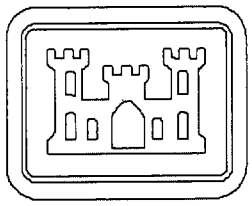

U.S. Army Corps of Engineers

New England District
Concord, Massachusetts

Supplemental Phase II Remedial Investigation of Sites 2, 4, and 6 at the Former Naval Auxiliary Landing Field Charlestown, Rhode Island

Contract No. DACW33-94-D-0009

SUPPLEMENTAL PHASE II STUDY
VOLUME I - TEXT
Task Order No. 36
DCN: CHRI-011501-AAAI

January 2001

98P-0892

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SUPPLEMENTAL PHASE II STUDY
VOLUME I - TEXT
SUPPLEMENTAL PHASE II REMEDIAL INVESTIGATION (PHASE II STUDY) OF SITES 2, 4, AND 6 AT THE FORMER NAVAL AUXILIARY LANDING FIELD (NALF) CHARLESTOWN, RHODE ISLAND

Contract No. DACW33-94-D-0009
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DCN: CHRI-011501-AAAI

Prepared for:

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 Virginia Road
Concord, Massachusetts 01742-2751

Prepared by:

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January 2001

W.O. No. 10971.036.001

SUPPLEMENTAL PHASE II STUDY
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VOLUME II

LIST OF ACRONYMS

bgs	below ground surface
BNs	base neutral compounds
CENAE	U.S. Army Corps of Engineers, New England District
CERCLIS	Comprehensive Environmental Response Compensation and Liability Information System
DERP	Defense Environmental Restoration Program
E&E, Inc.	Ecology and Environment, Inc.
EDI	Environmental Drilling, Inc.
ft	feet/foot
ft/yr	feet per year
FUDS	Formerly Used Defense Sites
gpm	gallons per minute
IT	IT Corporation
MCLs	maximum contaminant limits
msl	mean sea level
NALF	Navy Auxiliary Landing Field - Sites 2,4, and 6, Charlestown, Rhode Island
NTU	nephelometric turbidity units
OVM	organic vapor monitor
PAHs	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyl compounds
Phase II Study	Phase II Remedial Investigation
PHC	petroleum hydrocarbons
PID	photoionization detector
ppb	parts per billion
ppm	parts per million
PVC	polyvinyl chloride
QA	Quality assurance
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management

LIST OF ACRONYMS (continued)

SOW	Statement of Work
SVOCs	semi-volatile organic compounds
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
URS	URS Consultants, Inc
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VOCs	volatile organic compounds
WESTON	Roy F. Weston, Inc.

SECTION 1

EXECUTIVE SUMMARY

1. EXECUTIVE SUMMARY

Roy F. Weston, Inc. (WESTON®) conducted a Supplemental Phase II Remedial Investigation (Phase II Study) at the Former Naval Auxiliary Landing Field - Sites 2, 4, and 6, Charlestown, Rhode Island (NALF). Field Investigations were conducted between October and December 1998. The purpose of the Phase II Study was to investigate the nature and extent of potential soil and groundwater impacts in relation to a former fuel oil underground storage tank at Site 6, and landfilling of debris at Site 2 and Site 4. The primary objective of this study was to fill data gaps remaining from the previous Phase II Study by URS Consultants (URS) completed in September 1996.

Subsurface investigations included soil borings, monitor well installations, soil and groundwater sampling, and water level monitoring during October and November 1998. Five soil borings were drilled at Site 6. One boring and one monitor well were installed at Site 2. Two monitor wells were installed at Site 4. Soil samples were collected from soil borings and groundwater samples were collected from three new wells and five existing wells and were analyzed for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs), total petroleum hydrocarbons (TPH), and Resource Conservation and Recovery Act (RCRA) metals. New and preexisting monitor wells were also monitored for water levels, and surveyed for elevation and location.

At Site 2, soil samples were collected from two monitor well locations (LF201, LF202) to evaluate soil conditions below the fill in this area. One sample was collected from below the fill in each boring and analyzed for VOCs, SVOCs, and RCRA metals. No organic compounds were detected in the soil samples. Arsenic was the only metal detected from these two locations at a concentration above the Rhode Island Department of Environmental Management (RIDEM) Residential Direct Exposure criterion in the soil sample from Location LF201. This sample was collected from below the fill and below the water table. Comparison with results from previous studies at Site 2 shows that arsenic concentrations in the surface soil are lower than soil underlying the fill. As a result, it is likely that the detected arsenic is a naturally occurring

component of soil underlying the fill. In addition, because the depth of the detected arsenic is within the saturated zone, direct exposure to people or wildlife is unlikely.

Groundwater samples were collected at Site 2 from new well LF201 and existing wells CN16, CN06, CN08 that are all downgradient of fill areas at the site. Samples were unfiltered and analyzed for VOCs, SVOCs and total RCRA metals. Organic compounds (VOCs or SVOCs) were not detected in groundwater samples at Site 2. Lead was detected above RIDEM's criterion in the sample from existing well CN06 with a concentration of 29.6 parts per billion (ppb). Well CN06 and the other two existing wells were sampled during three previous studies and showed some comparisons of total and dissolved metals. Although lead results from CN06 were inconsistent, the strong indication is that suspended solids were the likely cause of the elevated total lead concentrations in unfiltered groundwater samples. Current total lead results from the three existing wells are consistent with results from previous studies. No lead was detected in unfiltered samples collected by WESTON from wells LF201, CN16, and CN08. It appears that lead concentrations detected in total metals groundwater samples at Site 2 are isolated and attributable to suspended solids. The interpreted groundwater flow direction indicates drinking water sources would not be affected.

At Site 4, soil samples were collected from monitor well locations LF401 and LF402 to evaluate soil conditions below the fill in this area. One soil sample was collected from each location and analyzed for VOCs, SVOCs, and RCRA metals. No organic compounds were detected in the soil samples. No metals were detected at concentrations above RIDEM criteria. No organic compounds (VOCs or SVOCs) were detected in groundwater samples from wells CN10, LF401, LF402 sampled at Site 4. Concentrations of barium were detected below the RIDEM criterion. These results and historical site data do not indicate adverse impact to the subsurface soils or groundwater due to fill materials at this site.

At Site 6, soil samples were collected from four borings in the vicinity of a former fuel oil underground storage tank (UST). One soil sample was collected from each location based on field screening observations and analyzed for VOCs, SVOCs, total recoverable petroleum hydrocarbons (TRPH), and total lead. No VOCs or SVOCs were detected in the soil samples. Concentrations of TRPH and lead detected were well below RIDEM criteria. Observations of

soil from the borings indicated fill to a depth of approximately 6 feet (ft) overlying outwash sand and gravel with refusal on probable bedrock at depths from approximately 12 to 22 ft below ground surface (bgs). Soils encountered did not possess petroleum odor, staining, or product. Soil boring samples results and observations from borings do not indicate any residual source soils in the area of the former fuel oil UST at Site 6. No new monitor wells were installed at Site 6 during this study due to the shallow bedrock refusals encountered, the limited thickness of saturated overburden and absence of impacted soils. No substances were detected in the WESTON groundwater samples from existing well CN09. These results are consistent with analytical results from previous samples collected from this well. As a result, there is no indication of residual groundwater at the location of the former fuel oil UST.

As a result of this Supplemental Phase II investigation, groundwater and soil conditions at Sites 2, 4, and 6 have been investigated. A network of monitor wells has been established at each site that adequately encompasses the potential source areas within each site. Results from this study lead to the following general conclusions as to nature and extent of environmental impacts at these sites:

- No organic compounds were detected in soil and groundwater samples at Site 2. Arsenic was detected above the RIDEM Residential Direct Exposure criterion in a saturated zone soil sample from below the fill at Site 2. Comparison with results from previous studies at Site 2 shows that arsenic concentrations in the surface soil are lower than soil underlying the fill. Based on the low levels of detection of arsenic in soil fill and lack of detection in groundwater, it is unlikely that arsenic is attributable to landfilled materials but rather a component of naturally occurring soils at the site. In addition, because the depth of the elevated arsenic detection is within the saturated zone, direct exposure to people or wildlife is unlikely.

- Lead was detected in groundwater from well CN06 at Site 2 above the RIDEM GA criterion. Groundwater sample data at Site 2 strongly indicate that lead detections in groundwater samples are isolated and attributable mainly to suspended solids in the samples. The interpreted groundwater flow direction indicates that existing drinking water sources would not be affected.

- Soil and groundwater samples analyzed from Site 4 did not detect any substances above RIDEM criteria. Based on these results, there is no indication of significant impact to underlying soil or groundwater from fill at the site.

- Concentrations of residual total petroleum hydrocarbons in soil from the area of a former fuel oil UST at Site 6 are below RIDEM Residential Direct Exposure criteria. No substances were detected in groundwater at this location. A plume of groundwater impact was not detected.

- Based on available soil and groundwater data, soil or groundwater remediation is not warranted at Sites 2, 4 and 6. There is no indication of significant impact to underlying soil and groundwater from potential source areas at Sites 2, 4, and 6.

The following recommendations are made based on review of existing data and the results of investigations for this study:

- Based on the current data, and results of previous risk assessment at the former NALF, a risk assessment is not recommended.

- Comparison of historical site data with results from this study indicates that detection of arsenic in a soil sample and lead in a groundwater sample at Site 2 are not likely attributable to persistent on-site sources. Additional soil and groundwater sampling at the site is not recommended.

- No further action is warranted at Site 2, Site 4, or Site 6 because there is no indication of significant impact to underlying soil and groundwater from past activities in these areas.

- In the absence of significant soil or groundwater impacts, and considering land use for the unforeseeable future at Sites 2 and 4 as a Federal Wildlife Refuge that limits public access to designated trails, it is unnecessary to remove fill at Site 2 and Site 4. Selective removal of debris should be considered to improve safety and appearance of these areas. However, removal activities may result in significant disruption to the wildlife habitat, trees, and shrubs that have developed there.

SECTION 2

GENERAL

2. GENERAL

2.1 INTRODUCTION

WESTON was contracted by the U.S. Army Corps of Engineers, New England District (CENAE) to perform a Phase II Study of Sites 2, 4 and 6 at the former NALF. The Phase II Study included the following activities:

- A review of historical information and previous environmental investigation reports and a site walkover.
- Sampling and analysis of soil samples from six (6) soil boring and three (3) monitor well locations.
- Installation of three (3) overburden monitor wells.
- Groundwater sampling and analysis of new and existing monitor wells.
- Water level monitoring.
- Location and elevation survey of borings and new/existing wells.

This Phase II Study describes the above field investigations performed at Sites 2, 4, and 6 at the former NALF. Data collected from these investigations have been used to characterize and evaluate the potential impact of former UST use and landfill areas on the quality of soil and groundwater at these sites, and to evaluate and recommend remediation options, if necessary.

Project objectives and background information about the site are summarized in this section. Section 3 describes the methodology used to perform the field investigations. Section 4 presents analytical results. Section 5 contains an evaluation of the data and resulting conclusions. Section 6 presents a discussion of remedial alternatives. Section 7 contains conclusions from the investigations and appropriate recommendations. Appendices A through E contain the WESTON Soil Boring/Monitor Well Logs, Field Notes, the Contract Laboratory Analytical Data Packages, Elevation/Location Survey Data, Groundwater Field Screening Data, respectively.

2.2 PROJECT OBJECTIVES

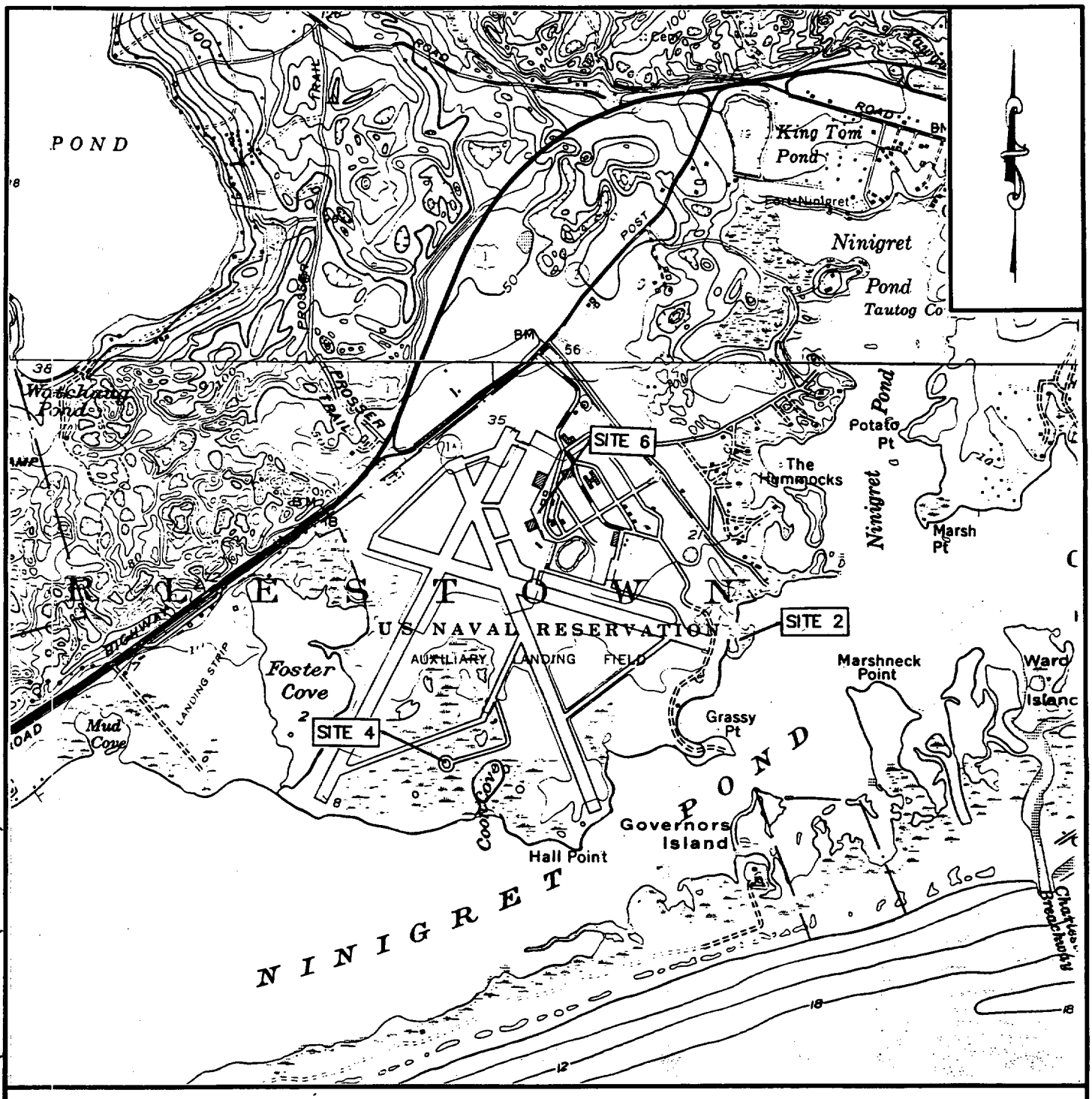
The Phase II Study was intended to meet the requirements of the Statement of Work (SOW) prepared by CENAE and dated July 30, 1998. This SOW was implemented under the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS). The results of the Phase II field investigations (monitor well installation, groundwater and soil sampling, water level measurements, data evaluation, and review of remediation alternatives) were intended to meet the project objectives. The project objectives, as specified in the SOW, were as follows:

- Investigate the nature and extent of potential soil and groundwater impacts in the vicinity of one former 5,000-gallon fuel oil UST at Site 6.
- Further evaluate the potential impact of buried debris on soil and groundwater quality at Sites 2 and 4.
- Evaluate remedial options, as necessary, to address environmental impacts.

