N00129.AR.000906
NSB NEW LONDON
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Basewide Groundwater Operable Unit Remedial Investigation Report

For

Naval Submarine Base New London

Groton, Connecticut

VOLUME II - SECTION 5 THROUGH REFERENCES

Northern Division
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

Contract Task Order 0312

December 2001

TETRA TECH NUS, INC.

5.0 AREA A LANDFILL AND WETLAND (SITE 2)

5.1 SITE DESCRIPTION

The Area A Landfill is located in the northeastern and north-central section of NSB-NLON and encompasses approximately 13 acres. The Area A Wetland is adjacent to the northeastern edge of the Area A Landfill and is approximately 23.6 acres in size. The general configuration of the Area A Landfill and Wetland is shown on Figure 5-1. The location of the Area A Landfill and Wetland in relation to other NSB-NLON IRP sites is shown on Figure 1-2. Separate detailed descriptions of the landfill and wetland are provided below.

5.1.1 Area A Landfill

The Area A Landfill is a relatively flat area bordered by a steep, wooded hillside that rises to the south, a steep wooded ravine to the west, and the Area A Wetland to the north. The landfill extends eastward along the wetland as far as a recreational area (tennis courts). Most filling occurred within the eastern and western limits of the landfill. Access to the landfill is via a road off Wahoo Avenue. The thickness of the landfill materials is estimated to range from 10 to 20 feet, based on test boring data.

According to the 1983 IAS Report, the landfill opened sometime before 1957. However, a 1957 aerial photograph shows no apparent landfilling, which may indicate a somewhat later start-up date. All combustible materials generated by base operations that were not salvageable were incinerated, and the residues were disposed in the DRMO, Goss Cove, and Area A Landfills. The base incinerator, which was located north of the Lower Subase along the waterfront at the present location of Building 478, ceased operation in 1963. From 1963 to 1973, refuse and debris were disposed in the Area A Landfill. Because on-site disposal of solid radioactive waste attributed to the Naval Nuclear Propulsion Program (NNPP) has been prohibited since the inception of the program, and because of information contained in site records, established policy, and interviews, the potential for NNPP radioactive material having been disposed on site is considered to be zero. Given what is known about the material used for fill, small amounts of general radioactive material (G-RAM) incorporated in consumer products (e.g., radioluminescent exit signs, smoke detectors, etc.) could have been disposed with other industrial material in the DRMO, Area A Landfill, or Goss Cove Landfills, although this is unlikely. It is not expected that the potential for G-RAM radioactivity in these former landfills would vary substantially from that in commercial landfills operated for typical civilian use.

The area fill method was reportedly used in landfill operations. New refuse was dumped along the face of previously deposited refuse and covered with earth. The cover material used on the landfill was sand and

gravel obtained from the Groton water supply reservoir. Landfilling operations ceased in 1973. After closure, a concrete pad was constructed in the southwestern portion of the landfill adjacent and northeast of Building 373 for above-ground storage of industrial wastes. Up to the time of the interim remedial action at the Area A Landfill, the pad was still in existence. In the early 1980s, 42 steel drums, 87 transformers (mineral oil and PCB), and 60 to 80 electrical switches were found to be stored on the pad. Two transformers and several electrical switches were reportedly leaking. Past leakage of oil was also evident. Most drums were stacked on wooden pallets and those having PCB labels were covered and bound with plastic sheeting. All these materials have since been properly disposed off site.

The IAS Report indicated that refuse, including steel drums, oxygen candles, wood and metal scrap, concrete, and tires, was exposed at the edge of the landfill adjacent to the wetland. The IAS Report also stated that petroleum compounds had recently been poured from containers and had flowed into the wetland at two locations (northwestern portions of the landfill) and that, when batteries were overhauled, spent sulfuric acid solution was transferred to barrels and transported to Area A for disposal. The acid was poured into trenches dug with a bulldozer and subsequently covered with soil.

Atlantic Environmental Services personnel performed an inspection of the Area A Landfill on September 30, 1988. Iron floc was observed along the toe of the slope of the landfill extending from the dike to the eastern end of the deployed parking lot. The slope of the landfill had been covered with fill, and material in the landfill was not visible. Sand bags, salt, supplies, and equipment were stored on top of the landfill. Several transformers, removed underground storage tanks, crane weights, and other equipment were previously stored on the concrete pad in the southwestern portion of the landfill. The remainder of the landfill was not paved until the recent interim remedial action in 1997.

In 1997, a low-permeability cover system was installed on the Area A Landfill as the interim remedial action for soils at the site. The cover system consisted of a bedding/gas management layer underlying a double liner, a drainage layer above the double liner, and an operating surface in selected areas at the top. The remedial action also included the installation of a surface water and groundwater interception trench along the southern border (upgradient) of the site.

The CBU Drum Storage Area (Site 1) and the Rubble Fill Area at Bunker A-86 (Site 4) were also addressed during the remedial action at the Area A Landfill. The CBU Drum Storage Area was an unpaved area located adjacent to the deployed parking area within the boundary of the Area A Landfill. The site was capped at the same time as the landfill and a no-further-action decision document was signed for the site. Construction debris and contaminated soil and sediment from the Rubble Fill Area at Bunker A-86 were removed from the site as part of a time-critical removal action and incorporated into the Area A Landfill subgrade. After the removal action, only exposed bedrock was left at the former Rubble

Fill Area at Bunker A-86. A no-further-action decision document was also signed for this site. Because these sites are incorporated into the Area A Landfill, no historical information for the sites is presented in this report. Background information for the sites can be found in the Existing Data Summary Report for the Basewide Groundwater Operable Unit Remedial Investigation (TtNUS, 1999c).

5.1.2 Area A Wetland

The location of the Area A Wetland was undeveloped, wooded land and possibly wetland until the late 1950s. In the late 1950s, dredge spoils from the Thames River were pumped to this area and contained within an earthen dike that extends from the Area A Landfill to the southern side of the Area A Weapons Center. Based on the boring logs, the total volume of dredged material in the wetlands is approximately 1.2 million cubic yards.

A small pond is located at the southern portion of the wetland, and between 1 and 3 feet of standing water is present during all seasons. Phragmites is the predominant type of vegetation. Atlantic Environmental Services reported that pesticide "bricks" were placed on the wetland ice during winter and allowed to dissolve as a mosquito control measure. These "bricks" consisted of formulated (water-soluble) DDT and were used in the 1960s, prior to the 1972 ban on 4,4'-DDT.

5.2 SITE INVESTIGATIONS

The details of all investigations, including historical and current, conducted at the Area A Landfill and Wetland are provided in the following subsections.

5.2.1 Initial Assessment Study (Envirodyne, 1983), Area A Landfill and Wetlands

In 1982, Envirodyne Engineers, Inc. performed an IAS at NSB-NLON as part of the NACIP program. The purpose of this study was to identify and evaluate past waste disposal practices and to assess the potential for environmental impacts. Envirodyne reviewed installation records, interviewed long-term and former employees, toured the installation, and photographed sites as part of the IAS.

Envirodyne identified 11 sites at NSB-NLON as having contained hazardous material; one site was Area A (Site 2), which included the Area A Landfill, the Area A Wetland, and the Area A Downstream Watercourses. The IAS concluded that the source of contamination for this site was still present and potentially releasing contaminants to the environment. The IAS recommended that further sampling of surface waters and sediments at this site be performed.

5.2.2 Verification Step 1A Study (Wehran, 1988), Area A Landfill and Wetland

In 1988, Wehran Engineering Corporation performed a Verification Step 1A Study for the DRMO Area, the OBDA, and the Area A Landfill as part of the NACIP program. The purpose of this study was to verify the presence or absence of contamination at these historically documented landfill areas. As part of the Verification Step 1A Study, Wehran performed three rounds of surface water and sediment sampling at six locations (SW-1 through SW-6) adjacent to the Area A Landfill site. These samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and metals.

The study concluded that the surface waters and sediments near the Area A Landfill have levels of metals, PAHs, and pesticides that exceed regulatory criteria; however, the immediate health threat to base personnel from these contaminants appears minimal. The Verification Step 1A Study recommended that a Site Characterization Step 1B Study be performed at the Area A site.

5.2.3 Phase I Remedial Investigation (Atlantic, 1992), Area A Landfill and Wetland

An investigation of 11 sites was completed at NSB-NLON by Atlantic Environmental Services, Inc. from 1990 through 1992. Area A Site 2, which includes the present Area A Landfill, the Area A Wetland, and the Area A Downstream Watercourses and OBDA, was one of the sites investigated.

The Phase I RI of the Area A Landfill consisted of test borings, monitoring well installation, and soil and groundwater sampling. Nine subsurface soil samples (greater than 2 feet deep) and one field duplicate were collected from one test boring and seven monitoring well borings at the site. Five surface soil samples (less than 2 feet deep) and one field duplicate were also collected and analyzed. All soil samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, and TCLP metals and pesticides. Landfill materials were encountered during drilling, generally to an average depth of 10 to 12 feet. Landfill materials that were encountered included glass, brick, wood, plastic, and ash, intermixed with sand and gravel material used as cover.

Twelve groundwater samples (plus two field duplicates) were collected from five shallow and 7 deep monitoring wells. All groundwater samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, and radiological parameters (gross alpha and gross beta).

The Phase I RI concluded that several risk exposure scenarios exceeded acceptable regulatory levels and that a FS should be performed for the Area A Landfill site.

5.2.4 Focused Feasibility Study (Atlantic, 1995c), Area A Landfill

In response to the recommendations of the Phase I RI, an FFS for the Area A Landfill site was completed by Atlantic Environmental Services in 1995. Field investigation activities were conducted in support of the FFS in order to characterize the subsurface soil in the vicinity of the bituminous concrete pad located at the southwestern end of the landfill.

Ten surface soil samples plus one field duplicate and 10 subsurface soil samples plus two field duplicates were initially collected during the FFS. All surface soil samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals. Other surface soil analyses included dioxin on sample 2LTB13; engineering parameters including grain size distribution, moisture content, specific gravity, organic content, cation exchange capacity, pH, and TOC on sample 2LTB17; and a complete TCLP analysis including VOCs, SVOCs, pesticides/PCBs, herbicides, and metals on sample 2LTB18.

Seven of the 10 subsurface soil samples plus the two field duplicates were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals. In addition, sample 2LTB22 (6 to 8 feet deep) was analyzed for TCL VOCs, TCL SVOCs, and TAL metals and sample 2LTB22 (8 to 10 feet deep) was analyzed for TCL pesticides/PCBs. Sample 2LTB19 (4 to 6 feet deep) was only analyzed for engineering parameters. Other analyses included dioxin on sample 2LTB23 and its field duplicate (2LTB33) and the complete TCLP suite on sample 2LTB26.

Three additional subsurface soil samples (LFSB03, LFSB04, and LFSB05) were collected as part of a supplemental investigation sampling round for the Phase I RI to support the FFS. These samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals. Samples of the concrete pad were also collected during the FFS from four areas where evidence of staining was observed and these were analyzed for TCL pesticides/PCBs.

The FFS concluded that off-site landfilling and off-site incineration provide superior protection of the environment but that the landfilling alternative is more cost effective than the incineration alternative.

5.2.5 Design Analysis Report (B&R Environmental, 1996c), Area A Landfill

The purpose of this document was to provide an interim remedial design for the Area A Landfill that included a containment or capping action. Further evaluation of groundwater conditions at the site would then determine if additional remedial actions would be necessary. This document concluded that the final cover system at the Area A Landfill represented the action necessary to prevent the release of waste materials contained in the landfill into the environment and to prevent human exposure to these waste

materials. It also concluded that the cap provides the desired improvements to the landfill while maintaining the site for current government use.

5.2.6 Groundwater Leachate Modeling Study for Remedial Design (B&R Environmental, 1996b), Area A Landfill

B&R Environmental performed this study in 1996 in support of the remedial design of a cover system for the Area A Landfill. The objectives of this study were to predict the impact of the landfill cover system on the saturated thickness of the fill material within the landfill and on the flow and composition of the groundwater/leachate discharging from the Area A Landfill to the Area A Wetland and to compare the slope stability effectiveness and cost of the landfill cover system with those of a landfill cover system featuring a toe drain.

In support of this investigation, eight soil samples were collected and analyzed for geotechnical parameters, and one groundwater seep sample was collected and analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals. The study concluded that the cover system would be stable, reduce the water table beneath the landfill, reduce contaminant migration from the unsaturated to the saturated zone, and reduce the mass flux of the contaminants of concern from the landfill to the wetlands. This study also concluded that the cover system compared favorably to one with a toe drain system and should not be replaced by such a system.

5.2.7 Phase II Remedial Investigation (B&R Environmental, 1997a), Area A Landfill and Wetland

A Phase II RI at 13 sites at NSB-NLON was conducted by B&R Environmental from 1995 through 1997. The Area A Landfill Site 2 was investigated as part of the RI. Three surface and seven subsurface soil samples were collected from two test borings located near Building 373 and analyzed for PCBs in the field using a gas chromatograph. One surface sample and one subsurface sample were also analyzed for dioxins at a fixed-base laboratory. Groundwater samples were collected from 27 monitoring wells during the first round of the Phase II RI. Five of these samples were collected from newly installed wells and 22 were collected from existing wells. Most of these samples were analyzed for TCL VOCs, TCL SVOCs, and TAL metals (total and dissolved). Additional analyses included four samples for TCL PCBs, four samples for radiological parameters (gross alpha, gross beta, and a complete gamma spectrum), and three samples for water-quality parameters including oil and grease, ammonia, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), total phosphorus, and total suspended solids (TSS). Eight deep and six shallow wells were sampled during the second round of groundwater sampling, resulting in a total of 14 samples (between shallow and deep aquifers) plus one field duplicate. All were analyzed for TCL VOCs, TCL SVOCs, and TAL metals (total and dissolved). In

addition, one sample was analyzed for TCL PCBs and four samples were analyzed for radiological parameters.

The findings of the Phase II RI concluded that shallow groundwater contamination exists at the site, the landfill soil may pose a threat to human receptors due to PCB concentrations in the landfill, and chemicals in the soil could adversely impact ecological receptors; however, the installation of the cover system will eliminate these risks.

The Phase II RI recommended that, in addition to the planned landfill cover system, institutional controls including access/use restrictions and groundwater monitoring should be implemented at the site.

5.2.8 Report for Interim Remedial Action at Area A Landfill (B&R Environmental, 1998a), Area A Landfill

This report, submitted by B&R Environmental in 1998, certified that all construction procedures, inspection activities, field and laboratory testing results, and surveys conducted at the Area A Landfill site (including the CBU Drum Storage Area) during remedial activities involving the installation of the final cover system were performed according to specifications.

5.2.9 Quarterly Groundwater Monitoring Reports (Tetra Tech NUS, 2000d), Area A Landfill

Quarterly groundwater monitoring is being performed at the Area A Landfill in response to the Interim Remedial Action (IRA) completed in 1997 at the landfill to address the risk from direct exposure to landfill material and to minimize the risk of migration of COCs from the landfill to the surrounding Area A Wetlands via groundwater. The IRA consisted of capping the landfill with a low-permeability cover system and installing a surface water and shallow groundwater interception and diversion system upgradient from the cover system. The groundwater monitoring is being conducted to evaluate the effectiveness of the IRA as part of the post-closure associated with the Area A Landfill cap.

Sixteen monitoring wells, 10 surface water locations, and one surface seep location have been sampled quarterly as part of the groundwater monitoring program. Since groundwater monitoring has begun, samples have been collected over 5 quarters: October 1999 (Round 1), January 2000 (Round 2), April 2000 (Round 3), July 2000 (Round 4), and December 2000 (Round 5). The analytical program consists of analyzing each sample for TCL volatile and semivolatile organics, TCL pesticides and PCBs, TAL inorganics, and miscellaneous water chemistry parameters.

5.2.10 Basewide Groundwater OU RI, Area A Landfill and Wetland

During the BGOURI, only groundwater samples were collected from existing monitoring wells to further characterize this site. The monitoring wells included in the Groundwater Monitoring Program for the Area A Landfill were the only wells sampled and, in fact, the results presented in this RI constitute the results for Round 4 of the monitoring program for Site 2. A summary of the sampling and analytical program is presented in Table 5-1. The 11 monitoring wells that were sampled are shown on Figure 5-1. The wells are primarily located within the Area A Wetland and adjacent to the Area A Landfill to determine if contaminants are migrating from the landfill. Groundwater samples were collected from the 11 existing wells and a field duplicate was also collected from monitoring well 2WGW47DS. Samples from 10 of the 11 monitoring wells were filtered in the field and analyzed for dissolved metals. Monitoring well 2WMW38DS did not produce significant water and recovered slowly. During the Round 4 sampling effort, the well did not recover fast enough to obtain sufficient sample volume to complete analysis for both total and filtered metals. The methodology used to complete groundwater sampling was discussed in Section 2.3.

Wells that were on the upgradient side of the Area A Landfill and Wetlands were included in the set of background samples and not in the Site 2 data set.

5.2.11 Area A Landfill/Wetland Interface Sampling (HNUS, 1994b), Area A Landfill and Wetland

As part of the landfill/wetland interface sampling performed by Halliburton NUS Corporation in 1994, 10 landfill side sediment samples and 10 wetland side sediment samples were collected and analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, and TOC to determine extent of contamination. The data obtained from this study indicated that the Area A Landfill appeared to be the source of VOCs, the asphalt paved parking lot could be the cause of the SVOC contamination, and inorganic contamination was attributable to background levels in most cases.

5.2.12 Other Investigations

Four sediment samples (2WSD23, 2WSD24, 2WSD25, and 2WSD26) were collected from the southwestern portion of the Area A Wetland (along the earthen dike) as part of the Area A Downstream/OBDA FFS completed by B&R Environmental in late 1997. These four samples were analyzed for TCL pesticides/PCBs, grain size distribution, moisture content, and TOC.

5.3 PHYSICAL CHARACTERISTICS

This section presents a summary of site physical characteristics for the Area A Landfill and Wetland based on information generated during the Phase I and Phase II RIs and this investigation. Topography

and surface features, surface water, soils, geology, and hydrogeology are discussed in the subsections that follow.

5.3.1 Surrounding Topography and Surface Features

Figure 1-3 and Figure 5-1 show the topography and surface features of the Area A Landfill and Wetland and the surrounding sites. The ground surface at the Area A Landfill slopes gently across the landfill toward the Area A Wetland. A steep hillside (central bedrock high) borders the southern edge of the landfill. Near the northwestern edge of the landfill, the ground surface drops along a steep ravine and dike to the OBDA. The ground surface increases in elevation to the northeast from the tennis courts to Route 12 and Baldwin Hill. The ground surface elevation across the landfill from upgradient to the downgradient edge ranges from approximately 90 to 80 feet msl. Adjacent to the toe of the landfill, the Area A Wetland ground surface is at an elevation of approximately 72 feet msl. During the interim remedial action completed at the site in 1997, the Area A Landfill was covered with an engineered cap and paved over with asphalt.

The Area A Wetland is a relatively flat-lying, swampy, vegetated area. In general, the surface elevation of the wetland is between 70 and 80 feet. The surface elevation increases to nearly 100 feet in the northeastern corner of the wetland. This area was historically a stream valley. After the earthen dike was constructed and the ground surface of the wetland was raised by filling with dredge spoil, groundwater levels rose to the point such that the dredge spoil placed in the northeastern corner became saturated. Several areas within the Area A Wetland are elevated. The most prominent topographic feature is a bedrock knob, located between the Area A Weapons Center and the Area A Landfill. Test boring 2WTB4 confirmed the presence of bedrock within 1 foot of the ground surface at this location. Additionally, the local bedrock knob is confirmed by the historical surficial geology map, which pre-dates the construction of the earthen dike and filling activities.

5.3.2 Surface Water Features

Runoff from the Area A Landfill cover system drains as overland flow northward into the Area A Wetland. Surface runoff from areas upgradient of the landfill are collected in a drainage ditch on the southern side of the landfill, then conveyed to the Area A Wetland via a culvert through the eastern side of the landfill.

A small pond is located at the southeastern end of the wetland. Between 1 and 3 feet of standing water is present in the pond during all seasons. Water from the wetland discharges through an earthen dike at the western edge of the wetland via four 24-inch metal culverts to the Area A Downstream Watercourses. These watercourses subsequently discharge into the Thames River. Several shallow intermittent drainage channels cross the wetland.

5.3.3 Soil Characteristics

The SCS Soils Map (SCS, 1983) classifies the soil at most of the Area A Landfill as Udorthents-Urban land. This soil type is defined as excessively drained to moderately drained soils that have been disturbed by cutting and filling. Along the southwestern slope of the landfill and in upgradient areas, the soil is classified as the Hollis-Charlton-Rock complex. Stones and boulders are intermingled with a dark, fine, sandy loam. Bedrock outcrops are prevalent in the area.

The soil at the Area A Wetland is also classified as Udorthents-Urban land. This is consistent with historical information regarding the placement of dredge spoils in the area. The surface of the Area A Wetland is covered with a 2-foot layer of roots and plant debris derived from Phragmites, the predominant vegetation.

5.3.4 Geology and Hydrogeology

5.3.4.1 Geology

Area A Landfill

The Area A Landfill contains 10 to 20 feet of miscellaneous fill that consists of fine- to coarse-grained sand and gravel, as well as refuse including ash, wood fragments, paper, brick fragments, and asphalt. The fill is generally underlain by 10 to 20 feet of dredge spoil. Where no dredge spoil underlies the fill material, the fill material directly overlies a thin alluvial layer or the bedrock surface. Dredge spoil is encountered mainly beneath the easternmost portion of the landfill. Along the southeastern border of the landfill, the fill material is underlain by alluvium consisting of silty sand. The alluvium is underlain by a layer of gravel and gneiss boulders. Boulders were also identified outside the eastern edge of the landfill at well cluster 2LMW19. Geologic cross sections that show subsurface conditions at the Area A Landfill and Wetland are shown on Figures 4-10 and 4-11.

The bedrock beneath the Area A Landfill has been identified as the biotite-quartz-feldspar gneiss of the Mamacoke Formation. Bedrock topography is shown on Figure 1-4. Quartzite was identified at a depth of 80 feet in the 2LMW20D boring log. This is consistent with the existence of quartzite layers within the Mamacoke Formation. The bedrock surface slopes to the northeast toward the Area A Wetland from the large central bedrock high in the center of the facility. The landfill is situated along the flank of the bedrock ridge such that the depth to bedrock increases to the northeast. In the western portion of the site, the landfill is situated immediately adjacent to the hillside and the depth to bedrock is typically less than 20 feet, whereas in the eastern portion the landfill is located farther out from the hillside and the

depth to bedrock increases to 70 feet. There appears to be a localized bedrock depression at 2LMW8D; however, there are insufficient data to verify the extent of the depression.

An understanding of the effects of the landfill cap on the hydrogeology are difficult to assess quantitatively. The complicating factors is that the wells that were measured prior to the installation of the cap were infrequently measured following the installation of the cap. A qualitative assessment comparing potentiometric surface maps from pre-cap conditions versus post-cap conditions shows that there could be a slight decrease in water elevation beneath the cap following construction. To more thoroughly assess this issue, it would be necessary to measure the same wells that were measured during the Phase II RI during similar seasons, similar levels of rainfall, etc. Thus, accurate quantitative assessment of hydrogeologic changes due to cap placement is not possible with the available data.

Area A Wetland

The Area A Wetland is underlain by dredge spoils that consist of silt and clay with traces of fine sand and shell fragments. The make-up of the dredge spoils reflects their original depositional environment, (i.e., river bottom sediments). The dredge spoils extend across the present site southeastward to 2WMW3 (near the tennis courts) and southwestward beneath the Area A Landfill. Dredge spoils are between 25 and 35 feet thick on the southern side of the wetland adjacent to the landfill and 10 to 15 feet thick on the northeastern side of the wetland. Where dredge spoil does not lie directly on bedrock, it is underlain by a thin remnant of topsoil, which consists of dark, organic-rich silt, clay, and traces of roots. The topsoil is in turn underlain by alluvial deposits.

The alluvial deposits that underlie portions of the Area A Wetland lie between dredge spoil materials/topsoil and bedrock. These deposits consist primarily of sand, with gravel and/or silt, and are significantly more coarse grained than the overlying dredge spoils. The observed thickness of the alluvium in the Area A Wetland borings ranged from 0 to approximately 36 feet. Since most borings/wells are located along the fringes of the wetland, the presence/thickness of alluvium within the central portion of the alluvium can only be estimated. Where present, the alluvium was first encountered at elevations typically ranging from 45 to 50 feet msl in the eastern portion of the wetland and 35 to 40 feet msl in the western portion near the dike.

