVESTIGATION

RESPONSE TO COMMENTS ON THE DRAFT FINAL REMEDIAL INVESTIGATION REPORT FOR AREA OF CONTAMINATION (AOC) 57, DATED OCTOBER 1999 DEVENS, MASSACHUSETTS

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NEW ENGLAND DIVISION

APRIL 2000

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RESPONSE TO COMMENTS ON THE DRAFT FINAL REMEDIAL INVESTIGATION REPORT AREA OF CONTAMINATION (AOC) 57 DATED OCTOBER 1999
DEVENS, MASSACHUSETTS

USEPA Comments Dated December 16, 1999
Comment Incorporation
Response to MADEP and USEPA Comments on the Draft Remedial Investigation Report for AOC 57 dated August 1997

GENERAL COMMENTS

1. **Comment 5**. The response states that the text will be revised to include a qualitative discussion of surface water and sediment data for Cold Spring Brook. Upon review of Section 7.0, in the Draft Final Remedial Investigation (RI) Report, no qualitative discussion of the data was found. This discussion should be provided as specified.

   Response: USEPA General Comment #5 (dated August 1997) requested evaluation of the risks from exposure to Cold Spring Brook surface water and sediment for a child receptor under a wading scenario. The comment further requested additional information on Cold Spring Brook to determine if the human health risk assessment (HHRA) should include an evaluation of a fishing and/or swimming exposure scenario. The response stated that a qualitative discussion of the data would be provided in the risk assessment (Section 9.0).

   In light of the Supplemental Sampling conducted in 1998, surface water and sediment data at Area 2 were quantitatively evaluated for potential exposures in the HHRA and are presented in Section 9.0 of the RI. Surface water and sediment analytical data from the RI as well as previous investigations are discussed in Subsections 7.2.1.1, 7.2.1.2, 7.2.1.4, 7.2.4, and 7.2.5.

SPECIFIC COMMENTS

1. **Comment 9**. The comment requested that the relative positions of surface water and sediment sampling locations SSD/SSW-93-06A and SSD/SSW-94-06C, relative to SSD/SSW-93-06B, be displayed. The response states that the locations of SSD/SSW-93-06A and SSD/SSW-94-06C have been added to Figure 5-3, Previous Investigation Sampling Locations. In the Draft Final RI Report, Figure 5-4, Previous Investigation Sampling Locations, SSW/SSD-93-06A, SSW/SSD-93-06B, and SSD-93-06C, are

shown. Location SSD/SSW-93-06C however, is not shown. Please review for possible typographical errors in sample location numbers in order to confirm that the figure is correct.

Response: The text reference to SSD/SSW-94-06C is a typographical error. The correct exploration should be SSD-93-06C. No surface water was collected at this location because there was no standing water. Figure 5-4 is correct.

2. **Comment 11**. The response to the comment has been incorporated into the Draft Final RI Report. However, sample number 57M-98-05X, shown on page 5-19, Section 5.4.5, is incorrect. Sample number 57M-98-05X should be changed to 57M-95-05X.

   Response: The suggested change will be made.

3. **Comment 13**. The comment requested that the sequence of borings, 57M-95-04A through 57M-95-08B, be written as 57M-95-04A, 57M-95-04B, 57M-95-05X, 57M-95-07X, 57M-95-08A, and 57M-95-08B. The response affirms that the suggested change has been made. The suggested change was adopted in paragraph one of Section 5.4.5. of the Draft Final RI Report, but the sequence written in paragraph two (57M-95-01X through 57M-95-08B), and that in paragraph three (57M-95-06X through 57M-95-08B), should be written out to clarify the actual borings in question.

   Response: The suggested change will be made.

4. **Comment 15**. The comment requested that the Aquifer Test Completion Checklist be provided in an appendix. The response states that the Aquifer Test Completion Checklists for all hydraulic conductivity testing performed are included in Appendix F. Upon review of the Draft Final RI Report, no Aquifer Test Completion Checklist was found in any of the appendices. Please add the checklist, as described in the Project Operations Plan (ABB-ES, 1995), to the report.

   Response: The Aquifer Test Completion Checklists will be added to Appendix F.

5. **Comment 16**. The comment stated that hydraulic conductivity determinations were only provided for the Bouwer and Rice method. It was requested that hydraulic conductivity determinations for both the Bouwer and Rice and the Hvorslev methods be provided in Sections 6.3.1 and 6.3.2 of the report. The response states that conductivities calculated

by Hvorslev analysis will be added to these sections. Hydraulic conductivities as calculated by the Hvorslev method, however were not included in the Draft Final RI Report. Please address this omission.

Response: Hydraulic conductivity estimates as calculated by the Hvorslev method will be added to Sections 6.3.1 and 6.3.2. The Hvorslev estimates will be in addition to the existing hydraulic conductivity estimates as calculated using the Bouwer and Rice method.

6. **Comment 18.** The response to this comment has been incorporated into the Draft Final RI Report, but as indicated in Comment 9 above, sample location numbers may be incorrect. Section 7.2.1.2, page 7-18, refers to both SSD/SSW-94-06B and SSD/SSW-93-06B, as well as SSD-94-06C and SSD-93-06C. Please review this section along with Figure 5-4 for accuracy of sample location numbers.

   Response: The text reference to SSD/SSW-94-06C is a typographical error. The correct exploration should be SSD-93-06C. No surface water was collected at this location because there was no standing water. Figure 5-4 is correct.

7. **Comment 29.** The original comment requested that methods used to characterize habitats (transect lengths, wetland area sizes, and survey methods) be described. The response states that transect lengths and estimated wetland areas will be included in Section 9.2.1 and in Figure 9-1, along with a brief description of the survey method used to categorize the wetland habitat.

   The length of transects have been added to Section 9.2.1 of the Draft Final RI Report, however the other points in the comment have not been incorporated into the revised report. Wetland area information and survey method information is still missing from the Draft Final RI Report. Further, in the Draft Final RI Report, Figure 9-1, the transects are shown but lengths are not given, nor is wetland area shown. Please provide the above missing information, as detailed in the response to the comment.

   Response: As indicated in subsection 9.2.1, p. 9-41, paragraph 5, HLA ecologists used a modified line transect method to complete the ecological characterization, and referenced the U.S. Army Corps of Engineers 1987 guidance for that method.

The ecological characterization is intended to be a *qualitative* description of the habitats at AOC 57. Transects were used simply as a means of identifying the different habitats across the stream channel section (i.e., from AOC 57 upland to the opposite shore upland) for selecting appropriate receptors for the ERA; therefore, little attention was given to measuring habitat widths or transect lengths. The lengths described in subsection 9.2.1 and the transects shown in Figure 9-1 are estimated.. Given the ambiguous nature of this information, the Army has since reconsidered the value that this information would have in Figure 9-1, and therefore limited the presentation of this information to subsection 9.2.1.

The wetland areas were not measured or recorded during the ecological characterization (completed in October of 1995) or the wetland delineation (completed in October of 1993). The Army will review historical aerial photos and current maps to provide estimates of the wetland areas in subsection 9.2.1.

8. **Comment 31**. The comment recommended that risk to amphibians and reptiles be discussed in the uncertainties section. The response explains that uncertainties associated with food-chain exposure and dermal exposure for amphibians and reptiles are included in Table 9-36, Potential Sources of Uncertainty in Ecological Risk Assessment. In the Draft Final RI Report, Table 9-68, Potential Sources of Uncertainty in Ecological Risk Assessment, uncertainties associated with lack of toxicity information for amphibians and reptiles are discussed, as stated in the response.

   The response also commits to clarification of Section 9.2.2.2, Identification of Exposure Pathways, to state that dermal exposure for sensitive life stages of amphibians are evaluated in the ecological risk assessment (ERA). This response was incorporated adequately into the Draft Final RI.

   However, amphibians are introduced in the Wildlife subsection, but should be discussed perhaps in the Aquatic Receptors subsection as they are evaluated, along with other aquatic biota, by screening against aquatic criteria (as provided in Appendix O). Further, literature derived benchmarks for amphibians (from AQUIRE) in Appendix O, Table O-1.9, are provided for only three chemicals: 1,1,2-trichloroethylene, bis (2-ethylhexyl)phthalate, and aluminum. Numerous toxicity data for amphibians, which were not incorporated into the derivation of an Effect Concentration, are available in AQUIRE and may warrant consideration.

Response: Subsection 9.2.2.1 identifies juvenile amphibians as aquatic receptors. Subsection 9.2.2.2 under Wildlife describes the distinction between exposures to amphibians from contaminants in soil and surface water. Subsections 9.2.2.1 and 9.2.2.2 for Wildlife will be further clarified to indicate that soil exposures are relevant only for *adult* amphibians, and subsection 9.2.2.2 for Aquatic Receptors will repeat those listed in subsection 9.2.2.1.

Table O-1.9 represents the accumulated results of many search efforts in the AQUIRE database;, these searches were not limited to exclude certain aquatic receptors. The Army does not believe that the effort involved in conducting a new AQUIRE search would be warranted. Amphibian toxicity data obtained from other sources (Devillers and Exbrayat, 1996) included in the Final AOC 50 RI will be included in the Final AOC 57 ERA as Table O-1.10 in Appendix O. AQUIRE information for amphibians presented in the AOC 50 ERA will also be reviewed for possible inclusion in the Final AOC 57 ERA.