CENAE developed the former NALF Sites 2, 4, 6 SOW in response to results from a previous Phase II Remedial Study (URS, 1996) that detected concentrations of petroleum hydrocarbons in soil and groundwater at Site 6, believed to be related to the former UST. Additional information regarding groundwater quality in portions of Sites 2 and 4 were also needed in order to complete the evaluation of potential impact of existing fill areas. A site history is provided in the section that follows.

2.3 SITE LOCATION AND SITE HISTORY

The former NALF is located southeast of and adjacent to Route 1 in Charlestown, Rhode Island (Figure 2-1). The information in this subsection is based on information included in previous reports (IT Phase I Study, 1993; URS Phase II Study, 1996) and observations by WESTON during the Phase II Study. The former NALF was active from approximately 1940 to 1973. The former NALF occupies 605 acres and is bordered on the south and east by Ninigret Pond (Figure 2-2). The western border of the former NALF is Foster Cove.



BASE MAP IS A PORTION OF THE FOLLOWING U.S.G.S. 7.5 MINUTE QUADRANGLE:
QUONOCHONTAUG, RHODE ISLAND, 1975; AND CAROLINA, RHODE ISLAND, 1970 1:24,000

1 MILE 0.5 0 1

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

SUPPLEMENTAL PHASE II REMEDIAL INVESTIGATOIN
AT THE FORMER NALF, SITES 2, 4, AND 6
CHARLESTOWN, RI

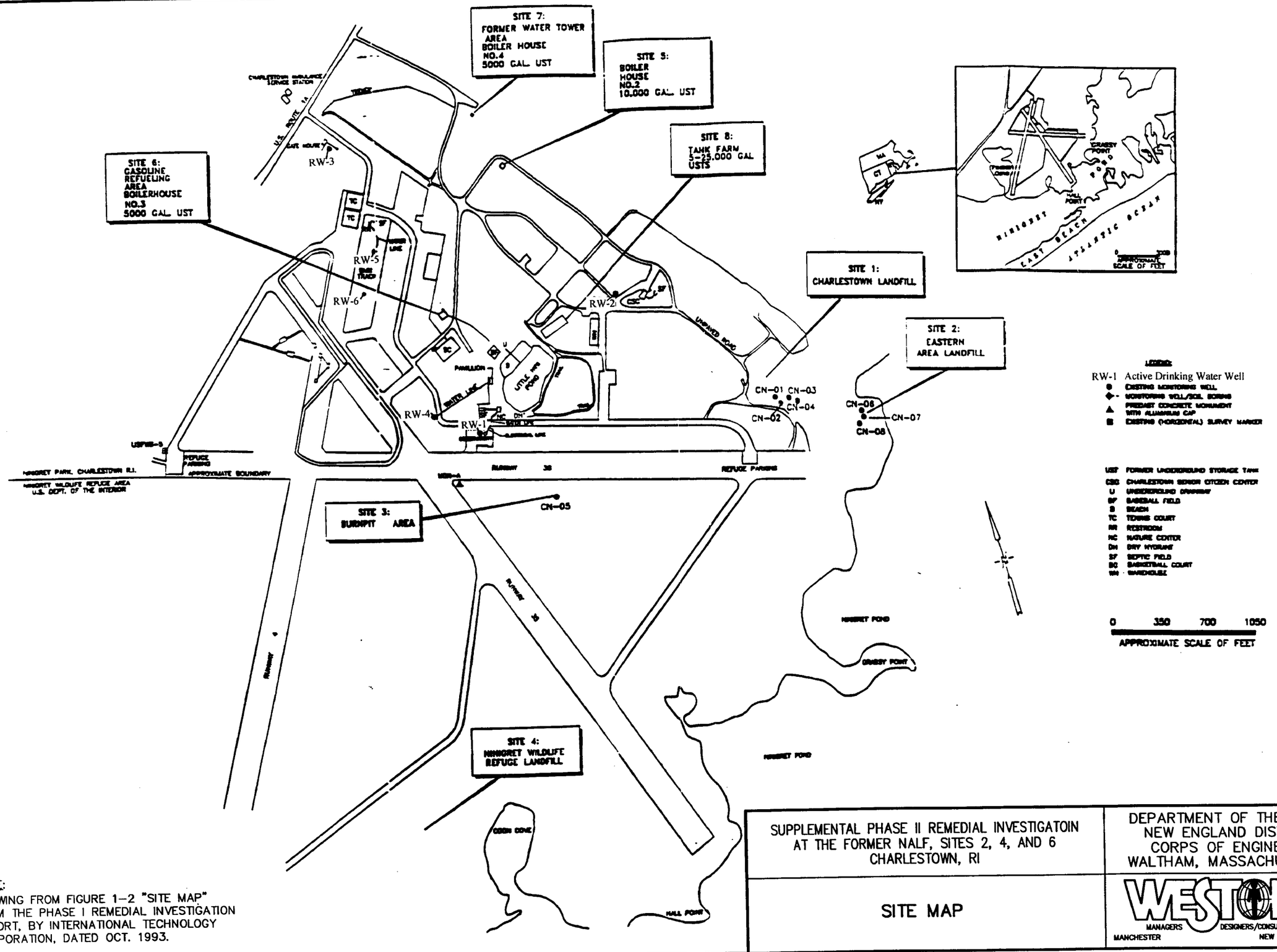
DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

LOCATION MAP

WESTON
MANAGERS DESIGNERS/CONSULTANTS
MANCHESTER NEW HAMPSHIRE

DRAWN	K.J.C.
DATE	MAR 98
FIGURE NO.	2-1

FILE NAME: G:\DESIGN\DWG\ACOE\CHRLSTWN\FIG1-1.DWG (PLOT 1=10)



NOTE:
DRAWING FROM FIGURE 1-2 "SITE MAP" FROM THE PHASE I REMEDIAL INVESTIGATION REPORT, BY INTERNATIONAL TECHNOLOGY CORPORATION, DATED OCT. 1993.

SUPPLEMENTAL PHASE II REMEDIAL INVESTIGATOIN AT THE FORMER NALF, SITES 2, 4, AND 6
CHARLESTOWN, RI

SITE MAP

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

WESTON MANAGERS DESIGNERS/CONSULTANTS MANCHESTER NEW HAMPSHIRE

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DATE JAN 01
FIGURE NO. 2-2

FILE NAME: G:\DESIGN\DWG\ACOE\CHRLSTWN\FIG1-2.DWG (PLOT 1=1)

Sites 2, 4, 6 and the Charlestown Landfill are identified in the U.S. Environmental Protection Agency (USEPA) Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) site RI987480910. The former NALF lies within a GA Groundwater Area as classified by the Rhode Island Department of Environmental Management (RIDEM, 1996). Six active drinking water wells exist at the former NALF, as shown on Figure 2-2.

Site 2, also known as the Eastern Area Landfill, is located beyond the eastern end of Runway 30, adjacent to Ninigret Pond (Figure 2-2). This site is a topographic depression that was used for disposal of construction debris including concrete, bricks, and metal parts. The fill is covered at most locations. This area is also characterized by scrub/shrub vegetation. The nearest drinking water well is located approximately 1800 ft northwest of the site (RW-2; Figure 2-2).

Site 4, the Ninigret Wildlife Refuge Landfill, is located approximately 500 ft northwest of Coon Cove in the Wildlife Refuge area (Figure 2-2). This site is a flat wetland area surrounding an abandoned bunker. The low areas surrounding the bunker were used for disposal of trash, discarded appliances, tires, cans, bottles, and other miscellaneous debris. The fill in this area is exposed at the surface in many areas, and heavily overgrown with vegetation. The nearest drinking water well is over 0.5 miles north of the site.

Site 6, also known as Boiler House No. 3, is located approximately 700 ft northwest of Little Nini Pond in Ninigret State Park (Figure 2-2). The boiler house location included one 5,000-gallon UST that served as the boiler's fuel oil source. The tank occupied an area approximately 6 ft by 23 ft. The tank was excavated as part of decommissioning activities in the late 1980's. The boiler house was also removed. The location is adjacent to a basketball court in a mowed grassy area. The nearest drinking water wells are located approximately 700 ft northwest (RW-5 and RW-6) and south (RW-4) of the site as shown on Figure 2-2. The Site 6 property is currently owned and operated by the Town of Charlestown and is open to the public for various recreational activities.

2.4 PREVIOUS INVESTIGATIONS

In 1987, Ecology and Environment, Inc. (E&E, Inc.) completed a Phase I report for the former NALF, including investigations at Site 2 and Site 4. These investigations included the installation and sampling of monitor wells, surface water and surface soil sampling and soil sampling. At Site 2, four surface soil samples were collected from two locations (CN11 and CN12), in which levels of metals, acetone, toluene, and pesticide were detected. Three monitor wells, CN06, CN07 and CN08, were installed at Site 2. Concentrations of metals, acetone, and TPH were detected in groundwater samples from these wells. At Site 4, two surface soil samples were collected from one location (CN15), in which levels of acetone, polynuclear aromatic hydrocarbons (PAHs), metals, and pesticide were detected. Surface water samples were collected from two locations (CN16 and CN17) near Site 4, which contained detectable concentrations of lead and mercury. The E&E, Inc. investigation did not include Site 6.

A Phase I Remedial Investigation (RI) Report for the former NALF was prepared by IT Corporation (IT) in 1993. The Phase I investigation included soil sampling of one boring and installation and sampling of one monitor well at Site 4 (well CN10) and Site 6 (well CN9). Soil and groundwater samples from Sites 4 and 6 were analyzed for VOCs, base neutral compounds (BNs), TPH, pesticides, polychlorinated biphenyl compounds (PCBs), and metals. At Site 2, filtered groundwater samples were collected from existing wells CN06, CN07, and CN08. No organic compounds were detected in groundwater samples. Dissolved concentrations of lead, antimony, and cadmium exceeded Federal maximum contaminant limits (MCLs). At Site 4, one composite soil sample was collected from boring CN10, in which concentrations of seven metals were detected. At Site 6, observations from boring CN09 indicated no stained soil, but field-screening results indicated VOC levels near the water table. TPH was detected in the groundwater at a level of 0.7 mg/l. VOCs, PAHs and TPH were detected in one composite soil sample from boring CN09, with TPH concentrations ranging from 9,200 to 16,000 mg/kg.

A Phase II Remedial Investigation was conducted at the former NALF in July 1994 by URS that included investigations at Sites 2 and 4 (URS, 1996). The results of this investigation were summarized in the Phase II RI Report prepared by URS in September 1996. At Site 2, three test

pits were dug (TP-7, -8, and -9), and three soil samples were analyzed from the native soil underlying the fill. Trace amounts of methylene chloride, low concentrations of SVOCs, petroleum hydrocarbons (PHC), pesticides, and metals were detected in soil samples collected from beneath the fill. Four sediment samples were collected in the vicinity of Site 2 (SED-1 through -4). Low concentrations of methylene chloride, carbon disulfide, SVOCs, pesticides, TPH, and metals were detected. One new monitor well was installed and sampled at Site 2 (CN16). Three existing wells (CN06, 07, 08) were also sampled. Low concentrations of acetone, 1,2-dichloroethane, xylenes, PAHs, and metals were detected in groundwater samples. At Site 4, nine surface soil samples were collected from fill areas. Low concentrations of toluene, methylene chloride, chloroform, 2-butanone, SVOCs, pesticides, TPH and metals were detected. No subsurface soil samples were collected from Site 4 during the Phase II RI. Seven surface water samples and eleven sediment samples were collected around the perimeter of Site 4. Low concentrations of VOCs, SVOCs, pesticides, and metals were detected. A groundwater sample from well CN10 was analyzed and found to contain concentrations of eleven metals. No VOCs, SVOCs, pesticides/PCBs, or TPH were detected in the groundwater sample. The Phase II findings (URS, July 1994), concluded that no unacceptable risks were posed by substances detected at Sites 2 and 4, and that no further remedial action was warranted.

SECTION 3

SITE INVESTIGATIONS

3. SITE INVESTIGATIONS

3.1 INTRODUCTION

This Phase II study summarizes activities conducted by WESTON between October and December 1998. Field investigations performed at the former NALF Sites 2, 4, and 6 included the following activities:

- Sampling and analysis of soil samples collected from five soil borings advanced at the former UST footprint area at Site 6 and one soil boring at Site 2.
- Installation of one overburden monitor well at Site 2 and two overburden monitor wells at Site 4.
- Sampling and analysis of groundwater samples collected from the three newly installed wells and four existing wells.
- Recording water level elevations in monitor wells.
- Surveying investigation points.

An overview of field explorations conducted as part of the Phase II Study is provided below.