Bedrock beneath the southern portion of the wetland has been identified as the Mamacoke Formation. The northernmost portion of the wetland is underlain by the Granite Gneiss, a gneissic biotite granite. The bedrock surface slopes to the valley occupied by the Area A Wetland from northern, eastern, and central bedrock highs toward the center of the wetland. The lowest bedrock elevation of 8.7 feet was identified at monitoring well location 2WMW3D. There are no data to confirm the bedrock elevation within the center of the wetland. There are two localized bedrock highs. In the northwestern central portion of

the wetland, the bedrock high corresponds to a topographic high and dry area within the wetland. This topographic high was identified on a historical surficial geology map (USGS, 1960). At the Weapons Center, a remnant bedrock high exists. This bedrock feature is the remnant of past blasting activity that lowered a formerly higher bedrock elevation at this location.

5.3.4.2 Hydrogeology

Area A Landfill

Groundwater was encountered within the dredge spoil, alluvium, and bedrock underlying the Area A Landfill and Wetland. In some areas, the bottom portion of the fill materials in the Area A Landfill is also below the water table. Depth to groundwater averages about 10 feet across the landfill. The saturated thickness of the overburden materials ranges from less than 10 feet to at least 65 feet across the landfill.

Figure 1-5 shows historic basewide shallow overburden groundwater contours, including the Area A Landfill, Area A Wetland, and the OBDA. Figures 4-2 and 4-4 show northern region shallow groundwater contours based on June and August 2000 water-level data. Groundwater flows northeastward across most of the Area A Landfill, from the topographic/bedrock high to the Area A Wetland. Figure 1-6 shows historic basewide bedrock groundwater flow contours, and Figures 4-3 and 4-5 show bedrock flow contours for the northern region based on June and August 2000 water-level data (Tables 2-2 and 2-3). Both overburden and bedrock groundwater flow maps show a similar flow pattern, indicating an overall hydraulic connection between the two units. Upward groundwater gradients from the bedrock to the overburden/fill are predominant in the landfill area. Hydraulic potentials between the bedrock and overburden groundwater at the 2LMW7, 2LMW8, 2LMW17, 2LMW18, and 2LMW20 well clusters differ by 3 to 7 feet. This suggests that, although groundwater flow directions in the bedrock and overburden are similar, the degree of hydraulic connection varies spatially and there is restriction of flow between the overburden and bedrock in some areas, likely as a result of the presence of low-permeability dredge spoil materials.

East of the Area A Landfill, near the 2LMW19 and 2WMW3 well clusters, local groundwater flow is to the north and west into the Area A Wetland. Groundwater elevations in the bedrock and overburden are similar, and vertical gradients are minimal.

In the western portion of the Area A Landfill near the dike, groundwater flows to the northwest toward the Area A Downstream Watercourses. At the 2LMW9 well cluster, the groundwater elevation in the overburden is relatively high, presumably as a result of the presence of the dike acting as a damming effect on the shallow groundwater. In the bedrock, the groundwater potential is significantly lower when

compared to the groundwater potential in other bedrock wells at the Area A Landfill, reflecting a hydraulic connection and flow to the Area A Downstream Watercourses.

This abnormally low bedrock groundwater level may be related to a groundwater discharge seep that is present at the toe of the OBDA. The seep, which is located at an elevation that would correspond with the projected bedrock groundwater level, may be a local discharge point for bedrock groundwater.

Estimated hydraulic conductivities based on the pumping test performed during the Phase II RI are 3.5 ft/day at 2LOW1S and 2.1 ft/day at well 2LOW2S. The geometric mean of these two values is 2.7 ft/day. Slug tests performed during the RI field investigations (Table 4-1) indicate that the average hydraulic conductivity for the combined fill material and dredge spoil was 2.1 ft/day. The estimated hydraulic conductivity for the dredge spoil alone was 1.0 ft/day. These hydraulic conductivity test data suggest that the dredge spoils have a somewhat lower hydraulic conductivity than the fill materials.

An estimate of the average seepage velocity of shallow overburden groundwater was determined by assuming a porosity of 0.30, a flow gradient of 0.074 (based on water-level measurements taken in June 2000), and a hydraulic conductivity of the Area A Landfill materials of 2.7 ft/day. The seepage velocity is estimated to be 0.67 ft/day.

Area A Wetland

Groundwater is present within the overburden and bedrock underlying the Area A Wetland. As is typical for wetland environments, the water table is nearly at the ground surface throughout most of the Area A Wetland. Overburden (both the dredge spoils and alluvium) exists largely under saturated conditions. Due to the finer grained nature of the dredge spoils in comparison to the alluvium, the two units are distinct from a hydrogeologic perspective but are hydraulically connected.

Figure 1-5 shows historic shallow overburden groundwater contours for the Area A Wetland. Groundwater flow directions in the bedrock mimic the shallow overburden flow pattern. Figures 4-2 and 4-4 show northern region shallow groundwater contours based on June and August 2000 water-level data. Figure 1-6 shows historic basewide bedrock groundwater flow contours, and Figures 4-3 and 4-5 show bedrock flow contours for the northern region based on June and August 2000 water-level data. Groundwater flows from higher elevations toward the bedrock valley and ultimately travels to the Area A Downstream Watercourses through a combination of discharge to local streams within the wetland and aquifer underflow. Groundwater elevations are similar in the bedrock and overburden, but the gradient is slightly upward at the 2WMW5 well cluster and slightly downward at the 2WMW21 well cluster. The hydraulic gradient is relatively flat across the Area A Wetland.

The shallow groundwater flow gradient is approximately .009 based on the June 2000 water-level measurements. Using a hydraulic conductivity of 1.0 ft/day, based on slug testing completed in the dredge spoils, and assuming an effective porosity of 0.30, the estimated groundwater seepage velocity through the dredge spoils is .03 ft/day. Based on an average hydraulic conductivity of 5.26 ft/day for the alluvium, the alluvium is significantly more permeable than the dredge spoils, and groundwater flow velocities are expected to be higher. Using the same gradient and porosity as were used for the dredge spoils, a flow velocity of 0.16 ft/day for the alluvium was calculated.

5.4 NATURE AND EXTENT OF CONTAMINATION

5.4.1 Previous Investigations - Area A Landfill

Soil, groundwater, and pavement sampling was conducted at the Area A Landfill during the Phase I and Phase II RIs and the FFS. Based upon the results of these investigations, the nature and extent of contamination of the soil and groundwater at the Area A Landfill are discussed on a matrix-specific basis in the following subsections.

5.4.1.2 Historic Soil Data

Several VOCs, including three ketones, four monocyclic aromatics, five chlorinated aliphatics, and carbon disulfide were detected in the Area A Landfill soil samples. With the exception of acetone, methylene chloride, ethylbenzene, toluene, and total xylenes, the VOCs were infrequently detected (in from one to three of 35 samples). Acetone and methylene chloride, which are both common laboratory contaminants, were detected at concentrations ranging from 0.009 mg/kg to 0.25 mg/kg and from 0.001 mg/kg to 0.025 mg/kg, respectively.

Four monocyclic aromatic compounds were detected at relatively high concentrations in the soil sample collected from a depth interval of 4 to 8 feet from boring 2LTB23 (chlorobenzene at 4.5 mg/kg, ethylbenzene at 28 mg/kg, toluene at 3.2 mg/kg, and total xylenes at 140 mg/kg). This boring is located near the eastern side of the former concrete pad. Surface soil sample 2LSS1 (0 to 6 inches), collected from an area about 200 feet east of former Building 373 and adjacent to the northeastern corner of the former concrete pad, contained high concentrations of three monocyclic aromatic hydrocarbons (ethylbenzene at 14 mg/kg, total xylenes at 75 mg/kg, and chlorobenzene at 4.5 mg/kg). These results indicate the possible occurrence of a recent spill because monocyclic aromatics were not prevalent in the groundwater samples collected in the area surrounding the concrete pad, as discussed in the next section. These monocyclic aromatics were also detected at substantially lower concentrations in from one to 11 other soil samples. Chlorobenzene was detected at a concentration of 0.043 mg/kg in surface soil sample 2LSS2 (0 to 0.5 feet bgs). Ethylbenzene and total xylenes were detected in the soil sample

collected at a depth interval of 6 to 8 feet bgs from boring 2LTB20, located approximately 30 feet northeast of former Building 373, at concentrations of 7.7 mg/kg and 8.8 mg/kg, respectively. Concentrations of ethylbenzene in the remaining soil samples ranged from 0.002 mg/kg to 0.068 mg/kg, concentrations of toluene ranged from 0.004 mg/kg to 0.027 mg/kg, and concentrations of total xylenes ranged from 0.004 mg/kg to 0.69 mg/kg. All other VOCs were detected at concentrations ranging from 0.002 mg/kg to 0.022 mg/kg.

Twenty-two SVOCs were detected in the Area A Landfill soil samples; 16 of these SVOCs were PAHs. Maximum concentrations of 14 SVOCs were detected in the soil sample collected from a depth interval of 6 to 8 feet bgs from boring 2LTB20. Maximum concentrations of PAHs ranged from 0.22 mg/kg (acenaphthylene) to 61 mg/kg (phenanthrene). 2,4-Dimethylphenol, 4-methylphenol, bis(2-ethylhexyl)phthalate, carbazole, di-n-butyl phthalate, and dibenzofuran were also each detected in one to six samples.

Fifteen pesticides and four PCBs were detected in the Area A Landfill soil samples. Maximum concentrations were associated with various samples, although the maximum concentrations of five pesticides were detected in the field duplicate soil sample collected at a depth interval of 10 to 12 feet bgs from boring 2LTB29, and the maximum concentrations of three pesticides and one PCB were detected in the soil sample or field duplicate sample collected from a depth interval of 4 to 8 feet bgs from boring 2LTB23. These two borings were located approximately 80 feet and 40 feet, respectively, east of the former concrete pad. Aroclor 1254, 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE were detected most frequently; Aroclor-1254 was detected in 22 of 45 soil samples, and 4,4'-DDT and its degradation products were each detected in 13 or 14 of 35 soil samples. The remaining pesticides and PCBs were detected in one to eight soil samples. The four detected PCBs, 4,4'-DDT, and 4,4'-DDD were also reported at the greatest concentrations. The maximum concentrations of the four detected PCBs ranged from 1.7 mg/kg (Aroclor 1242) to 100 mg/kg (Aroclor 1254), and the maximum concentrations of 4,4'-DDT and 4,4'-DDD were 2.3 mg/kg and 2.2 mg/kg, respectively.

Octachlorodibenzo-p-dioxin (OCDD) was detected at concentrations ranging from 0.0016 mg/kg to 0.0025 mg/kg in four Area A Landfill soil samples. In addition, three furans (1,2,3,4,6,7,8-HpCDF at 0.0002 mg/kg, 1,2,3,4,7,8-HxCDF at 0.0003 mg/kg, and 1,2,3,6,7,8-HxCDF at 0.0002 mg/kg) were detected in the soil sample collected from a depth interval of 4 to 8 feet bgs from boring 2LTB23. No other dioxins or furans were detected in the four soil samples analyzed for these parameters.

Twenty-four metals and cyanide were detected in the Area A Landfill soil samples. Seventeen of these metals were detected in from 32 to 35 of 35 soil samples. Maximum concentrations of 12 metals were detected in the soil sample collected from a depth interval of 6 to 8 feet from boring 2LTB22. The boring

log indicates that this sample was collected in fill material. Notable concentrations associated with this sample include those reported for copper (21,600 mg/kg), lead (1,780 mg/kg), nickel (1,440 mg/kg), and zinc (9,850 mg/kg).

TPH was detected at concentration of 46.7 mg/kg and 48.2 mg/kg in the two Area A Landfill soil samples analyzed for this parameter. Analyses for percent ash, cation exchange capacity, pH, specific gravity, and TOC were performed for two soil samples.

TCLP extraction followed by analysis for pesticides and metals was performed for 16 Area A Landfill soil samples. Analyses for TCLP VOCs, SVOCs, and herbicides were also performed for two of the 16 leachates. No organic compounds were detected in the TCLP leachates. Seven metals were detected in TCLP leachate samples. Arsenic, barium, cadmium, and lead were each detected in more than half of the leachates (i.e., in nine to 16 of the 16 leachates). Maximum concentrations of arsenic, chromium, selenium, and silver were detected in the leachate of the soil sample collected from a depth interval of 2 to 8 feet bgs from well boring 2LMW9.

5.4.1.3 Historic Groundwater Data

Appendix D presents descriptive statistics (frequency of detection, minimum and maximum concentrations, range of detection limits for nondetects, 95% UCL, and sample number and location associated with maximum concentration) and associated COPC screening criteria for each analyte detected at least once in groundwater samples collected from the Area A Landfill.

Groundwater samples were collected from overburden and bedrock wells at the Area A Landfill. Well 2LMW19S was screened at an interval that spans both the overburden and bedrock aquifers. Groundwater samples collected from this well are considered to be representative of the overburden aquifer for purposes of data evaluation.

Overburden Wells

Eleven VOCs, including five monocyclic aromatics, three chlorinated aliphatics, two ketones, and carbon disulfide, were detected in the groundwater samples collected from overburden wells. The reported concentrations of most of these VOCs were relatively low, ranging from 1 µg/L to 22 µg/L. However, reported concentrations of the monocyclic aromatics (benzene, chlorobenzene, ethylbenzene, toluene, and total xylenes) ranged from 1 µg/L (toluene) to 1,200 µg/L (chlorobenzene). The maximum concentrations of these chemicals, as well as the maximum concentration of chloroform, were associated with groundwater samples collected from well 2LMW18S, which is located in the central portion of the landfill.

Twenty-four SVOCs were detected in the groundwater samples collected from Area A Landfill overburden wells. Various classes of SVOCs, including chlorinated benzenes, substituted phenols, PAHs, and phthalates, as well as 2,4-dinitrotoluene, benzoic acid, carbazole, dibenzofuran, and n-nitrosodiphenylamine, were detected. In general, SVOCs were infrequently detected at relatively low concentrations. With the exception of naphthalene, which was detected in 11 of 23 samples, the remaining SVOCs were detected in from one to seven samples, and 15 of the SVOCs were detected only in one to three of 23 samples. Concentrations of all but five SVOCs [1,2,4-trichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, bis(2-ethylhexyl) phthalate, and naphthalene] ranged from 0.5 µg/L to 22 µg/L. The concentrations of the five aforementioned SVOCs ranged from 1 µg/L to 140 µg/L. Bis(2-ethylhexyl) phthalate is considered to be a common laboratory contaminant. Maximum concentrations of 18 of the 24 SVOCs were associated with groundwater samples collected from well 2LMW18S.

Three PCBs were detected in groundwater samples collected from well 2LMW18S. Aroclor 1016 was detected at a concentration of 7.5 µg/L in a groundwater sample collected from this well during Round 2 of the Phase II RI, Aroclor 1254 was detected at concentrations of 130 µg/L and 150 µg/L in the field duplicate samples collected from this well during the Phase I RI, and Aroclor 1260 was detected at concentrations of 710 µg/L and 290 µg/L in groundwater samples collected from this well during Rounds 1 and 2, respectively, of the Phase II RI. No other pesticides or PCBs were detected in any of the groundwater samples collected from the overburden wells at the Area A Landfill.

Twenty-two metals were detected in the unfiltered groundwater samples collected from the Area A Landfill overburden wells, and 21 metals were detected in the associated filtered groundwater samples. In general, reported concentrations of metals in filtered and unfiltered samples were relatively similar (i.e., at the same order of magnitude). Exceptions to this statement include reported results for chromium, vanadium, and zinc; maximum concentrations reported for each of these metals in unfiltered groundwater samples were from eight to 32 times greater than the maximum concentrations reported for the respective metals in filtered groundwater samples. A majority of the maximum concentrations were associated with samples collected from wells 2LMW18S and 2LMW13S.

Radionuclide analyses (gross alpha and gross beta) were performed for groundwater samples collected from six overburden wells during the Phase I RI. Complete gamma spectrum analyses, in addition to analyses for gross alpha and gross beta, were performed for four groundwater samples collected from overburden wells during the Phase II RI. Analytical results for radio nuclide analysis are provided in the Phase II RI report (B&R Environmental, 1997a). Gross alpha was detected at concentrations of 3.3 pCi/L and 11 pCi/L in samples from overburden wells 2LMW17S and 2LMW18S, respectively. Gross beta was

detected in groundwater samples from Area A Landfill overburden wells at concentrations ranging from 3.7 pCi/L to 85 pCi/L.

The only radionuclide identified by complete gamma spectrum analysis was naturally occurring potassium-40. Potassium-40 was detected at concentrations of 250 pCi/L (Round 1) and 130 pCi/L (Round 2) in groundwater samples collected from well 2LMW7S during the Phase II RI.

Analyses for several general chemistry parameters, including ammonia, BOD, COD, hardness, oil and grease, TOC, total phosphorus, and TSS were also performed for selected groundwater samples collected from the Area A Landfill overburden wells.

Bedrock Wells

Nine VOCs, including two monocyclic aromatics, five chlorinated aliphatics, one ketone, and carbon disulfide, were detected in from one to four of the 24 groundwater samples collected from Area A Landfill bedrock wells. Maximum concentrations of 1,1,2,2-PCE, 4-methyl-2-pentanone, and TCE were 140 µg/L, 49 µg/L, and 23 µg/L, respectively. Maximum concentrations of the remaining VOCs ranged from 1 µg/L to 6 µg/L. Maximum concentrations of the five chlorinated aliphatics (1,1,2,2-PCE, total 1,2-dichloroethene, methylene chloride, PCE, and TCE) were associated with groundwater samples collected from well 2LMW13D. Unlike the groundwater samples collected from the Area A Landfill overburden wells (specifically well 2LMW18S), monocyclic aromatics were not detected at significant concentrations in groundwater samples from the Area A Landfill bedrock wells. Chlorobenzene and total xylenes were the only detected monocyclic aromatics, and maximum concentrations reported for these chemicals in groundwater samples from the bedrock wells were only 6 µg/L and 2 µg/L, respectively.

Only one-third of the total number of SVOCs detected in groundwater samples from Area A Landfill overburden wells were detected in groundwater samples collected from Area A Landfill bedrock wells. Five phthalates (which are common field and laboratory contaminants), 4-methylphenol, phenol, and benzoic acid were detected in from one to five of the 24 groundwater samples collected from bedrock wells. Diethyl phthalate was detected in sample 2LGW17D-2 at a concentration of 120 µg/L. All other reported SVOC concentrations ranged from 0.5 µg/L to 10 µg/L. Neither pesticides nor PCBs were detected in any of the groundwater samples collected from the bedrock wells.

Twenty-three metals were detected in the unfiltered groundwater samples collected from the Area A Landfill bedrock wells, and 21 metals were detected in the associated filtered groundwater samples. As was true for groundwater samples collected from Area A Landfill overburden wells, reported concentrations of metals in filtered and unfiltered samples for most metals were relatively similar (i.e., at the same order of magnitude). Exceptions to this statement include reported results for aluminum,

cadmium, chromium, copper, and lead; maximum concentrations reported for each of these metals in unfiltered groundwater samples from bedrock wells were from eight to 200 times greater than the maximum concentrations reported for the respective metals in filtered groundwater samples. With the exception of antimony, cadmium, mercury, nickel, silver, and thallium in unfiltered samples and beryllium, cadmium, nickel, selenium, and vanadium in filtered samples, maximum concentrations of metals detected in groundwater samples from bedrock wells were from 1.5 to 27 times less than maximum concentrations of respective metals detected in groundwater samples from overburden wells. A majority of the maximum concentrations detected in the bedrock well samples were associated with samples collected from wells 2LMW19D and 2LMW9D. These wells are located on opposite ends of the Area A Landfill.

Radionuclide analyses (gross alpha and gross beta) were performed for seven groundwater samples collected from bedrock wells during the Phase I RI. Complete gamma spectrum analyses, in addition to analyses for gross alpha and gross beta, were performed for four groundwater samples collected from bedrock wells during the Phase II RI. Analytical results for radionuclide analysis are provided in the Phase II RI report (B&R Environmental, 1997a). Potassium-40 was not detected in any of these groundwater samples. Gross alpha was detected at concentrations ranging from 2.9 pCi/L to 24 pCi/L in groundwater samples collected from Area A Landfill bedrock wells, and gross beta was detected in corresponding samples at concentrations ranging from 3.7 pCi/L to 42 pCi/L. Maximum concentrations for gross alpha and gross beta in these samples were associated with the groundwater sample collected from bedrock well 2LMW13D during Round 2 of the Phase II RI.

Seventeen of the groundwater samples collected from Area A Landfill bedrock wells were analyzed for hardness. Reported results for this parameter ranged from 72 mg/L to 304 mg/L.

5.4.2 Previous Investigations - Area A Wetland

This section presents an evaluation of the nature and extent of contamination in the Area A Wetland. The discussion includes chemical analytical results for soil, sediment, groundwater, and surface water collected during the Phase I RI, the Phase II RI, the Area A Downstream/OBDA FFS, and the Area A Landfill FFS. Because of the fluctuating nature of the groundwater table at the site during wet versus dry periods, it is often difficult to distinguish between soil and sediment matrices. In addition, any potential impact to groundwater and surface water from soil and sediment would be collective. Therefore, analytical results for soil and sediment samples are evaluated collectively for this site.

5.4.2.1 Historic Soil and Sediment Data

Several VOCs, including carbon disulfide, two ketones, four monocyclic aromatics, and four halogenated aliphatics, were detected in the Area A Wetland soil and sediment samples. 2-Butanone, acetone, and carbon disulfide were detected most frequently (in from 19 to 32 of 60 samples) and at the greatest concentrations (ranging from 0.005 mg/kg to 1.4 mg/kg, from 0.027 mg/kg to 0.85 mg/kg, and from 0.002 mg/kg to 0.042 mg/kg, respectively). Halogenated aliphatics (1,1-dichloroethene, methylene chloride, PCE, and TCE) were detected in from one to nine samples at concentrations ranging from 0.002 mg/kg to 0.016 mg/kg. Monocyclic aromatics (benzene, chlorobenzene, toluene, and total xylenes) were detected in from one to six samples at concentrations ranging from 0.002 mg/kg to 0.014 mg/kg. These results are not considered to be indicative of a major source of VOCs.

PAHs were the most frequently detected class of compounds in the sediment and soil samples; they were also detected at the greatest concentrations. Other SVOCs detected in sediment and soil samples include three phthalate esters at concentrations ranging from 0.021 mg/kg to 3.5 mg/kg, three phenols (each detected in only one sample at concentrations ranging from 0.043 mg/kg to 0.24 mg/kg), 1,4-dichlorobenzene (at a concentration of 0.042 mg/kg in sample T6-B only), benzoic acid [at a concentration of 32 mg/kg in sediment sample 112690-2WSD9(0-0.5) and at concentrations ranging from 0.13 mg/kg to 0.78 mg/kg in four other samples], and carbazole (at concentrations ranging from 0.025 mg/kg to 0.13 mg/kg in six samples).

Concentrations of PAHs generally decreased with depth. The greatest total concentrations of both carcinogenic PAHs (CPAH; 227 mg/kg) and non-carcinogenic PAHs (NPAH; 184.4 mg/kg) were associated with sediment sample 2WSD9, collected from the Area A Weapons Center drainage culvert. Other than sample 2WSD9, concentrations of CPAHs and NPAHs were generally greatest along the boundary of the Area A Landfill (particularly along the northwestern end of the boundary). Concentrations of CPAH and NPAH in all individual samples collected in the eastern part of the wetland area (i.e., away from the landfill boundary) were less than 1 mg/kg; only CPAH and NPAH concentrations detected in composite samples from the eastern portion of the wetland exceeded 1 mg/kg.

Twenty-nine sediment samples were analyzed for 4,4'-DDT and its metabolites and dieldrin using field screening methodologies. No pesticides were detected.