9. **Comment 40**. The original comment asserted that the exposure frequency of 10 days per year used for a maintenance worker should be augmented to 30 days to be more conservative. The response states that a discussion of the uncertainty associated with exposure frequency will be added to Section 9.1.6, Evaluation of Uncertainties. Upon review of the Evaluation of Uncertainties, discussed in Section 9.1.5 in the Draft Final RI Report, no discussion of the uncertainty associated with exposure frequency was found. This discussion should be added as stated in the response.

   Response: The discussion was not provided in the uncertainty section because the exposure frequency for the maintenance worker was revised from 10 days per year to 26 days per year (2 times per week, April through October). Documentation of the exposure frequency is presented in the exposure factors table (Table 9-38; some pages of which were omitted during publication of the Draft Final RI, but have been included in the Final RI).

10. **Comment 43**. The comment requested that a discussion of Area 2 - Recreational Land Use exposures to subsurface soil by workers be included in the report. The response maintains that the text will be revised to state, "The interim lead screening value for residential soil (400mg/kg) was used..." Neither this quote given in the response, nor a related statement, can be found in the Draft Final RI Report. Please revise the text as stated in the response.

Response: The referenced statement will be added. Also please note that a quantitative evaluation of construction worker exposures to subsurface soil in the wetland at Area 2 and Area 3 was included in the Draft Final risk assessment. In addition, the interim lead screening value for residential soil (400 mg/kg) was used to evaluate potential risks associated with lead in soils (see page 9-32).

11. **Comment 47**. The comment asked for enhancement of slug test information. The response stated that dimensions of the slug are provided in the Aquifer Testing Completion Checklists provided in Appendix F. In the Draft Final RI Report, the Aquifer Testing Completion Checklist cannot be found in the appendices. Please add the checklist, as described in the Project Operations Plan (ABB-ES, 1995), to the report.

    Response: The Aquifer Test Completion Checklists will be added to Appendix F.

12. **Comment 59**. The comment noted that in the figure for Contaminant Pathway Model for Ecological Receptors, the term "food" is unclear and should be replaced with "biota". The response agrees to making this change in the figure, but in Figure 9-2 in the Draft Final RI Report, the change has not been made. Please change "food" to "biota", as recommended in the comment.

    Response: Agreed, Figure 9-3 will be revised to show that *bioconcentration* from surface water and *bioaccumulation* from sediment in *prey items/biota*, and subsequent ingestion result in a complete exposure pathway for wildlife.

13. **Comment 60**. The comment requested that the exploration/sample identification for the five sediment samples collected in September 1995 be provided in Table 5-1, Summary of Investigation Activities. The response states that the suggested changes have been made. In Table 5-1 of the Draft Final RI Report, the information is still missing. Please make the change as suggested in the comment.

    Response: All of the exploration location IDs are provided in Table 5-1. The additional sediment samples were from locations 57D-95-03X through 57D-95-07X where two samples, a surficial and deep (2 to 5 feet), were collected. Please refer to Section 5.4.2 for a discussion of sampling methodology.

14. **Comment 61**. The comment requested that well location for G3M-92-07X be plotted on

Figure 6-7. The response states that, due to scale constraints, the well cannot be plotted , but that the location will be referenced in the figure. In Figure 6-7 of the Draft Final RI Report, the location is not referenced. Please reference the location of the well as stated in the response.

Response: The location of G3M-92-07X will be referenced on Figure 6-7 as requested.

15. **Comment 64**. The response adequately addressed the comment and was incorporated into the Draft Final RI Report. While reviewing the RI for this comment, however, some inconsistencies were discovered which should be addressed. Table 7-15 shows analytical results for groundwater. For several metals, maximum concentrations reported in Table 9-14 do not agree with concentrations shown in Table 7-15. For example, for site 57M-95-03X, lab sample number DV4F*172 concentrations for arsenic listed in Table 7-15 are 40.1 ug/L and 42.3 ug/L, but the maximum value reported in Table 9-14 is 40.1 ug/L, not 42.3 ug/L. Please review the concentrations used in Table 9-14 to determine CPCs.

    Response: The arsenic concentration reported for sample DV4F*172 of 40.1 ug/L is associated with a filtered sample. As shown in Table 9-14, the maximum concentration of arsenic in filtered groundwater samples at Area 3 Industrial Use is 40.1 ug/L. Table 9-14 will be reviewed to ensure that maximum groundwater concentrations are accurately reported.

16. **Comment 65**. The comment referred to Table 9-8, Calculation of Volatilization Factors, noting that the unit "L" was not defined. The response states that the unit "L" and other units will be defined in the revised table. In the Draft Final RI Report, there is no table with the information provided in the original Table 9-8, Calculation of Volatilization Factors. Similarly, the information in Table 9-7, Groundwater Contaminant Release Analysis, in the Draft Report is not provided in a table in the Draft Final Report. If these tables were inadvertently omitted, they should be added to the revised report, with the units defined as discussed in this comment and response.

    Response: Because concentrations of VOCs in groundwater at AOC 57 were very low, maximum groundwater concentrations were compared to MCP GW-2 groundwater standards (which are protective for vapor migration to indoor air at a cancer risk level of

$1x10^{-6}$ and a non-cancer HI of 0.2). As shown in Table 9-21, the maximum groundwater concentrations are generally several orders of magnitude below the GW-2 standards, indicating that risks are below $1x10^{-6}$ and a HQ of 0.1. Therefore, the vapor migration exposure pathway was considered insignificant, and potential exposures to vapors that may migrate from groundwater to indoor air were not quantitatively evaluated in the Draft Final risk assessment. The language in Section 9.1.2.1 (page 9-18) concerning the approach used to screen this exposure pathway will be strengthened with the evidence presented in this comment response.

RESPONSE TO COMMENTS ON THE DRAFT FINAL REMEDIAL INVESTIGATION REPORT AREA OF CONTAMINATION (AOC) 57 DATED OCTOBER 1999 DEVENS, MASSACHUSETTS

USEPA Comments Dated December 16, 1999

Inadequate Responses

EPA Letter to Army dated September 18, 1997 titled USEPA New England Review of the Response to Comments on the Draft Remedial Investigation Report for AOC 57

GENERAL COMMENTS

1. **Comment 1**. The original comment discussed the appropriateness of the data used to derive reference toxicity values (RTVs). The response to this comment indicated that the RTVs derived were sufficiently conservative, and were consistent with the approach employed at other Areas of Contamination (AOC) at Devens. This response does not acknowledge that ecological risk assessment is a rapidly evolving field. Therefore, the methods of assessing ecological risks at other AOCs in the past may not be adequate given the current understanding of ecological risk assessment procedures. According to the U.S. Army's *Tri-Service Procedural Guidelines for Ecological Risk Assessment* (June 1996) when LC_{50} (or LD_{50}) data must be used to derived RTVs, a safety factor of 0.01 (or the LC50 divided by 100) should be applied rather than the value of 0.2 which was used in this risk assessment. In addition, the hierarchy of data use presented in Figure 12 of this guidance (Tri-Services 1996) should be used to select values to develop RTVs. Therefore, in all cases NOAEL data is preferred to LOAEL data, which is preferred to an LC_{50}. The RTVs should be derived using NOAEL data preferentially, and where LC_{50} data must be used, the safety/uncertainty factors applied should total to a value of 0.01.

   Selected RTVs in the Draft Final RI Report are the same as those in the Draft Report. The suggestions in this comment were not incorporated into the revised report.

   Response: The Army has previously responded to this USEPA comment with the following rebuttal, which was discussed with the USEPA, MADEP, and USFWS at the January 1998 meeting.

   > It is the Army's understanding that the *Tri-Services Procedural Guidelines for Ecological Risk Assessment* (Wentsel et al., 1996) provides a recommended method for profiling ingestion toxicity data (i.e., NOAEL, LOAEL, and LD_{50} data), and for applying extrapolation factors to these data. This method is intended to link an RTV for a specific exposure duration to a population of receptors in the field (in order to estimate toxicity to that population within a given exposure period). The Army believes that use of these factors may seriously overestimate potential ecological risk. Although appropriate during an initial risk screening, overly conservative methodologies employed during the conduct of an ERA can result in marginalizing the importance of the risk analysis.
   >
   > The primary objective of using uncertainty factors, as suggested by the reviewer and Wentsel et al. (1996), is to

derive more conservative estimates of risk (i.e., reduce Type II error). However, applying extrapolation factors does not reduce risk uncertainties. The Army believes that the approach employed in the AOC 57 ERA is sufficiently conservative. It is the Army's experience that using additional extrapolation factors as suggested by the reviewer, in the absence of a sound technical basis for doing so, can result in risk conclusions that are not supported by other lines of evidence (i.e., site-specific toxicity studies, or visual observations regarding the presence of "sensitive" species or guilds). Quantitative surveys of small mammal populations have shown that healthy populations exist at sites where the predicted risk (based on the selection of conservative RTVs) suggests that toxic conditions exist for small mammal populations.

Based on experience at other Devens and DoD sites, professional experience suggests that using LOAELs without additional extrapolation factors is less likely to over-estimate risk at a site; especially in situations (like at AOC 57) where the ecological community appears to be generally in good health. This, in turn, will likely result in realistic conclusions about risk that can feasibly be incorporated into remedial decisions (as opposed to identifying protective threshold levels at concentrations orders of magnitude less than background or upstream conditions).