3.2 SOIL BORINGS

Environmental Drilling, Inc. (EDI) drilled six soil borings on October 26-28, 1998, under the supervision of a WESTON geologist. The methodology and rationale for the soil borings was provided in the Project Work Plan prepared by WESTON, and dated October 23, 1998. The purpose of the soil borings was to assess residual petroleum hydrocarbons in soil at the location of the former UST at Site 6, and potential soil impacts related to fill at Sites 2 and 4. Soil samples were collected continuously in 2 ft intervals within each borehole by driving a standard split spoon sampler inside hollow stem augers with a 140-pound hammer falling 30 inches. Soil samples were collected from five boring locations and three monitor well locations (SB01 to SB08) for lithologic characterization following ASTM method D2488-93 by a WESTON geologist. Boring logs are included in Appendix A. A portion of each sample was field screened for organic vapors via handheld photoionization detector (PID) organic vapor monitor (OVM) using the jar headspace method. Boreholes were abandoned by

tremie-grouting with a cement/bentonite grout mixture. Field screening results and visual observations did not indicate the presence of organic compounds, sheen or product in soil cuttings. Based on field screening observations and site background data, soil cuttings were spread on the ground surface at each boring location.

One sample from each boring was submitted for laboratory analysis selected from based on visual observations and the highest field screening results. Soil samples were collected as discrete samples, not composited, and submitted to Katahdin Analytical Laboratories, Westbrook, Maine for analysis. Soil samples from Sites 2 and 4 were collected from native soil directly beneath the interface with the overlying fill material. Soil samples from Site 2 and Site 4 were analyzed for VOCs (SW-846 Method 8260B), SVOCs (SW-846 Method 8270C), and Total RCRA metals (SW-846 Method 6010B), including mercury (SW-846 Method 7471A). Soil samples from Site 6 were analyzed for VOCs (SW-846 Method 8260B), SVOCs (SW-846 Method 8270C), total recoverable petroleum hydrocarbons (TRPH, SW-846 Method 418.1), and total lead (SW-846 Method 6010A). Soil samples for VOC analysis were preserved using methanol by placing an appropriate volume of soil in a pre-preserved, laboratory prepared jar. In addition, appropriate trip blank, duplicate, matrix spike, and matrix spike duplicate samples were collected. Quality assurance (QA) samples were also submitted to the CENAE QA laboratory, Severn Trent Laboratories, Burlington, Vermont.

3.3 MONITOR WELLS

Three overburden monitor wells installed in two borings at Site 4 and one boring at Site 2 during 1998, by EDI under supervision of a WESTON geologist. The methodology for the well installations was provided in the Project Work Plan prepared by WESTON, and dated October 23, 1998. The rationale for the locations of the monitor wells was based on the results from previous investigations and observations from soil borings. One monitor well was installed downgradient of the western portion of the fill area at Site 2 (LF201). Two wells were installed at Site 4 to evaluated groundwater quality and flow across the fill area, with one well located in the upgradient portion (LF401) and the other in the downgradient portion (LF402) of the fill area. No new wells were installed at the Site 6 due to shallow bedrock refusal in unsaturated overburden.

Overburden wells were installed using a truck-mounted drilling rig via 4.25-inch inner diameter hollow-stem auger drilling techniques. Well completion logs are provided in Appendix A. The monitor wells were installed within the augers by placing 2-inch diameter schedule 40 polyvinyl chloride (PVC) with 10 ft of 10-slot machine bridge screen, and flush thread jointed riser, and a threaded bottom cap at the bottom of the borehole. Sufficient riser was added to allow for a 2 ft stickup. The screen interval was placed such that the observed water table was at least 2 ft below the top of screen. The sand pack consisted of No.1 Morie sand. The sand pack was placed to fill the annulus around the well as the augers were removed from the borehole. The sand pack extended into the vadose zone a minimum of 2 ft above the top of the well screen. A bentonite chip seal was placed over the sand pack to a minimum thickness of 3 ft, and hydrated with potable water. The remaining annulus was grouted using a cement/bentonite mixture (94lbs cement/6lbs bentonite powder/7gal water). Surface completions on monitor wells consist of a lockable 4-inch diameter pipe with hinged cover, 6 ft long, placed over the PVC stickup, and cemented in place centered in a 2 ft by 2 ft by 6-inch thick concrete pad. Monitor wells have keyed-alike locks and slip-on PVC caps. Well identification information was stamped into the metal protective casing.

3.4 WELL DEVELOPMENT

New overburden monitor wells were developed by the surge and overpump method using a submersible pump to remove fines from the wells. Well development was performed until the discharge water ran clear or for a maximum of 4 hours per well. No problems were encountered during well development. Estimated yields of the new wells ranged from 0.5 to 2 gallons per minute (gpm). Purged well water was field screened with a handheld PID. Water samples were inspected during development to document sediment, turbidity and color and noted in the field logbook. Measurements of field parameters, temperature, pH, conductivity, oxidation-reduction potential, dissolved oxygen, and turbidity were obtained during groundwater sampling (see Subsection 3.6). Field screening results did not indicate the presence of organic compounds, and no evidence of sheen or product was present. Based on field screening results, and site background data, the purged water was discharge to the ground at each well location upon completion of the development.

3.5 WATER LEVELS

Groundwater levels were measured in nine new and existing monitor wells at the former NALF Sites 2, 4, and 6 on December 2, 1998. Water levels were recorded using an electronic water level meter calibrated to 0.01 ft divisions. The depth to water in each well was measured from the top of the surveyed PVC casing and recorded along with the date and time. Water level elevations were calculated by subtracting the depth to water from the surveyed casing elevation. These data were used to evaluate groundwater flow conditions at the site and are discussed in Section 5.

3.6 GROUNDWATER SAMPLING

One round of groundwater samples was collected from the three newly installed monitor wells and five existing wells on December 2, 1998 using USEPA low flow sampling methods. Water level measurements and field parameters were recorded during the sampling event. Groundwater samples from existing well CN09 at Site 6 were analyzed for VOCs, SVOCs, TRPH, and total lead. Groundwater samples from Site 2, and Site 4 were analyzed for VOCs, SVOCs, and RCRA metals. Details of the methodology were provided in the Project Work Plan. A peristaltic pump and dedicated tubing were used to purge wells through a cell that continuously monitored the parameters temperature, pH, conductivity, oxidation-reduction potential, turbidity and dissolved oxygen. In addition, organic vapor concentrations were monitored using a hand held PID and the jar headspace method. Groundwater samples were collected after stabilization of these parameters as outlined in the Low Flow Sampling guidance. Static water levels were recorded in wells prior to pumping. Groundwater samples were <u>not</u> filtered. Groundwater samples from monitor well CN09 at Site 6 were analyzed for VOCs (SW-846 Method 8260B), SVOCs (SW-846 Method 8270C), TRPH (SW-846 Method 418.1), and total lead (SW-846 Method 6010B). Groundwater samples collected at Site 2 (wells LF201, CN06, CN08, and CN16) and Site 4 (LF401, LF402, and CN10) were analyzed for VOCs (SW-846 Method 8260B), SVOCs (SW-846 Method 8270C), and RCRA Metals (SW-846 Method 6010B, mercury via SW-846 Method 7470A). In addition, trip blank, duplicate, matrix spike, and matrix spike duplicate samples were collected. QA samples were also submitted to the CENAE QA laboratory, Severn Trent Laboratories, Burlington, Vermont.

3.7 FIELD SURVEYING

Location and elevation data for soil borings and monitor wells were collected during a survey conducted on December 8, 1998. Data was collected relative to mean sea level (msl) (NGVD 1929) based on monuments at the former NALF and survey coordinates provided in the Phase I Report by IT (1993). Coordinates and elevations were established for the ground surface at each soil boring location and top of casing and ground surface for each new and existing monitor well. The locations of pertinent cultural features (i.e., telephone poles and roadways) were also included for base map preparation. The horizontal coordinates were surveyed to the closest 1.0 ft and referenced to the existing local reference points. A ground elevation to the nearest 0.1 ft was obtained. Monitor well casing elevations was surveyed to the nearest 0.01 ft. The vertical survey included a minimum of one existing common datum at each site (existing monitor well). Survey data and monument information are included in Appendix D.

SECTION 4

ANALYTICAL RESULTS

4. ANALYTICAL RESULTS

4.1 INTRODUCTION

The results of field screening, analytical sampling, and monitoring of soil and groundwater at the site as part of this investigation are summarized below. Groundwater samples were collected from new and existing wells and submitted to the contract laboratory. Soil samples were collected from six soil borings and submitted to the contract laboratory. Soil samples were field screened via handheld PID. Soils were characterized according to ASTM Method D2488-93, and observations of staining, or odor in samples was noted. Water levels were recorded in monitor wells prior to sample collection.

4.2 SOIL SAMPLES

Soil samples from Sites 2, 4, and 6 were collected from shallow overburden depths. Fill was encountered at the boring and monitor well locations, overlying glacial deposits. In general, borings were not drilled to bedrock, although bedrock is indicated at a shallow depth at Site 6 due to auger refusal. Results from analytical samples collected from boring and monitor well locations are summarized in Table 4-1. The distribution of substances detected is illustrated for Site 2, 4, and 6 on Figures 4-1, 4-2, and 4-3, respectively.

At Site 2, soil samples were collected from two monitor well locations (LF201, LF202) to evaluate soil conditions below the fill in this area. One sample was collected from below the fill in each boring and analyzed for VOCs, SVOCs, and RCRA metals. No organic compounds were detected in the soil samples. Seven metals were detected in the samples as shown on Figure 4-1. Arsenic was the only metal detected from the two borings sampled with a concentration above the RIDEM Residential Direct Exposure Criterion. Arsenic was detected in a saturated zone soil sample from below the fill at Site 2 at a concentration of 7.1 parts per million (ppm), above the RIDEM residential direct exposure criterion of 1.2 ppm. Comparison with results from previous studies at Site 2 show that arsenic concentrations in the surface soil are lower than soil underlying the fill. Four surface soil samples collected by E&E from Site 2 detected arsenic at or below 1.03 ppm (E&E, 1987).

Table 4-1

Summary of Analytical Results for Soil Samples Collected By WESTON from Sites 2, 4, and 6 at the Former Naval Auxiliary Landing Field, Charlestown, Rhode Island

Parameter	Units	RIDEM Criteria[1]	Sample ID									
			Site 2			Site 4		Site 6				
			LF201-S009	LF202-S013	LF202-S113	LF401-S007	LF402-S009	BH301-S019	BH302-SO11	BH302-S111	BH303A-S013	BH304-S017
TPH	mg/kg	500	NA	NA	NA	NA	NA	270J[2]	25U	25U	33	25U
Metals												
Arsenic	mg/kg	1.2	7.1	0.31U[1]	0.21 U	1.5U[1]	0.15 U	NA	NA	NA	NA	NA
Barium	mg/kg	5500	31.1	10.3	14	13.9	4.1	NA	NA	NA	NA	NA
Cadmium	mg/kg	39	0.85	0.02 U	0.03 U	0.03 U	0.02 U	NA	NA	NA	NA	NA
Chromium	mg/kg	1400	13.6	1.6	1.1	2.3	0.56	NA	NA	NA	NA	NA
Lead	mg/kg	150	91.6J[1]	3.2J[1]	2.7J[1]	4.2J[1]	3.2J[1]	6.2J[1]	4J[1]	4.2J[1]	6.8J[1]	4.8J[1]
Mercury	mg/kg	8.5	0.06	0.01 U	0.01 U	0.01 U	0.01 U	NA	NA	NA	NA	NA
Selenium	mg/kg	390	1.2	0.23 U	0.36 U	0.34 U	0.27 U	NA	NA	NA	NA	NA

Note: No VOCs or SVOCs were detected in samples analyzed.

[1] RIDEM Direct Exposure Criteria for Soil. Shaded values in the table indicate an exceedance of RIDEM criteria.

Samples for VOCs extracted by EPA Method 5035 and analyzed per EPA Method 8260B.

Samples for SVOCs extracted by EPA Method 3540 and analyzed per EPA Method 8270C. No SVOCs were detected above the sample PQL.

Samples for TPH analyzed per EPA Method 418.1.

Samples for total lead and total RCRA metals extracted by EPA Method 3050B and analyzed per EPA Method 6010B. Mercury was analyzed by EPA Method 7471A.

NA = Not analyzed.

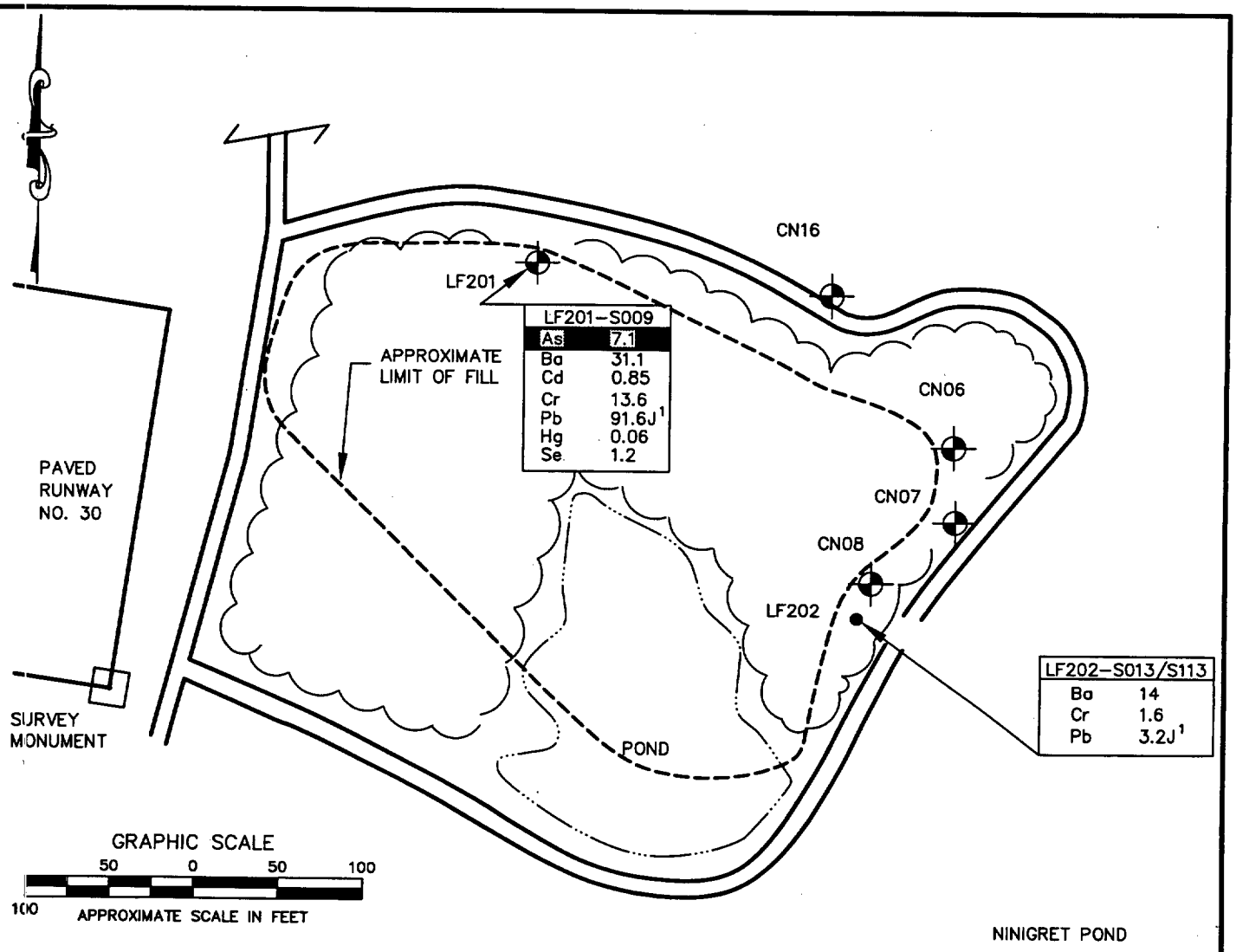
U = Parameter not detected above the sample PQL listed.