The fixed-base laboratory detected pesticides in several sediment samples. 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were detected most frequently (in 13 to 18 samples) and at the greatest concentrations (ranging from 0.0044 mg/kg to 4.8 mg/kg). Maximum concentrations of these three pesticides were detected in sediment sample 2WSD25(0.0-1.0), which was collected at the outfall into the Area A Downstream watercourses. Aroclor 1260 was detected in seven samples, at concentrations ranging from 0.082 mg/kg

to 1.5 mg/kg. These seven samples were all located along the northwestern boundary of the landfill. Alpha- and gamma-chlordane were also detected in 12 and 11 FFS samples, respectively, but at much lower concentrations (C_{max} = 0.029 mg/kg). The remaining pesticides were detected in from one to four samples at concentrations ranging from 0.0021 mg/kg to 0.038 mg/kg. With the exceptions of 4,4'-DDT and its degradation products detected in sediment sample 2WSD25 and nearby sediment sample 2WSD24, pesticide concentrations were greater in samples collected along the northwestern boundary of the Area A Landfill than in samples collected elsewhere in the Area A Wetland.

All 22 TAL metals plus boron and cyanide were detected in the Area A Wetland soil and sediment samples. Most of the maximum concentrations of these analytes were also detected in samples collected along the northwestern boundary of the landfill; 10 of the maximum concentrations were associated with sample T7-B. With the exception of antimony, boron, cyanide, mercury, selenium, and silver, each of the inorganic analytes was detected in from 52 to 61 of 61 samples.

Analysis for TOC was performed for 24 of the Area A Wetland sediment samples. Reported concentrations for this parameter ranged from 8,420 mg/kg to 91,000 mg/kg.

TCLP extraction followed by analysis for pesticides and metals was performed for 42 soil and sediment samples. Pesticides were not detected in any of the TCLP leachates. All eight TCLP metals were detected in the TCLP leachates of the soil and sediment samples, although mercury was detected in only two of 42 leachates. Arsenic, barium, cadmium, and chromium were each detected in more than half of the 42 leachates. Lead was detected at the greatest concentration, with a maximum concentration of 1.5 mg/L. Maximum concentrations of the remaining metals ranged from 0.0006 mg/L (mercury) to 0.67 mg/L (barium).

5.4.2.2 Historic Groundwater Data

Groundwater samples from both overburden and bedrock wells were collected at the Area A Wetland. Appendix D presents descriptive statistics (frequency of detection, minimum and maximum concentrations, range of detection limits for nondetects, 95% UCL, and sample number and location associated with maximum concentration) and associated COPC screening criteria for each analyte detected at least once in groundwater samples collected from the Area A Wetland.

Overburden Wells

Carbon disulfide (2 µg/L) and total xylenes (1 µg/L) were each detected in a single Area A Wetland groundwater sample. No other VOCs were detected in the 10 groundwater samples that were collected from Area A Wetland overburden wells. Benzoic acid and two phthalate esters were also each detected

in one groundwater sample. Concentrations of these SVOCs ranged from 0.8 µg/L to 1 µg/L. Neither pesticides nor PCBs were detected in any of the Area A Wetland groundwater samples. These results indicate minimal organic contamination of groundwater in the overburden aquifer.

Twenty-two metals and cyanide were detected in the unfiltered groundwater samples, and 19 metals were detected in the filtered groundwater samples. In general, maximum concentrations of metals detected in filtered and unfiltered samples were at the same order of magnitude. Notable results among filtered and unfiltered samples include maximum concentrations reported for arsenic (138 µg/L), barium (754 µg/L), boron (3,340 µg/L), iron (131,000 µg/L), magnesium (1,080,000 µg/L), manganese (9360 µg/L), silver (9.8 µg/L), sodium (8,180,000 µg/L), and zinc (183 µg/L). Almost half of the maximum concentrations of metals and cyanide were associated with the groundwater sample collected from well 2WMW21S, located near the eastern border of the site.

Radionuclide analyses (gross alpha and gross beta) were performed for groundwater samples collected during the Phase I RI. Gross alpha was detected at a concentration of 2.8 pCi/L in the groundwater sample collected from well 2WMW6S. Gross beta was detected in the three samples analyzed for this parameter at concentrations ranging from 4.4 pCi/L to 40.2 pCi/L.

Analyses for hardness were performed for seven of the groundwater samples collected from the overburden wells. Reported concentrations for this parameter ranged from 96 mg/L to 6,150 mg/L.

Bedrock Wells

VOCs were not detected in the 16 groundwater samples collected from Area A Wetland bedrock wells. 2-Methylphenol (2 µg/L), 4-methylphenol (3 µg/L), and phenol (14 µg/L) were detected in a single groundwater sample collected from bedrock well 2WMW22D (Figure 1-6) during Round 2 of the Phase II RI. Benzoic acid and three phthalate esters were also detected in from one to five of the 16 samples. With the exception of bis(2-ethylhexyl) phthalate, which was detected at a concentration of 31 µg/L in one sample, concentrations of these SVOCs ranged from 0.5 µg/L (benzoic acid) to 13 µg/L [bis(2-ethylhexyl) phthalate]. Neither pesticides nor PCBs were detected in any of the Area A Wetland groundwater samples. Therefore, results for the groundwater samples collected from Area A Wetland bedrock wells also indicate minimal organic contamination.

Twenty-one metals were detected in the unfiltered groundwater samples collected from the bedrock wells, and 20 metals were detected in the filtered groundwater samples. Cyanide was not detected in these samples. In general, maximum concentrations of metals detected in filtered and unfiltered samples were at the same order of magnitude. Notable results among filtered and unfiltered samples include maximum concentrations reported for aluminum (9,910 µg/L), barium (904 µg/L), iron (108,000 µg/L), manganese

(7,160 µg/L), nickel (116 µg/L), sodium (1,290,000 µg/L), and zinc (274 µg/L). Approximately 41 percent and 37 percent, respectively, of the maximum concentrations of metals were associated with groundwater samples collected from wells 2WMW6D (located along the fence that surrounds the adjoining Area A Weapons Center) and 2WMW3D (located near the tennis courts at the southern end of the site). A comparison of the results indicates that the concentrations of most metals in groundwater samples collected from overburden and bedrock wells were relatively similar. However, the maximum concentrations of arsenic, boron, copper, magnesium, potassium, sodium, and vanadium in overburden samples were greater than five times the maximum concentrations reported for respective metals in the bedrock samples, and the maximum concentration reported for lead for bedrock samples was greater than five times the maximum concentration reported for lead in the overburden samples.

As previously noted, radionuclide analyses (gross alpha and gross beta) were performed for groundwater samples collected during the Phase I RI. Gross alpha was detected at concentrations of 4.7 pCi/L and 42.2 pCi/L in two groundwater samples collected from bedrock wells, and gross beta was detected at concentrations ranging from 3.8 pCi/L to 51 pCi/L in three groundwater samples collected from bedrock wells. Maximum concentrations for both gross alpha and gross beta were associated with well 2WMW3D.

Hardness analyses were performed 12 of the unfiltered groundwater samples and three of the unfiltered groundwater samples collected from Area A Wetland bedrock wells. Reported concentrations for this parameter in unfiltered groundwater samples ranged from 18 mg/L to 840 mg/L, and reported concentrations in filtered groundwater samples ranged from 16 mg/L to 124 mg/L.

5.4.2.3 Historic Surface Water Data

Eleven surface water samples plus one field duplicate sample were collected at the Area A Wetland. PCE was the only VOC detected in the 11 surface water samples. It was detected at a concentration of 0.002 mg/L in sample 2WSW12, which was collected from an area adjacent to the Area A Landfill. Diethyl phthalate, a common field and laboratory contaminant, was detected at a concentration of 0.002 mg/L in one of the three surface water samples analyzed for SVOCs. Pesticides and PCBs were not detected in any of the 11 samples that were analyzed for these parameters. These analytical results indicate that there is essentially no organic contamination present in the Area A Wetland surface water.

Nineteen metals were detected in the Area A Wetland unfiltered surface water samples, and 14 metals were detected in the filtered surface water samples. Maximum concentrations of metals were associated with various samples. Notable results include maximum concentrations reported for aluminum (20,900 µg/L), cadmium (126 µg/L), manganese (1,870 µg/L), nickel (84.7 µg/L), and zinc (334 µg/L).

Radionuclide analyses (gross alpha and gross beta) were performed for surface water samples collected from two locations during the Phase I RI. Gross beta was detected only in the surface water sample and field duplicate sample collected from location 2WSW2 (near the Area A Wetland outlet), at concentrations of 6.9 pCi/L and 11 pCi/L, respectively.

Hardness analyses were performed for one filtered and nine unfiltered Area A Wetland surface water samples. Hardness was not detected in the filtered sample and one of the unfiltered samples. Reported results for hardness for the remaining unfiltered samples ranged from 16 mg/L to 160 mg/L.

5.4.3 Basewide Groundwater OU RI

This section presents a discussion of the current nature and extent of groundwater contamination at the Area A Landfill and Wetland, based on groundwater data collected from the overburden aquifer during the BGOURI. The groundwater wells are located in the Area A Wetland adjacent to the northeastern boundary of the Area A Landfill.

A summary of the groundwater samples collected and the analyses performed on each is presented in Table 5-1. Table 5-2 presents a summary of the positive analytical detections at Site 2. As part of the HHRA (Section 5.6), a screening process for COPCs was performed. Table 5-3 presents a summary of the chemicals retained as COPCs as a result of the screening process. Tables 5-4 and 5-5 present descriptive statistics and the COPC screening criteria for each analyte detected in at least one groundwater sample at the Area A Landfill. The distribution of COPCs and their concentrations are presented in Figure 5-2.

Six VOCs (2-butanone, acetone, carbon disulfide, ethylbenzene, toluene, and TCE) were detected in the 11 groundwater samples that were collected from the overburden aquifer. Concentrations of most of these VOCs were relatively low, ranging from 0.4 µg/L to 26 µg/L, with the exception of acetone (120 µg/L) at well 2WGW39DS. VOCs were detected infrequently in overburden groundwater during the current investigation, with the exception of 2-butanone and acetone. Acetone, carbon disulfide, ethylbenzene, and toluene were detected in overburden groundwater samples collected from within the landfill area during previous investigations. Carbon disulfide was detected in overburden groundwater samples collected from within the wetland area during previous investigations.

Benzoic acid, 3&4-methylphenol, and phenol were the only SVOCs detected in overburden groundwater samples. Benzoic acid (2.3 J µg/L) and phenol (2.5 J µg/L) were only detected in one sample. 3&4-Methylphenol was detected in 3 groundwater samples at concentrations ranging from 0.75 J µg/L to 3.5 J µg/L. Benzoic acid was also detected in overburden groundwater samples detected from within the landfill area and wetland area during the previous investigations.

4,4'-DDD (0.058 J µg/L) was detected in one sample and was the only pesticide detected in overburden groundwater samples. 4,4'-DDD was not detected in groundwater samples from the landfill area or wetland area during previous investigations. High dissolved solids were detected in the groundwater sample, and it is likely that the DDD was bound to the solids.

Fifteen metals were detected in unfiltered overburden groundwater samples and 13 metals were detected in filtered overburden groundwater samples. Reported concentrations of metals in filtered and unfiltered samples were relatively similar (i.e., at the same order of magnitude). The most notable metals detected in overburden groundwater samples were arsenic, barium, and mercury. Detected concentrations of arsenic in unfiltered samples ranged from 16.1 J µg/L to 30.4 J µg/L. Detected concentrations of barium in unfiltered samples ranged from 28.4 J µg/L to 920 µg/L. Mercury was detected in only two samples at concentrations of 0.12 J µg/L and 1.5 µg/L. During previous investigations, concentrations of aluminum, chromium, cobalt, nickel, vanadium, and zinc in overburden groundwater samples from the landfill area and aluminum, arsenic, nickel, and zinc in overburden groundwater samples from the wetlands area were higher than those from the current investigation. Concentrations of calcium, mercury, and potassium were higher in the samples collected during the current investigation than they were in samples collected in the landfill area during previous investigations. Concentrations of iron and mercury were higher in the samples collected during the current investigation than they were in samples collected in the wetland area during previous investigations. Of the metals detected in groundwater, only arsenic, barium, and mercury exceeded background.

5.5 CONTAMINANT FATE AND TRANSPORT

Five classes of chemicals were detected in groundwater at Site 2 in the BGOURI: ketones, halogenated aliphatics, monocyclic aromatics, pesticides, and metals. Phthalates, metals, and some miscellaneous chemicals (carbon disulfide and benzoic acid) were detected in groundwater at Site 2 in the Phase II RI. Since the time of the Phase II RI data collection (1996), the landfill has been capped, eliminating the possibility of human exposure to soil at the site and minimizing the amount of precipitation that could infiltrate through the soil and potentially transport contamination to the groundwater. Therefore, any chemicals detected in groundwater during the BGOURI are most likely the result of historical releases.

Cross contamination between the Area A Landfill and the Area A Wetland is being assessed by an ongoing groundwater monitoring program. However results from this investigation show that organic contamination in the Wetlands is minimal. Concentrations of arsenic, barium and mercury contamination are being monitored by the program and trends in contamination will be discussed in upcoming annual reports.

Ketones

Two ketones (2-butanone and acetone) were detected in the groundwater at Site 2 in the BGOURI. Ketones were not detected in groundwater samples collected during the Phase II RI. Acetone and 2-butanone are common laboratory and field contaminants often detected in environmental samples. However, acetone and 2-butanone were detected in sediment samples located adjacent to the landfill, which suggests that the landfill may be the source for ketones detected in sediment and groundwater. Ketones are highly volatile and soluble and do not readily adsorb to soil. Therefore, they are not considered to be persistent in the environment. Hydrolysis is generally not a significant fate process for this class of chemicals, nor is bioconcentration significant. Once in the groundwater, ketones may slowly degrade.

Halogenated Aliphatics

One halogenated aliphatic compound (TCE) was detected in one groundwater sample at Site 2 during the BGOURI. TCE was detected in bedrock groundwater during a historical investigation in monitoring well 2LMW13D. This well is just upgradient of monitoring well 3MW37S, which had a detection of TCE during the BGOURI. TCE was detected in one sediment sample (2SWD4) collected during the Phase II RI, although the sediment sample was not located in the vicinity of the groundwater well (3MW37S) that had the detected TCE concentration. Halogenated aliphatic hydrocarbons such as TCE are relatively water soluble and have a low capacity for retention by soil/sediment organic carbon and, therefore, TCE is frequently detected in groundwater. Leaching from soil/sediment may account for the presence of TCE in groundwater at the site. TCE may migrate through the soil/sediment column after being released by a spill event or by a subsurface release when solubilized by infiltrating precipitation. Some portion of TCE may be retained by the soil/sediment, but most of the chemical will continue migrating downward until it reaches the water table. At that time, migration is primarily lateral with the hydraulic gradient.

Monocyclic Aromatics

Monocyclic aromatic compounds (ethylbenzene, toluene, 3&4-methylphenol, and phenol) were detected sporadically in groundwater samples collect in the BGOURI. These compounds were also detected in groundwater samples collected during historical investigations. Toluene and ethylbenzene were detected sporadically in sediment soil samples collected adjacent to the landfill. Two of the sediment samples (TB-2 and TB-3) in which toluene was detected were located in the vicinity of one of the monitoring wells (2WMW39DS) where toluene was detected. Monocyclic aromatic compounds are not considered to be persistent in the environment, particularly in comparison to chemicals such as PCBs and pesticides. They may migrate through the soil column when solubilized by infiltrating precipitation. Some portion of these chemicals is retained by the soil, but most will continue migrating downward until they reach the

water table. Bioconcentration in aquatic animals is not expected to be significant for monocyclic aromatics. They are subject to degradation via the action of both soil and aquatic microorganisms. Although these compounds are amenable to microbial degradation, it is not anticipated that degradation will occur at an appreciable rate, although macronutrient availability is not known.

Pesticides

DDD was detected in one shallow groundwater well (2WGW47DS) at Site 2 during the BGOURI. Pesticides were not detected in shallow or deep groundwater during historical investigations. Pesticides were detected in soil samples from this area during the Phase II RI. Whether pesticides are sprayed, dusted, or applied directly to the soil, the soil is the ultimate sink for these chemicals. Surface soil runoff may carry pesticides to adjacent surface water bodies (i.e., the Thames River). Bioconcentration of pesticides in the food chain is another important fate mechanism. Hydrolysis, oxidation, and photolysis are not generally important fate mechanisms for pesticides in soil or water. Hydrolysis half-lives for several pesticides are reported in periods of months to years.

DDD, which is a metabolite of DDT, is considered to be a persistent chemical. It undergoes extensive adsorption to soil and is not highly soluble. Biodegradation may occur under both aerobic and anaerobic conditions in the presence of certain soil microorganisms. DDD is somewhat volatile, however, it is highly lipophilic and therefore readily bioaccumulates.

Metals

At Site 2, 21 metals were detected in shallow and deep groundwater samples during the Phase II RI and 15 metals were detected in shallow and deep groundwater samples during the BGOURI. Beryllium, boron, cadmium, copper, lead, silver, and thallium were detected during the Phase II RI but not during the BGOURI. Mercury was detected during the BGOURI but not in the Phase II RI. Overall, the concentrations of metals were higher in the samples collected during the Phase II RI than those in the BGOURI.

As noted in Section 3.3, metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. The major fate mechanisms for metals are adsorption to the soil matrix (as compared to being part of the soil structure) and bioaccumulation.

In addition, under normal conditions, metals are not very mobile in the environment. Because metals frequently remain bound to particulate matter, the major transport mechanism for metals is bulk movement processes (erosion). However, metals can become mobile in the environment under certain conditions. The mobility of metals is influenced primarily by their physical or chemical properties in

conjunction with the physical and chemical properties of the soil matrix. Factors that assist in predicting the mobility of metals are the soil/pore water pH, redox potential, and cation exchange capacity. The mobility of metals generally increases with decreasing soil pH and cation exchange capacity. The effect of REDOX potential varies for each metal.

Groundwater samples from the BGOURI were analyzed for total metals and dissolved metals. A comparison of the total and dissolved concentrations indicates that there was little difference between the total and dissolved concentrations, which indicates that the metals are more likely to be in the dissolved phase rather than bound to particulate matter. Metals in the dissolved phase would be more likely to migrate with groundwater than those bound to particulate matter.

Specific metals of concern are those that exceed background concentration values: arsenic, barium and mercury. Site specific geochemical conditions (e.g., pH and redox conditions) can influence the relative mobility of metals. In the case of barium, pH and redox conditions will have little effect on its mobility. The metal exists as a cation and is subject to retardation during transport mostly as a result of cation exchange reactions with aquifer surfaces. Arsenic mobility is strongly tied to site geochemical conditions because arsenic exists in the dissolved phase as one of two major anionic species. Arsenic is mobile as either the arsenate anion or as the arsenite anion. The arsenate ion is more prevalent in slightly oxidizing environments whereas the arsenite species predominates in more reducing environments. Either anion may be present in intermediate environments. Arsenic mobility is further enhanced when environmental pH is mildly acidic and the anionic species may be uncharged. Groundwater at Site 2 exhibits highly reducing oxidation-reduction potential (ORP) especially in those wells beneath the base of the landfill. [-126 to -451 mV in the BROURI (Round 4) sampling.] The groundwater pH is near neutral (6.6 to 7.15). The combination of neutral pH and reducing conditions favors the + 3 valence form of arsenic, present in water as a relatively mobile, uncharged form of arsenite (H_3AsO_3). This conclusion is based on Eh-pH diagrams published by Dove and Rimstidt (1985) and Brookins (1988) for systems containing arsenic, water, iron and sulfur species with concentrations similar to those reported for Site 2 groundwater. Figure 5-3 shows that there is a correlation of arsenic and barium. There is no similar correlation between arsenic and iron in groundwater. This lack of a correlation may indicate that the relationship between arsenic and iron oxyhydroxides is complicated by other factors (e.g. pH change creating neutral species, precipitation of iron sulfide minerals). Mercury mobility is governed by the geochemical environment as well. Mercury in oxidizing environments should be fairly mobile as an unchanged hydroxide complex. In more reducing environments dissolved mercury mobility will be limited in the presence of dissolved sulfide by precipitation as an insoluble mineral (HgS). Given the highly reducing conditions observed in the Site 2 groundwater near the wetland, the insoluble mercury sulfide mineral would be expected to form and limit mercury transport. This conclusion is based on the Eh-pH diagram

presented in Brookins (1988) for the system Hg-O-H-S-Cl at concentrations similar to those in Site 2 groundwater.

5.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific risk assessment for the identified exposure scenarios for Site 2. The risk assessment methodology was described in Section 3.4, and detailed calculations including RAGS Part D tables are presented in Appendix C. A summary of previous risk assessments for the site is also presented.

5.6.1 Data Evaluation

COPCs were identified for Site 2 using the risk-based screening levels, as discussed in Section 3.4.1. Table 5-3 summarizes the COPCs retained for Site 2. A discussion of direct contact exposure COPCs (i.e., those chemicals detected at concentrations in excess of USEPA and CTDEP direct contact exposure criteria) and additional COPCs is provided below. Additional COPCs are identified based on chemical migration tendencies: migration of groundwater to surface water and migration of volatiles from groundwater through building foundations into indoor air. These additional COPCs are not quantitatively evaluated in the HHRA because they are not considered to be significant contributors to the direct contact exposure pathways identified for potential human receptors.

A comparison of the maximum detected concentrations in groundwater to direct contact risk-based screening criteria is presented in Table 5-4. The maximum detected concentrations of the following chemicals in groundwater exceeded their direct contact risk-based COPC screening levels and were retained as COPCs for groundwater:

- VOCs-acetone
- Metals-arsenic, barium, and mercury

The maximum detected concentrations of chromium and manganese exceeded their respective screening criteria but were within background levels; consequently, chromium and manganese were not retained as COPCs. The maximum detected concentration of acetone exceeded its EPA Region IX PRG but was less than its CTDEP RSR.

A comparison of the maximum detected concentration in groundwater to migration criteria is presented in Table 5-5. The maximum detected concentrations of the following chemicals exceeded their respective screening criteria for protection of migration to surface water:

- Metals-arsenic and barium

The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from groundwater to indoor air.

5.6.2 Exposure Assessment

Only groundwater samples were collected during the current investigation. Consequently, only exposures to groundwater were evaluated in the risk assessment for Site 2. Construction workers were the only receptors identified for exposure to groundwater. Construction workers could come into contact with groundwater while excavating building foundations. In such an instance, construction workers could be exposed to the groundwater via dermal contact. Exposure assumptions for construction workers were presented in Table 3-14. Potential exposure pathways are summarized in Table 5-6.

As discussed in Section 3.4, the maximum detected concentration and average concentration were used for the exposure point concentrations for the RME and CTE, respectively. Exposure point concentrations for Site 2 are presented in Table 5-7.

5.6.3 Risk Characterization

Potential ICRs and HIs were calculated for construction workers exposed to groundwater using the methodology presented in Section 3.4. The results are summarized in Table 5-8 and are discussed below. Sample calculations and chemical-specific risks in RAGS Part D format are provided in Appendix C.

Carcinogenic Risks

No carcinogenic toxicity factors are available for the identified COPCs; consequently, ICRs were not estimated for construction workers exposed to groundwater.

Noncarcinogenic Risks

HIs for construction workers exposed to groundwater were 0.00008 and 0.00004 for the RME and CTE scenarios, respectively, which were less than EPA's and CTDEP's acceptable level of 1.0.

5.6.4 Summary of Previous Risk Assessments

5.6.4.1 Site 2A - Area A Landfill

Three potential receptor groups, full-time employees, older child trespassers, and construction workers, were considered for the Area A Landfill during the Phase II RI risk assessment. Because of the nature of the site, a future residential exposure scenario was not considered. Therefore, the only exposure to groundwater at the Area A Landfill was assumed to be direct contact with this medium for the construction worker during construction activities.

Noncarcinogenic risks associated with dermal contact with groundwater for the construction worker exceeded 1.0 for both RME and CTE scenarios (8,100 and 430, respectively). Elevated risks for the construction worker are a result of exposure to PCBs in groundwater because the individual HQs for PCBs for the RME and CTE scenarios were 8,100 and 430, respectively. Estimated risks associated with other chemicals detected in groundwater are relatively insignificant.

The incremental cancer risk associated with dermal contact with groundwater for the construction worker under the CTE (4.0×10^{-5}) was within USEPA's target risk range but exceeded the CTDEP target cancer risk (1×10^{-5}). The incremental cancer risk for this route of exposure under the RME (9.7×10^{-4}) exceeded the CTDEP target cancer risk and 1×10^{-4}, the upper limit of USEPA's target risk range. Potential carcinogenic risks for dermal contact with water were also attributed to PCBs.