The following example from the AOC 57 ERA for Area 2 Upland soil demonstrates the potential difficulties involved with using extrapolation factors:

The exposure concentration of arsenic in Area 2 soil is 21 µg/g, which only slightly exceeds the background value for arsenic in soil (19 µg/g). The food web model indicates that the exposure concentration of arsenic contributed to a negligible probability of risk (HQ = 1.3) for small mammals, as represented by the white-footed mouse. It is usually reasonable to assume that population level effects to native flora and fauna are unlikely at background concentrations.

The measurement endpoint selected to estimate this risk for small mammals is derived from an oral exposure study measuring reproductive effects in rats, for which an LOAEL of 0.58 mg/kgBW-day was obtained. Following the methodology outlined in Figure 12 of Wentsel et al. (1996), the chronic LOAEL would be adjusted by a factor of 5 to achieve a NOAEL:

$$0.58 \div 5 = 0.116$$

The NOAEL would then be adjusted by a factor of 16 because the white-footed mouse (*Peromyscus* sp., family Cricetidae) and laboratory rats (assuming *Rattus* sp. in family Muridae) are not in the same family:

$$0.116 \div 16 = 0.00725$$

The re-calculated risk estimate for white-footed mice exposed to arsenic in Area 2 soil now results in an HQ of 101. This suggests that there is a high likelihood that arsenic in Area 2 soil would cause adverse reproductive effects to white-footed mice, at concentrations that barely exceed background levels. If multiple conservative assumptions like these were made when selecting RTVs for all analytes, then the ERA would be needlessly conservative and broad in its identification of potential risk contributors.

The Army is aware of the advances in the field of ecological risk assessment, and on-going scientific work on the issue of toxicological extrapolations in risk analysis. Efforts have been made to develop appropriate uncertainty factors (UFs) for extrapolating between toxicity values for terrestrial wildlife. However, this work is still in progress, and the results presented at the November, 1996 Society of Environmental Toxicology and Chemistry (SETAC) conference suggest that there is a large degree of uncertainty associated with the use of conservative UFs. Other work presented at SETAC (EPT, 1996) suggests that applying UFs to certain data (i.e., to extrapolate from an LOAEL to an NOAEL), or using other extrapolation techniques (i.e., allometric scaling) without careful evaluation, may compound the uncertainty of an assessment.

References:

Ecological Planning and Toxicology, Inc. (EPT), 1996. Toxicity Extrapolations in Terrestrial Systems; submitted to Office of Environmental Health, Hazard Assessment, and Reproductive and Cancer Hazard Assessment Section of the California Environmental Protection Agency; Corvallis, Oregon; July 5, 1996.

In keeping with this rebuttal, the following uncertainty was added to the Draft Final AOC 57 ERA:

There is uncertainty associated with the food chain risk evaluations for wildlife, specifically associated with the selection of RTVs. Current Army guidance for conducting ERAs (Wentsel et al., 1997) suggests using NOAEL data for evaluating risks to wildlife. When NOAELs are not available, the guidance suggests applying uncertainty factors (UFs) of 10 to LOAELs, and 100 to LD_{50}s. In addition, the guidance also suggests applying other UFs to RTVs for inter-species extrapolations, and for laboratory-to-field extrapolations (effectively resulting in UFs of approximately 10,000 or more). These UFs are intended to add a degree of conservatism when evaluating risks for wildlife receptors for which specific toxicity data are lacking. While these UFs may be appropriate for use in screening-level assessments, they may add considerable uncertainty to baseline ERAs, potentially compromising the credibility of the risk conclusions and resulting in spurious remedial actions. When UFs are applied to RTVs, risk estimates for wildlife receptors may indicate a much higher potential for risk than is realistically possible. For example, UFs applied to the arsenic RTV for mortality in rats would result in a lethal HQ of 101 for the white-footed mouse, indicating a high probability of risk at background concentrations of arsenic in soil (such as was detected in Area 2 upland soil). Multiple conservative assumptions for each analyte would result in cumulative risk estimates (i.e., an HI) in the thousands. For these reasons, the Army has decided not to apply UFs to RTVs in the AOC 57 ERA; therefore, the food chain evaluation may underestimate potential risks to wildlife receptors, according to the suggested guidance.

SPECIFIC COMMENTS

1. **Comment 32**. The original comment discussed that the selected assessment endpoints were not sufficiently conservative. The response to this comment was that the most conservative data were used in generating RTVs to evaluate ecological effects. Information provided in this response should be added to Section 9.2.2.3, Identification of Endpoints, to clarify that the measurement endpoints included evaluation of sublethal effects as well as survival.

Section 9.2.2.3, Identification of Endpoints, has not been altered from the Draft RI to the Draft Final RI Report. The suggestions provided in this comment should be incorporated into the final report.

Response: Agreed. The first paragraph of subsection 9.2.2.3 will be revised to state the following: "... is the survival and propagation of receptor populations at AOC 57. *To ensure that the AOC 57 ERA is sufficiently conservative, the lowest dose for lethal (i.e., mortality) or sublethal (i.e., growth, development, or reproduction) effects were used in the ERA as measurement endpoint.* The specific objectives of the AOC 57 BERA are to determine..."

2. **Comment 33**. See General Comment 1.

   Response: See Response to General Comment 1.

3. **Comment 39**. The original comment discussed that, according to EPA policy, both the RME and central tendency (CT) exposure scenarios should be calculated and reported in the human health risk assessment (HHRA). The response to this comment was that, while future risk assessments will incorporate both CT and RME evaluations, no revisions will be made in this document; that is CT evaluations will not be added to the risk assessment in the present RI Report.

   While the response stated that no revisions would be made in this document, CT evaluations have been included for some scenarios. CT values for Area 3 - Recreational Area, Possible Future Land Use, are included in Table 9-44, though a summary of these values is not included in the Risk Characterization Results, Section 9.1.4.2. Please add the values from Table 9-44 to this summary.

   CT evaluations were also not included for the Unrestricted Future Land Use scenario for all areas. The legend in Table 9-44 states that these evaluations were omitted because only RME risks are assessed for residential exposures. This justification provided in the Draft Final RI Report is unacceptable. Under EPA policy, CT scenarios are required, regardless of exposure scenarios. Therefore, CT risks should be calculated for all exposure scenarios in this risk assessment.

Response: The results of the CT risk characterization (shown in Table 9-44) will be added to the risk characterization discussion in Section 9.1.4.2. The rationale for excluding the CT evaluation for the unrestricted land use scenario is presented in Section 9.1.2.2., and states "CT exposures were not evaluated for the unrestricted land use scenario, since decisions regarding the possible need for land use restrictions or other actions will be based on the RME risks". Essentially, the CT scenario was omitted from the risk characterization for unrestricted land use scenario in order to streamline the risk assessment. The Army would like to discuss with USEPA what benefit would be of including the CT scenario for unrestricted land use, and how the results of the CT evaluation will be used in risk-management decision-making.

RESPONSE TO COMMENTS ON THE DRAFT FINAL REMEDIAL INVESTIGATION REPORT AREA OF CONTAMINATION (AOC) 57 DATED OCTOBER 1999 DEVENS, MASSACHUSETTS

USEPA Comments Dated December 16, 1999

Draft RI/FS Supplemental Work Plan
for Area of Contamination (AOC) 57 Areas 2 and 3
Devens, Massachusetts

As a result of the review of the Supplemental Work Plan and comment incorporation into the Draft Final RI Report, the following comments appear to remain unresolved:

1. **Comment 2**. The comment requested clarification on how results from additional sampling will affect existing human and ecological risk assessments. The response stated that the additional data will be incorporated into the risk assessments. In the Draft Final RI, tables in Section 9 confirm that the additional samples have been used to establish new exposure point concentrations, as alluded to in the response. A review of tables presenting data for Contaminants of Potential Concern (Tables 9-2 through 9-4 in the Draft RI and Tables 9-4 through 9-19 in the Draft Final RI), however, reveals several inconsistencies between the Draft RI and the Draft Final RI. For example, it is unclear why aluminum in surface soil at Area 3 - Industrial Use Area was detected in 3 of 3 samples in the Draft RI but in only 2 of 2 samples in the Draft Final RI. Please explain why the number of soil samples analyzed is apparently lower in the Draft Final RI than the Draft RI.

   Inconsistencies are also evident in the Maximum Detected column. For example, in Area 2 - Industrial Use Area, the maximum detected concentration for manganese in groundwater is 724 ug/L in the Draft RI but only 177 ug/L in the Draft Final RI Report. Similarly, in Area 3 - Industrial Use Area, the maximum detected concentration for lead in surface soil is 425 mg/kg in the Draft RI but only 32.7 mg/kg in the Draft Final RI Report. Please review Tables 9-4 through 9-19 in the Draft Final RI for accuracy, as they relate to tables in the Draft RI.

   The comment also suggested using NOAEL based RTVs in the revised ecological risk assessment.

   Response: As shown in Table 9-2, soil associated with many sample locations at Area 3 was removed during the soil removal action. Consequently, data for those sample locations were not included in the revised Draft Final risk assessment and for some analytes, such as aluminum, the data set was reduced. With respect to groundwater data, as described in Section 9.1.1.1 and shown in Table 9-3, the groundwater data selected for each analyte was the most recent groundwater sampling result. Tables 9-12 through 9-15 will be reviewed to ensure that maximum groundwater concentrations are accurately reported.