U1=Positive result qualified as nondetect due to laboratory or field blank contamination.

J[1] = Positive lead result qualified as estimated due to high spike recovery.

J2=Positive TPH result qualified as estimated due to high MS/MSD recoveries.

Shaded and bolded values indicate an exceedance of RIDEM criteria.



NOTE:
MODIFIED FROM URS CONSULTANTS, INC. PHASE II INVESTIGATION REPORT, SEPTEMBER, 1996

LEGEND

- UNPAVED ROAD
- LIMIT OF VEGETATION
- POND MARGIN
- LF202 ● SOIL BORING
- LF201 ⊕ OVERBURDEN MONITOR WELL

As	ARSENIC mg/kg
Ba	BARIUM mg/kg
Cd	CADMIUM mg/kg
Cr	CHROMIUM mg/kg
Pb	LEAD mg/kg
Hg	MERCURY mg/kg
Se	SELENIUM mg/kg

NOTE: REFER TO ANALYTICAL RESULTS SUMMARY TABLE FOR EXPLANATION OF DATA QUALIFIERS.

DISTRIBUTION OF TOTAL METALS IN SOIL SAMPLES

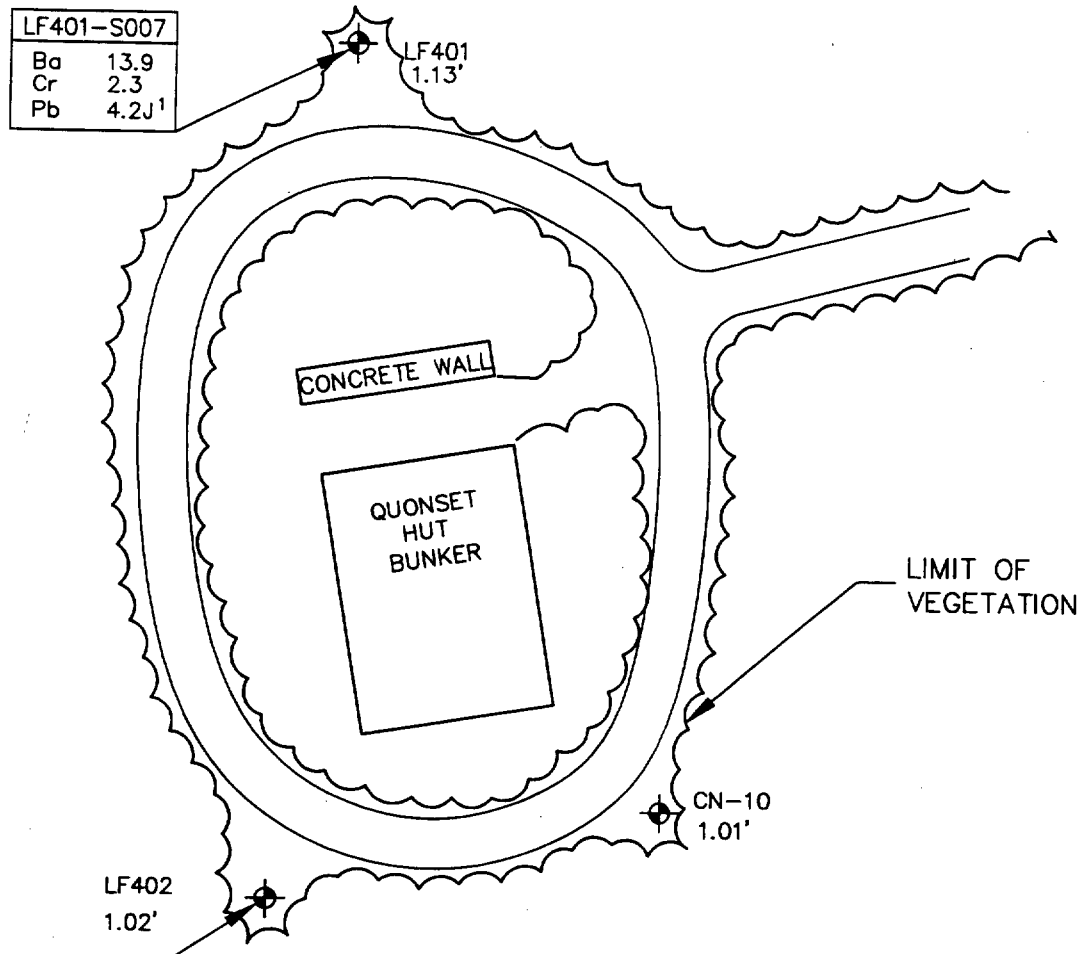
DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

FORMER NALF SITE 2
CHARLESTOWN, RHODE ISLAND

WESTON MANAGERS DESIGNERS/CONSULTANTS
MANCHESTER NEW HAMPSHIRE

DRAWN	BEG
DATE	JAN 2001
FIGURE NO.	4-1

FILE NAME: G:\DES\DWG\ACOE\CHRLSTWN\ST2-4-6\FIG4-3B.DWG (PLOT 1=100)



NOTE:
MODIFIED FROM URS CONSULTANTS, INC. PHASE II INVESTIGATION REPORT, SEPTEMBER, 1996

LEGEND

	UNPAVED ROAD
	LIMIT OF VEGETATION
	ON SITE STRUCTURE
1.02'	OVERBURDEN MONITOR WELL WATER LEVEL ELEVATION RECORDED 12/2/98
Ba	BARIUM mg/kg
Cr	CHROMIUM mg/kg
Pb	LEAD mg/kg

NOTE: REFER TO ANALYTICAL RESULTS SUMMARY TABLE FOR EXPLANATION OF DATA QUALIFIERS.

GRAPHIC SCALE
40 20 0 20 40
APPROXIMATE SCALE IN FEET

DISTRUBUTIONS OF TOTAL METALS IN SOIL SAMPLE

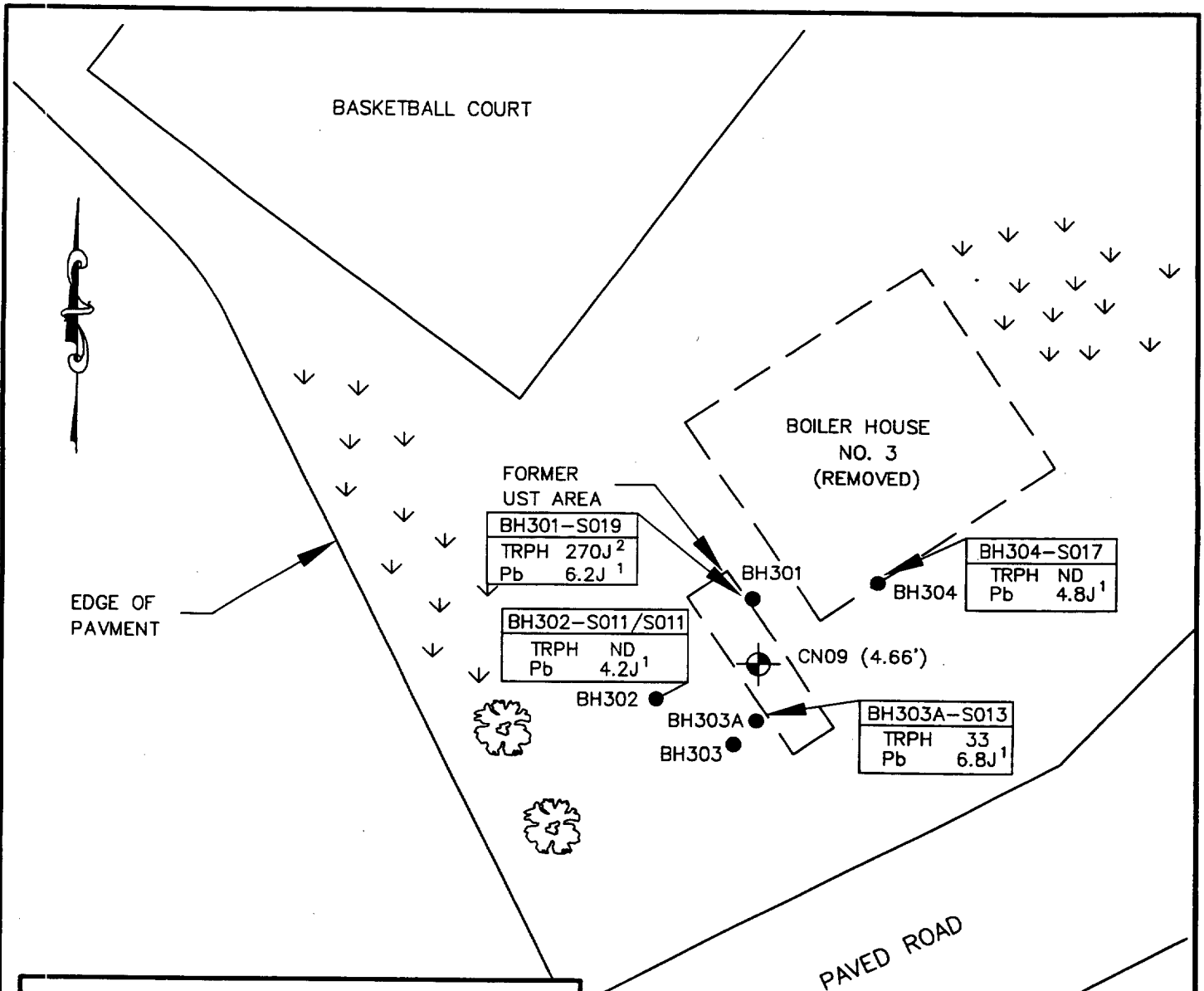
DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

FORMER NALF SITE 4
CHARLESTOWN, RHODE ISLAND

WESTON MANAGERS DESIGNERS/CONSULTANTS
MANCHESTER NEW HAMPSHIRE

DRAWN CDT
DATE JULY 1999
FIGURE NO. 4-2

FILE NAME: G:\DES\DWG\ACOE\CHRLSTWN\ST2-4-6\FIG4-4B (PLOT 1-40)



LEGEND

CN09 (4.66)	OVERBURDEN MONITOR WELL WATER LEVEL RECORDED 12/2/98
BH301	SOIL BORING
	GRASSY AREAS
	SMALL TREE
TRPH	TOTAL RECOVERABLE PETROLEUM HYDROCARBONS ug/l
Pb	TOTAL LEAD ug/l

NOTE: REFER TO ANALYTICAL RESULTS SUMMARY TABLE FOR EXPLANATION OF DATA QUALIFIERS.

GRAPHIC SCALE

20 10 0 10 20

APPROXIMATE SCALE IN FEET

NOTE:
MODIFIED FROM IT CORPORATION PHASE 1 RI REPORT, OCTOBER, 1993.

DISTRIBUTION OF TOTAL PETROLEUM HYDROCARBONS AND TOTAL LEAD IN SOIL SAMPLES

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

FORMER NALF SITE 6
CHARLESTOWN, RHODE ISLAND

WESTON MANAGERS DESIGNERS/CONSULTANTS
MANCHESTER NEW HAMPSHIRE

DRAWN	CDT
DATE	MAY 1999
FIGURE NO.	4–3

FILE NAME: G:\DES\DWG\ACOE\CHRLSTWN\ST2-4-6\DWG4-2B (PLOT 1=20)

Soil samples collected by URS from soil underlying fill at Site 2 test pit locations detected arsenic from 1.6 to 2.3 ppm, above the current RIDEM criterion (URS, 1996). Based on the low levels of detection of arsenic in soil fill and lack of detection in groundwater, it is unlikely that arsenic is attributable to landfilled materials but rather a component of naturally occurring soils at the site. In addition, because the depth of the elevated arsenic detection is within the saturated zone, direct exposure to people or wildlife is unlikely.

At Site 4, soil samples were collected from monitor well locations LF401 and LF402 to evaluate soil conditions below the fill in this area. One soil sample was collected from each location and analyzed for VOCs, SVOCs, and RCRA metals. No organic compounds were detected in the soil samples. Three metals were detected at concentrations below RIDEM criteria. These results do not indicate any adverse impact to the subsurface soils due to fill materials at this site.

At Site 6, soil samples were collected from four borings in the vicinity of a former fuel oil UST. One soil sample was collected from each location based on field screening observations and analyzed for VOCs, SVOCs, TRPH, and total lead. No VOCs or SVOCs were detected in the soil samples. Concentrations of TRPH and lead detected were well below RIDEM criteria. Observations of soil from the borings indicated fill to a depth of approximately 6 ft overlying outwash sand and gravel with refusal on probable bedrock at depths from approximately 12 to 22 ft bgs. Soils encountered did not possess petroleum odor, staining, or product. Soil boring samples results and observations from borings do not indicate any residual source soils in the area of the former fuel oil UST at Site 6.

4.3 MONITOR WELL GROUNDWATER SAMPLES

Analytical results from groundwater samples collected from Site 2, 4, and 6 are summarized in Table 4-2. The distribution of substances detected is illustrated for each site in Figures 4-4, 4-5, and 4-6. Field parameters monitored during purging of the wells are summarized in Table 4-3, showing the final values measured before sample collection. No new monitor wells were installed at Site 6 during this study due to the shallow bedrock refusals encountered, the limited thickness of saturated overburden and absence of impacted soils.