The landfill has been capped since the Phase II RI risk assessment was performed. An assessment of current risks is provided in Section 5.6.3.

5.6.4.2 Site 2B - Area A Wetlands

The baseline risk assessment conducted for the Area A Wetland as part of the Phase II RI focused on an older child trespasser and a construction worker under CTE and RME scenarios. Groundwater was not considered to be a potential medium for exposure for the trespasser. Dermal contact with groundwater was evaluated as a potential route of exposure for the construction worker.

Noncarcinogenic risks associated with exposure to groundwater for the construction worker were less than the USEPA acceptable level of 1.0 for the CTE scenario but exceeded 1.0 for the RME scenario. Elevated noncarcinogenic hazards for the construction worker under the RME scenario were primarily attributed to dermal exposure to manganese in groundwater. The chemical-specific HQ for manganese via dermal contact (1.7) slightly exceeded unity. Manganese is relatively abundant in the environment.

Lifetime ICR associated with dermal contact with groundwater for the CTE and RME scenarios for the construction worker were less than 1 x 10^{-5}, the CTDEP target cancer risk, and less than 1 x 10^{-6}, the lower bound of the USEPA target risk range.

5.6.5 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment, in general, was presented in Section 3.4.5. Site-specific uncertainties for Site 2 are discussed below.

Elimination of Chemicals as COPCs on the Basis of Background

In accordance with U.S. Navy policy, chemicals were eliminated as COPCs on the basis of comparison to background. Chromium and manganese were the only chemicals in groundwater with maximum detected concentrations that exceeded the direct contact screening criteria but were not retained as COPCs on the basis of background. Dermal exposure to groundwater by construction workers was the only exposure pathway evaluated at Site 2. Potential risks from exposures to manganese in water are negligible (USEPA, 2000e), consequently the elimination of manganese as a COPC on the basis of background does not effect the risk estimates for construction workers at Site 2. If exposures to chromium in groundwater by construction workers were evaluated in the HHRA then the resulting HQ for chromium would be 0.004 and the total HI would be 0.004 which is less than the USEPA and CTDEP acceptable level of 1.0.

5.7 SUMMARY AND RECOMMENDATIONS

5.7.1 Nature and Extent of Contamination

Six VOCs were detected in the groundwater samples collected during the BGOURI. Several of the VOCs were detected previously during historical soil and groundwater sampling events. Acetone was the only VOC COPC identified at Site 2. In general, acetone detections were at trace to low detections (i.e., less than 10 µg/L), with the exception of the concentration of 120 µg/L in well 2WMW39DS. Acetone is also known to be a common lab artifact.

Three SVOCs were detected in the groundwater samples collected during the BGOURI. None of the detected concentrations exceeded any of the relevant screening criteria.

One pesticide, 4,4'-DDD, was detected in a single groundwater sample. High dissolved solids were detected in the groundwater sample and it is likely that the DDD was bound to the solids.

Fifteen metals were detected in the unfiltered groundwater samples and 13 metals were detected in the filtered groundwater samples. Arsenic, barium, and mercury were the only metals identified as COPCs. Exceedances of background for these metals were sporadic because only one well (2WGW47DS) had detected concentrations of more than one metal that exceeded background. Concentrations of the other detected metals were below screening criteria. In general, metals concentrations were lower in the BGOURI than in previous investigations. This result was generally expected because only downgradient monitoring wells and not monitoring wells within the Area A Landfill were sampled during the BGOURI.

5.7.2 Contaminant Fate and Transport

Acetone, the only organic chemical identified as a COPC, belongs to the ketone class of chemicals. Ketones are highly volatile and soluble and do not readily adsorb to soil; therefore they are generally not considered to be persistent in the environment. Degradation of ketones will slowly occur in the groundwater environment. Given the overall low concentrations of acetone detected, the slow migration rate of groundwater at Site 2, and the presence of the wetland area, it is expected that detectable levels of acetone will not persist any significant distance downgradient of the Area A Landfill.

Arsenic, barium, and mercury were the only metals detected above screening criteria at Site 2. Metals are persistent in the subsurface environment but are typically not very mobile. The slightly acidic pH of the groundwater (as is characteristic of northern region groundwater) generally serves to enhance the solubility and mobility of metals. Aside from one well in which all three metals were detected at above-background levels, the exceedances of criteria for metals were scattered, limited to dredge spoil monitoring wells, and generally only slightly above background. This information indicates that there is no definable plume or significant source of metals contamination. Due to the natural buffering capacity characteristic of wetland environment, metals contamination is not expected to persist in groundwater to any significant extent.

5.7.3 Summary of Human Health Risk Assessment

The following items summarize the HHRA for Site 2.

- The HHRA for Site 2 considered exposures to construction workers. No soil samples were collected at Site 2; therefore, only exposures to groundwater were evaluated. Potential exposure pathways included dermal contact with groundwater.

- The maximum detected concentrations of acetone, arsenic, barium, and mercury exceeded their direct contact risk-based COPC screening levels and were retained for evaluation in the HHRA. The

maximum detected concentration of acetone exceeded its EPA Region IX PRG but was less than its CTDEP RSR.

- The maximum detected concentrations of arsenic and mercury exceeded their respective CTDEP screening criteria for protection of migration of groundwater to surface water.

- The maximum detected concentrations of all chemicals in groundwater were less than the CTDEP criteria for migration from groundwater to indoor air.

- ICRs and HIs for construction workers exposed to groundwater at Site 2 were within USEPA and CTDEP acceptable levels.

- The maximum detected concentrations of chromium and manganese in groundwater exceeded their respective screening criteria but were within background levels, consequently chromium and manganese were not retained as COCs in the HHRA. ICRs and His would still have been within USEPA and CTDEP target levels if these compounds have been evaluated in the HHRA.

5.7.4 Recommendations

The Navy completed a soil remedial action at Site 2, consisting of the construction of an engineered cap over the Area A Landfill along with an upgradient trench to reduce the amount of shallow groundwater reaching the landfill. The BGOURI activities for Site 2 were focused on evaluating the current groundwater conditions at the site. The monitoring wells included in the Groundwater Monitoring Program for the Area A Landfill were the only wells sampled during the BGOURI, and the results presented in this RI constitute the results for Round 4 of the monitoring program for Site 2. Based on the most recent groundwater data, the impacts of Site 2 on groundwater downgradient of the landfill are minimal, with only sporadic detections of acetone and several metals at concentrations above screening criteria.

The HHRA determined that risks posed by exposure of construction workers to groundwater at Site 2 are within USEPA and CTDEP acceptable levels, assuming that the workers are exposed to the maximum observed concentrations of site contaminants. Screening criteria for groundwater to surface water were exceeded for two metals (using maximum detected concentrations); however, with isolated exceptions, metals detections are within the background concentration range.

The BGOURI sampling results indicate that groundwater impacts associated with Site 2 are minimal and are localized. A quarterly Groundwater Monitoring Program is currently being implemented at Site 2. It is recommended that the program be continued to gather data to evaluate long-term trends in contaminant

concentrations. The data will be reviewed to determine if the appropriate monitoring well network is being used for the program. Should groundwater data indicate the need for additional remedial action evaluation at some point in the future, an FS should be performed at that time.

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TABLE 5-1

SUMMARY OF SAMPLING AND ANLYTICAL PROGRAM FOR SITE 2 BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION NSB-NLON, GROTON, CONNECTICUT

Sample ID	VOCs	SVOCs	Metals	Misc	Pesticides PCBs
2WGW38DS-04	X	X	X	X	X
2WGW39DS-04-F			X		
2WGW39DS04	X	X	X	X	X
2WGW40DS-04	X	X	X	X	X
2WGW40DS-04-F			X		
2WGW41DS-04	X	X	X	X	X
2WGW41DS-04-F			X		
2WGW42DS-04	X	X	X	X	X
2WGW42DS-04-F			X		
2WGW43DS-04	X	X	X	X	X
2WGW43DS-04-F			X		
2WGW44DS-04	X	X	X	X	X
2WGW44DS-04-F			X		
2WGW45DS-04	X	X	X	X	X
2WGW45DS-04-F			X		
2WGW46DS-04	X	X	X	X	X
2WGW46DS-04-F			X		
2WGW47DS04	X	X	X	X	X
2WGW47DS-04-F			X		
3GW37S-04	X	X	X	X	X
3GW37S-04-F			X		
GWFD071800-04	X	X	X	X	X
GWFD071800-04-F			X		

Note: Miscellaneous parameters include alkalinity, chemical oxygen demand, chloride, hardness, sulfate, TDS, TOC, and TSS.

TABLE 5-2

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR SITE 2
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	2WMW38DS	2WMW39DS	2WMW40DS	2WMW41DS	2WMW41DS	2WMW42DS	2WMW43DS	2WMW44DS
nsample	2WGW38DS-04	2WGW39DS-04	2WGW40DS-04	2WGW41DS-04	2WGW41DS-04-F	2WGW42DS-04	2WGW43DS-04	2WGW44DS-04
sample	2WGW38DS-04	2WGW39DS04	2WGW40DS-04	2WGW41DS-04	2WGW41DS-04-F	2WGW42DS-04	2WGW43DS-04	2WGW44DS-04
sample_dat	7/20/00	7/19/00	7/20/00	7/20/00	7/20/00	7/20/00	7/21/00	7/20/00
Volatile Organics (ug/L)								
2-BUTANONE	5 U	26	5 U	3 J		2 J	3 J	5 U
ACETONE	4 J	120	3 J	8		5	10	7
CARBON DISULFIDE	1 U	2	3 U	4 U		4 U	6	1 U
ETHYLBENZENE	1 U	0.3 J	1 U	1 U		1 U	1 U	1 U
TOLUENE	1 U	0.6 J	1 U	1 U		1 U	0.4 J	1 U
TRICHLOROETHENE	1 U	1 U	1 U	1 U		1 U	1 U	1 U
Semivolatile Organics (ug/L)								
3&4-METHYLPHENOL	5.2 U	3.5 J	6.2 U	5.2 U		5.1 U	5.1 U	0.75 J
BENZOIC ACID	21 U	2.3 J	25 U	21 U		20 U	20 UJ	20 U
PHENOL	5.2 U	2.5 J	6.2 U	5.2 U		5.1 U	5.1 UJ	5 U
Pesticides/PCBs (ug/L)								
4,4'-DDD	0.021 U	0.02 U	0.029 U	0.022 U		0.02 U	0.02 U	0.022 U
Metals (ug/L)								
ALUMINUM	115 U	69.1 U	69.1 U	69.1 U		97.4 U	69.1 U	69.1 U
ARSENIC	2.7 U	2.7 U	25.9 J	6 U		10.1 U	16.1 J	3 U
BARIUM	28.4 J	59.6	108	37.4		80.2	161	57.9
CALCIUM	48500	30700	230000	155000		129000	301000	101000
CHROMIUM	4.8 J	1.3 U	5 J	3.9 J		3.3 J	8.3 J	1.3 U
COBALT	0.94 U	0.94 U	0.94 U	0.95 J		0.94 U	0.94 U	0.94 U
IRON	112 U	5580	1410	2310		15400	2830	19200
MAGNESIUM	19400	8270	772000	477000		258000	942000	116000
MANGANESE	36.6	758	353	770		655	490	919
MERCURY	0.1 U	0.1 U	0.1 U	0.12 J		0.1 U	0.1 U	0.1 U
NICKEL	7.4	1.8 U	1.8 U	3.5 U		4.7 U	3.4 U	1.9 U
POTASSIUM	19900 J	9950	302000 J	185000 J		124000 J	355000 J	57900 J
SODIUM	193000	229000	6170000	3660000		2150000	7260000	950000
VANADIUM	13.9	0.91 U	7 U	2.7 U		4.9 U	9.5 J	2.8 U
ZINC	6.8 U	6.1 J	4.7 U	6.8 U		11 J	5.3 U	6.7 U
ARSENIC, FILTERED		2.7 U	13.8 U	8.4 U		12.6 U	10.9 U	2.7 U
BARIUM, FILTERED		46.4	79.3	58.3		69.7	127	54.9
CALCIUM, FILTERED		32000	221000	181000		163000	288000	103000
CHROMIUM, FILTERED		1.3 U	1.8 J	4.8 J		2 J	5.5 J	1.3 U
COBALT, FILTERED		1.1 U	0.94 U	1.3 J		0.94 U	0.99 J	0.94 U
IRON, FILTERED		5760	2260	13400		1030	481	11900
MAGNESIUM, FILTERED		11700	748000	553000		404000	980000	125000
MANGANESE, FILTERED		685	383	759		593	558	959

TABLE 5-2

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR SITE 2
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location nsample sample sample_dat	2WMW38DS 2WGW38DS-04 2WGW38DS-04 7/20/00	2WMW39DS 2WGW39DS-04 2WGW39DS04 7/19/00	2WMW40DS 2WGW40DS-04 2WGW40DS-04 7/20/00	2WMW41DS 2WGW41DS-04 2WGW41DS-04 7/20/00	2WMW41DS 2WGW41DS-04-F 2WGW41DS-04-F 7/20/00	2WMW42DS 2WGW42DS-04 2WGW42DS-04 7/20/00	2WMW43DS 2WGW43DS-04 2WGW43DS-04 7/21/00	2WMW44DS 2WGW44DS-04 2WGW44DS-04 7/20/00
MERCURY, FILTERED		0.1 U	0.1 U	0.1 U		0.12 J	0.1 U	0.1 U
POTASSIUM, FILTERED		14300	318000 J	216000 J		168000 J	325000 J	57400 J
SODIUM, FILTERED		271000	6590000	4240000		3320000	6970000	983000
VANADIUM, FILTERED		1.2 U	6.4 U	6.8 U		4.5 U	9.3 J	2.5 U
ZINC, FILTERED		17.2	3.2 U	4 U		7.6 U	4.9 U	6.4 U
Miscellaneous Parameters (ug/L)								
ALKALINITY	303	159	996	752		467	1200	547
CHEMICAL OXYGEN DEMAND	41.6	65.8	1040	651		362	1930	54.6
CHLORIDE	198 J	329 J	10500 J	7690 J		5140 J	13900 J	1980 J
HARDNESS as CaCO3	201	110	3750	2350		1380	4630	730
SULFATE	55.7	20 U	989	212		152	375	20 U
TOTAL DISSOLVED SOLIDS	813	782 J	16700	13600		9310	24800	3440
TOTAL ORGANIC CARBON	15.1	21	24	65.2		29.2	48.5	10.3
TOTAL SUSPENDED SOLIDS	4 U	22 J	78	123		67	34	45

TABLE 5-2

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR SITE 2
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location nsample sample sample_dat	2WMW45DS 2WGW45DS-04 2WGW45DS-04 7/20/00	2WMW46DS 2WGW46DS-04 2WGW46DS-04 7/20/00	2WMW47DS 2WGW47DS-04 2WGW47DS04 7/18/00	2WMW47DS 2WGW47DS-04-D GWFD071800-04 7/18/00	3MW37S 3GW37S-04 3GW37S-04 7/20/00	3MW37S 3GW37S-04-F 3GW37S-04-F 7/20/00
Volatile Organics (ug/L)						
2-BUTANONE	10	5 U	5 U	5 U	5 U	
ACETONE	38	5 U	5 U	5 U	5 U	
CARBON DISULFIDE	7	4 U	1 U	1 U	1 U	
ETHYLBENZENE	1 U	1 U	1 U	1 U	1 U	
TOLUENE	1 U	1 U	1 U	1 U	1 U	
TRICHLOROETHENE	1 U	1 U	1 U	1 U	1 J	
Semivolatile Organics (ug/L)						
3&4-METHYLPHENOL	5.2 U	1.2 J	5.2 U	5.1 U	5.1 U	
BENZOIC ACID	21 U	21 U	21 UR	20 UR	20 U	
PHENOL	5.2 U	5.2 U	5.2 UJ	5.1 UJ	5.1 U	
Pesticides/PCBs (ug/L)						
4,4'-DDD	0.022 U	0.022 U	0.058 J	0.042 J	0.021 U	
Metals (ug/L)						
ALUMINUM	69.1 U	138 U	220	292	69.1 U	
ARSENIC	4.2 U	28.4 J	29.6 J	30.4 J	2.7 U	
BARIUM	47.3	144	920	875	64.1	
CALCIUM	141000	334000	97900	94400	37500	
CHROMIUM	1.4 J	11.9 J	1.3 UJ	1.3 UJ	1.3 U	
COBALT	0.94 U	0.94 U	13.4	13.4	2.4 J	
IRON	615	429	234000	221000	188	
MAGNESIUM	514000	1020000	151000	150000	5530	
MANGANESE	189	224	8960	8450	269	
MERCURY	0.1 U	0.1 U	1.4	1.5	0.1 U	
NICKEL	1.4 U	4 U	4.2 U	5.7 U	1.2 U	
POTASSIUM	239000 J	361000 J	95600	96300	5790 J	
SODIUM	4220000	7930000	1400000	1400000	67000	
VANADIUM	14.6 J	4.1 U	0.71 UJ	0.71 UJ	0.71 U	
ZINC	3.1 U	11.1 J	8.2 J	9.9 J	3.2 U	
ARSENIC, FILTERED	4.6 U	29.3 J	35.5 J	32.4 J	2.7 U	
BARIUM, FILTERED	28.2 J	123	1070	1030	52.9	
CALCIUM, FILTERED	114000	327000	99700	98900	37300	
CHROMIUM, FILTERED	1.3 U	13.6 J	1.3 UJ	1.3 UJ	1.3 U	
COBALT, FILTERED	0.94 U	0.94 U	14.5	13.9	2.6 J	
IRON, FILTERED	649	167 U	263000	258000	219	
MAGNESIUM, FILTERED	362000	1060000	142000	142000	5530	
MANGANESE, FILTERED	230	228	10100	9850	264	

TABLE 5-2

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR SITE 2
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location nsample sample sample_dat	2WMW45DS 2WGW45DS-04 2WGW45DS-04 7/20/00	2WMW46DS 2WGW46DS-04 2WGW46DS-04 7/20/00	2WMW47DS 2WGW47DS-04 2WGW47DS04 7/18/00	2WMW47DS 2WGW47DS-04-D GWFD071800-04 7/18/00	3MW37S 3GW37S-04 3GW37S-04 7/20/00	3MW37S 3GW37S-04-F 3GW37S-04-F 7/20/00
MERCURY, FILTERED	0.1 U	0.1 U	0.82	1.3	0.1 U	
POTASSIUM, FILTERED	173000 J	360000 J	96100	94800	5090 J	
SODIUM, FILTERED	3250000	7940000	1380000	1370000	67300	
VANADIUM, FILTERED	4.1 U	4.3 U	0.71 UJ	0.71 UJ	0.71 U	
ZINC, FILTERED	4.7 U	6.5 U	13.6 J	18.7 J	3.9 U	
Miscellaneous Parameters (ug/l						
ALKALINITY	870	2420	323	384	120	
CHEMICAL OXYGEN DEMAND	146	2410	106	109	20 U	
CHLORIDE	4270 J	16800 J	3170 J	3570 J	107 J	
HARDNESS as CaCO3	2470	5030	870	850	116	
SULFATE	51.7	255	20 U	20 U	20	
TOTAL DISSOLVED SOLIDS	7430	29400	5680 J	6020 J	336	
TOTAL ORGANIC CARBON	16.4	63.2	10.3	13.8	4	
TOTAL SUSPENDED SOLIDS	31	66	181 J	165 J	4 U	

Notes:
Metals results for filtered samples correspond to the dissolved state. Metals results for unfiltered samples correspond to total metals.

TABLE 5-3

CHEMICALS RETAINED AS COPCs IN GROUNDWATER AT SITE 2
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Direct Contact	Migration Pathways	
		Surface Water	Volatilization
Volatile Organic Compounds			
Acetone	X		
Metals			
Arsenic	X	X	
Barium	X		
Mercury	X	X	

Notes:
X - Chemical is retained as a COPC.

TABLE 5-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 2
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Landfill and Wetlands (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																
78-93-3	2-BUTANONE	2	J	26		ug/L	2WGW39DS-04	5/11	5	26	NA	190 N	400 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
67-64-1	ACETONE	3	J	120		ug/L	2WGW39DS-04	8/11	5	120	NA	61 N	700 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
75-15-0	CARBON DISULFIDE	2		7		ug/L	2WGW45DS-04	3/11	1 - 4	7	NA	100 N	700 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
100-41-4	ETHYLBENZENE	0.3	J	0.3	J	ug/L	2WGW39DS-04	1/11	1	0.3	NA	130 N	700 700 700	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
108-88-3	TOLUENE	0.4	J	0.6	J	ug/L	2WGW39DS-04	2/11	1	0.6	NA	72 N	1000 1000 1000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
79-01-6	TRICHLOROETHENE	1	J	1	J	ug/L	3GW37S-04	1/11	1	1	NA	1.6 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Semivolatile Organics																
	3&4-METHYLPHENOL	0.75	J	3.5	J	ug/L	2WGW39DS-04	3/11	5.1 - 6.2	3.5	NA	18 N	35 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
65-85-0	BENZOIC ACID	2.3	J	2.3	J	ug/L	2WGW39DS-04	1/10	20 - 25	2.3	NA	15000 N	50000 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
108-95-2	PHENOL	2.5	J	2.5	J	ug/L	2WGW39DS-04	1/11	5 - 6.2	2.5	NA	2200 N	4000 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Pesticides																
72-54-8	4,4'-DDD	0.042	J	0.058	J	ug/L	2WGW47DS-04	1/11	0.02 - 0.029	0.058	NA	0.28 C	0.15 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Total Metals																
7429-90-5	ALUMINUM	220		292		ug/L	2WGW47DS-04-D	1/11	69.1 - 138	292	3560	3600 N	N/A 50-200 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI, BKG
7440-38-2	ARSENIC	16.1	J	30.4	J	ug/L	2WGW47DS-04-D	4/11	2.7 - 10.1	30.4	1.92	0.045 C	50 50 50	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-39-3	BARIUM	28.4	J	920		ug/L	2WGW47DS-04	11/11	N/A	920	227	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-70-2	CALCIUM	30700		334000		ug/L	2WGW46DS-04	11/11	N/A	334000	188000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-47-3	CHROMIUM	1.4	J	11.9	J	ug/L	2WGW46DS-04	7/11	1.3	11.9	49.9	11 N	50 100 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
7440-48-4	COBALT	0.95	J	13.4		ug/L	2WGW47DS-04, 2WGW47DS-04-D	3/11	0.94	13.4	48.6	220 N	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON	188		234000		ug/L	2WGW47DS-04	10/11	112	234000	28200	1100 N	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI

TABLE 5-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 2
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Landfill and Wetlands (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7439-95-4	MAGNESIUM	5530		1020000		ug/L	2WGW46DS-04	11/11	N/A	1020000	191000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7439-96-5	MANGANESE	36.6		8960		ug/L	2WGW47DS-04	11/11	N/A	8960	11700	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7439-97-6	MERCURY	0.12	J	1.5		ug/L	2WGW47DS-04-D	2/11	0.1	1.5	ND	0.36 N	2 2 2	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-02-0	NICKEL	7.4		7.4		ug/L	2WGW38DS-04	1/11	1.2 - 5.7	7.4	32.2	73 N	100 N/A 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-09-7	POTASSIUM	5790	J	361000	J	ug/L	2WGW46DS-04	11/11	N/A	361000	70800	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-23-5	SODIUM	67000		7930000		ug/L	2WGW46DS-04	11/11	N/A	7930000	1900000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-62-2	VANADIUM	9.5	J	14.6	J	ug/L	2WGW45DS-04	3/11	0.71 - 7	14.6	10.2	26 N	50 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-66-6	ZINC	6.1	J	11.1	J	ug/L	2WGW46DS-04	4/11	3.1 - 6.8	11.1	131	1100 N	5000 5000 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL, BKG
Dissolved Metals																
7440-38-2	ARSENIC, FILTERED	29.3	J	35.5	J	ug/L	2WGW47DS-04-F	2/10	2.7 - 13.8	35.5	1.92	0.045 C	50 50(9) 50	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-39-3	BARIUM, FILTERED	28.2	J	1070		ug/L	2WGW47DS-04-F	10/10	N/A	1070	227	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-70-2	CALCIUM, FILTERED	32000		327000		ug/L	2WGW46DS-04-F	10/10	N/A	327000	NA	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-47-3	CHROMIUM, FILTERED	1.8	J	13.6	J	ug/L	2WGW46DS-04-F	5/10	1.3	13.6	49.9	11 N	50 100 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
7440-48-4	COBALT, FILTERED	0.99	J	14.5		ug/L	2WGW47DS-04-F	4/10	0.94 - 1.1	14.5	48.6	220 N	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON, FILTERED	219		263000		ug/L	2WGW47DS-04-F	9/10	167	263000	28200	1100 N	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI
7439-95-4	MAGNESIUM, FILTERED	5530		1060000		ug/L	2WGW46DS-04-F	10/10	N/A	1060000	191000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7439-96-5	MANGANESE, FILTERED	228		10100		ug/L	2WGW47DS-04-F	10/10	N/A	10100	11700	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7439-97-6	MERCURY, FILTERED	0.12	J	1.3		ug/L	2WGW47DS-04-F-D	2/10	0.1	1.3	ND	0.36 N	2 2 2	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-09-7	POTASSIUM, FILTERED	5090	J	360000	J	ug/L	2WGW46DS-04-F	10/10	N/A	360000	70800	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-23-5	SODIUM, FILTERED	67300		7940000		ug/L	2WGW46DS-04-F	10/10	N/A	7940000	1900000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT

TABLE 5-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 2
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Landfill and Wetlands (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7440-62-2	VANADIUM, FILTERED	9.3	J	9.3	J	ug/L	2WGW43DS-04-F	1/10	0.71 - 6.8	9.3	10.2	26 N	50 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-66-6	ZINC, FILTERED	13.6	J	18.7	J	ug/L	2WGW47DS-04-F-D	2/10	3.2 - 7.6	18.7	131	1100 N	5000 5000 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL, BKG
Miscellaneous Parameters																
	ALKALINITY	120000		2420000		mg/L	2WGW46DS-04	11/11	N/A	2420000	1950	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
	CHEMICAL OXYGEN DEMAND	41600		2410000		mg/L	2WGW46DS-04	10/11	20,000	2410000	570	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
	CHLORIDE	107000	J	16800000	J	mg/L	2WGW46DS-04	11/11	N/A	16800000	4540	N/A	N/A 250 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NV
	HARDNESS as CaCO3	110000		5030000		mg/L	2WGW46DS-04	11/11	N/A	5030000	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
	SULFATE	20000		989000		mg/L	2WGW40DS-04	8/11	20,000	989000	45.2	N/A	N/A 250 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NV
	TOTAL DISSOLVED SOLIDS	336000		29400000		mg/L	2WGW46DS-04	11/11	N/A	29400000	6260	N/A	N/A 500 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NV
	TOTAL ORGANIC CARBON	4000		65200		mg/L	2WGW41DS-04	11/11	N/A	65200	37.7	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
	TOTAL SUSPENDED SOLIDS	22000	J	181000	J	mg/L	2WGW47DS-04	9/11	4,000	181000	236	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Footnotes:
1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 The risk-based COPC screening level for tap water use is presented. The value is based on a target hazard quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
7 Pyrene is used as a surrogate for phonanthrene.
8 Value is for hexavalent chromium.
9 The US EPA has approved a new MCL for arsenic of 10 ug/L. The new MCL goes into effect in 2006. The reduction in the MCL does not impact the human health risk assessment.