As discussed in response to General Comment 1, NOAEL data are more appropriate for use in a screening-level ERA, rather than in a baseline ERA. Refer to Response to General Comment 1.

2. **Comment 3.** The comment requested that total organic carbon (TOC) and grain size be included in analyses for sediment samples. The response states that TOC and grain size should be included in the analyses.

   While the Draft Final RI Report, Section 5.4.2, states that TOC and grain size analyses were done on sediment samples, only TOC results were presented in the tables. Grain size distribution results are not presented. Please include these results in the report.

   Response: Grain size analysis was not performed on the sediment samples collected in 1998 due to an oversight during sample collection. The text in Section 5.4.2 will be changed to reflect this.

3. **Comment 6.** The comment requested elaboration of how soil field screening results will be used to locate sediment sample locations. The response states that sediment samples will be located downgradient of areas with the highest contamination, based on data obtained from field analysis of soil samples. This discussion is not provided in the Draft Final RI Report. This explanation should be included in the Draft Final RI Report for clarity.

   The comment also inquired if field screening of sediments for TPHC will be used to determine sediment sample locations. The response expresses that all sediment samples will be field analyzed for TPHC, but did not state how the results would be evaluated to determine sediment sample locations. This discussion is not provided in the Draft Final RI Report. These criteria should be discussed in the Draft Final RI Report for clarity.

   Response: Text will be added to Section 5.4.2 to indicate that sediment sampling locations were selected based upon regulator input during the site walkover and using the field analytical data obtained during the soil sampling. As is stated in the comment and in the work plan the intent was to place sediment samples downgradient of areas with the highest levels of soil contamination.

Field analytical sediment samples for TPHC were collected concurrently with the off-site sediment samples. The field sediment samples for TPHC analysis were collected for comparative purposes and were not intended to assist in placing sediment sample locations. Sediment sample locations were determined as outlined above.

RESPONSE TO COMMENTS ON THE DRAFT FINAL REMEDIAL INVESTIGATION REPORT AREA OF CONTAMINATION (AOC) 57 DATED OCTOBER 1999 DEVENS, MASSACHUSETTS

USEPA Comments Dated December 16, 1999
Draft Final Remedial Investigation Report
Area of Contamination (AOC) 57
Devens, Massachusetts
October 1999

GENERAL COMMENTS:

1. Comment: Tables for each exposure scenario including the individual Chemicals of Potential Concern (CPCs) and their hazard quotients (HQs) or risk estimates should be presented in the HHRA. This type of tabular information would illuminate the risk drivers for the total risk estimates presented in the text and Table 10-1. For instance, the note on page 9-35, second paragraph, regarding the hazard index greater than 1 would be easier to put into context if the HQs for each of the CPCs and Aroclor 1260 were known (i.e., if Aroclor 1260 has a HQ less than 1, then no toxic endpoint from exposure to Aroclor 1260 would be expected).

   Response: A table that shows the cancer risk estimates and hazard quotients for each COPC will be presented for each exposure scenario associated with a cancer risk greater than $1x10^{-4}$ or a hazard index greater than 1. In addition, screening hazard index values will be segregated by target organ effect to help place risks into context. Tables will not be prepared for exposure scenarios associated with a screening hazard index of 1 or less, or a cancer risk that does not exceed the USEPA risk range, because detailed understanding of the COPCs that contribute risk to these scenarios is not necessary. The tables will be prepared based on RME risk estimates, and will be presented in the risk characterization section of the HHRA.

2. Comment: The residential exposure scenario and it's exposure factors are not described in this HHRA. Exposure parameters are not discussed in the text or in the Table 9 -38 (Exposure Factors). It also appears (re: Section 9.1.6, 1st paragraph 18th line) that a surface soil exposure point was used instead of a 1 -10 feet exposure point (i.e., since there are no present residences, a future residence would need to be constructed; Risk Update number 3). This information should be added to the report and exposure parameters should be reviewed.

   Response: Several pages of Table 9-38 were omitted during publication of the Draft

Final RI Report. The missing pages will be included in the Final RI Report. For areas of the site where surface soil does not pose risks above the USEPA cancer and/or non-cancer risk limits for future residential use (as demonstrated through a screening or segregated hazard index), risks associated with residential exposures to subsurface soil will be evaluated. For areas of the site where surface soils pose risks above the USEPA cancer and/or non-cancer risk limits for future residential use, adding a residential land use risk evaluation for potential exposures to subsurface soils (1 to 10 ft bgs) will not provide information that would change the conclusions of the risk assessment.

3. Comment: The selection of COPCs should be based upon relevant ecological benchmarks for each medium, such as ambient water quality criteria or sediment quality benchmarks. A comparison with background concentrations can be used in the selection of contaminants of concern but those background contaminants that exceed ecotoxicological benchmarks must be identified and carried through the risk assessment.

Response: Using benchmarks for selecting CPCs is consistent with the guidance described in the Process Document (USEPA, 1997) for screening-level ERAs. The Lower Cold Spring Brook Site Investigation (ABB-ES, 1995) for SA 57 (now AOC 57) included an ecological preliminary risk evaluation (PRE) that is consistent with this suggested methodology. In the ecological PRE for SA 57, nearly all maximum concentrations of chemicals detected in SA 57 sediment were identified as exceeding benchmarks; therefore, all chemicals detected in site media for the AOC 57 baseline ERA have been reported. The background screen using the established Devens background concentrations for surface soil, and the upgradient concentrations detected in Cold Spring Brook surface water and sediment, is an additional tool used for stream-lining the ERA.

For Area 2 surface water and sediment, and Area 3 surface water, the background screen was largely ineffective in removing heavy metals (i.e., non-nutrients) for further evaluation in the ERA. Manganese in Area 3 surface water was the one exception to this rule. Therefore, modifications based on this comment are, for the most part, not warranted for these media. This is not the case for Area 3 sediment, or surface soil at all three areas, where many metals were screened out as CPCs based on a comparison with the established 68th percentile background concentrations for surface soil. Rather than re-organize the baseline ERA for these media, a detailed uncertainty will be added to subsection 9.2.7 that outlines the potential risks associated with those chemicals screened out of the baseline ERA based on background or upgradient concentrations (including manganese in Area 3 surface water). Potential risks from RME and average concentrations of eliminated chemicals respective to risks from background/upgradient concentrations will be quantified and discussed.

The Army does not anticipate that this effort will change the existing conclusions for the baseline ERA.

Comment: Background risk can be evaluated separately from site-related risk and the discussion of cumulative, site-related and background risks should be thoroughly discussed within the risk characterization phase of the ecological risk assessment to aid in the ultimate risk management decision-making of the site. Therefore, the approach used to identify the contaminants of concern must be revised and the remainder of the ecological risk assessment modified to include any chemicals that were eliminated based solely on the background data comparison. This revision could occur with evaluating the background risks as a separate section within the assessment to eliminate the need to revise the entire document.

Response: See response to specific comment 3

4. Comment: The document *"Heavy Metals in Sediments of Massachusetts Lakes and Ponds"* (Rojko, 1990) was used in lieu of collecting site-specific background data for inorganic chemicals in Cold Spring Brook sediments. This reference is suitable only for evaluating chemicals for which neither risk-based screening values nor reasonable upgradient sample data are available.

Response: The Rojko (1990) concentrations of metals in Massachusetts lake and pond sediment were used *in conjunction with* the concentrations detected in upgradient sediment samples collected from Cold Spring Brook. The Rojko values were considered appropriate for use in the AOC 57 ERA because (1) there are limited upgradient data (i.e., two samples), and (2) the AOC 57 marshes at Area 2 and floodplain forest at Area 3 are depositional in nature (i.e., like lake and pond environments).These values also add perspective to the levels of chemicals that are commonly detected in sediment throughout the Commonwealth of Massachusetts.

Only those chemicals that fall within the range of "normal" lake/pond sediment concentrations were eliminated, and only two metals detected in sediment (cadmium at 2.3 µg/g, and vanadium at 40.3 µg/g, both at Area 2) were eliminated by this criterion alone. The addition of these two chemicals to the AOC 57 ERA for Area 2 sediment will have little impact on the results; therefore, the Army does not believe that the effort involved in replacing these chemicals in the ERA is warranted. Instead, these two chemicals will be included in the uncertainty described in response to comment 3.

5. **Comment:** The separate areas of AOC 57 are further divided by habitat type for the purposes of food chain modeling. This is appropriate for identifying the likely foraging frequency of the receptors in each area, however it may underestimate risk for receptors such as the barred owl or the red fox that may forage across several of the habitat types. For example, risks were calculated separately for the barred owl for Area 2 upland and floodplain soils. The problem with this approach is that the barred owl might reasonably be expected to forage in both of these contiguous areas of suitable habitat. The exposure routes and receptor species might be different between these two areas, however the risk to a single species foraging in both areas would be additive. It would seem to be appropriate to sum the risks from contiguous areas for the same species. Note that this comment would only apply to species with a site foraging frequency factor of less than one foraging across several contiguous areas. Please clarify or recalculate risks accordingly.