Table 4-2

Summary of Analytical Results from Groundwater Samples Collected by WESTON on December 2, 1998 at the Former NALF Sites 2, 4, and 6 Charlestown, Rhode Island

Parameter	Units	RIDEM Criteria[1]	Site 2 LF201-M101	Site 2 LF201-M001	Site 2 CN16-M001	Site 2 CN06-M001	Site 2 CN08-M001	Site 4 CN10-M001	Site 4 LF402-M001	Site 4 LF401-M001	Site 6 CN09-M001	Site 6 CN09-M101	Site 6 CN09-M201	TB-1
Metals														
Barium	ug/L	2,000	28.5	29.4	232	218	131	21	20.6	29.6	NA	NA	2.5U[1]	NA
Chromium	ug/L	100	1.1U[1]	0.63U	51.4	3.9U[2]	1.4U[2]	0.63U	1.4U[2]	1.8U[2]	NA	NA	1.2U[1]	NA
Lead	ug/L	15	1.31U	1.31U	6.8U[2]	**29.6**	1.31U	1.31U	6.2U[2]	1.31U	1.4U[1]	1.31U	2.8U[1]	NA

[1] Regulatory criteria based on Table 3, GA Groundwater Quality Criteria, from the State of Rhode Island Rules and Regulations for the Investigation and Remediation of Hazardous Materials Releases, Amended August 1996.

Samples for total lead and total RCRA metals extracted by EPA Method 3050B and analyzed per EPA Method 6010B, and mercury by EPA Method 7470A.

NA = Not analyzed.

NL = Not Listed in RIDEM Criteria.

U = Parameter not detected above the sample PQL listed.

U[1] = Result qualified as non-detected due to method blank contamination.

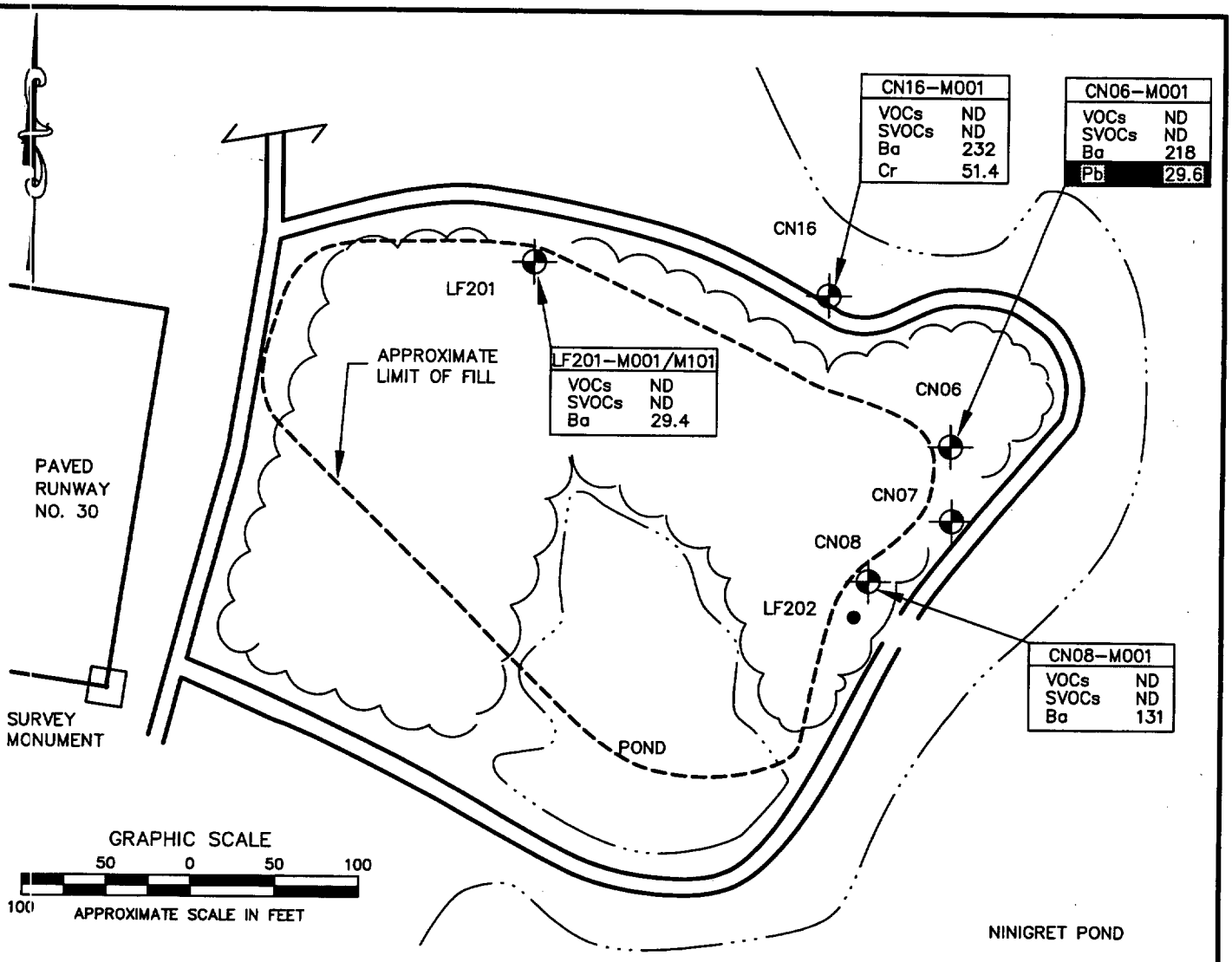
U[2] = Positive result qualified as non-detected due to field blank contamination.

Shaded and bolded values indicate an exceedance of RIDEM criteria.

Site 2 and Site 4 samples were analyzed for VOCs (8260B), SVOCs (8270C), and RCRA metals (6010B).

Site 6 samples were analyzed for VOCs (8260B), SVOCs (8270C), TRPH (418.1), and total lead (6010B).

Note: No organic compounds were detected in groundwater samples.



NOTE:
MODIFIED FROM URS CONSULTANTS, INC. PHASE II INVESTIGATION REPORT, SEPTEMBER, 1996

LEGEND

	UNPAVED ROAD
	LIMIT OF VEGETATION
	POND MARGIN
LF202 ●	SOIL BORING
LF201 ⊕	OVERBURDEN MONITOR WELL

VOCs	VOLATILE ORGANIC COMPOUNDS, ug/l
SVOCs	SEMIVOLATILE ORGANIC COMPOUNDS, ug/l
Ba	BARIUM ug/l
Cr	CHROMIUM mg/kg
Pb	TOTAL LEAD ug/l
ND	PARAMETERS NOT DETECTED

OVERBURDEN GROUNDWATER ANALYTICAL RESULTS

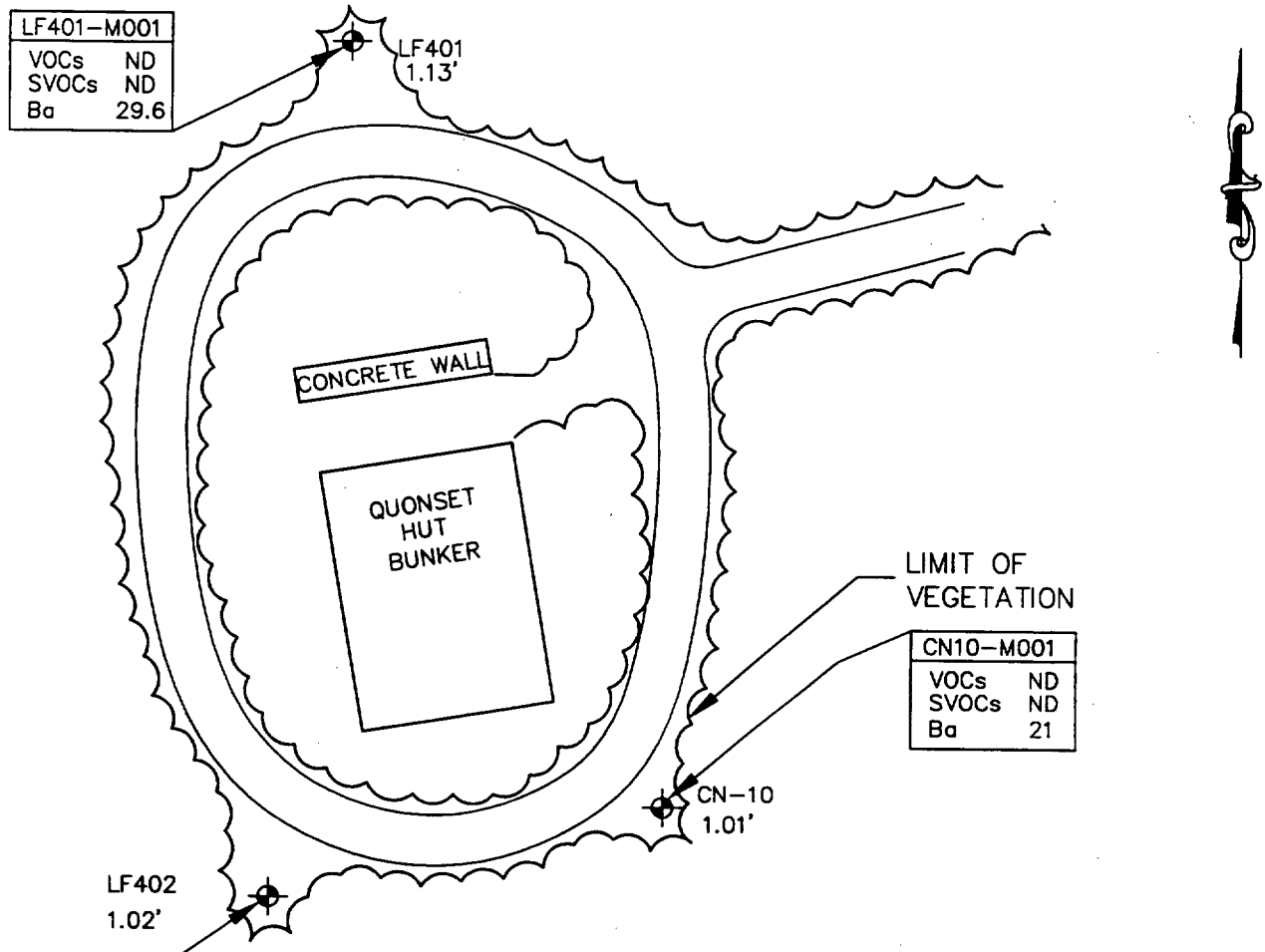
DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

FORMER NALF SITE 2
CHARLESTOWN, RHODE ISLAND

WESTON MANAGERS DESIGNERS/CONSULTANTS
MANCHESTER NEW HAMPSHIRE

DRAWN CDT
DATE JULY 1999
FIGURE NO. 4–4

FILE NAME: G:\DES\DWG\ACOE\CHRLSTWN\ST2-4-6\FIG4-3A.DWG (PLOT 1=100)



NOTE:
MODIFIED FROM URS CONSULTANTS, INC. PHASE II INVESTIGATION REPORT, SEPTEMBER, 1996

LEGEND

	UNPAVED ROAD
	LIMIT OF VEGETATION
	ON SITE STRUCTURE
1.02'	OVERBURDEN MONITOR WELL WATER LEVEL ELEVATION RECORDED 12/2/98
VOCs	VOLATILE ORGANIC COMPOUNDS, ug/l
SVOCs	SEMIVOLATILE ORGANIC COMPOUNDS, ug/l
Ba	BARIUM ug/l
ND	PARAMETERS NOT DETECTED

GRAPHIC SCALE
40 20 0 20 40
APPROXIMATE SCALE IN FEET

GROUNDWATER ANALYTICAL RESULTS

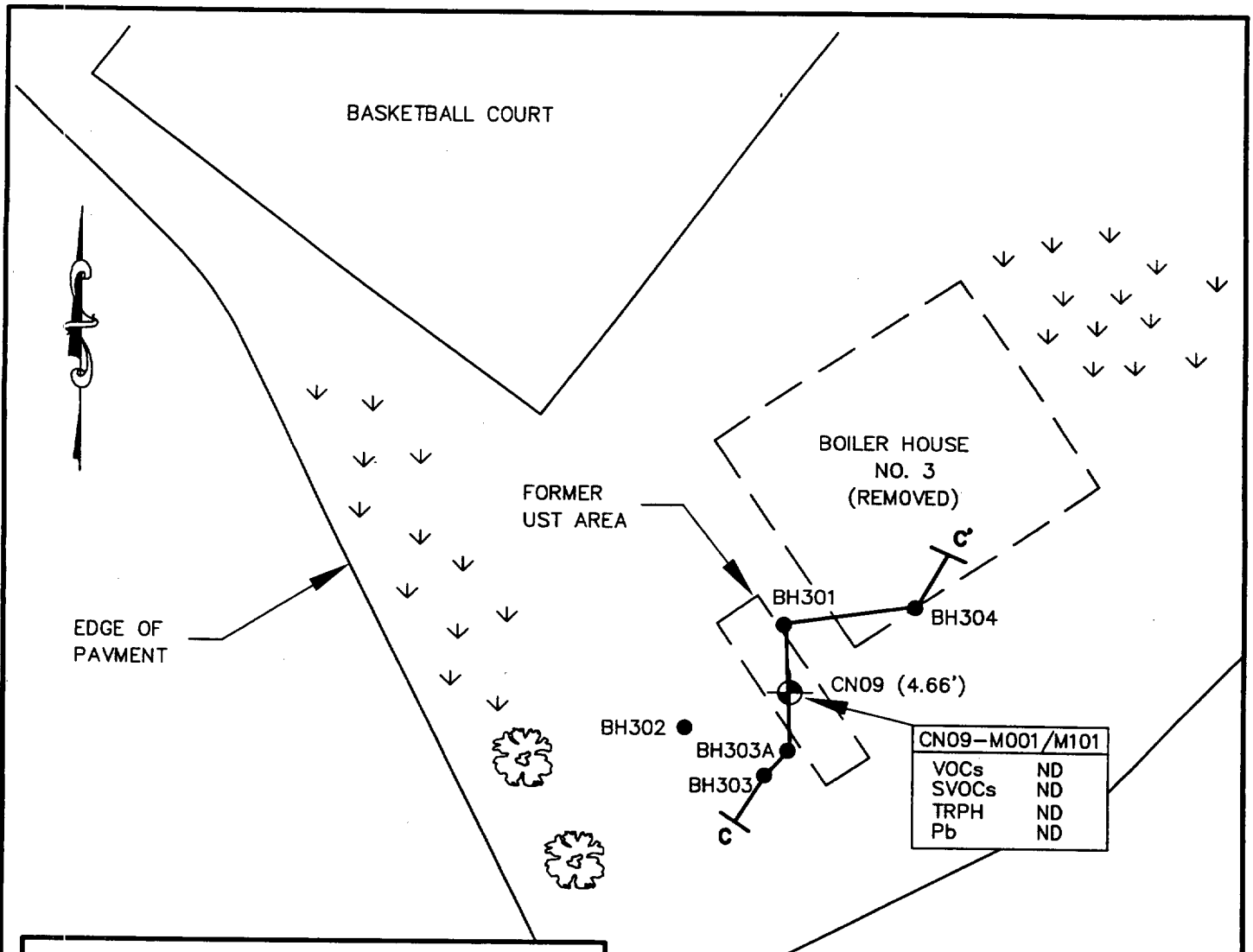
DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

FORMER NALF SITE 4
CHARLESTOWN, RHODE ISLAND

WESTON MANAGERS DESIGNERS/CONSULTANTS
MANCHESTER NEW HAMPSHIRE

DRAWN	CDT
DATE	JULY 1999
FIGURE NO.	4-5

FILE NAME: G:\DES\DWG\ACOE\CHRLSTWN\ST2-4-6\FIG4-4A (PLOT 1-40)



LEGEND

C — C'	CROSS-SECTION LOCATION
CN09 (4.66)	OVERBURDEN MONITOR WELL WATER LEVEL ELEVATION RECORDED 12/2/98
BH301	SOIL BORING
	GRASSY AREAS
	SMALL TREE
VOCs	VOLATILE ORGANIC COMPOUNDS, ug/l
SVOCs	SEMI VOLATILE ORGANIC COMPOUNDS, ug/l
TRPH	TOTAL RECOVERABLE PETROLEUM HYDROCARBON ug/l
Pb	TOTAL LEAD ug/l
ND	PARAMETERS NOT DETECTED

GRAPHIC SCALE

20 10 0 10 20

APPROXIMATE SCALE IN FEET

NOTE:
MODIFIED FROM IT CORPORATION PHASE 1 RI REPORT, OCTOBER, 1993.