Associated Samples:

2WGW38DS-04	2WGW42DS-04	2WGW45DS-04-F	3GW37S-04
2WGW39DS-04	2WGW42DS-04-F	2WGW46DS-04	3GW37S-04-F
2WGW39DS-04-F	2WGW43DS-04	2WGW46DS-04-F	
2WGW40DS-04	2WGW43DS-04-F	2WGW47DS-04	
2WGW40DS-04-F	2WGW44DS-04	2WGW47DS-04-D	
2WGW41DS-04	2WGW44DS-04-F	2WGW47DS-04-F	
2WGW41DS-04-F	2WGW45DS-04	2WGW47DS-04-F-D	

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
N/A = Not Applicable.
FED-MCL = Federal Maximum Contaminant Level (USEPA, August 2000).
FED-SMCL = Federal Secondary Maximum Contaminant Level (USEPA, August 2000).
FED-AL = Federal Action Level (USEPA, August 2000).
CTDEP-RSR = Connecticut DEP Remediation Standard Regulations, 1996.
CTDEP-MCL = Connecticut Maximum Contaminant Level.

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No Toxicity Information.
EPAI = USEPA Region one does not advocate evaluation of this chemical.
NV = These compounds are not evaluated in the HHRA and are only presented for informational purposes.

TABLE 5-5

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 2
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Landfill and Wetlands (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Surface Water Protection Criteria(5)	Volatilization Criteria(5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics															
78-93-3	2-BUTANONE	2	J	26		ug/L	2WGW39DS-04	5/11	5	26	N/A	N/A	50000	NO	BSL
67-64-1	ACETONE	3	J	120		ug/L	2WGW39DS-04	8/11	5	120	N/A	N/A	50000	NO	BSL
75-15-0	CARBON DISULFIDE	2		7		ug/L	2WGW45DS-04	3/11	1 - 4	7	N/A	N/A	N/A	NO	NTX
100-41-4	ETHYLBENZENE	0.3	J	0.3	J	ug/L	2WGW39DS-04	1/11	1	0.3	N/A	580000	50000	NO	BSL
108-88-3	TOLUENE	0.4	J	0.6	J	ug/L	2WGW39DS-04	2/11	1	0.6	N/A	4000000	23500	NO	BSL
79-01-6	TRICHLOROETHENE	1	J	1	J	ug/L	3GW37S-04	1/11	1	1	N/A	2340	219	NO	BSL
Semivolatile Organics															
	3&4-METHYLPHENOL	0.75	J	3.5	J	ug/L	2WGW39DS-04	3/11	5.1 - 6.2	3.5	N/A	N/A	N/A	NO	NTX
65-85-0	BENZOIC ACID	2.3	J	2.3	J	ug/L	2WGW39DS-04	1/10	20 - 25	2.3	N/A	N/A	N/A	NO	NTX
108-95-2	PHENOL	2.5	J	2.5	J	ug/L	2WGW39DS-04	1/11	5 - 6.2	2.5	N/A	92000000	N/A	NO	BSL
Pesticides															
72-54-8	4,4'-DDD	0.042	J	0.058	J	ug/L	2WGW47DS-04	1/11	0.02 - 0.029	0.058	N/A	N/A	N/A	NO	NTX
Total Metals															
7429-90-5	ALUMINUM	220		292		ug/L	2WGW47DS-04-D	1/11	69.1 - 138	292	3560	N/A	N/A	NO	BKG
7440-38-2	ARSENIC	16.1	J	30.4	J	ug/L	2WGW47DS-04-D	4/11	2.7 - 10.1	30.4	1.92	4	N/A	YES	ASL
7440-39-3	BARIUM	28.4	J	920		ug/L	2WGW47DS-04	11/11	N/A	920	227	N/A	N/A	NO	NTX
7440-70-2	CALCIUM	30700		334000		ug/L	2WGW46DS-04	11/11	N/A	334000	188000	N/A	N/A	NO	NTX
7440-47-3	CHROMIUM VI	1.4	J	11.9	J	ug/L	2WGW46DS-04	7/11	1.3	11.9	49.9	110	N/A	NO	BSL, BKG
7440-48-4	COBALT	0.95	J	13.4		ug/L	2WGW47DS-04, 2WGW47DS-04-D	3/11	0.94	13.4	48.6	N/A	N/A	NO	BKG
7439-89-6	IRON	188		234000		ug/L	2WGW47DS-04	10/11	112	234000	28200	N/A	N/A	NO	NTX
7439-95-4	MAGNESIUM	5530		1020000		ug/L	2WGW46DS-04	11/11	N/A	1020000	191000	N/A	N/A	NO	NTX
7439-96-5	MANGANESE	36.6		8960		ug/L	2WGW47DS-04	11/11	N/A	8960	11700	N/A	N/A	NO	BKG
7439-97-6	MERCURY	0.12	J	1.5		ug/L	2WGW47DS-04-D	2/11	0.1	1.5	ND	0.4	N/A	YES	ASL
7440-02-0	NICKEL	7.4		7.4		ug/L	2WGW38DS-04	1/11	1.2 - 5.7	7.4	32.2	880	N/A	NO	BSL, BKG
7440-09-7	POTASSIUM	5790	J	361000	J	ug/L	2WGW46DS-04	11/11	N/A	361000	70800	N/A	N/A	NO	NTX
7440-23-5	SODIUM	67000		7930000		ug/L	2WGW46DS-04	11/11	N/A	7930000	1900000	N/A	N/A	NO	NTX
7440-62-2	VANADIUM	9.5	J	14.6	J	ug/L	2WGW45DS-04	3/11	0.71 - 7	14.6	10.2	N/A	N/A	NO	NTX
7440-66-6	ZINC	6.1	J	11.1	J	ug/L	2WGW46DS-04	4/11	3.1 - 6.8	11.1	131	123	N/A	NO	BSL, BKG
Dissolved Metals															
7440-38-2	ARSENIC, FILTERED	29.3	J	35.5	J	ug/L	2WGW47DS-04-F	2/10	2.7 - 13.8	35.5	1.92	4	N/A	YES	ASL
7440-39-3	BARIUM, FILTERED	28.2	J	1070		ug/L	2WGW47DS-04-F	10/10	N/A	1070	227	N/A	N/A	NO	NTX
7440-70-2	CALCIUM, FILTERED	32000		327000		ug/L	2WGW46DS-04-F	10/10	N/A	327000	188000	N/A	N/A	NO	NTX
7440-47-3	CHROMIUM, FILTERED	1.8	J	13.6	J	ug/L	2WGW46DS-04-F	5/10	1.3	13.6	49.9	110	N/A	NO	BSL, BKG
7440-48-4	COBALT, FILTERED	0.99	J	14.5		ug/L	2WGW47DS-04-F	4/10	0.94 - 1.1	14.5	48.6	N/A	N/A	NO	BKG
7439-89-6	IRON, FILTERED	219		263000		ug/L	2WGW47DS-04-F	9/10	167	263000	28200	N/A	N/A	NO	NTX
7439-95-4	MAGNESIUM, FILTERED	5530		1060000		ug/L	2WGW46DS-04-F	10/10	N/A	1060000	191000	N/A	N/A	NO	NTX
7439-96-5	MANGANESE, FILTERED	228		10100		ug/L	2WGW47DS-04-F	10/10	N/A	10100	11700	N/A	N/A	NO	BKG
7439-97-6	MERCURY, FILTERED	0.12	J	1.3		ug/L	2WGW47DS-04-F-D	2/10	0.1	1.3	ND	0.4	N/A	YES	ASL
7440-09-7	POTASSIUM, FILTERED	5090	J	360000	J	ug/L	2WGW46DS-04-F	10/10	N/A	360000	70800	N/A	N/A	NO	NTX
7440-23-5	SODIUM, FILTERED	67300		7940000		ug/L	2WGW46DS-04-F	10/10	N/A	7940000	1900000	N/A	N/A	NO	NTX
7440-62-2	VANADIUM, FILTERED	9.3	J	9.3	J	ug/L	2WGW43DS-04-F	1/10	0.71 - 6.8	9.3	10.2	N/A	N/A	NO	BKG
7440-66-6	ZINC, FILTERED	13.6	J	18.7	J	ug/L	2WGW47DS-04-F-D	2/10	3.2 - 7.6	18.7	131	123	N/A	NO	BSL, BKG
Miscellaneous Parameters															
	ALKALINITY	120000		2420000		mg/L	2WGW46DS-04	11/11	N/A	2420000	1950	N/A	N/A	NO	NTX
	CHEMICAL OXYGEN DEMAND	41600		2410000		mg/L	2WGW46DS-04	10/11	20,000	2410000	570	N/A	N/A	NO	NTX

TABLE 5-5

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 2
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Landfill and Wetlands (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Surface Water Protection Criteria(5)	Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
	CHLORIDE	107000	J	16800000	J	mg/L	2WGW46DS-04	11/11	N/A	16800000	4540	N/A	N/A	NO	NTX
	HARDNESS as CaCO3	110000		5030000		mg/L	2WGW46DS-04	11/11	N/A	5030000	ND	N/A	N/A	NO	NTX
	SULFATE	20000		989000		mg/L	2WGW40DS-04	8/11	20,000	989000	45.2	N/A	N/A	NO	NTX
	TOTAL DISSOLVED SOLIDS	336000		29400000		mg/L	2WGW46DS-04	11/11	N/A	29400000	6260	N/A	N/A	NO	NTX
	TOTAL ORGANIC CARBON	4000		65200		mg/L	2WGW41DS-04	11/11	N/A	65200	37.7	N/A	N/A	NO	NTX
	TOTAL SUSPENDED SOLIDS	22000	J	181000	J	mg/L	2WGW47DS-04	9/11	4,000	181000	236	N/A	N/A	NO	NTX

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Footnotes:
1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 Connecticut DEP Surface Water Protection criteria.
6 Connecticut DEP Volatilization criteria.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the CTDEP surface water protection or volatilization criteria.

Associated Samples:

2WGW38DS-04	2WGW42DS-04	2WGW45DS-04-F	3GW37S-04
2WGW39DS-04	2WGW42DS-04-F	2WGW46DS-04	3GW37S-04-F
2WGW39DS-04-F	2WGW43DS-04	2WGW46DS-04-F	
2WGW40DS-04	2WGW43DS-04-F	2WGW47DS-04	
2WGW40DS-04-F	2WGW44DS-04	2WGW47DS-04-D	
2WGW41DS-04	2WGW44DS-04-F	2WGW47DS-04-F	
2WGW41DS-04-F	2WGW45DS-04	2WGW47DS-04-F-D	

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No Toxicity Information.

TABLE 5-6

SELECTION OF EXPOSURE PATHWAYS FOR SITE 2
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Groundwater	Overburden/Bedrock Aquifer	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	None Quant	Construction workers may have dermal contact with groundwater during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers do not have contact with groundwater.
				Residents	Adult	Ingestion Dermal	On-Site On-Site	None None	Residential land usage is not expected to occur at Site 2.
					Child	Ingestion Dermal	On-Site On-Site	None None	Residential land usage is not expected to occur at Site 2.
		Air	Overburden/Bedrock Aquifer	Construction Workers	Adult	Inhalation	On-site	None	Construction workers exposure via volatilization is expected to be insignificant due to dilution with outdoor air.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers do not have contact with site groundwater.
				Residents	Adult	Inhalation	On-site	None	Residential land usage is not expected to occur at Site 2.
					Child	Inhalation	On-site	None	Residential land usage is not expected to occur at Site 2.

TABLE 5-7

EXPOSURE POINT CONCENTRATIONS FOR SITE 2
BASEWIDE GROUNDWATER OPERABLE UNIT REMEIDAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Groundwater	
	RME[1] (ug/L)	CTE[1] (ug/L)
Volatile Organic Compounds		
Acetone	120	18.4
Inorganics		
Arsenic	30.0	10.6
Barium	898	153
Mercury	1.45	0.184

Notes:
1 - The maximum detected concentration is used for the RME scenario and the average concentration is used for the CTE scenario.

TABLE 5-8

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 2
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
REASONABLE MAXIMUM EXPOSURES								
Construction Worker	Groundwater	Dermal Contact	0.0E+00	- -	- -	- -	0.00008	- -
CENTRAL TENDENCY EXPOSURES								
Construction Worker	Groundwater	Dermal Contact	0.0E+00	- -	- -	- -	0.00004	- -

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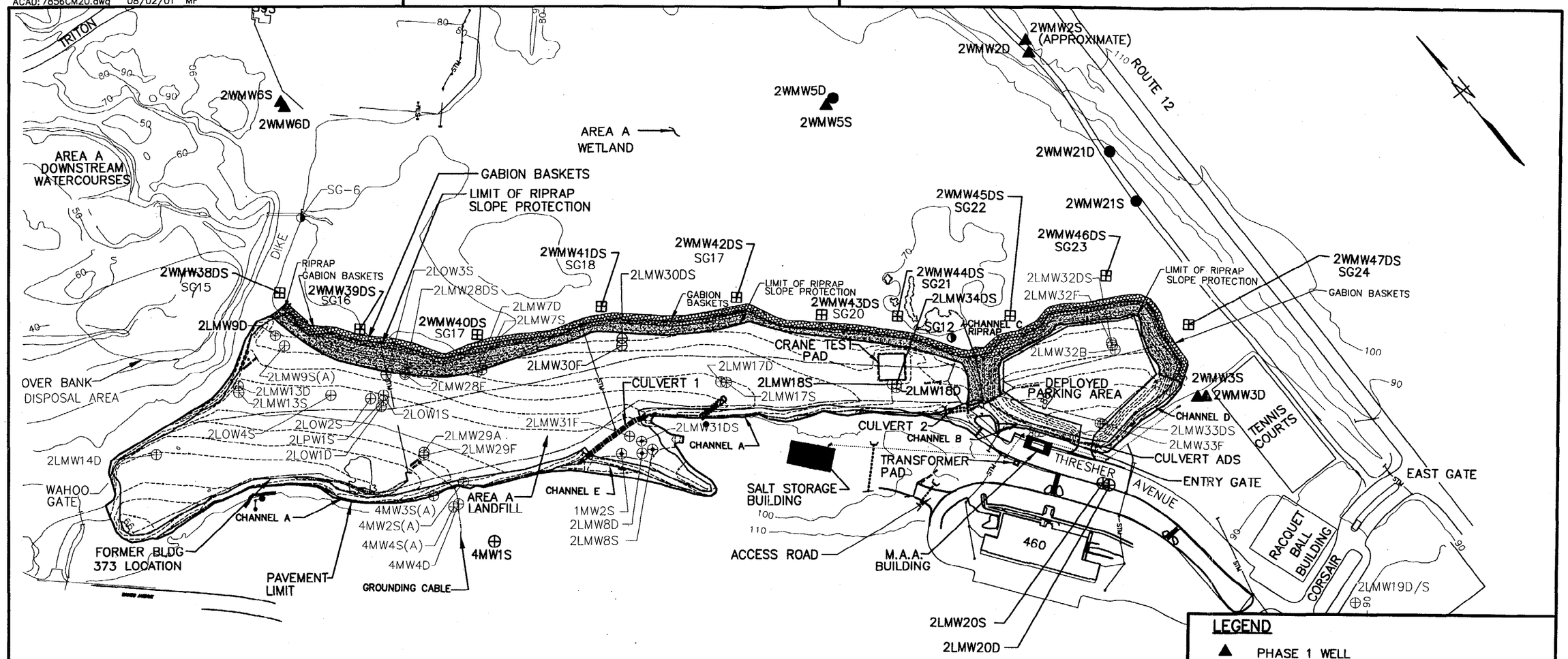

LEGEND

- ▲ PHASE 1 WELL
- ● PHASE 2 WELL
- ⦶ WELLS INSTALLED FOR INVESTIGATIONS OTHER THAN THAN PHASE 1 AND 2 RI's
- ◑ STAFF GAUGE
- ⊞ MONITORING WELL & STAFF GAUGE CLUSTERS INSTALLED FOR INVESTIGATIONS OTHER THAN PHASE 1 & 2 RIs.
- △ SEEP LOCATION
- (A) ABANDONED

NOTE

1. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON AND PHASE II RI WORK PLAN (ATLANTIC, MAY 1993).

0 200 400
SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/19/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

SITE MAP
SITE 2 – AREA A LANDFILL
NSB-NLON
GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY David Arcone DATE 8-7-01
APPROVED BY DATE
DRAWING NO. FIGURE 5-1
REV. 1

FORM CADD NO. SOUTH_BH.DGN – REV 0 – 02/11/97

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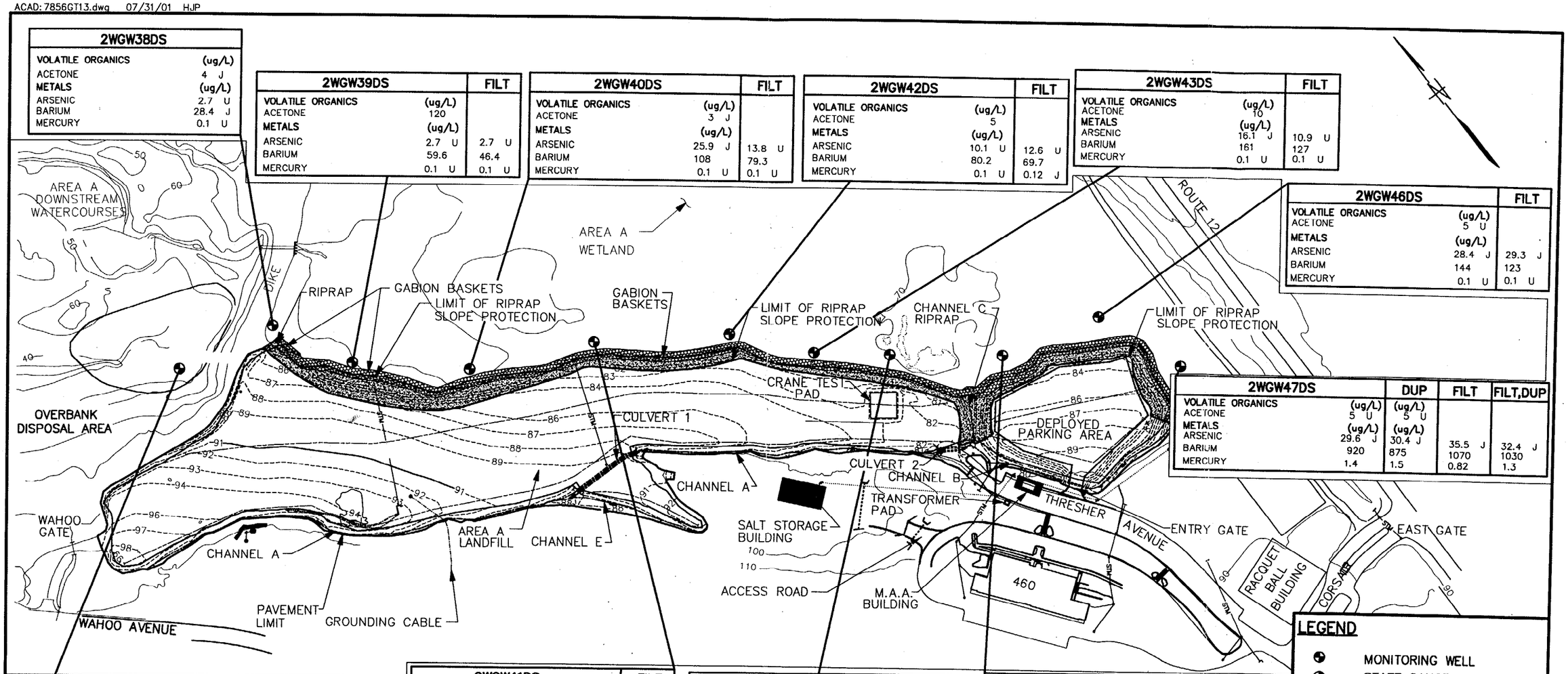

2WGW38DS	
VOLATILE ORGANICS	(ug/L)
ACETONE	4 J
METALS	(ug/L)
ARSENIC	2.7 U
BARIUM	28.4 J
MERCURY	0.1 U

2WGW39DS		FILT
VOLATILE ORGANICS	(ug/L)	
ACETONE	120	
METALS	(ug/L)	
ARSENIC	2.7 U	2.7 U
BARIUM	59.6	46.4
MERCURY	0.1 U	0.1 U

2WGW40DS		FILT
VOLATILE ORGANICS	(ug/L)	
ACETONE	3 J	
METALS	(ug/L)	
ARSENIC	25.9 J	13.8 U
BARIUM	108	79.3
MERCURY	0.1 U	0.1 U

2WGW42DS		FILT
VOLATILE ORGANICS	(ug/L)	
ACETONE	5	
METALS	(ug/L)	
ARSENIC	10.1 U	12.6 U
BARIUM	80.2	69.7
MERCURY	0.1 U	0.12 J

2WGW43DS		FILT
VOLATILE ORGANICS	(ug/L)	
ACETONE	10	
METALS	(ug/L)	
ARSENIC	16.1 J	10.9 U
BARIUM	161	127
MERCURY	0.1 U	0.1 U

2WGW46DS		FILT
VOLATILE ORGANICS	(ug/L)	
ACETONE	5 U	
METALS	(ug/L)	
ARSENIC	28.4 J	29.3 J
BARIUM	144	123
MERCURY	0.1 U	0.1 U

2WGW47DS		DUP	FILT	FILT,DUP
VOLATILE ORGANICS	(ug/L)	(ug/L)		
ACETONE	5 U	5 U		
METALS	(ug/L)	(ug/L)		
ARSENIC	29.6 J	30.4 J	35.5 J	32.4 J
BARIUM	920	875	1070	1030
MERCURY	1.4	1.5	0.82	1.3

3GW37S		FILT
VOLATILE ORGANICS	(ug/L)	
ACETONE	5 U	
METALS	(ug/L)	
ARSENIC	2.7 U	2.7 U
BARIUM	64.1	52.9
MERCURY	0.1 U	0.1 U

2WGW41DS		FILT
VOLATILE ORGANICS	(ug/L)	
ACETONE	8	
METALS	(ug/L)	
ARSENIC	6 U	8.4 U
BARIUM	37.4	58.3
MERCURY	0.12 J	0.1 U

2WGW44DS		FILT
VOLATILE ORGANICS	(ug/L)	
ACETONE	7	
METALS	(ug/L)	
ARSENIC	3 U	2.7 U
BARIUM	57.9	54.9
MERCURY	0.1 U	0.1 U

2WGW45DS		FILT
VOLATILE ORGANICS	(ug/L)	
ACETONE	38	
METALS	(ug/L)	
ARSENIC	4.2 U	4.6 U
BARIUM	47.3	28.2 J
MERCURY	0.1 U	0.1 U

LEGEND

- MONITORING WELL
- STAFF GAUGE

NOTE:

1. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON AND PHASE II RI WORK PLAN (ATLANTIC, MAY 1993).