Response: The barred owl and red fox are the only representative wildlife receptors that may forage in contiguous suitable habitat, and that have SFFs less than 1. However, as can be seen by the HIs presented in Table 9-60, the additive risks are also not high enough to represent a potential concern to these receptors. For example:

	Area 2 Upland	Area 2 Floodplain	Area 3	**Additive Risk**
Barred owl (RME)	0.00021	0.00028	0.00034	**0.00083**
Barred owl (Average)	0.00013	0.00011	0.00017	**0.00041**
Red fox (RME)	0.000077	NA	0.0011	**0.0012**
Red fox (Average)	0.000045	NA	0.00030	**0.00035**

This will be addressed as an uncertainty in subsection 9.2.7.

RESPONSE TO COMMENTS ON THE DRAFT FINAL REMEDIAL INVESTIGATION REPORT AREA OF CONTAMINATION (AOC) 57 DATED OCTOBER 1999 DEVENS, MASSACHUSETTS

SPECIFIC COMMENTS:

1. **Comment: Page 9-6, 1st Paragraph, Section 9.1.1.1, Soil.** As noted, EPA uses 0 to 1 foot to define surface soil. The logic for this choice is that this is a reasonable depth that someone might routinely be exposed (i.e., from gardening to surficial contact). Since the data collection is complete for this HHRA, please discuss in either or both the Risk Characterization or Uncertainty Sections how homogeneous the soil in the 0 to 1 foot range is to the soil in the 1 - 2 foot range (i.e., same soil type?, general consistency in analyte concentrations, etc).

   Response: Soils within the 0-1 foot and 1-2 foot soil intervals are relatively homogenous. Because the contaminant release that occurred at the site was primarily subsurface, and migrated along the soil-groundwater interface (not via overland flow), it is possible that soils 1-2 ft bgs are associated with higher contaminant concentrations than soils 0-1 ft bgs. Therefore, including soils 1-2 ft bgs as "surface soils" provides a conservative assessment of potential exposures to site media. This discussion will be added to the uncertainty section of the risk assessment.

2. **Comment: Table 9-1.** Please explain why only one possibly two sample locations for Area 3 are used to estimate exposure for the recreational scenario in HHRA.

   Response: Soil samples were collected at the site during field investigations and soil removal actions spread over several years. For the purposes of site characterization, the locations that were sampled were selected to define the nature and extent of site-related contamination. For the purposes of risk assessment, Area 2 and Area 3 were subdivided into industrial use areas (upland areas) and recreational use areas (wetland areas) based on current and future land uses of the site. Soil within each area was then further subdivided into surface soil (0-2 ft bgs in this risk assessment) or subsurface soil (2-10 ft bgs in this risk assessment). In the case of the Area 3 recreational use subsurface soil, there are only two sample locations in the subsurface soil exposure point. Although this number of samples could appear to be inadequate for exposure assessment, based on the objectives of the field investigations, the low number of samples actually indicates that subsurface soil in the Area 3 recreational (wetland area) is at the boundary of site-related contamination. This is further illustrated by the risk estimates calculated for potential exposures to Area 3 recreational use subsurface soil; risks are well below the USEPA risk limits, indicating that contaminant levels in the soil at this area are at levels that do not pose risk of concern to human health.

3. **Comment: Page 9-7, 3rd Paragraph, Section 9.1.1.1, Groundwater.** As described in both Region 1's Risk Update numbers 2 (8/94) and 5 (9/99), the highest temporal average for each contaminant in each well (i.e., as long as a sufficient number of samples have been collected) should be used for the exposure point. If a temporal average can not be generated, then the maximum concentration of each contaminant among all wells should be used. The ground water exposure point described in the text appears to deviate from regional guidance. In the future, the ground water exposure points should be determined in accordance with the regional guidance cited above.

   Response: The groundwater exposure point concentration for each area of the site (e.g., Area 2 industrial, Area 3 recreational, etc.) is based on the maximum detected concentration from the most recent round of groundwater sampling at each wellhead in the Area. Data from the most recent round of groundwater sampling were used because historical groundwater sampling was not performed using low-flow sampling techniques, and some historical groundwater samples were collected prior to soil removal actions at the site. This approach does not appear to be inconsistent with USEPA regional guidance.

4. **Comment: Page 9-24, Section 9.1.3, Toxicity Assessment.** A discussion about Aroclor/Poly chlorinated byphenyl (PCB) toxicity assessment should also be included in this section. Were PCB congener analyses performed (i.e., since the tables presenting the risk estimates and HQs for each chemical/scenario are missing this is hard to ascertain; it appears that congener analyses were not completed). The regional guidance for PCB risk assessment is in Risk Update number 4 (11/96).

   Response: A discussion concerning PCB toxicity will be included in toxicity profiles, which will be added to Appendix N. A discussion concerning the selection of the appropriate cancer slope factor values for evaluation of PCB toxicity will be added to the toxicity assessment section of the risk characterization. PCB congener analyses were performed on all samples collected at the site. However, only Aroclor-1248 and Aroclor-1260 were detected.

5. **Comment: Page 9-34, 1st paragraph, last line, Section 9.1.5, Evaluation of Uncertainty.** Not all uncertainty is conservative.

   Response: The word "conservative" will be removed from line 16.

6. **Comment: Page 9-34, Section 9.1.5, Evaluation of Uncertainty.** The discussion referenced in Section 9.1.1.3 (2cnd paragraph) regarding background in the uncertainty does not seem to be addressed in this section. Please add this discussion.

   Response: A discussion will be added that addresses the background contribution of risk for inorganic analytes that are significant contributors to site risk.

7. **Comment: Page 9-35, 1st paragraph, Section 9.1.5, Evaluation of Uncertainty.** The discussion regarding the overestimate of risk due to use of the maximum (i.e., when the 95% UCL is greater than the maximum/less than 10 samples in data set) or the use of the 95% UCL when there are one or two samples much higher in a data set is inappropriate and should be removed from the text or rewritten. The 95% UCL is the best estimate of the average exposure, when we do not have enough data to fully characterize the site (e.g., a sufficient grid sampling plan). When the 95 % UCL is greater than the maximum concentration, then the maximum is a better estimate of the true average concentration of a chemical. These tables should be added to the report and should be reviewed when they become available. Although the use of the a maximum or 95% UCL in place of a true average will add to the uncertainty, the exposure point chosen may be either higher or lower than the true average.

   Response: The tables showing derivation of the exposure point concentrations have been included in the risk characterization (see Tables 9-22 through 9-37). The discussion concerning the 95% UCL will be rewritten or removed.

8. **Comment: Table 9-38.** The derivations of the adherence factors should be included in the report (i.e., either in this table or in the text). The adherence factor for the commercial industrial worker is very low.

   Response: A table will be added to the report to document the derivation of the soil adherence factors.

9. **Comment: Page 9-49 Section 9.2.3** ***Hazard Assessment and Selection of CPCs.*** As noted in the general comments, the selection of COPCs is based on background concentrations. This screening is not risk-based, and may eliminate contributors to risk. Risk-based ecological benchmarks should be the primary screening tool for identifying chemicals of potential concern, with the presumption that concentrations below these benchmarks will not harm ecological receptors. It should be noted, for example, that upgradient concentrations of arsenic (110 mg/kg) exceed the Ontario Ministry of the Environment (OMOE) Severe Effect Level (SEL), and that the upgradient concentrations of copper, lead, manganese, and zinc exceed their respective Lowest Effect Levels (LELs) (Jaagumagi, 1995). All of these chemicals were eliminated as CPPCs for Area 3 sediments. While the upgradient concentrations are relevant from a risk-management perspective, they should not be used to identify COPCs.

   Response: See response to General Comment 3. Potential risk from these chemicals will be addressed as an uncertainty.

10. **Comment: Page 9-53, Section 9.2.3.7** ***Area 3 Sediment.*** In this section the rationale was presented for using values presented by Rojko (1990) to identify CPCs in Cold Spring Brook. This reference classifies sediments according to how they compare with sediments in Massachusetts lakes and ponds, however it does not provide any measure of risk. As stated previously, COPC selection should be risk-based.

    Response: See response to General Comments 3 and 5. No chemicals were screened out of the baseline ERA for Area 3 sediment using the Rojko values exclusively. Potential risks from the chemicals that were screened out of the ERA (using upgradient concentrations alone, or a combination of upgradient concentrations and Rojko values) will be addressed as an uncertainty.

RESPONSE TO COMMENTS ON THE DRAFT FINAL REMEDIAL INVESTIGATION REPORT AREA OF CONTAMINATION (AOC) 57 DATED OCTOBER 1999
DEVENS, MASSACHUSETTS

MADEP Comments Dated December 30, 1999
Draft Final Remedial Investigation Report
Area of Contamination (AOC) 57,
Devens Massachusetts
October 1999

GENERAL COMMENTS

1. a. **Comment**. Contaminants of Concern (COCs) released in Areas 2 and 3 have migrated and subsequently impacted the adjacent wetland associated with Coldspring Brook. Based on conclusions of the risk assessment, there would be unacceptable human health risks associated with unrestricted land use of soil and groundwater at AOC 57. The report subsequently recommends conducting a feasibility study to evaluate alternatives to remove potential human health risks associated with potential future potable use of Area 3 groundwater and hypothetical future residential exposures to soil and groundwater. Based on Table 7 of Appendix N *Human Health Risk Assessment,* elevated EPH hydrocarbon ranges are still detected in environmental media for surface soil/sediment).