GROUNDWATER ANALYTICAL RESULTS

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

FORMER NALF SITE 6
CHARLESTOWN, RHODE ISLAND

WESTON MANAGERS DESIGNERS/CONSULTANTS
MANCHESTER NEW HAMPSHIRE

DRAWN CDT
DATE JULY 1999
FIGURE NO. 4-6

FILE NAME: G:\DES\DWG\ACOE\CHRLSTWN\ST2-4-6DWG4-2A (PLOT 1=20)

Table 4-3
Groundwater Field Screening Parameters
Former NALF - Sites 2, 4, and 6
Charlestown, Rhode Island

Well ID	Parameter									
	Sampling Date	Initial Depth To Water (ft)	Final Depth To Water (ft)	PID (ppm)	Temperature (C)	Spec. Conduc. (uS/cm)	pH	OPR/Eh (mv)	DO mg/L	Turbidity (NTU)
CN-09	12/2/98	17.60	17.60	0	15.1	-0.004	5.7	-303	2.94	4.72
LF-201	12/2/98	8.30	8.30	0.0*	11.7	0.157	6.53	-163	0.89	2.56
CN-16	12/2/98	9.21	NA	NA	11.8	0.78	6.68	-333	NA	8.8
CN-06	12/2/98	9.70	NA	NA	12.4	1.96	6.28	-87	NA	4.02
CN-08	12/2/98	6.79	NA	NA	11.0	2.81	6.49	-366	NA	0.2
LF-401	12/2/98	8.40	8.41	0.0*	10.7	0.32	5.99	-421	NA	1.2
LF-402	12/2/98	7.98	7.98	0.0*	11.5	0.07	5.87	78	2.57	0.49
CN-10	12/2/98	7.32	7.32	NA	11.8	0.069	5.78	83	1.57	1.3

PID = Photo Ionization Detector

ORP = Oxidation Reduction Potential (stand in for Eh)

DO = Dissolved Oxygen

Depth To Water measured from top of inner casing

* = PID headspace readings recorded during well development on 10/28/98.

NA= Not analyzed.

At the direction of the Contracting Officer, one monitor well was installed at Site 2 and two monitor wells were installed at Site 4. Groundwater samples were collected for analysis from these four new wells and five existing monitor wells.

At Site 2, groundwater samples were collected from four monitor wells (LF201, CN16, CN06, CN08) that are downgradient of fill areas at the site. Samples were analyzed for VOCs, SVOCs and total RCRA metals. Organic compounds (VOCs or SVOCs) were not detected in groundwater samples at Site 2. Three metals were detected in groundwater samples at Site 2. Lead was detected above RIDEM criterion in the sample from existing well CN06 with a concentration of 29.6 ppb. The field-measured turbidity of the sample was 4.02 nephelometric turbidity units (NTU), See Table 4-3.

Well CN06 was sampled during three previous studies for total and dissolved metals. In 1987, a total metal sample collected by E&E from this well had a lead concentration of 35 ppb. Lead was not detected in the corresponding dissolved metal sample. In 1993, a dissolved metal sample collected by IT had a lead concentration of 50 ppb. A corresponding total metal sample was not collected by IT. In 1996, total and dissolved metal samples collected from this well by URS did not detect lead.

In addition, lead has been detected in total metal groundwater samples from wells CN07, CN08 and CN16 at Site 2 during previous investigations (E&E, 1987; URS 1996), with detected concentrations ranging from 2.6 ppb to 208 ppb. Corresponding dissolved metal results detected only a low (2.2 ppb) lead concentration in one sample from well CN07. Dissolved lead concentrations ranging from 50 ppb to 110 ppb were detected in samples collected by IT from these wells. Total metal samples were not collected by IT. Lead was not detected in total metals samples collected by WESTON from these three wells.

The above data show that lead has not been detected consistently in dissolved metals groundwater samples from wells at Site 2. It is concluded that lead concentrations detected in total metals groundwater samples at Site 2 have been affected by suspended soil particles in the samples, and not representative of dissolved metals concentrations. The lack of organic compounds present in groundwater samples from the site indicates that no persistent groundwater plume exists at Site 2. Based on results from groundwater samples from Site 2, and interpreted

groundwater flow at the site, lead is not likely to migrate to existing drinking water sources at the former NALF.

Groundwater samples were collected at Site 4 from three monitor wells (LF401, LF402, CN10) located radially around, and surrounding the fill areas at the site. Samples were analyzed for VOCs, SVOCs, and total RCRA metals. No organic compounds (VOCs or SVOCs) were detected in groundwater samples at Site 4. Concentrations of barium were detected below the RIDEM criterion. As a result, there is no indication of an adverse impact to groundwater from fill materials at the site.

At Site 6, a groundwater sample was collected from existing well CN09. The sample was analyzed for VOCs, SVOCs, TRPH, and total lead. A duplicate groundwater sample was also collected at this location. No substances were detected in the groundwater samples from well CN09. These results are consistent with analytical results from previous samples collected from this well. As a result, there is no indication of petroleum hydrocarbons groundwater at the location of the former fuel oil UST.

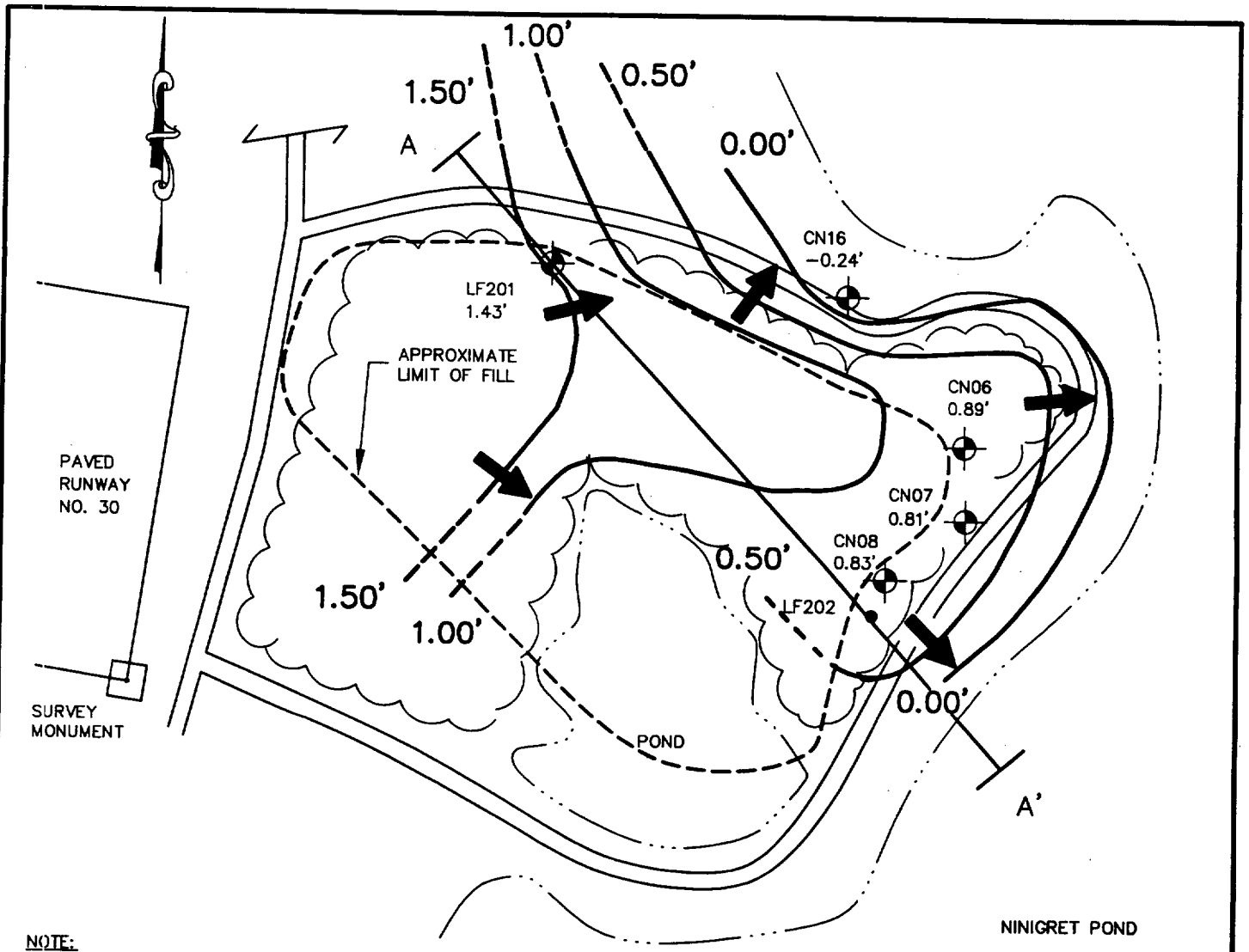
4.4 WATER LEVEL MONITORING

Water level elevation data collected during this investigation includes groundwater levels measured from nine monitor wells in November 1998. Monitoring for tidal influence on groundwater flow was not conducted as part of this investigation. Water levels were recorded as elevations referenced to mean sea level based on existing site benchmarks, and the precision of the elevations is considered to be +/-0.01 ft. These data are summarized in Table 4-4. These data were used to produce potentiometric surface contour maps of overburden groundwater for Sites 2 and 4 (Figures 4-7 and 4-8). At Site 6, only one well exists, therefore the direction and hydraulic gradient of overburden groundwater at that site could not be confirmed. A discussion of the water level data is presented in Section 5.3 of this report.

Table 4-4
Summary of Water Level Elevations Recorded by WESTON from Monitor Wells at Sites 2, 4 and 6 at the Former Naval Auxiliary Landing Field, Charlestown, Rhode Island

Well ID	GS Elev	TIC Elev	11/12/98			12/2/98		
			Time	DTW	Water Elev	Time	DTW	Water Elev
Site 2								
LF-201	7.49	9.73	11:39	8.40	1.33	11:40	8.30	1.43
CN-06	6.65	9.15	11:35	8.38	0.77	12:40	8.26	0.89
CN-07	5.86	7.99	11:28	7.27	0.72	NR	7.18	0.81
CN-08	5.92	7.53	11:23	6.43	1.10	13:40	6.70	0.83
CN-16	6.57	9.07	11:18	8.25	0.82	12:01	9.31	-0.24
Site 4								
LF-401	6.54	9.33	17:45	8.18	1.15	15:42	8.20	1.13
LF-402	6.06	8.96	17:14	7.82	1.14	14:30	7.94	1.02
CN-10	6.56	8.31	16:42	7.19	1.12	15:08	7.30	1.01
Site 6								
CN-9	22.34	22.12	9:20	17.06	5.06	9:00	17.46	4.66

GS Elev = Ground Surface Elevation above mean sea level.
TIC Elev = Top of Inner Casing Elevation.
DTW = Depth to water from top of inner casing.
Water Elev = Groundwater elevation in monitor well.
NR = Not Recorded.