0 200 400
SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 1/18/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

COPCs IN GROUNDWATER
SITE 2 – AREA A LANDFILL
NSB-NLON
GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY David Kerosa DATE 8-7-01
APPROVED BY DATE
DRAWING NO. FIGURE 5-2
REV. 1

FORM CADD NO. SOUTH_BH.DGN – REV 0 – 02/11/97

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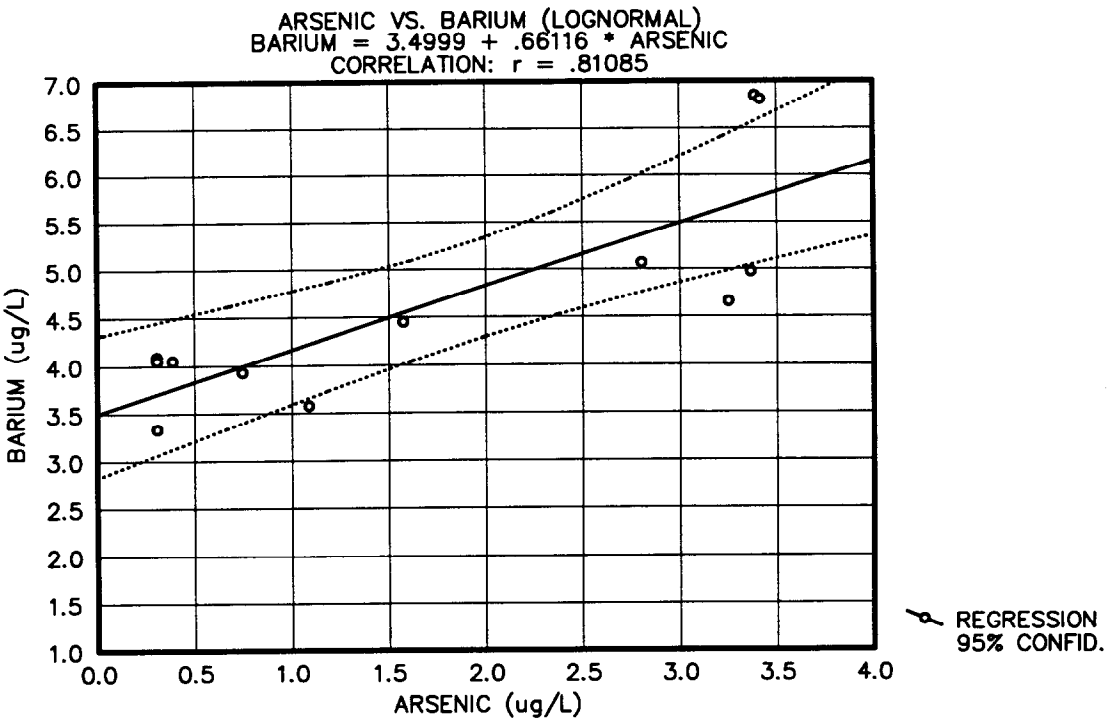

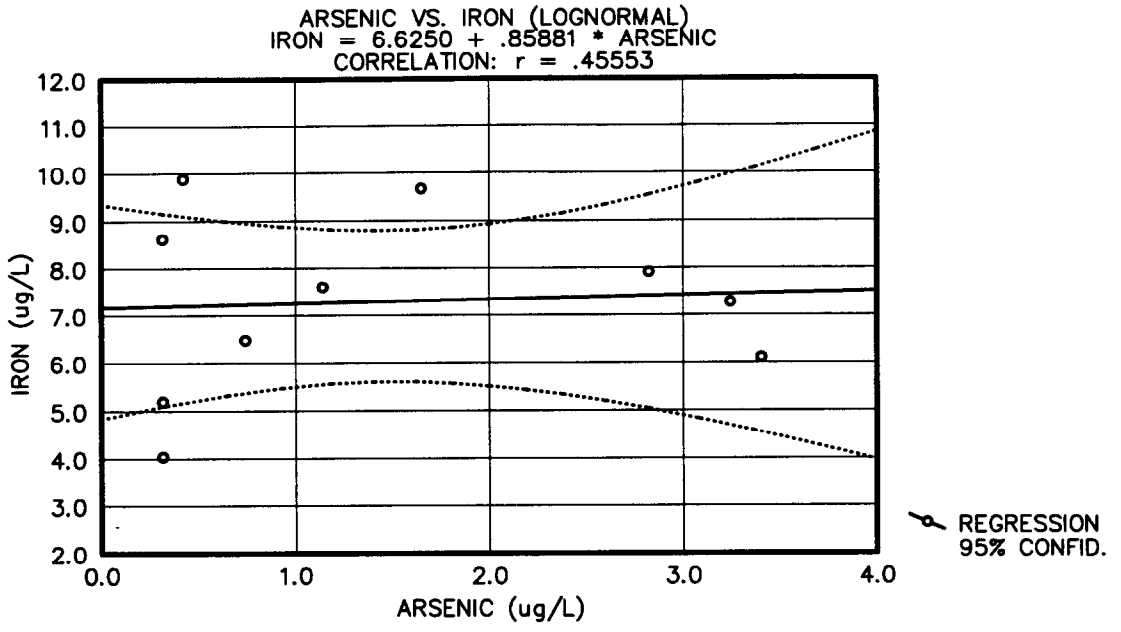

DRAWN BY MF DATE 8/1/01	Tetra Tech NUS, Inc.	CONTRACT NO. 7856	OWNER NO. 0312
CHECKED BY DATE	CORRELATION OF ARSENIC TO BARIUM AND ARSENIC TO IRON IN GROUNDWATER NSB – NEW LONDON GROTON, CONNECTICUT	APPROVED BY David Cerone DATE 8-7-01	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE NONE		DRAWING NO. FIGURE 5-3	REV. 0

FORM CADD NO. TtNUS_AV.DWG – REV 0 – 1/22/98

6.0 SITE 3 – AREA A DOWNSTREAM WATERCOURSES/OBDA AND SITE 14 - OBDANE

6.1 SITE DESCRIPTION

For the BGOURI, the Area Downstream Watercourses/OBDA (Site 3) and OBDANE (Site 14) are evaluated collectively. This approach was taken because the OBDANE falls within the general site boundary of the Area A Downstream Watercourses/OBDA site and any impacts from the OBDANE will be detected in the groundwater beneath Site 3. Descriptions of each of the sites are provided below.

6.1.1 Area A Downstream Watercourses/OBDA

The Area A Downstream Watercourses receive surface water and groundwater recharge from the Area A Landfill, Area A Wetland, Torpedo Shops, OBDANE, and surrounding areas and convey them to the Thames River. The Area A Downstream Watercourses include North Lake and several small ponds (Upper Pond, Lower Pond, and OBDA Pond) and interconnected streams (Streams 1 through 6). The general configuration of the Area A Downstream Watercourses and adjacent areas is shown on Figure 6-1. The locations of these sites within NSB-NLON are shown on Figure 1-2.

The primary water discharge point from the Area A Wetland to the Area A Downstream Watercourses is through four 24-inch diameter metal culvert pipes located within the dike that separates the Area A Wetland from the Area A Downstream Watercourses. The discharge from these culverts forms a small stream (Stream 4) that flows westward for approximately 200 feet into Upper Pond. Upper Pond discharges to Stream 3, which flows northward and then westward toward Triton Avenue (past the OBDANE site) to the entrance of the Torpedo Shops. At this location, it meets the drainage channel from the Torpedo Shops and forms Stream 5. Stream 5 flows westward along Triton Avenue through the Small Arms Range and under Shark Boulevard and eventually discharges to the Thames River at the DRMO outfall. Upper Pond also has a discharge structure on the south side. A second pond (Lower Pond), northwest of Upper Pond, is a natural depression and is recharged by groundwater inflow. The outlet of the pond forms Stream 2, which enters a storm sewer and flows to the west around North Lake.

Groundwater discharges from the Area A Landfill to a small pond (the OBDA Pond) located at the base of the dike and the OBDA. Stream 1 flows from this pond westward toward North Lake, a recreational swimming area for Navy personnel. Under normal flow conditions, the stream enters a culvert that by-passes North Lake and discharges to a stream (Stream 6) below the outfall of the lake. Stream 6, which is formed by Stream 1, Stream 2, and the outflow of North Lake, flows westward under Shark Boulevard and through the golf course to the Thames River. North Lake is filled with potable water every

year and drained at the end of the season. Surface water levels in North Lake do not appear to coincide with groundwater levels in adjacent monitoring wells, indicating little hydraulic connection between surface water of North Lake and the shallow groundwater.

Most of the area is within designated Explosive Safety Quantity Distance (ESQD) arcs of the Area A Weapons Center; therefore, further development is not planned for this area. Navy regulations prohibit construction of inhabited buildings or structures within these arcs and, while existing buildings operate under a waiver of these regulations, no further construction is planned.

A Proposed Plan and ROD were completed for this site; the ROD was signed in late 1997. A Remedial Design was completed for the soil and sediment at Site 3 in 1999. The Remedial Action for Site 3 soil and sediment was completed in 1999 and 2000. During the Remedial Action, contaminated soil and sediment was dredged and hauled off site for disposal, and wetlands and waterways in the area were restored.

A previously unknown source of petroleum contamination was detected during the Remedial Action at Site 3. The source was found during the remediation of Stream 5 and is located on the north side of the stream just east of the Small Arms Range. Petroleum product was discovered emanating from the north side of the excavation. Upon further investigation, a small disposal area (i.e., drums, cable, etc.) was discovered upgradient of the location where petroleum was discovered. No additional investigation or remedial actions have been taken at this new source area.

The OBDA is located on the slope of the dike below and adjacent to the Area A Landfill. It is located on the southwestern end of the dike where the angle of the slope approaches 45 degrees. A small wetland exists at the base of the dike. The OBDA area was used as a disposal site after the earthen dike was constructed in 1957. The IAS report (NEESA, 1983) indicated that the material had been there for many years. The IAS report also indicated that the materials were not covered and included 30 partially covered 200-gallon metal fuel tanks and scrap lumber. Atlantic personnel inspected the OBDA on September 30, 1988 and observed approximately 30 empty, unlabeled 200-gallon tanks, old creosote telephone poles, several empty unlabeled 55-gallon drums, and rolls of wire. Orange sediments were observed in the water discharging from the base of the dike embankment. All the debris from the OBDA area was removed and disposed off site as part of a time-critical removal action in 1997.

6.1.2 OBDANE

The OBDANE site is located in a heavily wooded area on the edge of a ravine northwest of the Area A Landfill, west of the Area A Weapons Center, and south of the Torpedo Shops. At one time, miscellaneous wastes were apparently dumped over the bedrock edge. The site is circular and

approximately 80 feet in diameter. A dirt road provides limited access to the wooded site. Figure 6-1 shows the general site arrangement. A nearly vertical 20-foot-high bedrock face is located at the eastern edge of the site. The rest of the site slopes to the southwest.

The IAS report stated that the vegetation at the site indicated that no dumping had occurred within 10 years prior to the 1982 investigation. Atlantic personnel inspected the site on September 30, 1988, and verified the IAS report of the presence of several empty fiber drums. No visual staining or stressed vegetation were observed at this time. No development of this area is currently planned.

An Action Memorandum for a non-time critical removal action was prepared for Site 14 by the Navy in 1999. A Work Plan for the removal action has been prepared and the removal action will be conducted in 2001.

6.2 SITE INVESTIGATIONS

The details of all investigations, including historical and current, conducted at the Area A Downstream Watercourses/OBDA and OBDANE are provided in the following subsections.

6.2.1 Area A Downstream Watercourses/OBDA

6.2.1.1 Initial Assessment Study (Envirodyne, 1983)

In 1982, Envirodyne Engineers performed an IAS at NSB-NLON as part of the NACIP program. The purpose of this study was to identify and evaluate past waste disposal practices and to assess the potential for environmental impacts. Envirodyne reviewed installation records, interviewed long-term and former employees, toured the installation, and photographed sites as part of the IAS.

Envirodyne identified 11 sites at NSB-NLON as having contained hazardous material; two of the sites were Area A (Site 2), which included the Area A Landfill, the Area A Wetland, and the Area A Downstream Watercourses/OBDA (Site 3). The IAS concluded that the source of contamination for this site was still present and potentially releasing contaminants to the environment. The IAS recommended that further sampling of surface waters and sediments at this site be performed.

6.2.1.2 Verification Step 1A Study (Wehran, 1988)

In 1988, Wehran Engineering Corporation performed a Final Verification Step 1A Study for the DRMO Area, the OBDA, and the Area A Landfill as part of the NACIP program. The purpose of this study was to verify the presence or absence of contamination at these historically documented landfill areas. As part of the Verification Step 1A Study, Wehran performed three rounds of surface water and sediment

sampling at six locations (SW-1 through SW-6) adjacent to the Area A Landfill site, including the OBDA. These samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and metals.

The study concluded that the surface waters and sediments near the Area A Landfill Site have levels of metals, PAHs, and pesticides that exceed regulatory criteria; however, the immediate health threat to base personnel from these contaminants appears minimal. The Verification Step 1A Study recommended that a Site Characterization Step 1B Study be performed at the Area A Site.

6.2.1.3 Phase I Remedial Investigation (Atlantic, 1992)

An investigation of 11 sites was completed at NSB-NLON by Atlantic Environmental Services from 1990 through 1992. Two sites, Area A (Site 2) which includes the present Area A Landfill, the Area A Wetland, and the Area A Downstream Watercourses/OBDA (Site 3) were identified.

One surface and four subsurface soil samples were collected from five monitoring well borings completed during the Phase I RI. With the exception of the surface soil sample collected from well 3MW12S, which was located adjacent to the wetland at the OBDA, the soil sampling was conducted at locations in undeveloped wooded areas where no past disposal had been reported. All five soil samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals (total), and TCLP metals. In addition, TCLP pesticides analysis was conducted on the surface soil sample collected from well 3MW12S.

Twenty-two sediment samples (plus three field duplicates) were collected for analysis from the wetland near the OBDA and the Area A Downstream Watercourses and associated ponds. The samples were collected from 18 sample locations and included five sample locations at the OBDA. Two sediment samples were collected at each OBDA sampling location (0 to 6 inches and 12 to 18 inches). All sediment samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals (total), and TCLP metals and pesticides.

Three shallow (overburden) and five deep (bedrock) monitoring wells were installed and sampled in this area, accounting for eight groundwater samples (plus one field duplicate). Additionally, 12 surface water samples (plus two field duplicates) were collected from this area. All groundwater and surface water samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals (total). In addition, gross alpha and gross beta radiological analyses were performed for three surface water samples and all groundwater samples except for the field duplicate sample. A wildlife survey was also performed in this area during the Phase I RI.

The Phase I RI concluded that several risk exposure scenarios exceeded acceptable regulatory levels and that a FS should be performed at the Area A Downstream Watercourses and OBDA Site.

6.2.1.4 Focused Feasibility Study (Atlantic, 1994b)

A draft FFS covering surface soil and sediments at Site 3 was completed by Atlantic Environmental Services in 1994. During this investigation, eight surface soil samples (plus one field duplicate) were collected and analyzed for TCL pesticides/PCBs. Six of the eight surface soil samples were also analyzed for grain size distribution, moisture content, and TOC. Additionally, 12 sediment samples (plus one field duplicate) were collected. Sample locations are shown on Figure 6-1. Ecological sampling was also performed as part of the FFS.

Based on RI and FFS sampling results, VOCs, SVOCs, and PCBs were not found in the sediments at Site 3; however, pesticides were detected in sediment samples. In addition, DDTR was detected in all the soil samples at the site. The FFS concluded that off-site landfilling and on-site thermal desorption provide superior protection of the environment and that the landfilling alternative is more cost effective than the on-site thermal desorption alternative.

6.2.1.5 Phase II Remedial Investigation (B&R Environmental, 1997a)

A Phase II RI at 13 sites at NSB-NLON was conducted by B&R Environmental from 1995 through 1997. Area A Downstream Watercourses and OBDA Site 3 was one of the sites investigated. Thirteen new groundwater wells (seven shallow and six deep) were installed and sampled during the Phase II RI. Eight previously installed monitoring wells were also sampled. Two rounds of groundwater sampling were completed, and 23 samples (including two field duplicates) were collected during each sampling round. All groundwater samples collected during both rounds of sampling were analyzed for TCL VOCs, TCL SVOCs, and TAL metals (total and dissolved). In addition, nine selected samples and one duplicate were analyzed for gross alpha and gross beta radiological parameters. Four sediment samples and 16 surface water samples (including two field duplicate samples) were also collected at this site.

6.2.1.6 Phase II RI Supplemental Ecological Investigation (B&R Environmental, 1997a)

Four additional rounds of surface water and sediment sampling were conducted as part of the Phase II RI, primarily to obtain ecological data for the site. Twenty-one surface water samples (plus from one to three field duplicates) and 21 sediment samples were collected during Rounds 1, 2, and 3. Only 17 surface water samples (plus one field duplicate) and seventeen sediment samples were collected during Round 4 because four sample stations were dry at the time of sampling. Samples collected during Rounds 1, 3, and 4 were analyzed for TSS (surface water samples) and macroinvertebrate taxonomy

(sediment samples) only. Samples collected during Round 2 were analyzed for several additional ecological and chemical parameters.

Off-site reference samples were also collected for surface water and sediment in conjunction with the ecological sampling. These samples were collected from a reference stream and two ponds, similar in nature to the Area A Downstream and OBDA ponds and streams. For example, the reference ponds and stream had similar substrate, morphology, vegetation, current velocity, water temperature, pH, and dissolved oxygen (DO) levels but were located away from known sources of contamination to provide adequate data on background concentrations of constituents. The two ponds were Niantic Pond and Pequot Woods Ponds. The reference stream was Fishtown Brook, which is formed by the discharge from Pequot Woods Pond.

A soil gas survey was also performed in December 1993, as part of the Phase II RI. Forty-five soil gas samples were collected from a 150- by 150-foot grid in the vicinity of monitoring well 2DMW15. Sampling was attempted at two additional locations (D19 and D41) but could not be completed due to repeated auger refusal at location D19 and the presence of water at location D41. All samples were field-screened for PCE, TCE, and toluene.

The Phase II RI concluded that VOCs were present in the groundwater at Site 3, the site poses noncarcinogenic risks to the site worker and older child trespasser, and notable concentrations of pesticides exist in site soil and sediments. The Phase II RI recommended that the feasibility study for this site should be revisited to focus on pesticides in soil and sediment, more sampling is required to delineate pesticide contamination and determine the origin of VOCs in groundwater, and finally, the debris associated with the OBDA should be removed.

6.2.1.7 Focused Feasibility Study for Soil and Sediment (B&R Environmental, 1997f)

A FFS for soil and sediment at Site 3 was completed by B&R Environmental in December, 1997. No additional samples were collected during this investigation, which evaluated four remedial alternatives for the Area A Downstream Watercourses and OBDA: no action; capping, restoration of wetlands and waterways, and institutional controls; dredging, on-site dewatering, off-site disposal of sediment and soil, restoration of wetlands and waterways, and monitoring; and dredging, on-site dewatering, on-site thermal desorption of sediment and soil, on-base reuse of treated soil, off-site disposal of sediment, restoration of wetlands and waterways, and monitoring.

6.2.1.8 Proposed Plan, Record of Decision, and Remedial Action (B&R Environmental, 1997c and 1997g and Foster Wheeler, 2000)

The preferred remedial alternative in the Proposed Plan consisted of dredging, on-site dewatering, off-site disposal of sediment and soil, restoration of wetlands and waterways, and monitoring. The ROD, signed in December 1997, indicated that the Navy would proceed with the preferred remedial alternative.

The site was remediated during the summer of 2000 by the Navy's Remedial Action Contractor, Foster Wheeler, Inc. Streams 1 through 5 and the ponds (OBDA, Upper, and Lower) within Area A Downstream Watercourses/OBDA were addressed during the remedial action. Approximately 18,050 tons of contaminated soil and sediment were excavated and disposed at off-site disposal facilities during the action. The site was then restored.

6.2.1.9 Basewide Groundwater OU RI

During the BGOURI, both soil and groundwater samples were collected from Site 3 to further characterize the site. Three soil samples were collected and analyzed to determine the soil's characteristics for groundwater fate and transport modeling purposes. The samples were analyzed for bulk density, porosity, pH, and TOC, and the results are provided in Appendix B. Soil sample S3SB290911 was collected in order to obtain the data for porosity, pH, TOC, and bulk density. This sample was a replacement for the soil sample not collected from 3MW14S. The methodology used to complete soil sampling was discussed in Section 2.2.

During the first phase of the RI, seven shallow overburden temporary monitoring wells were installed and sampled to determine the extent of VOC contamination. A summary of the sampling and analytical program is presented in Table 6-1. The seven temporary monitoring wells that were sampled are shown on Figure 6-1. A field duplicate was also collected from temporary monitoring well 3TW22. The methodology used to complete groundwater sampling was discussed in Section 2.3. The temporary monitoring wells were properly abandoned after sampling was completed.

One permanent overburden monitoring well (2DMW29S) was also sampled during the first phase of the RI. The sample's ID was S3MW29S03. The results from this well were used for screening purposes and were not subsequently used in the RI for COPC screening or the human health risk assessment. Monitoring well 2DMW11D was destroyed during the OBDA remediation, therefore it was not sampled.

A comparison of the groundwater data collected from this well during the Phase II RI against current groundwater screening criteria shows that there are no exceedances of regulatory criteria. Therefore, there was no reason to replace this well after the remedial activity.

Seventeen existing permanent overburden and bedrock monitoring wells were sampled during the second phase of the RI. One newly installed permanent overburden monitoring well (3MW14S) was also sampled during the second phase of the RI. A summary of the sampling and analytical program for these wells is also presented in Table 6-1. The analytical program for the Site 3 wells included natural-attenuation-specific parameters. The 18 monitoring wells that were sampled are also shown on Figure 6-1. A field duplicate was also collected from monitoring well 2DMW24D. Samples from two of the 18 monitoring wells were filtered in the field and analyzed for dissolved metals. The methodology used to complete groundwater sampling was discussed in Section 2.3.

6.2.2 OBDANE

6.2.2.1 Initial Assessment Study (Envirodyne, 1983)

In 1982, Envirodyne Engineers performed an IAS at NSB-NLON as part of the NACIP program. The purpose of this study was to identify and evaluate past waste disposal practices and to assess the potential for environmental impacts. Envirodyne reviewed installation records, interviewed long-term and former employees, toured the installation, and photographed sites as part of the IAS.

Envirodyne identified 11 sites at NSB-NLON as having contained hazardous material; one site was the Overbank Disposal Area Northeast, or OBDANE (Site 14). The IAS concluded that the source of contamination for this site was still present and potentially releasing contaminants to the environment. The IAS recommended that "No Dumping" signs be posted at the site.