Response: MADEPs comment is noted.

b) In the fall of 1994, the Army, USEPA, and MADEP agreed that MADEP published toxicity values would be used when EPA values are not available. Using MADEP toxicity values for those chemicals lacking USEPA published values enables quantification of risks rather than a qualitative discussion of risks for those chemicals in the uncertainty section of the risk assessment. It is recommended that this approach be used at AOC57.

Response: MADEP dose-response values for petroleum hydrocarbons (e.g., EPH and VPH) were used in the risk characterization. Available oral and inhalation cancer slope factors for all Class A, B, and C COPCs have been used. Oral RfDs published in USEPA sources have been used for all COPCs except benzo(b)flouranthene (for which a USEPA-approved dose-response value is not available). An oral RfD for benzo(b)fluoranthene will be selected in accordance with MADEP criteria, as described *in "Guidance for Disposal Site Risk Characterization* (MADEP, 1995). Inhalation RfCs are not available for three

COPCs for which there are potentially complete inhalation exposure pathways: arsenic, dieldrin, and Aroclor-1260 (other COCPs for which inhalation RfCs are not available are non-volatile and were detected in groundwater, surface water, or sediment and, therefore, there is no complete inhalation exposure pathway). Of these COPCs, dose-response values approved by MADEP are available for arsenic and Aroclor-1260. However, the only inhalation exposure route for these two COPCs - the particulate inhalation exposure route - contributes relatively insignificant exposures relative to oral and dermal contact exposures. Therefore, using the MADEP-approved inhalation RfCs for these two COPCs would not change the conclusions of the risk assessment. Consequently, the RfCs for Aroclor-1260 and arsenic will not be incorporated into the quantitative risk estimates. However, the uncertainty associated with excluding the MADEP inhalation RfCs for arsenic and Aroclor-1260 will be addressed in the uncertainty section; the discussion will provide documentation that conclusions of the risk assessment would not change if those RfCs were used.

c) Total Site Risk - As noted in several page specific comments, when evaluating cancer and non-cancer risks for various exposure scenarios the total risk for each scenario is equal to the sum of the risks from all evaluated pathways. This exercise should be completed for all scenarios evaluated for AOC 57.

Response: Cumulative receptor risk (i.e., summation of risk among all exposure pathways and exposure media for each receptor population) was calculated for the maintenance worker, commercial/industrial worker, and recreational child exposure scenarios.

For the construction worker, cumulative receptor risk was calculated separately for surface soil and subsurface soil. Risk for each medium were not added together because risks were calculated assuming 100% exposure to each medium; adding risks together for surface soil and subsurface soil would result in doubling the assumed exposure during each day-exposed (i.e., the effective soil ingestion rate would be 960 mg/day). To accommodate this comment, risks for surface soil and subsurface soil will be added together. However, the risk for each medium will be multiplied by a factor of 0.5 prior to summation in order to reflect the assumption that a construction worker would contact both media each day, but that only 1/2 of the exposure on each day would occur at each medium.

For the residential scenarios, cumulative receptor risks were calculated separately for soil (cumulative risk based on summation of child and adult receptor risks for exposure to soil) and groundwater (cumulative risk based on adult 30-year exposure to groundwater, per USEPA, 1994). The risk characterization (including Table 9-44) will be revised to show cumulative receptor risk for residential land use. The calculation for cancer risk will be based on the sum of the child soil risk, adult soil risk, and adult groundwater risk. The non-cancer risk will be calculated separately for the child and adult receptors. The non-cancer risk for the child receptor will be the hazard index for soil, and the non-cancer risk for the adult will be the sum of the adult soil risk and adult groundwater risk.

d) The Human Health Risk Assessment did not evaluate the exposure to subsurface soil for the residential scenario. MADEP understands that EPA Region I does not require evaluation of this pathway. However, MADEP recognizes the potential for receptors to be exposed to contaminated subsurface soil if the subsurface soils were brought closer to (or to) the surface. A qualitative discussion should be provided that addresses the possible risks present if residential exposure to subsurface soils were evaluated.

Response: For areas of the site where surface soil does not pose risks above the USEPA cancer and/or non-cancer risk limits for future residential use (as demonstrated through a screening or segregated hazard index), risks associated with residential exposures to subsurface soil will be evaluated. For areas of the site where surface soils pose risks above the USEPA cancer and/or non-cancer risk limits for future residential use, adding a residential land use risk evaluation for potential exposures to subsurface soils (1 to 10 ft bgs) will not provide information that would change the conclusions of the risk assessment.

e) This risk assessment does not appear to evaluate the potential for the presence of hot spots . A review of the data indicates that the detected concentrations of chromium (2410 ug/g) and lead (5660 ug/g in surface soil sample 57E-95-13X in (Area 2 Recreational Use) are greater than 100 times the concentration of these analytes in surrounding samples. Since both of these are recognized as constituents of concern, it is recommended that subsurface soil sampling location

57E- 95-13X be evaluated separately as a hot spot. No other obvious hot spots were identified in this report. MADEP recommends that the data be reevaluated to determine if other hot spots exist.

Response: The identification of hot spots is an activity that is required under the MCP. Since AOC 57 is a CERCLA site, it is not clear for what purpose hot spots would be identified, or in what context they would be evaluated. The soil, sediment, and surface water exposure point concentrations used in the risk assessment were generally based on the maximum detected concentrations, because the 95% UCL was either not calculated (too few samples) or was greater than the maximum detected concentration. Therefore, analyte concentrations identified by MADEP as possible "hot spots" (e.g., 5660 mg/kg lead; 2410 mg/kg chromium) were evaluated in the risk characterization; the exposure point concentrations for lead and chromium at Area 2 recreational surface soil were based on the maximum detected concentrations identified in this comment.

PAGE SPECIFIC COMMENTS

Volume I

1. **Comment: Sec. 8.2, pg 7.** Please explain why the Fate and Transport of Contaminates section does not discuss PCBs at AOC 57.

   Response: A discussion of the fate and transport of PCBs will be added to Section 8.2.

2. **Comment: Fig. 7-5.** Groundwater1996 field Analytical Detects Area 3, reveal elevated levels of chlorinated VOC in groundwater. Given the nature of the surficial geologic materials consisting of postglacial deposits of sands, the fact that bedrock or other confining geologic unit was not encountered in any of the borings, and the presence of dissolved chlorinated VOCs in groundwater at depth, the potential exists for dissolved chlorinated VOCs in groundwater at depth below current screened intervals of existing wells at Area 3. Based on the current groundwater analytical data, the vertical extent of chlorinated VOCs in groundwater has not been adequately defined. MADEP recommends the installation of 1 monitoring well at depth with field or laboratory GC screening of groundwater during well installation to define the vertical extent of

chlorinated VOCs.

Response: It is true that chlorinated VOCs were detected in groundwater at or near the water table, however,the detections were approximately 1/1000th of the solubility levels for the respective compound. Likewise the levels of chlorinated solvents found in soils are insufficient to suggest a source of free product. It is also true that site soils are comprised of glacial sands and no confining units were encountered. However there is no basis for the statement that chlorinated VOCs were detected at depth. In order for chlorinated VOCs to be present below current screened intervals there would have to be either DNAPL present or downward vertical hydraulic gradients to transport dissolved phase contaminants. As discussed earlier detected levels of chlorinated VOCs are far below what would be associated with the potential presence of a DNAPL. Inference from vertical gradients at Area 2 and proximity to the persistent standing water in the wetland suggest upward vertical gradients at Area 3.

Based upon these data the Army does not feel that additional monitoring wells are warranted.

3. **Comment: Table 7-8.** This Table lists oil recovered from a trench excavated in the wetland at Area 2 had PCBs contamination of Aroclor 1254, at concentrations 28.4 ppm, Aroclor 1242, 29.7 ppm and Aroclor 1260 81.9 ppm. How much oil was removed and explain why an oil recovery system was not installed at the site to help prevent oil and PCBs from continuing to enter Coldspring Brook Wetland. Before the recovery trench was backfilled were soil samples/sediment samples collected from the trench side walls and analyzed for contamination.

Response: It is unknown how much oil was recovered from the trench during the Area 2 Removal Action. The soil removal action was believed to have removed the upgradient source of the contaminants discovered in the trench and it was agreed at the time to backfill the excavation and perform an RI/FS at Area 2. All known soil samples collected as part of the Area 2 Removal Action are provided in the RI report.

4 **Comment: Table 7-10.** Soil screening at Test pit 57E -95-15X had TPH results of 5000 ppm at 0 feet depth and at 5 feet depth 28000 ppm of TPH. In addition to TPH a laboratory confirmed analysis of 7.3 ppm of PCB 1260 was detected at a depth of 2 feet. Please explain why this petroleum and PCB impacted soil wall not excavated and removed.

Response: The analytical results referenced were collected during the field investigation phase of the RI performed at AOC 57. The purpose of the RI was to characterize the nature and extent of contamination and to gather data to aid in the FS. It was not prudent or practical to make remedial action decisions during the field investigation phase without benefit of the full data set from the RI. Furthermore, the PCB sample referenced in the comment was analyzed at an off-site laboratory. The results of this analysis were not available until after the completion of the field investigation.