NOTE:
MODIFIED FROM URS CONSULTANTS, INC. PHASE II INVESTIGATION REPORT, SEPTEMBER, 1996

LEGEND

- UNPAVED ROAD
- LIMIT OF VEGETATION
- POND MARGIN
- LF202 ● SOIL BORING
- LF201 ⊕ OVERBURDEN MONITOR WELL
- OVERBURDEN GROUNDWATER POTENTIOMETER SURFACE CONTOUR IN FT. ABOVE MEAN SEA LEVEL. WATER LEVEL RECORDED 12/2/98. ARROW DENOTES INTERPRETED GROUNDWATER FLOW DIRECTION.
- A — A' CROSS – SECTION LOCATION

GRAPHIC SCALE
100 50 0 50 100
APPROXIMATE SCALE IN FEET

OVERBURDEN GROUNDWATER POTENTIOMETRIC SURFACE MAP

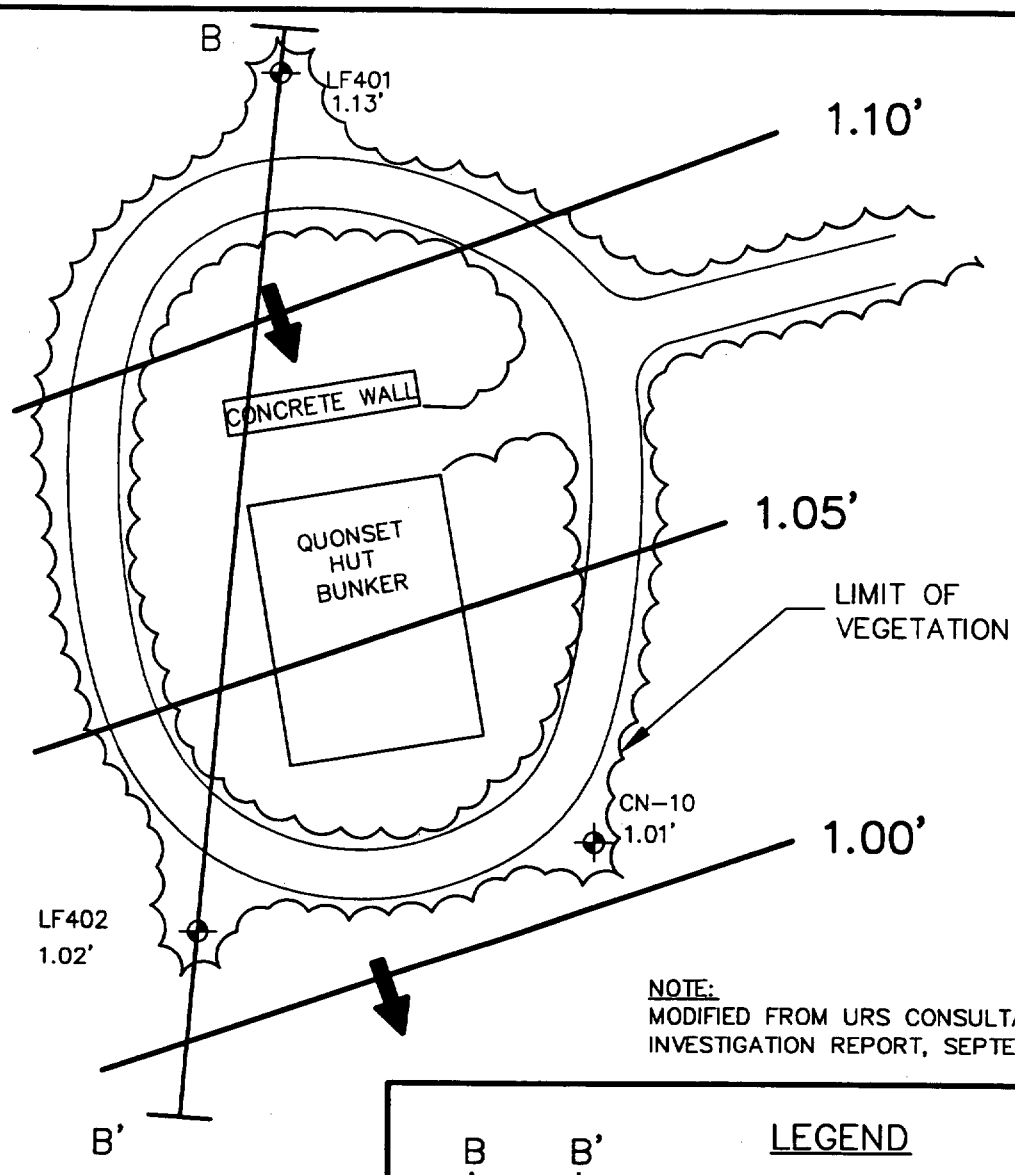
FORMER NALF SITE 2 CHARLESTOWN, RHODE ISLAND

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WESTON MANAGERS DESIGNERS/CONSULTANTS
MANCHESTER NEW HAMPSHIRE

DRAWN	CDT
DATE	JULY 1999
FIGURE NO.	4-7

FILE NAME: G:\DES\DWG\ACOE\CHRLSTWN\ST2-4-6\FIG4-3.DWG (PLOT 1=100)



NOTE:
MODIFIED FROM URS CONSULTANTS, INC. PHASE II INVESTIGATION REPORT, SEPTEMBER, 1996

LEGEND

- B — B' : CROSS – SECTION LOCATION
- UNPAVED ROAD
- LIMIT OF VEGETATION
- ON SITE STRUCTURE
- 1.02' : OVERBURDEN MONITOR WELL WATER LEVEL ELEVATION RECORDED 12/2/98
- GROUNDWATER POTENTIOMETRIC SURFACE CONTOUR IN FEET ABOVE MEAN SEA LEVEL FOR WATER LEVEL RECORDED 12/2/98. ARROW DENOTES INTERPRETED GROUNDWATER FLOW DIRECTION.

GRAPHIC SCALE
40 20 0 20 40
APPROXIMATE SCALE IN FEET

OVERBURDEN GROUNDWATER POTENTIOMETRIC SURFACE MAP

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

FORMER NALF SITE 4
CHARLESTOWN, RHODE ISLAND

WESTON MANAGERS DESIGNERS/CONSULTANTS
MANCHESTER NEW HAMPSHIRE

DRAWN CDT
DATE MAY 1999
FIGURE NO. 4-8

FILE NAME: G:\DES\DWG\ACOE\CHRLSTWN\ST2-4-6\FIG4-4 (PLOT 1-40)

Water level measurements from five overburden wells at Site 2 indicate a radial pattern of groundwater flow. The highest groundwater elevation is at the western part of the site at location LF201. Groundwater elevations decline in a radial pattern, mimicking topography, toward Ninigret Pond at approximately Sea Level where the land meets the tidally influenced pond (Figure 4-7).

At Site 4, data from three overburden monitor wells indicate a south-southeastern overburden groundwater flow direction with a very low gradient of less than 0.001 (Figure 4-8). This is consistent with the generally coarse-grained overburden soils and proximity of the site to the coastline.

4.5 INVESTIGATION DERIVED WASTE

Soil cuttings generated during drilling activities were field screened using a PID OVM to monitor jar headspace. Based on the absence of detectable organic vapors in cuttings generated, soil cuttings were spread on the ground surface at the location of each boring or well drilled. During low flow groundwater sampling of monitor wells, the small volume of purge water generated was contained and field screened using a PID OVM to monitor jar headspace during sampling. Based on the absence of organic vapors detected, the purged water was discharged at the respective well locations at the completion of sampling. Used personnel protective equipment and dedicated sampling equipment such as surgical gloves and tubing were bagged and properly disposed as industrial waste.

SECTION 5

DISCUSSION OF RESULTS

5. DISCUSSION OF RESULTS

This Phase II Remedial Investigation Report is a presentation of data collected to date, including background information provided by CENAE, and observations made during soil and groundwater sampling, monitor well installations, and water level monitoring. These data are integrated into an interpretation of the character and distribution of substances in soil and groundwater at the site, and conceptual model of site hydrogeology in the following section. This information forms the basis of the preliminary evaluation of remedial alternatives at the site presented in Section 6.

5.1 CHEMICAL CONSTITUENTS IN SOIL

Analytical results from soil samples collected from Sites 2, 4, and 6 detected low concentrations of target analytes. No background soil samples have been collected at the former NALF. Arsenic was detected in a saturated zone soil sample from below the fill at Site 2 at a concentration of 7.1 ppm, above RIDEM residential direct exposure criterion of 1.2 ppm. Comparison with results from previous studies at Site 2 show that arsenic concentrations in the surface soil are lower than soil underlying the fill. Arsenic concentrations above RIDEM criterion were detected in native soil underlying fill from test pit locations excavated during a previous study at Site 2 (URS, 1996). However, soil fill metal concentrations from previous studies at Site 2 did not exceed RIDEM criteria (E&E, 1987). Based on the low levels of detection of arsenic in soil fill and lack of detection in groundwater, it is unlikely that arsenic is attributable to landfilled materials but rather a component of naturally occurring soils at the site. In addition, because the depth of the elevated arsenic detection is within the saturated zone, direct exposure to people or wildlife is unlikely. No substances were detected above RIDEM criteria in soil samples from Site 4. TRPH and lead concentrations were detected at Site 6 well below RIDEM criteria. Based on the depth and concentrations of substances detected, there is no indication of significant impact to soil or groundwater from existing fill areas at Sites 2 and 4 or the former UST at Site 6.

5.2 CHEMICAL CONSTITUENTS IN GROUNDWATER

Groundwater samples from eight monitor wells detected low concentrations of total metals below RIDEM criteria, with the exception of lead detected in one sample from Site 2. No organic compounds were detected in groundwater samples analyzed at Sites 2, 4 and 6 in this study. Lead was detected in a groundwater sample from well CN06 at Site 2 at an estimated concentration of 29.6 ppb exceeding the RIDEM's criterion of 15 ppb. At Site 2, wells CN06, CN07, CN08, and CN16 that are all downgradient of fill areas, were sampled during three previous studies and showed some comparisons of total and dissolved metals. In 1987, a total metal sample collected by E&E from well CN06 had a lead concentration of 35 ppb. Lead was not detected in the corresponding dissolved metal sample. In 1993, a dissolved metal sample collected from this well by IT had a lead concentration of 50 ppb. A corresponding total metal sample was not collected by IT. In 1996, total and dissolved metal samples collected from this well by URS did not detect lead.

In addition, lead has been detected in total metal groundwater samples from wells CN07, CN08 and CN16 at Site 2 during previous investigations (E&E, 1987; URS 1996), with detected concentrations ranging from 2.6 ppb to 208 ppb. Corresponding dissolved metal results detected only a low (2.2 ppb) lead concentration in one sample from well CN07. Dissolved lead concentrations ranging from 50 ppb to 110 ppb were detected in samples collected by IT from these wells. Total metal samples were not collected by IT. Current total lead results from the three existing wells CN06, CN08, and CN16 sampled by WESTON are consistent with results from previous studies. Lead was not detected in total metals samples collected by WESTON from wells LF201, CN08 and CN16.

The above data show that lead has not been detected consistently in dissolved metals groundwater samples from wells at Site 2. Although lead results from CN06 were inconsistent, the strong indication is that suspended solids were the likely cause of the elevated total lead concentrations in groundwater samples. The lack of organic compounds present in groundwater samples from the site indicates that no persistent plume of groundwater impact exists at Site 2. It appears that lead concentrations detected in total metals groundwater samples at Site 2 are isolated and attributable to suspended solids. The interpreted groundwater flow direction

indicates drinking water sources would not be affected. Based on available information, there does not appear to be a significant impact to groundwater from existing fill areas at Sites 2 and 4, and the former fuel oil tank location at Site 6.

5.3 HYDROGEOLOGIC ANALYSIS

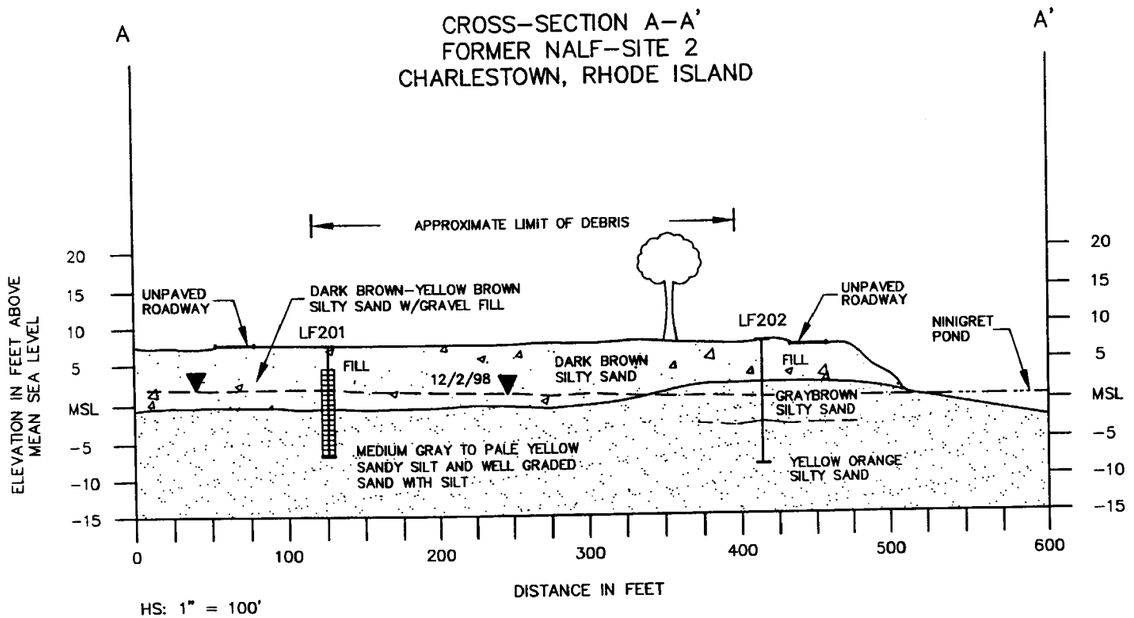
A conceptual model of groundwater flow at each site was developed incorporating historical data from previous studies, and the data collected for this supplemental Phase II investigation. Geologic cross sections were prepared for each site based on observations from soil boring, and water level data from this study as illustrated in Figure 5-1. Potentiometric surface maps were developed based on water levels monitored during this study (Figures 4-7 and 4-8). Data from previous investigations reviewed for this report include hydraulic conductivity testing, water level monitoring and tidal monitoring at the former NALF. Due to the lack of bedrock well data from the former NALF, the following discussion emphasizes overburden groundwater flow at each site.

The geology at the former NALF and surrounding region is detailed in previous reports (IT, 1993; URS, 1996). A brief summary of the former NALF geology is provided as follows. The former NALF is underlain by Quaternary glacial deposits composed of outwash (stratified drift) and till, overlying variably fractured Paleozoic granite, gneiss, pegmatite, and Precambrian metamorphic rocks. Overburden sediments are up to 75 ft thick at the former NALF and consist of stratified fine to coarse sand and gravel overlying a generally thin, dense glacial till. In general, the water table is located within the stratified drift. Unsaturated overburden has been observed in northwestern portions of the former NALF where overburden is less than 20 ft thick (Site 6).

Overland flow at the former NALF is limited due to the generally high permeability of overburden sediments and fill areas, with the exception of paved parking areas and runways. Runoff from paved areas is directed to a storm drain system that discharges to Little Nini Pond.