6.2.2.2 Phase I Remedial Investigation (Atlantic, 1992)

An investigation of 11 sites was completed at NSB-NLON by Atlantic Environmental Services from 1990 through 1992. OBDANE Site 14 was one of the sites investigated. The Phase I RI field investigation at this site consisted of surface soil sampling. Four surface soil samples were collected from two locations within the limits of the identified disposal area during the 1990 Phase I RI. A sample was collected from the 0- to 6-inch and 12- to 18-inch interval from each location. A fifth sample (14SS3C) plus a field duplicate were composites of the two surface samples. The Phase I RI concluded that there was negligible risk associated with this site and recommended that a supplemental Step I Investigation be performed for Site 14.

6.2.2.3 Phase II Remedial Investigation (B&R Environmental, 1997a)

A Phase II RI at 13 sites at NSB-NLON was conducted by B&R Environmental from 1995 through 1997. OBDANE Site 14 was one of the sites investigated. A single shallow monitoring well (14MW1S) was

installed in the presumed downgradient direction from the site during the Phase II RI. The well was sampled during Rounds 1 and 2 of the Phase II RI and analyzed for TCL VOCs, TCL SVOCs, and TAL metals (total and dissolved) in each round.

Six additional soil samples were collected from three different borings during the Phase II RI. Samples were collected from depths of 0 to 2 feet and 8 to 10 feet from boring 14TB1 (located within the limits of the disposal area) and from depths of 0 to 2 feet and 2 to 4 feet from boring 14TB2 (located south of the disposal area). Two soil samples were also collected from the boring drilled for the installation of a monitoring well (14MW1) from depth intervals of 0 to 2 feet and 2 to 4 feet. In addition, a single surface soil sample (0 to 6 inches) was collected approximately 75 feet south of the disposal area. All soil samples were analyzed for TCL VOCs, TCL SVOCs, and TAL metals (total). In addition, the two soil samples from 14MW1 were also analyzed for TCLP metals and the soil sample 14SS3 was also analyzed for TCL pesticides/PCBs.

The Phase II RI concluded that all human health risks were found to be within or below USEPA's target range; however, arsenic was found in surface soil samples at concentrations that slightly exceeded state standards, and lead contamination was found in surface soil samples approximately 80 feet south of the site. The RI Report recommended that further characterization of the surface soil with respect to arsenic and lead should be completed.

6.2.2.4 Basewide Groundwater OU RI

During the BGOURI, only one groundwater sample was collected from the existing monitoring well (14MW1S) to further characterize this site. A summary of the analytical program for the single sample is presented in Table 6-1. Monitoring well 14MW1S is shown on Figure 6-1. The groundwater sample collected from monitoring well 14MW1S was not filtered in the field nor was it analyzed for dissolved metals. The methodology used to complete groundwater sampling was discussed in Section 2.3.

6.3 PHYSICAL CHARACTERISTICS

This section presents a summary of site physical characteristics for Sites 3 and 14 based on information generated during the Phase I, Phase II, and BGOU RIs. Topography and surface features, surface water, soils, geology, and hydrogeology are discussed in the subsections that follow.

6.3.1 Topography and Surface Features

Sites 3 and 14 are located within the lower portion of a northwest-trending valley (northern valley) situated between the topographic/bedrock high that occupies the central area of the NSB-NLON and the

topographic/bedrock high that forms the northern border of the NSB-NLON. Figure 6-1 shows the topography and surface features of Sites 3 and 14. The northern valley is relatively narrow in the eastern portion of the site near the earthen dike, then widens downvalley to the west.

The ground surface elevation drops steeply approximately 30 to 40 feet from the Area A Wetland across the dike to the downstream valley floor. The ground surface in the downstream area near the dike is at an approximate elevation of 40 feet msl. From the base of the dike, the ground surface elevation gently drops along the lower stream valley (Site 3) toward the Thames River. A local topographic high that rises to 70 feet msl exists east of North Lake and is believed to reflect a local bedrock high. The OBDA is located in a relatively flat area at the base of the dike. The ground elevation is approximately 40 feet msl at the OBDA. The OBDANE is located near the base of the bedrock high that slopes southwestward from the Area A Weapons Center. The ground elevation at the OBDANE ranges from approximately 80 to 50 feet msl. Downslope of the site, the ground flattens toward the Area A Downstream Watercourses.

There are relatively few buildings (Buildings 281, 468, 223, 282, 454) at Site 3. Most of these buildings are associated with the recreational area at North Lake and the golf course. A large portion of the area is a golf course. Further development is not planned for this area because most of it is within the designated ESQD arcs of the Weapons Center.

6.3.2 Surface Water Features

The Area A Downstream Watercourses receive surface water and groundwater recharge from the Area A Landfill, Area A Wetland, Torpedo Shops, OBDANE, and surrounding areas and convey them to the Thames River. The Area A Downstream Watercourses include North Lake and several small ponds (Upper Pond, Lower Pond, and OBDA Pond) and interconnected streams (Streams 1 through 6).

6.3.3 Soil Characteristics

According to the SCS Soils Map (SCS, 1983), the soil in the eastern portion of Site 3 (between the earthen dike and North Lake) is Charlton-Hollis complex. This complex consists of rocky, fine sandy loam. In the western portion of the site, which is primarily a golf course, the soil is classified as Udorthents-Urban land. Along the bedrock high near wells 2DMW16, 2DMW24, and 2DMW25, the soil is classified as the Hollis-Charlton-Rock complex. This soil is defined as stones and boulders intermingled with a dark, fine, sandy loam. The soils at the OBDA and OBDANE are also defined as the Hollis-Charlton-Rock complex.

6.3.4 Geology and Hydrogeology

The following discussion describes geologic and hydrogeologic conditions at Sites 3 and 14. Additional information regarding the northern region geology and hydrogeology can be found in Section 4.1 of this report, as well as in previous site investigation reports prepared for NSB-NLON.

Geology

The geology of Sites 3 and 14 consists of overburden deposits (primarily of silt, sand, and gravel) overlying metamorphic bedrock. The bedrock within Sites 3 and 14 has been identified as the Mamacoke Formation. The overburden consists of silty sand and gravel and is mapped as stratified drift of former meltwater streams (USGS, 1960). Although these are natural materials, they have most likely been re-worked in the area of the golf course. Figures 4-8, 4-9, and 4-11 show generalized geologic cross sections that include portions of Site 3.

In general, the overburden thickness increases from the valley margins to the center of the valley and from southeast to northwest along the valley axis. The overburden thickness is less than 5 feet at wells 2DMW23S and 2DMW10D and less than 15 feet at wells 2DMW25D and 2DMW27D. The overburden is thicker in the golf course area, and bedrock surface was not encountered in the 50-foot boring at well 2DMW26D.

The bedrock surface slopes from the northern and central bedrock highs that surround the area toward the northwest-trending valley. There appears to be a localized bedrock high at well 2DMW15D. The depth to bedrock is only 4 feet at this location, and the bedrock surface elevation is higher than was encountered in surrounding boreholes. This local bedrock high corresponds to a local topographic high within the valley.

The OBDA is located along the base of the earthen dike, below and adjacent to the Area A Landfill. During the Phase I RI, two monitoring wells were installed (3MW12S and 3MW12D) in this area. The boring logs indicate that the overburden locally consists of sand and boulders. The depth to bedrock was approximately 15 feet.

The overburden at OBDANE consisted of sand with traces of mica. There are bedrock exposures upslope of the site. Bedrock was encountered at depths of 12 feet bgs at OBDANE.

Hydrogeology

Groundwater is present in both the overburden and bedrock underlying Sites 3 and 14. The saturated thickness of the overburden ranges from a few feet, along the valley margins, to greater than 40 feet, in the central portion of the stream valley. Depth to groundwater ranges from a few feet in the eastern portion to over 15 feet in the golf course area to the west. Figures 4-2 and 4-4 show groundwater flow patterns in the shallow overburden across Sites 3 and 14, based on the June and August 2000 rounds of water-level measurements. Figures 4-3 and 4-5 show groundwater flow patterns for the shallow bedrock during the same time periods. In both the overburden and bedrock, groundwater flows from the topographic/bedrock highs and the Area A Wetland to the site. From the downstream area, groundwater flows to the west toward and discharges into the Thames River. At the OBDA, there are upward gradients between the overburden and bedrock at the 2DMW11 and 3MW12 well clusters. Vertical gradients between the overburden and bedrock are mixed across Site 3 but are predominantly upward. A downward gradient was observed at well cluster 2DMW24S/D, and upward head differentials were observed at well clusters 2DMW16S/D, 2DMW25S/D, and 2DMW28S/D (see Tables 2-2 and 2-3).

Along the valley margins and near the Area A Wetlands dike, local groundwater flow gradients are steep. As the bedrock slope becomes milder and the overburden thickens, the hydraulic gradients flatten. The overall hydraulic gradient in the direction of groundwater flow across Site 3 within both the overburden and bedrock is approximately 0.024, based on the June and August 2000 water-level data. In both the overburden and bedrock, the hydraulic gradient slightly steepens toward the Thames River.

Slug tests have been performed in a total of 40 overburden and bedrock wells over the course of the various RI field investigations (see Table 4-1). Slug test results for alluvium and bedrock wells are most applicable to Site 3. For the alluvium, an overall average (geometric mean) hydraulic conductivity of 5.3 ft/day was calculated from the test results. For the bedrock, an overall average bulk hydraulic conductivity of 1.8 ft/day was calculated from the slug test results.

Using a flow gradient of 0.024, a hydraulic conductivity of 5.3 ft/day, and a measured porosity of 0.33, the average groundwater flow velocity through the predominantly sandy alluvial materials across Site 3 was calculated as approximately 0.4 ft/day. This velocity is based on limited data, especially in regard to hydraulic conductivities, and therefore should be regarded as a rough estimate only.

6.4 NATURE AND EXTENT OF CONTAMINATION

The soil and sediment data collected from previous investigations is not discussed since a removal action in 2000 removed all of the assessed material.

6.4.1 Historic Investigations - Site 3

Groundwater sampling was conducted at Site 3 during the Phase I and Phase II RIs and the FFS. Based upon the results of these investigations, the nature and extent of contamination of groundwater at the site are discussed in the following text. Appendix D presents descriptive statistics (frequency of detection, minimum and maximum concentrations, range of detection limits for nondetects, 95% UCL, and sample number and location associated with maximum concentration) and associated COPC screening criteria for each analyte detected at least once in groundwater samples collected from Site 3.

Groundwater samples from both overburden and bedrock wells installed within the Area A Downstream Watercourses and downgradient of the OBDA were collected during previous investigations. Well 2DMW27S was screened at an interval that spans both the overburden and bedrock aquifers. Groundwater samples collected from this well are considered to be representative of the overburden aquifer for purposes of data evaluation.

Overburden Wells

Seven VOCs, including six halogenated aliphatics and benzene, were detected in the groundwater samples collected from the overburden wells at the Area A Downstream Watercourses. Each VOC was detected in from one to three of 25 samples. Most of the positive results were associated with samples collected from well 2DMW29S, located along Triton Road in the north-central portion of the site. Maximum concentrations of total 1,2-dichloroethene (28 µg/L), bromodichloromethane (2 µg/L), chloroform (12 µg/L), methylene chloride (11 µg/L), and vinyl chloride (130 µg/L) were detected in samples from this well. As discussed in the Phase II RI (B&R Environmental, 1997a), none of these chemicals were identified in the surface water samples collected from the adjacent drainageway along Triton Road. The source(s) of this groundwater contamination is not known. However, a potential source could be a recently discovered disposal area along Triton Road.

Two phthalate esters (plasticizers that are common field and laboratory contaminants) and benzoic acid were each detected in from one to three of the groundwater samples collected from overburden wells. Concentrations of bis(2-ethylhexyl)phthalate ranged from 6 µg/L to 59 µg/L. This SVOC was also detected at a concentration of 3 µg/L in one of the groundwater samples collected from the off-site residential wells. Concentrations of the remaining two SVOCs ranged from only 0.6 µg/L to 0.7 µg/L. Neither pesticides nor PCBs were detected in groundwater samples collected from the overburden wells.

Twenty-three metals were detected in unfiltered groundwater samples collected from the overburden wells and 19 metals were detected in the associated filtered groundwater samples. Greater than two-thirds of the maximum concentrations of metals were associated with samples collected from overburden

wells 2DMW30S and 2DMW12S. Notable results for metals include maximum concentrations reported for aluminum (97,400 µg/L), arsenic (23.9 µg/L), barium (835 µg/L), manganese (6,710 µg/L), vanadium (229 µg/L), and zinc (800 µg/L).

Radionuclide analyses (gross alpha and gross beta) were performed for three groundwater samples collected from overburden wells during the Phase I RI. Complete gamma spectrum analysis and analyses for gross alpha and gross beta were performed for four groundwater samples collected from overburden wells during the Phase II RI. Gross alpha concentrations reported for samples collected from the overburden wells ranged from 6 pCi/L to 89 pCi/L, and gross beta concentrations ranged from 5.1 pCi/L to 64 pCi/L. Maximum concentrations of gross alpha and gross beta were associated with the groundwater sample collected from well 3MW12S during Round 2 of the Phase II. Complete gamma spectrum analyses performed during Rounds 1 and 2 of Phase II yielded no positive results for radionuclides.

Analyses for hardness were performed for 19 of the groundwater samples collected from overburden wells. Reported results for this parameter ranged from 43 mg/L to 456 mg/L.

Bedrock Wells

Five halogenated aliphatics (1,1,2,2-tetrachloroethane, total 1,2-dichloroethene, chloroform, methylene chloride, and TCE) were detected in the groundwater samples collected from bedrock wells at the Area A Downstream Watercourses. Each VOC was detected in from one to four of the 25 groundwater samples. Concentrations ranged from 1 µg/L (TCE) to 17 µg/L (also TCE). Maximum concentrations of 1,1,2,2-tetrachloroethane, total 1,2-dichloroethene, and TCE were detected in the groundwater sample collected from well 2DMW16D, located approximately 125 feet southeast of North Lake, during the Phase I RI.

Eleven SVOCs were also detected in groundwater samples from the Area A Downstream Watercourses bedrock wells. Six PAHs, ranging in concentration from 1 µg/L to 4 µg/L, were detected in the groundwater sample collected during Round 1 of the Phase II RI from well 3MW12D. This well is located at the downgradient edge of the OBDA. As discussed in the Phase II RI (B&R Environmental, 1997a), PAHs were also prevalent contaminants in the sediment samples collected from the OBDA wetland. The dredge spoils placed in this area are the most likely source of PAH contamination.

In addition, bis(2-ethylhexyl)phthalate was detected in five groundwater samples at concentrations ranging from 2 µg/L to 20 µg/L. Two additional phthalates, benzoic acid, and phenol were each detected in one or two groundwater samples at concentrations ranging from 0.5 µg/L to 5 µg/L. As previously

noted, phthalates are considered to be common laboratory contaminants. Neither pesticides nor PCBs were detected in any of the groundwater samples.

Twenty-two metals were detected in unfiltered groundwater samples collected from the bedrock wells and 18 metals were detected in the associated filtered groundwater samples. Approximately 42 percent of the maximum concentrations of metals were associated with samples collected from bedrock well 2DMW12D. Notable results for metals include maximum concentrations reported for manganese (7,630 µg/L) and sodium (3,560,000 µg/L).

Radionuclide analyses (gross alpha and gross beta) were performed for three groundwater samples collected from overburden wells during the Phase I RI. Complete gamma spectrum analysis and analyses for gross alpha and gross beta were performed for four groundwater samples collected from overburden wells during the Phase II RI. Positive results for samples collected from the bedrock wells ranged from 3.1 pCi/L to 35 pCi/L, and gross beta concentrations ranged from 5.6 pCi/L to 40 pCi/L. Complete gamma spectrum analyses performed during Rounds 1 and 2 of Phase II yielded no positive results for radionuclides.

Analyses for hardness were performed for 19 of the groundwater samples collected from bedrock wells. Reported results for this parameter ranged from 28 mg/L to 572 mg/L.

6.4.2 Historic Investigations – Site 14

This section presents an evaluation of the nature and extent of contamination in the OBDANE (Site 14). The discussion includes analytical results for soil and groundwater samples collected during the Phase I and Phase II RIs. Appendix D presents descriptive statistics (frequency of detection, minimum and maximum concentrations, range of detection limits for nondetects, 95% UCL, and sample number and location associated with maximum concentration) and associated COPC screening criteria for each analyte detected at least once in groundwater samples collected from Site 14.

Soil

Eleven VOCs were detected in the 10 OBDANE soil samples analyzed for this fraction. However, eight of these VOCs, including six chlorinated hydrocarbons, benzene, and total xylenes, were detected in a single surface soil sample at very low concentrations (i.e., with one result at a concentration of 0.008 mg/kg and the remaining results at concentrations of 0.002 mg/kg or 0.003 mg/kg). This sample, 14SS3, was collected from a depth interval of 0 to 0.5 foot bgs at a location approximately 75 feet south (and cross-gradient) of the actual disposal area. PCE was detected in two surface soil samples at concentrations of 0.002 mg/kg and 0.003 mg/kg. Toluene (0.018 mg/kg) and methylene chloride

(0.007 mg/kg) were each detected in a single soil sample. These results are not considered to be indicative of a major source of VOCs.

Ten PAHs and benzoic acid were detected in from two to five of the eight OBDANE soil samples analyzed for SVOCs. The maximum concentrations of all PAHs were detected in the soil sample collected from a depth interval of 8 to 10 feet bgs from boring 14TB1, located in the northwestern portion of the disposal area; however, these maximum concentrations were relatively low, ranging from 0.04 mg/kg (phenanthrene) to 0.11 mg/kg [benzo(a)pyrene and chrysene]. The sum of all SVOC concentrations reported for this sample was 0.877 mg/kg. The sum of SVOC concentrations reported for the sample collected from a depth interval of 0 to 2 feet from boring 14TB1 was 0.757 mg/kg. No SVOCs were detected in the soil sample collected at a 2- to 4-foot interval from boring 14TB2A. The sums of SVOC concentrations for the remaining OBDANE soil samples ranged from 0.029 mg/kg to 0.43 mg/kg.

Surface soil samples 14SS3 and 14SS3C were also analyzed for pesticides and PCBs. 4,4'-DDT (0.4 mg/kg) and related compounds, 4,4'-DDE (0.074 mg/kg) and 4,4'-DDD (0.011 mg/kg), were detected in sample 14SS3. These results do not appear to indicate that pesticide-contaminated material was disposed at this site but rather that this site may have been affected by past base-wide applications of 4,4'-DDT.

Twenty-three metals were detected in the soil samples, although five of these metals (antimony, boron, mercury, selenium, and silver) were detected in only one or two samples. The maximum concentrations of 10 metals were detected in the samples collected from a depth interval of 0 to 2 feet bgs from well 14MW1S. Four additional maximum concentrations were detected in the sample collected from a depth interval of 2 to 4 feet bgs from this same well. Three metals (arsenic, boron, and lead) were detected in surface sample 14SS3 at concentrations (16.3 mg/kg, 27.6 mg/kg, and 403 mg/kg, respectively) notably greater than the respective concentrations of these metals detected in the other soil samples. All other metals in surface soil sample 14SS3 were reported at concentrations below the maximum detected concentrations for the other samples. Because soil samples collected from the disposal area do not contain these metals at elevated concentrations, a source could not be identified.

TCLP extraction followed by analysis for metals was performed for four of the OBDANE soil samples. Cadmium (0.0079 mg/L), chromium (0.0032 mg/L), and lead (0.306 mg/L) were each detected in one of the TCLP leachates. Barium was detected in two of the TCLP leachates (0.1 mg/L and 0.11 mg/L).

Groundwater

Only one VOC (carbon disulfide) and one SVOC [bis(2-ethylhexyl)phthalate] were detected in the two groundwater samples collected from well 14MW1S. Both chemicals were detected at an estimated

concentration of 1 µg/L. Bis(2-ethylhexyl)phthalate was also detected at a concentration of 3 µg/L in one of the off-site residential wells. Neither of these compounds was detected in any of the soil samples collected at the site. Therefore, as stated in the preceding section, the OBDANE does not appear to be a major source of organic contamination.

Eleven metals were detected in the unfiltered OBDANE groundwater samples, and 12 metals were detected in the associated filtered groundwater samples. With the exception of aluminum (detected at a concentration of 171 µg/L in unfiltered sample 14GW1S only), there were no significant differences between filtered and unfiltered metals results (i.e., filtered and unfiltered results for the remaining metals were at the same order of magnitude). Maximum concentrations of arsenic in filtered samples and of boron and cobalt in unfiltered samples exceeded respective concentrations of these metals detected in the unfiltered groundwater samples collected from the off-site residential wells. Notable results include boron (Cmax = 130 µg/L) and manganese (Cmax = 779 µg/L) in both filtered and unfiltered samples.

Analyses for hardness were also performed for the two OBDANE groundwater samples. Reported results for this parameter were 24 µg/L and 32 µg/L.

6.4.3 Basewide Groundwater OU RI

This section presents a discussion of the current nature and extent of groundwater contamination at Sites 3 and 14, based on groundwater data collected during the BGOURI. A summary of the groundwater samples collected is presented in Table 6-1. Results from the Phase II RI are presented in Table 6-3. The Phase II RI data were not used in the statistical analysis. The data from 2DMW11D would not impact the HHRA or the conclusions in Section 6. Tables 6-2 and 6-3 present a summary of the positive analytical detections at Sites 3 and 14. Table 6-2 presents the positive detections for temporary wells, and Table 6-3 presents the positive detections for permanent wells. As part of the HHRA (Section 6.6) process, a screening process for COPCs was performed. The chemicals retained as COPCs as a result of the screening process are presented in Table 6-4. Tables 6-5 and 6-6 in the HHRA present descriptive statistics and the COPC screening criteria for each analyte detected in at least one groundwater sample at the Area A Landfill. The distribution of COPCs and their concentrations are presented on Figure 6-3.

Overburden Wells

Four VOCs (chloroform, cis-1,2-dichloroethene, TCE, and vinyl chloride) were detected in one or more of the 10 groundwater samples that were collected from the overburden aquifer. Detected concentrations of these VOCs ranged from 1.71 µg/L (cis-1,2-dichloroethene) to 31.3 µg/L (vinyl chloride). VOCs were detected infrequently in overburden groundwater. Chloroform, 1,2-dichloroethene (total), and vinyl chloride were also detected in overburden groundwater samples collected during previous investigations.

Concentrations of these chemicals were lower in samples collected during the current investigation than they were in samples collected during the previous investigations.

Acetone was detected at concentrations of 27.8 J µg/L and 28.9 J µg/L in two samples collected from temporary wells installed in the overburden aquifer. Cis-1,2-dichloroethene (1.71 µg/L) and vinyl chloride (4.65 µg/L) were detected in one groundwater sample collected from a temporary well.

A detailed discussion of potential sources of VOCs in groundwater is provided in Section 6.5.2 (Natural Attenuation Evaluation).

Several PAHs and 4-methylphenol were the only SVOCs detected in groundwater at Site 3. Concentrations of most of these SVOCs were low, ranging from 0.03 J µg/L (benzo(k)fluoranthene) to 2 J µg/L (4-methylphenol). With the exception of fluoranthene, which was detected in 3 groundwater samples, each of the SVOCs detected was only found in one groundwater sample. PAHs and 4-methylphenol were not detected in overburden groundwater samples collected during previous investigations.

Trace levels of 4,4'-DDD (0.019 J µg/L) and 4,4'-DDT (0.034 J µg/L) were the only pesticides detected in groundwater from the overburden aquifer at Site 3. These compounds were only detected in the sample collected from monitoring well 2DMW30S. High levels of total suspended solids were measured in this well and are the likely cause of the detections of DDD and DDT. Pesticides were not detected in overburden groundwater samples collected during previous investigations.

Fifteen metals were detected in unfiltered overburden groundwater samples and nine metals were detected in filtered overburden groundwater samples. Reported concentrations of metals in filtered and unfiltered samples were relatively similar (i.e., at the same order of magnitude). In general, the detected concentrations of metals were low. Arsenic at a concentration of 6.1 µg/L at well 2DMW29S was the only metal that exceeded the HHRA screening criteria. Concentrations of all metals were lower in groundwater samples collected during this investigation than they were in samples collected during previous investigations.

Bedrock Wells

Three VOCs (chloroform, cis-1,2-dichloroethene, and TCE) were detected in nine groundwater samples collected from the bedrock aquifer. Concentrations of these VOCs were low, ranging from 1.88 µg/L (TCE) to 8.76 J µg/L (TCE), and were detected infrequently in bedrock groundwater during the current investigation. Chloroform, 1,2-dichloroethene (total), and TCE were also detected in bedrock groundwater samples collected during previous investigations. Concentrations of 1,2-dichloroethenes

and TCE were lower in samples collected during the current investigation than they were in samples collected during the previous investigations.