5. **Comment: Table 7-12.** Field sample location 57E-95-24X in Area 2 or 3 with a confirmed analytical of 64,900 ppm TPH the location of this sample could not be located on the figures. MADEP request the location and depth of this sampling site be shown on the figures and discuss in the report whether the impacted soil was removed.

   Response: Test pit 57E-95-24X is located at Area 3 (refer to Table 7-12) within the center of the historical disposal area. The test pit is located at the center of the radial array of test pits 57E-96-29X through 57E-96-31X and is shown on Figures 7-3 and 7-4. This soil was removed during the 1999 Area 3 Soil Removal Action which is discussed in Section 7.3.

6. **Comment: Table 7-15.** Elevated levels of Arsenic in groundwater have been confirmed at AOC 57. MADEP anticipates the future ROD for AOC57 to limit the use of groundwater at the site.

   Response: MADEPs comment is noted.

7. **Comment: Pg. 9-19, para 4.** This paragraph states that groundwater data collected from AOC 57 was compared the MCP Method 1 risk-based standards to evaluate the potential migration to indoor and ambient air. This procedure is inappropriate as part of a baseline risk assessment. The purpose of a quantitative baseline risk evaluation is to look at the cumulative effects of known/potential exposures via various environmental media looking at site-specific conditions. Both USEPA and MADEP risk guidance calls for demonstrating that indoor and ambient air is or will not be affected by contaminants in shallow ground water, which may be achieved by indoor air sampling, soil gas studies, or fate and transport modeling. This exercise should be completed for AOC 57.

   Response: Because concentrations of VOCs in groundwater at AOC 57 were very low, maximum groundwater concentrations were compared to MCP GW-2 groundwater standards (which are protective for vapor migration to indoor air at a cancer risk level of $1x10^{-6}$ and a non-cancer HI of 0.2). As shown in Table 9-21, the maximum groundwater concentrations are generally several orders of magnitude below the GW-2 standards, indicating that risks for the vapor migration pathway are below $1x10^{-6}$ and a HQ of 0.1. Therefore, the vapor migration exposure pathway was considered insignificant, and potential exposures to vapors that may migrate from groundwater to indoor air were not quantitatively evaluated in the Draft Final risk assessment. The language in Section 9.1.2.1 (page 9-18) concerning the approach used to screen this exposure pathway will be strengthened with the evidence presented in this comment response.

8. **Comment: Pg. 9-20, para 4.** For cancer and non-cancer risks, various pathways are assumed to be additive, as long as the risks are for the same individuals and time period. The risks summarized in this section should evaluate the combined risks calculated for both the surface soil and subsurface soil for the construction worker. The combined risks should then be compared to the acceptable cancer risk range and non-cancer limit (HQ).

   Response: Please see the response to General Comment C.

9. **Comment: Pg. 9-30, para 5.** See Comment to page 9-29, paragraph 4.

   Response: See response to Comment to page 9-29, paragraph 4.

10. **Comment: Pg. 9-31, para 2.** As discussed in the comment to page 9-29, paragraph 4, cancer and non-cancer risks for the various pathways are assumed to be additive. The cancer risk summarized in this section should evaluate the combined risks calculated for both the adult (surface soil and groundwater) and child (surface soil). The combined risks should then be compared to the acceptable cancer risk range.

    Response: Please see the response to General Comment C.

11. **Comment: Pg. 9-31, para 5.** The central tendency cancer risk value was identified as equal to $3 X 10^{-6}$ in this section. According to Table 9-44, it is $3 x 10^{-7}$. Verify which number is correct and make appropriate changes.

    Response: The correct value is $3x10^{-7}$; the text will edited accordingly.

12. **Comment: Pg. 9-32, para 3**. See Comment to page 9-29, paragraph 4.

Response: See response to Comment to page 9-29, paragraph 4.

13. **Comment: Pg. 9-32, para 4.** See Comment to page 9-31, paragraph 1.

Response: The CT cancer risk is $5x10^{-5}$; the text will edited accordingly.

14. **Comment: Pg. 9-33, para 3.** See Comment to page 9-29, paragraph 4.

Response: See response to Comment to page 9-29, paragraph 4.

15. **Comment: Pg. 9-33, para 5**. See Comment to page 9-31, paragraph 1.

Response: The CT cancer risk is $9x10^{-6}$; the text will be edited accordingly.

16. **Comment: Pg. 9-50, para 1.** The text states that the process for selecting sediment contaminant of potential concern is based on "background" data collected from lakes and ponds in Massachusetts. It is unclear how this data set for lakes and ponds represents "background" concentrations for Cold Spring Brook. If analytes are to be eliminated as CPCs based on "background" concentrations, then the "background" concentrations need to reflect upgradient concentrations within the same waterway. Sampling data from upstream locations in Cold Spring Brook should be used in place of regional lake and pond data for the selection of contaminants of potential concern at Cold Spring Brook

Response: See response to General USEPA Comment 5.

17. **Comment**: **Pg. 9-53, para 3.** See Comment to page 9-50, paragraph 1.

Response: See response to General USEPA Comment 5. Only cadmium and vanadium in Area 2 sediment were screened out of the ERA using the Rojko values; these will be addressed in an uncertainty.

18. **Comment: Pg. 9-53, para 4.** See Comment to page 9-50, paragraph 1.

Response: See response to General USEPA Comment 5. There are no metals in Area 3 sediment screened out as CPCs using the Rojko criteria exclusively. Chemicals screened out of the ERA using upgradient concentrations alone, or a combination of upgradient concentrations and Rojko values, will be discussed as an uncertainty.

19. **Comment: Pg. 9-67, para 1.** The RI states that the arsenic Reference toxicity value (RTV) is conservative for the muskrat. Please provide justification to support this statement such as comparing this RTV with other RTVs available in the literature (e.g., Sample et al., 1996). In addition, additional discussion should be provided to support the statement that adverse effects to small mammals (represented by the muskrat) from detected lead and manganese concentrations within Area 2 surface water and sediment are unlikely.

Response: Additional discussion will be provided regarding the statement that the selected RTV for arsenic is conservative. As discussed in the last sentence of paragraph 1 on p. 9-67, the rationale that small mammals are not likely at risk from lead and manganese in Area 2 surface water and sediment is justified by the finding that the estimated exposures only slightly exceed the conservative RTVs.

20. **Comment: Table 9-44** According to Table 9-44, a Receptor Total was not calculated for the Possible Future Land Use - construction worker (surface and subsurface soil) and for the Unrestricted Future Land Use - residential (adult surface soil, child surface soil, and adult groundwater). The individual cancer and non-cancer (except for residential) risks should be summed to yield a Total Receptor Risk. The Total Receptor cancer and non-cancer risks are then compared to EPA's acceptable cancer risk range of 1E-04 to 1E-06 and the non-cancer HQ of 1. This table needs to be corrected to show the cumulative receptor cancer and non-cancer risks.

Response: Please see the response to General Comment C.

21. **Comment: Table 9-58** A soil:plant bioaccumulation factor (BAF) of zero was assigned to lead based on a reference (Levine et al., 1989) that suggests lead does not bioaccumulate in plant tissue. However, references (Boggess, 1977; Behan et al., 1979; and Jenkins, 1980) cited in Eisler (1988) suggest otherwise. It seems prudent to use a bioaccumulation factor as provided in Baes et al. (1984) in a baseline characterization.

Response: The Army will review the Eisler document; it is possible that the data cited in Eisler (1988) are based on organo-lead values, which would not be appropriate for the AOC 57 ERA. If this is the case, then the Army does not believe that a change to the lead BAF is warranted. If the Eisler document suggests that inorganic lead may bioaccumulate in plants, then a BAF of 0.009, based on the Baes (1984) plant BTF of 0.045 multiplied by a factor of 0.2 (assuming 80% plant water content), would be incorporate in the Final baseline ERA for AOC 57. However, this change will likely have little impact on the AOC 57 ERA conclusions.

22. **Comment:** Table 9-38. According to paragraph 3 on page 9-21, information pertaining to the parameters used in current/future use, possible future use, and unrestricted future use scenarios should be provided in this Table. Parameters are presented for only the possible future land use: commercial/industrial and construction workers.

    Response: Several pages of Table 9-38 were omitted during publication of the Draft Final RI Report. The missing pages will be included in the Final RI Report.

23. **Comment: Table 9-64** Ambient Water Quality Criteria (AWQC) are presented for unfiltered and filtered surface water sampling results. It should be noted that AWQC are available (Federal Register, December 10, 1998) for dissolved (i.e., filtered) surface water constituents. These values should be used for the filtered metals. Please correct the table accordingly.

    Response: Agreed. The differences between the hardness-adjusted AWQC for filtered and non-filtered metals are negligible; therefore, it is expected that there will be no impact on the ERA conclusions.

24. **Comment: Table 10-2** This table does not indicate that small mammals may be at risk from detected concentrations of some metals within the sediments of Area 2. See comment 5. Please revise the table if appropriate.

    Response: See response to comment 19. No additional metals need to be added to Table 10-2. The Army is unclear about the MADEP's reference to comment 5.