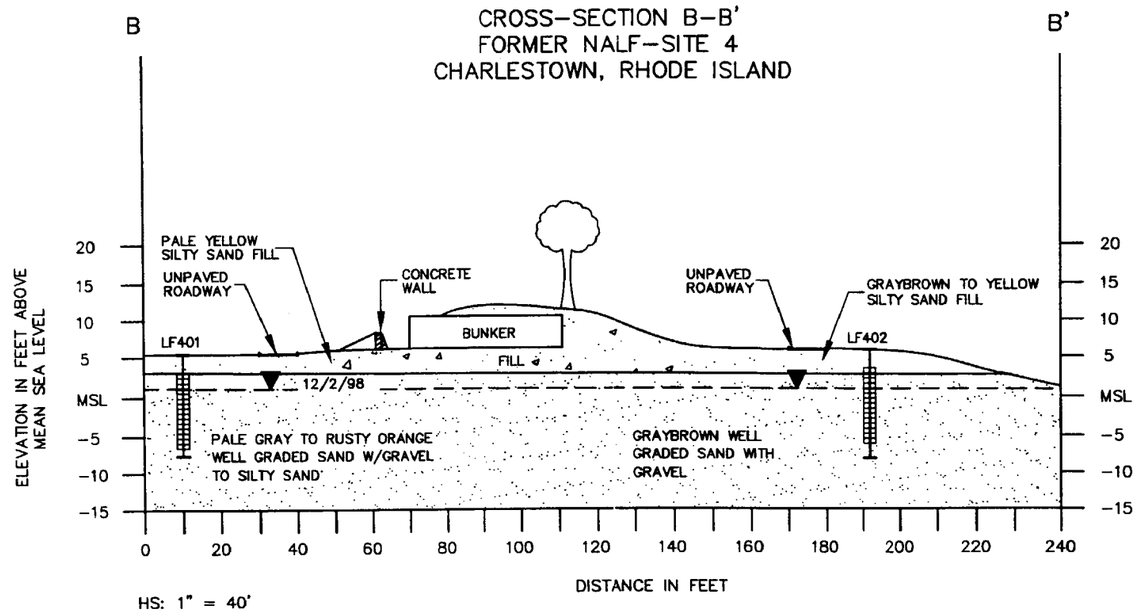
In general, regional groundwater flow in the overburden is directed from west to east, toward the coastline.

CROSS-SECTION A-A'
FORMER NALF-SITE 2
CHARLESTOWN, RHODE ISLAND



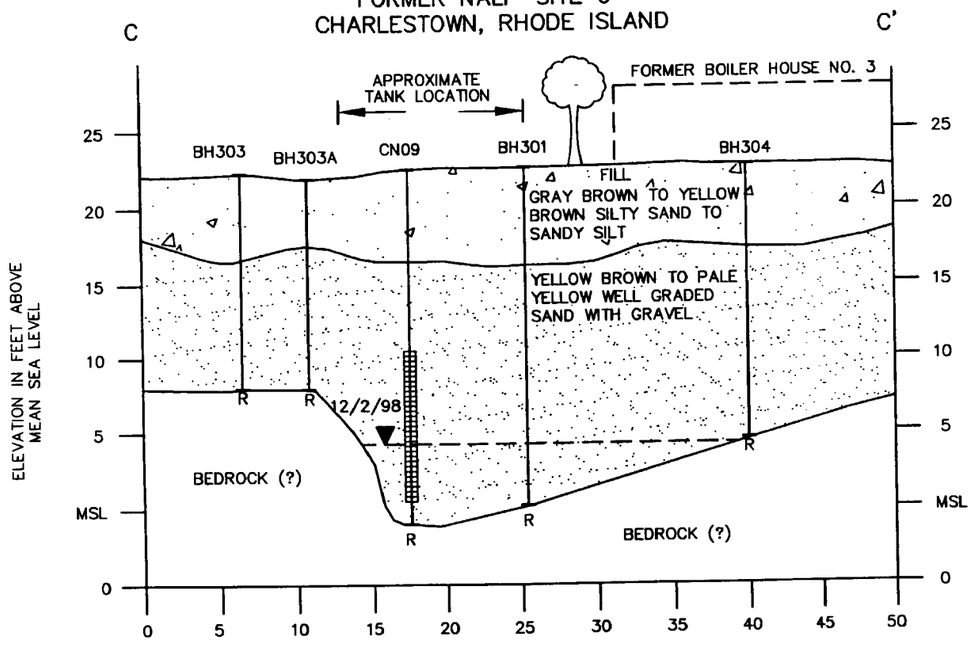
HS: 1" = 100'
VS: 1" = 20'
VE = 5X

CROSS-SECTION B-B'
FORMER NALF-SITE 4
CHARLESTOWN, RHODE ISLAND



HS: 1" = 40'
VS: 1" = 20'
VE = 2X

CROSS-SECTION C-C'
FORMER NALF-SITE 6
CHARLESTOWN, RHODE ISLAND



HS: 1" = 10'
VS: 1" = 10'
NO VERTICAL EXAGGERATION

LEGEND

- FILL
- OVERBURDEN SEDIMENTS
- BORING TOTAL DEPTH
- R — REFUSAL
- MONITOR WELL SCREEN INTERNAL
- 12/2/98 — WATER TABLE 12/2/98 MEASURED

SUPPLEMENTAL PHASE II REMEDIAL INVESTIGATOIN
AT THE FORMER NALF, SITES 2, 4, AND 6
CHARLESTOWN, RI

SITE CROSS-SECTIONS

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WESTON MANAGERS DESIGNERS/CONSULTANTS
MANCHESTER NEW HAMPSHIRE

DRAWN CDT
DATE JUNE 1999
FIGURE NO. 5-1

FILE NAME: G:\DES\DWG\ACOE\CHRLSTWN\ST2-4-6\SECTIONS.DWG (PLOT 1=1)

The former NALF is bordered on the east by the Ninigret Pond estuary. Due to the highly variable thickness of overburden, and locally shallow depth to bedrock at the former NALF, overburden saturated thickness ranges from 0 to 25 ft. Water level elevations at the former NALF historically range from sea level up to about 10 ft above msl, with the highest groundwater elevation at the northwest part of the area. Data from previous investigations indicates that tidal fluctuations have a measurable affect on water levels in wells screened in coarse-grained soils. Tidal affects of wells screened in fine sediments are not measurably affected. The range of groundwater elevation fluctuation attributable to tides was documented to be up to approximately 0.3 ft in wells from Site 2 within a few hundred feet of Ninigret Pond (URS 1996, P. 3-19). Previous reports indicated hydraulic conductivity values of soils at the former NALF range from 10^{-4} cm/sec to 10^{-1} cm/sec representing the range of soil types from silty fine sand to coarse sand and gravel, respectively.

At Site 2, up to 8 ft of fill was observed overlying silty sand to sandy silt, approximately 2 ft of which was below the water table (Figure 5-1, cross-section A-A'). Bedrock was not encountered. Observed fill material was primarily soil with little manmade materials such as brick or concrete. No potentially hazardous materials were observed in borings. Groundwater flow appears to mimic topography flowing from the west toward the shoreline of Ninigret Pond with a hydraulic gradient of approximately 0.005 to 0.01 at the site. A small freshwater pond exists along the southeast margin of Site 2, separated from Ninigret Pond by a low manmade berm used for site access. Hydraulic conductivity data from previous studies at Site 2 determined hydraulic conductivity values ranging from 4.7×10^{-4} cm/sec [486 feet per year (ft/yr)] to 1.39×10^{-2} cm/sec (14,383 ft/yr). Using an estimated effective porosity of 20% yields an estimated range of seepage velocity of approximately 12 ft/yr to 700 ft/yr for the site. This indicates that rainfall and groundwater migrating through the site has a generally low residence time and that dissolved constituents in groundwater are likely to migrate readily to downgradient areas. As a result, the lack of substances detected in groundwater samples from overburden wells at the site in conjunction with the existing hydrogeologic data indicate that little impact to groundwater and nearby surface water is likely from existing on-site fill.

At Site 4, fill was observed to be very thin, from approximately 2 to 4 ft thick (Figure 5-1, cross-section B-B'). Bedrock was not encountered at the site. Water level data from

on-site wells indicates that the fill bottom is approximately 2 ft above the water table. Overburden groundwater flow at the site is from northwest toward the southeast toward Coon Cove with a hydraulic gradient of approximately 0.007. Based on topography of the site, overland flow is radial away from the fill area. Hydraulic conductivity tests and tidal monitoring were not performed on wells at Site 4. The lack of substances detected in groundwater and the hydrogeologic data from the site indicates little impact to groundwater due to existing on-site fill.

At Site 6, bedrock was encountered at depths of approximately 15 to 23 ft bgs, overlain by a poorly sorted sand and gravel overburden (Figure 5-1, cross-section C-C'). Groundwater was encountered in one of the four borings and the existing monitor well at the site. Approximately 5 ft of saturated overburden exists over a small area at the site, centered on the existing monitor well. Due to the shallow bedrock and unsaturated overburden in this area, overburden groundwater flow is likely to be strongly influence by topography of the bedrock surface and fracturing in the bedrock. Regional groundwater flow across the site area is directed toward the southeast. Soil and groundwater sample results do not indicate any impact to groundwater from existing fill materials at the site.

SECTION 6

ANALYSIS OF REMEDIATION ALTERNATIVES

6. ANALYSIS OF REMEDIATION ALTERNATIVES

6.1 REMEDIAL OBJECTIVES

The evaluation of remedial alternatives is conducted for the purpose of recommending appropriate remedial action to reduce constituent concentrations below remedial objectives. The remedial objectives currently considered for this site are based on the RIDEM, Division of Site Remediation, *Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases* (DEM-DSR-01-93), as amended August 1996. Chemical concentrations measured in the soil and groundwater samples collected at the site were compared to Method 1 Direct Exposure Criteria for Residential sites, GA Leachability Criteria for soil, GA Groundwater Objectives, and Upper Concentration Limits.

Soil and groundwater data from this study do not indicate concentrations of organic compounds above RIDEM residential direct exposure criteria or leachability criteria at Sites 2, 4, and 6. Arsenic was the only metal detected above RIDEM residential direct exposure criterion in soil at Site 2. Arsenic was detected above the RIDEM criterion in one of two borings sampled by WESTON in a saturated zone soil sample from the natural soil beneath fill at Site 2. According to Rule 8.02A of the Remediation Regulations, the direct exposure criteria apply only in the vadose zone. In addition, arsenic was not detected in a groundwater sample from this location. Arsenic exceedances were detected in native soil underlying fill from test pit locations excavated during a previous study at Site 2 (URS, 1996). However, soil fill metal concentrations from previous studies at Site 2 did not exceed RIDEM criteria (E&E, 1987). As a result, it is likely that the detection of arsenic is not related to fill at Site 2, but rather the natural composition of site soils. Based on available soil chemical data, soil remediation is not warranted at Site 2 and remedial alternatives for soil remediation were not evaluated.

Lead was detected above the RIDEM GA criterion in one total metals groundwater sample collected by WESTON from Site 2. No exceedances of the RIDEM criteria were detected in soil or groundwater samples collected by WESTON from Sites 4 and 6. Historical data from Site 2 wells indicates that the detection of lead is related to suspended solids in the sample. Based on current and historical groundwater sample data, sample results at Sites 2, 4, and 6 do not indicate

the presence of groundwater impact from potential source areas at these sites. No groundwater impact plume was detected. As a result, groundwater remediation is not warranted at these sites and remedial alternatives for groundwater remediation were not evaluated.

SECTION 7

CONCLUSIONS AND RECOMMENDATIONS

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

As a result of this Phase II study, groundwater and soil conditions at Sites 2, 4, and 6 have been investigated. A network of monitor wells has been established at each site that adequately encompasses the potential source areas within each site. An examination of the data presented in Sections 1 through 5 of this report leads to the following general conclusions as to nature and extent of environmental impacts at these sites:

- No organic compounds were detected in soil and groundwater samples at Site 2. Arsenic was detected above the RIDEM Residential Direct Exposure criterion in a saturated zone soil sample from below the fill at Site 2. Comparison with results from previous studies at Site 2 shows that arsenic concentrations in the surface soil are lower than soil underlying the fill. Based on the low levels of detection of arsenic in soil fill and lack of detection in groundwater, it is unlikely that arsenic is attributable to landfilled materials but rather a component of naturally occurring soils at the site. In addition, because the depth of the elevated arsenic detection is within the saturated zone, direct exposure to people or wildlife is unlikely.

- Lead was detected in groundwater from well CN06 at Site 2 above the RIDEM GA criterion. Groundwater sample data at Site 2 strongly indicate that lead detections in groundwater samples are isolated and attributable mainly to suspended solids in the samples. The interpreted groundwater flow direction indicates that existing drinking water sources would not be affected.

- Soil and groundwater samples analyzed from Site 4 did not detect any substances above RIDEM criteria. Based on these results, there is no indication of significant impact to underlying soil or groundwater from fill at the site.

- Concentrations of residual total petroleum hydrocarbons in soil from the area of a former fuel oil UST at Site 6 are below RIDEM Residential Direct Exposure criteria. No substances were detected in groundwater at this location.

- Based on available soil and groundwater data, soil or groundwater remediation is not warranted at Sites 2, 4 and 6. There is no indication of significant impact to underlying soil and groundwater from potential source areas at Sites 2, 4, and 6. No groundwater impact plume was detected.

7.2 RECOMMENDATIONS

The following recommendations are made based on review of existing data and the results of investigations for this study:

- Based on the current data, and results of previous risk assessment at the former NALF, a risk assessment is not recommended.
- Comparison of historical site data with results from this study indicates that detection of arsenic in a soil sample and lead in a groundwater sample at Site 2 are not likely attributable to persistent on-site sources. Additional soil and groundwater sampling at the site is not recommended.
- No further action is warranted at Site 2, Site 4, or Site 6 because there is no indication of significant impact to underlying soil and groundwater from past activities in these areas.
- In the absence of significant soil or groundwater impacts, and considering land use for the unforeseeable future at Sites 2 and 4 as a Federal Wildlife Refuge that limits public access to designated trails, it is unnecessary to remove fill at Site 2 and Site 4. Selective removal of debris should be considered to improve safety and appearance of these areas. However, removal activities may result in significant disruption to the wildlife habitat, trees, and shrubs that have developed there.

SECTION 8

REFERENCES

8. REFERENCES

1. Rhode Island Department of Environmental Management. 1996. Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases. Amended August.

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3. WESTON, 1998. Final Project Work Plan, Supplemental Phase II Remedial Investigation at the Former Naval Auxiliary Landing Field, Sites 2,4, and 6, Charlestown, Rhode Island. 23 October.

4. URS Consultants, Inc., 1996. Phase II Remedial Investigation Report, Final, Former Naval Auxiliary Landing Field, Charlestown, Rhode Island. September.

5. Ecology and Environment, Inc., 1987. Engineering Report on Contamination Evaluation at the Former Naval Auxiliary Landing Field, Charlestown, Rhode Island. March.