25. **Comment: Table O-1.1** An exposure duration of 0.75 and 0.5 are presented for the American robin and great blue heron, respectively. It is unclear why the exposure

duration for these species is not 1.0 (as it is for the mallard and the remaining species). Unless the sub-lethal reference toxicity values (RTVs) for the American robin and great blue heron are based on studies conducted for one year or more, it is appropriate to use an exposure duration factor of 1.0 as their length of exposure (i.e., the breeding season) is likely to exceed the exposure duration in the RTV study. Please reassess risk to these two species using an exposure duration factor of 1.0.

Response: The Army's purpose for selecting EDs less than 1 for the robin and heron are based on the percentage of the year that they are expected to forage at AOC 57. Herons are only expected to forage at AOC 57 for one-half of the year because of migration; they are unable to forage in the AOC 57 area during wintertime frozen conditions. While robins are around all year, their wintertime diet consists primarily of berries; they do not forage in soil for earthworms or other invertebrates during the wintertime, thus reducing their direct and indirect soil exposures. This will be explained in the notes of Table O-1.1 in Appendix O.

The Army agrees with the reviewer's point that the length of exposure for wildlife species (i.e., the breeding season) may be the same as or longer than the duration of some laboratory studies on which the RTVs are based. By assuming EDs of 1 for both of these receptors, the estimated risks for the robin would increase by 33%, and estimated risks for the heron would be doubled.

Mercury accounts for most of the estimated risk to herons; risks to the heron and robin from exposure to other chemicals were otherwise negligible. A 33% increase in the risk estimate for the robin or a 100% increase in the risk estimates for the heron for chemicals other than mercury would have no impact on the risk conclusions for AOC 57.

The mercury RTV is based on a reproductive behavior study on mallards; however the exposure duration for this study is not reported. The Army will determine the exposure duration, and if it is less than 1 year, an uncertainty will be added to subsection 9.2.7. A discussion of other uncertainties will also be included, such as the implications that body-weight scaling would have, and the questionable risks from mercury in AOC 57 surface water and sediment.

If the mercury RTV was adjusted by body weight scaling factors for the mallard and heron, then the RTV used to estimate risks to the heron would likely be much lower. This would likely counter the effect of doubling the heron's ED. In addition, the risks associated with mercury at AOC 57 are questionable because (1) the majority of risks are based on unfiltered surface water sample results from one highly turbid sample (mercury was not detected in the filtered sample), and (2) mercury was detected in only one sediment sample that was not collected in close proximity to the disposal area.

Volume III

26. **Comment: Appendix N, Table 7** Samples EX57W14X, EX57W15X and EX57W16X soil samples revealed elevated petroleum contamination in the EPH ranges of C9 - C8, C19-C32, Aliphatics and C11- C22 Aromatics. These samples were taken from the open excavation in the immediate area of the Coldspring Brook wetland at Area 3. They represent samples of the impacted soil remaining at the site. Explain why TPH analysis was not conducted at the above noted sample locations and what reasons this contaminated soil was left in place.

Response: It is assumed that the commentor is referring to TPH analysis as a screening tool and not as an off-site analysis. As was stated in the Removal Action Memorandum (February, 1999) and the Response to Comments on the Removal Action Memorandum (February, 1999) screening of soils was performed with a PID. Based upon results of the off-site confirmatory sampling additional excavation was performed to attain the proposed cleanup goals.

Three separate excavations were performed to eliminate as much of the soil contamination as possible. The residual contamination detected in the last phase of confirmatory sampling was incorporated into the RI risk assessments.

RESPONSE TO COMMENTS ON THE DRAFT FINAL REMEDIAL INVESTIGATION REPORT AREA OF CONTAMINATION (AOC) 57 DATED OCTOBER 1999
DEVENS, MASSACHUSETTS

CX Comments Received January 7, 2000
Draft Final Remedial Investigation Report
Area of Contamination (AOC) 57,
Devens, Massachusetts
October 1999

Risk Assessment Comments: Meyer

1. **Comment: 482483-1068** The document frequently refers to "USEPA requirements for site closure, a no further action decision must be supported by the demonstration that a site does not pose an unacceptable risk for future unrestricted land use". Though this statement is not inconsistent with the NCP if it is based upon written guidance it should be cited in the RI document. The text as stated seems to be a strict interpretation of OSWER directive 9355.7-04 "Land Use in the CERCLA Remedy Selection Process" (1995).

   Response: The statement is not based upon known written guidance. This practice has been mandated by USEPA Region I and personally communicated to the Army.

Toxicity Assessment

2. **Comment: 482483-1069** Recommend adding uncertainty discussion regarding the RfDs for EPH and VPH. These are not EPA approved toxicity values and these are based upon surrogate toxicity values for a range of hydrocarbons. There is considerable uncertainty associated with the values which warrants discussion.

   Response: An uncertainty discussion regarding use of the MADEP dose-response values for EPH and VPH will be added to the section.

3. **Comment: 482483-1070** Since there are HIs above 1 which are leading to recommendations for further study in an FS, recommend that the organ specific effects be segregated and discussed.

   Response: Hazard index values will be segregated by target organ effect for exposure scenarios associated with a screening hazard index value greater than 1. For some exposure scenarios that have screening hazard index values greater than 1, the segregated HI will likely demonstrate that risks are below the USEPA threshold HI of 1 (e.g., child resident at Area 2 upland). For other exposure scenarios that have screening hazard index values greater than 1, there is a single COPC that has a hazard quotient greater than 1 (e.g. Aroclor-1260 in the Area 2 wetland has a HQ greater than 1 for the construction worker and residential scenarios). Therefore, the segregated HI will not necessarily demonstrate that risks are below the USEPA threshold HI of 1, but will likely demonstrate that risks are due to a single chemical of concern.

4. **Comment: 482483-1071** The exclusion of the inhalation pathway for VOCs needs to be better justified. Stating that sandy soils and warm days in the present tense would not contribute to a complete exposure pathway does not make sense. However, sandy soils would lead to decreased concentrations over time for spills that happened in the past. Recommend focussing on the low concentrations of VOCs found during the RI investigation and using this as justification for VOCs being an insignificant contributor to risk. Additionally there is a lack of inhalation toxicological data for wildlife, this could also be used as a justification for excluding the pathway.

   Response: Agreed.

5. **Comment: 482483-1072** The recommendation for soils at Areas 2 and 3 to proceed to an FS did not carefully consider the data and all elements of the risk assessment:

   Given the uncertainties associated with the toxicity and exposure parameters used in the risk assessment and that the HI for soils were 2 and 4 for the industrial and recreational areas respectively, a reasonable risk management decision for the soils at Area 2 would be no further action. Segregation of organ specific effects may further support this decision.

   Segregation of organ specific effects should also be performed for Area 3 soils. This may also support an NFA for this area, but also the fact that the unacceptable HI for the recreational area is 3 and is only based upon 2 samples could justify an NFA for this area.

   If the groundwater at Areas 2 and 3 does proceed to an FS, recommend that it focus upon institutional controls that would be needed in addition to the groundwater classification.

Response: The Army has received specific instruction from USEPA to exclude risk management/site closure language from the risk characterization and RI Report. Please see the response to comment on section 9.1.4.2 regarding hazard index segregation.

RESPONSE TO COMMENTS ON THE DRAFT FINAL REMEDIAL INVESTIGATION REPORT AREA OF CONTAMINATION (AOC) 57 DATED OCTOBER 1999
DEVENS, MASSACHUSETTS

USACE NED Comments dated December 2, 1999
Draft Final Remedial Investigation Report
Area of Contamination (AOC) 57,
Devens Massachusetts
October 1999

GENERAL COMMENTS:

1 **Comment:** It appears that the data assessment results (i.e., estimated, rejected data) which are summarized in Appendix D of the document are not incorporated into the data summary tables in the RI report. The data tables should be adjusted to reflect the impacts described in the data assessment reports.

Response: Based on procedures established between USAEC and HLA, analytical results obtained from the IRDMIS data base are used in the report without additional qualification by HLA. Data quality reports contain evaluations of data quality indicators and interpretations on the data usability of the IRDMIS results. Those data quality considerations that were interpreted to be important for data sets used in RI assessments were identified in Section 7.1 of the RI report. RI authors were to incorporate these considerations into assessments in Section 7.2 and 9.0. In some cases, this means that reported concentrations are interpreted to be false positives, estimated, or unusable results. HLA will review the contamination and risk assessment and verify that data usability considerations identified in Appendix D and Sections 7.1 have been identified and incorporated in the RI.

2. **Comment: 2/8-7/8.** The referenced Tables 8-1 and 8-2 are not included in the document. Please include them. Also, recommend adding a discussion of the fate and transport of arsenic in groundwater to this section (as briefly described in the Executive Summary section of the report).

Response: The referenced tables were inadvertently omitted from the Draft Final Report. The tables will be included in the Final version. The "Inorganics" subsection of Section 8.2 will be augmented to include a more in depth discussion of the fate and transport of arsenic as recommended.

RESPONSE TO COMMENTS ON THE DRAFT FINAL REMEDIAL INVESTIGATION REPORT AREA OF CONTAMINATION (AOC) 57 DATED OCTOBER 1999 DEVENS, MASSACHUSETTS

3. **Comment: Appendix D-2/D4.2.** The referenced tables D4-3 and D4-4 are not included in the document.

Response: A spot check of several documents showed that the referenced tables are included in Appendix D of the Draft Final. It is possible that the tables were omitted from the USACE version during production.