No SVOCs, pesticides, or PCBs were detected in groundwater samples collected from the bedrock aquifer.

Fourteen metals were detected in unfiltered bedrock groundwater samples and eight metals were detected in filtered bedrock groundwater samples. Reported concentrations of metals in filtered and unfiltered samples were relatively similar (i.e., at the same order of magnitude). In general, the detected concentrations of metals were low. Arsenic at 6.1 µg/L in well 2DMW29S and thallium at 4.4 J µg/L at well 2DMW10D were the only metals that exceeded the HHRA screening criteria. Concentrations of all metals were lower in groundwater samples collected during this investigation, than they were in samples collected during previous investigations, with the exception of silver and zinc.

6.5 CONTAMINANT FATE AND TRANSPORT

6.5.1 Chemical-Specific Evaluation

Four classes of chemicals were detected in groundwater during the BGOURI: halogenated aliphatics, PAHs, pesticides, and metals. Halogenated aliphatics, PAHs, and metals were also detected in groundwater during the Phase II RI. These classes were also detected in soil samples collected during the Phase II RI. No soil samples were collected for analysis during the BGOURI.

Halogenated Aliphatics

TCE and vinyl chloride were the most notable halogenated aliphatics in groundwater during both the Phase II RI and BGOURI. TCE was only detected in deep wells during the Phase II RI but was detected in both shallow and deep wells during the BGOURI. The maximum detected concentrations of TCE were higher in the BGOURI (max = 8.76 µg/L) than they were in the Phase II RI (max = 3 µg/L). Vinyl chloride has only been detected in shallow groundwater during both investigations and only in one permanent well (2DMW29S). The detected concentration of vinyl chloride was lower in the BGOURI (31.3 µg/L) than it was in the Phase II RI (130 µg/L). TCE and vinyl chloride were not detected in soil samples collected during the Phase II RI so a source area could not be identified. Halogenated aliphatic hydrocarbons such as TCE are relatively water soluble and have a low capacity for retention by soil organic carbon and, therefore, TCE is frequently detected in groundwater. TCE may migrate through the soil column after being released by a spill event or by a subsurface release, either as a product/waste or, if bound to soil particles or otherwise immobilized, when solubilized by infiltrating precipitation. Some portion of TCE may be retained by the soil, but most of the chemical will continue migrating downward until it reaches the

water table. At that time, migration is primarily with the hydraulic gradient, unless it is present as a separate phase, in which case it will tend to sink [TCE can be a dense non-aqueous-phase liquid (DNAPL) chemical].

TCE is susceptible to anaerobic degradation and one of its degradation products is vinyl chloride. The presence of vinyl chloride in Site 3 groundwater is likely the result of the degradation of TCE.

Polynuclear Aromatic Hydrocarbons (PAHs)

PAHs were detected sporadically in deep groundwater during the Phase II RI and in shallow groundwater during the BGOURI. PAHs were only detected in surface soil in the Phase II RI. PAHs are generally considered to be fairly immobile in the environment. As noted in Section 3.3, PAHs have very low solubilities, vapor pressures, and Henry's Law constants and high organic carbon partition coefficient (K_{oc}s) and octanol-water partition coefficient (K_{ow}s). The low-molecular weight PAHs (e.g., acenaphthene, anthracene, fluorene, phenanthrene) are more mobile (higher solubilities, etc.) than the high-molecular-weight PAHs [e.g., benzo(a)pyrene, benz(a)anthracene, chrysene, etc.]. PAHs in soil are much more likely to bind to soil and be transported via mass transport mechanisms than go into solution. PAHs can be degraded via aerobic bacteria but may be relatively persistent in the absence of microbial population or macronutrients such as phosphorous and nitrogen.

Pesticides

Trace levels of DDT and its metabolite DDD were detected in one shallow groundwater well (2DMW30S) at Site 3 during the BGOURI. High levels of total suspended solids were measured in this well and are the likely cause of the detections of DDD and DDT. Pesticides were not detected in shallow or deep groundwater during the Phase II RI. Whether pesticides are sprayed, dusted, or applied directly to the soil, the soil is the ultimate sink for these chemicals. Surface soil runoff may carry pesticides to adjacent surface water bodies. Bioconcentration of pesticides in the food chain is another important fate mechanism. Hydrolysis, oxidation, and photolysis are not generally important fate mechanisms for pesticides in soil or water. Hydrolysis half-lives for several pesticides are reported in periods of months to years.

DDT and its metabolites (DDD and DDE) are considered to be persistent chemicals. They undergo extensive adsorption to soil and are not highly soluble. Biodegradation may occur under both aerobic and anaerobic conditions in the presence of certain soil microorganisms. Under aerobic conditions, DDT may be transformed to DDE, and under anaerobic conditions, DDD may result. DDD, DDE, and DDT are, however, somewhat volatile, with a reported half-life of 100 days for DDT. They are highly lipophilic and therefore readily bioaccumulate.

Metals

Twenty-four metals were detected in shallow and deep groundwater samples during the Phase II RI investigation and 18 metals were detected in shallow and deep groundwater samples during the BGOURI. Antimony, beryllium, boron, mercury, selenium, and vanadium were detected during the Phase II RI but not during the BGOURI. Overall, the concentrations of metals were higher in the samples collected during the Phase II RI than those in the BGOURI. The concentrations of most of the detected metals in samples collected during the BGOURI were within naturally occurring background levels. No background samples were collected during the Phase II RI.

As noted in Section 3.3, metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. The major fate mechanisms for metals are adsorption to the soil matrix (as compared to being part of the soil structure) and bioaccumulation.

In addition, under normal conditions, metals are not very mobile in the environment. Because metals frequently remain bound to particulate matter, the major transport mechanism for metals is bulk movement processes (erosion). However, metals can become mobile in the environment under certain conditions. The mobility of metals is influenced primarily by their physical or chemical properties in conjunction with the physical and chemical properties of the soil matrix. Factors that assist in predicting the mobility of metals are the soil/pore water pH, REDOX potential, and cation exchange capacity. The mobility of metals generally increases with decreasing soil pH and cation exchange capacity. The effect of REDOX potential varies for each metal.

Groundwater samples S32MW10D01 and S32DMW16S01 were analyzed for total metals and dissolved metals. A comparison of the total and dissolved concentrations indicates that there was little difference between the total and dissolved concentrations for calcium, magnesium, manganese, potassium, and sodium, which indicates that these metals are more likely to be in the dissolved phase rather than bound to particulate matter. Metals in the dissolved phase would be more likely to migrate with groundwater than those bound to particulate matter.

6.5.2 Natural Attenuation Evaluation

This section contains the site-specific natural attenuation evaluation for Site 3. The procedure used to conduct the evaluation is summarized in Section 3.3.4. This evaluation is preliminary, and it is understood that additional data collection activities and data evaluation would be necessary prior to selecting monitored natural attenuation as a remedial alternative.

As stated in Section 3.3.4, the goals of the assessment are as follows:

- To determine if natural attenuation of petroleum and chlorinated hydrocarbons is currently occurring in the groundwater.
- To determine the process by which natural attenuation is occurring in the groundwater.
- To determine if natural attenuation and/or bioremediation are viable processes for remediation of petroleum and chlorinated hydrocarbons in the groundwater.

The three lines of evidence that can be used to estimate natural attenuation of petroleum and chlorinated hydrocarbons are as follows:

- Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points.
- Hydrogeological and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the site and the rate at which such processes will reduce contaminant concentrations to required levels.
- Data from field or microcosm studies that directly demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern.

The first and second lines of evidence are used to assess natural attenuation in this RI. The following natural attenuation evaluation is segregated into three subsections (hydrogeology, chemicals of concern, and geochemical). These three subsections provide the necessary information to prove or disprove that natural attenuation is occurring via the two lines of evidence discussed above. The results of the assessment are summarized in a conclusions section.

6.5.2.1 Evaluation

Hydrogeology

Hydrogeologic data are important in natural attenuation assessments to show groundwater flow directions and possible contaminant migration pathways from source areas to downgradient receptors. The data can also be incorporated into a groundwater contaminant fate and transport model to predict the effects of

natural attenuation in the future. For this assessment, the data will only be used to show groundwater flow directions and possible contaminant migration pathways.

Two rounds of water-level measurements were taken at select monitoring wells in the Northern Region during this RI. Measurements were taken in overburden and bedrock monitoring wells. The measurements were used to create potentiometric surface maps for the overburden and bedrock aquifers. Figures 4-2 and 4-4 depict the June 2000 and August 2000 overburden potentiometric surface maps, respectively. Figures 4-3 and 4-5 depict the June 2000 and August 2000 bedrock potentiometric surface maps, respectively.

From the figures, it is evident that the overall groundwater flow direction is from east to west toward the Thames River. The overburden and bedrock maps show that groundwater flows from the upland hills to the south and north toward the valley and then toward the Thames River. The effect of the Area A Wetland is also evident on the potentiometric surface maps. Another observation that can be made from the figures is that water levels were generally higher in June 2000 than in August 2000.

Water levels were measured in several overburden/bedrock well clusters during both the June and August measurement events. There is a downward flow gradient in monitoring well clusters 7MW2S/D, 7MW5S/D, and 2DMW24S/D, which are located along the fringe of the valley near the toe of the upland hills. An upward flow gradient was detected in well cluster 2DMW28S/D during both sampling events. This cluster is located in the middle of the valley at the downgradient end.

Potential source areas located upgradient of Area A Downstream include the Torpedo Shops, Area A Weapons Center, OBDANE, OBDA, Area A Wetland, and Area A Landfill. These sites are all shown on the potentiometric surface maps. A recent memorandum regarding the use, storage, and disposal of hazardous materials and waste at Naval Submarine Base-New London Weapons Complex is included in Appendix F.

In addition to these source areas, two other potential sources are located north of Triton Road at its eastern end. The one potential source area is the Small Arms Range. A remedial action for lead was previously conducted at this site. The other source area was discovered during the remediation of Stream 5. It is located on the northern side of Stream 5, just east of the Small Arms Range. Petroleum product was discovered emanating from the northern side of an excavation during the remediation of Stream 5. Upon further investigation, a small waste disposal area (i.e., drums, cable, etc.) was discovered upgradient of the location where petroleum was discovered. No additional investigative or remedial actions have been taken at this new source area.

Chemicals of Concern

Analytical data for groundwater samples are summarized in Tables 6-5 and 6-6. Groundwater COPCs for the Area A Downstream are depicted on Figure 6-2. From the table and figures, it can be seen that chlorinated solvents and petroleum hydrocarbons were detected in groundwater and both are susceptible to biodegradation.

It appears from the analytical results that the original chlorinated solvent released in Area A Downstream is TCE. This compound was detected in 9 of 25 samples at concentrations ranging from 1.9 to 8.8 µg/L. Historically, it was detected less frequently but at similar concentrations (see Appendix D). During this RI, TCE was detected sporadically throughout Area A Downstream and no significant source area or plume is evident. It was detected in monitoring wells along the northern (i.e., 2DMW10D, 2DMW29S, and 2DMW23D) and southern (i.e., 2DMW16S and 2DMW16D) sides of the site and in the central portion (i.e., 2DMW28D and 3MW14S) of the site. Based on groundwater flow directions and the sporadic nature of the low-concentration detections, it is likely that several minor sources of the product are located within or upgradient of Area A Downstream. TCE has been detected at low concentrations in groundwater samples from upgradient source areas such as Area A Landfill, Area A Weapons Center, and Torpedo Shops. The new source area discovered during the remediation of Stream 5 is located in close proximity and upgradient of 2DMW29S.

Degradation compounds of TCE that were detected in Area A Downstream groundwater samples include cis-1,2-DCE, vinyl chloride, ethene, and ethane. Cis-1,2-DCE was detected in monitoring wells 2DMW16D and 2DMW29S. Vinyl chloride was detected in monitoring well 2DMW29S and temporary well 3TW1, which is located downgradient of 2DMW29S. Ethene and ethane were only detected in monitoring well 2DMW29S. The detection of daughter products, especially ethene and ethane, indicates that complete biodegradation of TCE is occurring in the groundwater in the vicinity of 2DMW29S. However, the detection of TCE in the downgradient monitoring well 3MW14S indicates that some TCE may be escaping the anaerobic zone where reductive dechlorination occurs. The detection of a daughter product in 2DMW16D also indicates that biodegradation is occurring to some extent in the vicinity of this well.

Chloroform was also detected in Area A Downstream groundwater samples. It was detected in 4 of 25 samples at concentrations ranging from 2.1 to 5.7 µg/L. This compound is a chlorinated methane and can biodegrade in the environment. Chloroform is formed as a daughter product during the biodegradation of carbon tetrachloride. However, chloroform is also formed during the process of chlorinating drinking water. Chloroform was detected in three wells (2DMW25S, 2DMW25D, and 2DMW26S) located downgradient of North Lake. Potable water is used to fill North Lake during the summer swim season and it is likely that the potable water is the source of the chloroform detected in the Area A Downstream groundwater.

SVOC found in fuel oils were detected Area A Downstream samples. The compounds were detected most frequently in monitoring well 2DMW30S, and a few were detected in monitoring wells 2DMW16S and 2DMW24S. The new source area discovered during the remediation of Stream 5 is located in close proximity and upgradient of 2DMW30S. Petroleum products were detected during the remediation near this source area. Monitoring wells 2DMW16S and 2DMW24S are located in close proximity to each other, and it is probable that they were impacted by the same unknown source.

Geochemical

The analytical results for the geochemical parameters collected for this natural attenuation assessment are summarized in Table 4-3. The sample numbers for Area A Downstream begin with "S3." Tag maps of the significant geochemical parameters were also prepared and are presented on Figures 4-18 through 4-30.

Dissolved oxygen concentrations ranged from nondetect to 8.0 mg/L. Dissolved oxygen concentrations indicative of anaerobic conditions were detected in overburden monitoring wells 2DMW11S, 2DMW16S, 2DMW24S, and 2DMW26D and bedrock monitoring wells 2DMW15D, 2DMW16D, 2DMW24D, and 2DMW25D. The dissolved oxygen concentrations detected in monitoring wells 2DMW30S (overburden) and 3MW12D (bedrock) were slightly above the criteria for anaerobic conditions (i.e., 0.5 mg/L). In general, these data indicate that anaerobic conditions are present in Site 3 overburden and bedrock groundwater from the Area A Wetlands dike to below North Lake. It is likely that biological activity and the anaerobic, reducing conditions present in the Area A Wetland are the reasons for the anaerobic conditions in the Area A Downstream groundwater. Conditions in overburden and bedrock groundwater west of North Lake are generally aerobic and indicate that the impacts of the Area A Wetlands on Site 3 groundwater have dissipated at this point. Low dissolved oxygen concentrations also correspond well with the detection of organic contaminants in 2DMW16S, 2DMW16D, 2DMW24S, 2DMW25D, 2DMW26D, and 2DMW30S. The aerobic conditions detected in 2DMW29S and the detection of daughter products in this well suggest that an anaerobic, reducing zone is located upgradient of this well.

REDOX potentials measured in Site 3 groundwater ranged from –226 mV to 209 mV. REDOX potentials indicative of anaerobic, reductive conditions were measured in groundwater at overburden monitoring wells 2DMW16S, 2DMW24S, 2DMW26D, 3TW01, and 2DMW30S and bedrock monitoring wells 2DMW10D, 2DMW15D, 2DMW16D, 2DMW24D, 2DMW25D, and 2DMW28D. In general, this list of wells correlates well with the list of wells with low dissolved oxygen concentrations and confirms that reductive conditions exist at these wells. The causes of the reductive conditions are probably the Area A Wetland and biological activity related to the low levels of organic contamination detected at these wells.

Nitrate concentrations in Area A Downstream groundwater samples ranged from nondetect to 0.55 mg/L. Nitrate was not detected in 2DMW16D, 2DMW24S, and 2DMW28D. Nitrite concentrations in these same samples ranged from nondetect to 0.016 mg/L. Nitrite was detected in overburden monitoring wells 2DMW11S, 2DMW16S, 2DMW28S, 2DMW30S, and 3MW14S and bedrock monitoring wells 2DMW24D, 2DMW25D, and 2DMW27D. Ammonia concentrations ranged from nondetect to 1.04 mg/L. Ammonia was detected in all wells except 2DMW26S and 3MW14S. Based on the low concentrations of nitrate and the positive detections of nitrite and ammonia, it appears that denitrification is occurring within Area A Downstream groundwater. The detections of nitrite indicate that denitrification is occurring in groundwater along the southern side of the site from 2DMW11S to 2DMW28S and in the northeastern corner of the site in the vicinity of 2DMW30S and 3MW14S.

Divalent iron [Iron (II)] was detected in a majority (i.e., 13 of 18) of the monitoring wells in Area A Downstream. The concentrations ranged from 0.2 mg/L to 6.0 mg/L. The highest concentrations of divalent iron detected in overburden groundwater were found in monitoring wells 2DMW24S, 2DMW26D, and 2DMW29S. Divalent iron was detected in all bedrock monitoring wells except 2DMW23D. This well is located north and upgradient of Area A Downstream. The pervasive detections of divalent iron in Area A Downstream groundwater indicate that both the reducing conditions in the upgradient Area A Wetland and biological activity related to the low levels of organic contamination in Area A Downstream are probably the causes of iron reduction.

Soluble manganese [Mn (II)] was detected in all but three groundwater samples collected from Area A Downstream monitoring wells, indicating that manganese reduction is occurring within or upgradient of the site. Soluble manganese was detected at concentrations ranging from 0.3 mg/L to >47.5 mg/L. The detections and nondetects of soluble manganese correlate fairly well with the divalent iron data. The same reducing conditions that caused the pervasive divalent iron detections are also probably the cause of the pervasive soluble manganese detections.

Analytical data do not suggest that sulfate reduction is a significant biodegradation process that is occurring within Area A Downstream groundwater. Sulfate concentrations ranged from 6.25 mg/L to 70.3 mg/L. Neither sulfide nor hydrogen sulfide were positively detected in any groundwater sample from Area A Downstream.

Significant concentrations of methane were detected in samples from monitoring wells 2DMW24S, 2DMW26D, and 2DMW29S. Concentrations in these wells ranged from 170 µg/L to 400 µg/L, and concentrations in the remaining wells ranged from nondetect to 98 µg/L. These data suggest that methanogenesis is occurring in the groundwater in the vicinity of these wells. Other chemical and geochemical data also indicate biological activity is occurring in these areas. Carbon dioxide

measurements were generally uniform in all Area A Downstream wells, with most concentrations between 20 mg/L and 60 mg/L. Low carbon dioxide concentrations did not correlate with high methane concentrations as is expected during methanogenesis. This indicates that there is an ample supply of carbon dioxide to fuel methanogenesis.

Ethane and ethene, which are end products of dechlorination of chlorinated solvents, were detected in the groundwater sample from 2DMW29S. The detection of these compounds, as well as the detection of other daughter products within the degradation chain of TCE (i.e., cis-1,2-dichloroethene and vinyl chloride) in this same well, indicates that complete biodegradation of TCE is occurring in the vicinity of this well.

Chloride concentrations ranged from 6.17 mg/L to 495 mg/L. The highest concentrations of chloride were detected in 2DMW16D and 2DMW28S. The elevated concentration of chloride in 2DMW16D correlates well with other chemical (i.e., detections of TCE and cis-1,2-dichloroethene) and geochemical data (i.e., anaerobic conditions and high concentrations of divalent iron and soluble manganese) and indicates that reductive dechlorination is occurring in the vicinity of this well. The elevated concentration of chloride in 2DMW28S does not correlate well with other chemical or geochemical data and therefore this information is inconclusive.

The pH of the Area A Downstream groundwater is slightly acidic to near neutral, with values ranging from 5.35 to 7.88. This range is similar to values measured in upgradient wells in the Area A Weapons Center, Area A Landfill, Area A Wetlands, and Torpedo Shops and are within the optimal range for bioactivity. The pH of overburden groundwater was generally more acidic than the pH in bedrock groundwater. Alkalinity and pH values correlate well throughout the Area A Downstream, with the exception of the values measured in monitoring well 2DMW27D. The only well that shows a correlation between biological activity and higher values of pH and alkalinity is monitoring well 2DMW16D.

All TOC concentrations in the groundwater at Area A Downstream were less than 5.0 mg/L, with the exception of the TOC concentration in 2DMW29S (i.e., 18 mg/L). The high concentration of TOC in 2DMW29S, which indicates that a source of anthropogenic carbon is present in the groundwater, along with the detection of daughter products in this well, indicates that conditions are favorable for reductive dechlorination in the vicinity of this well.

6.5.2.2 Conclusions

Hydrogeologic and groundwater analytical data from this RI suggest that there are multiple minor sources of petroleum and chlorinated hydrocarbons impacting the Area A Downstream groundwater. The potential source areas are as follows:

- The new disposal area discovered during the remediation of Stream 5.
- An unknown source located upgradient of monitoring well cluster 2DMW16S and 2DMW16D.
- A historic source located upgradient of 2DMW26S, most likely the leach fields located within the Torpedo Shops site.
- Separate minor sources in the vicinity or upgradient of monitoring wells 2DMW10D and 2DMW23D.

Chemical and geochemical data indicate that biodegradation processes are occurring in the Area A Downstream, most notably in the vicinity of 2DMW29S. The geochemical data indicate that the biodegradation processes that are occurring in the Area A Downstream groundwater include denitrification, iron reduction, manganese reduction, and methanogenesis. The pervasive detections of divalent iron and soluble manganese in Area A Downstream groundwater indicate that both the reducing conditions in the upgradient Area A Wetland and biological activity related to the low levels of organic contamination in Area A Downstream are probably the causes of iron and manganese reduction.

Overall the hydrogeologic, chemistry, and geochemical data indicate that multiple minor sources of petroleum and chlorinated hydrocarbons are impacting the Area A Downstream groundwater and biodegradation and other natural attenuation processes are acting to reduce organic contaminants to relatively insignificant levels in the Area A Downstream. Historical chemistry data show that chlorinated solvents were previously detected less frequently but at similar concentrations in Area A Downstream groundwater. Because there are multiple source areas and they are not thoroughly understood, a collective recommendation for pursuing monitored natural attenuation for Area A Downstream cannot be made at this time. Based on the chemistry and geochemical data, it is likely that monitored natural attenuation would be viable for the source area impacting 2DMW29S.

6.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific risk assessment for the identified exposure scenarios for Site 3. The risk assessment methodology was described in Section 3.4, and detailed calculations including RAGS Part D tables are presented in Appendix C. A summary of previous risk assessments for the site is also presented.

6.6.1 Data Evaluation

COPCs were identified for Sites 3 and 14 using the risk-based screening levels presented and discussed in Section 3.4.1. Table 6-4 summarizes the COPCs retained for Sites 3 and 14. A discussion of direct contact exposure COPCs (i.e., those chemicals detected at concentrations in excess of USEPA and CTDEP direct contact exposure criteria) and additional COPCs is provided below. Additional COPCs are identified on chemical migration tendencies: migration of groundwater to surface water and migration of volatiles from groundwater through building foundations into indoor air. These additional COPCs are not quantitatively evaluated in the HHRA because they are not considered to be significant contributors to the direct contact exposure pathways identified for potential human receptors.

A comparison of the maximum detected concentrations in groundwater to direct contact risk-based screening criteria is presented in Table 6-5. The maximum detected concentrations of the following chemicals in groundwater exceeded their direct contact risk-based COPC screening levels and were retained as COPCs for groundwater:

- VOCs-chloroform, cis-1,2-dichloroethene, TCE, and vinyl chloride
- SVOCs-benzo(a)pyrene
- Metals-arsenic and thallium

The maximum detected concentrations of chromium and manganese exceeded their respective screening criteria but were within background levels; consequently, chromium and manganese were not retained as COPCs.

A comparison of the maximum detected concentration in groundwater to migration criteria is presented in Table 6-6. The maximum detected concentration of the arsenic exceeded its CTDEP screening criteria for protection of migration of groundwater to surface water. The maximum detected concentration of vinyl chloride exceeded its CTDEP criteria for migration from groundwater to indoor air.

6.6.2 Exposure Assessment

Only groundwater samples were collected during the current investigation. Consequently, only exposures to groundwater were evaluated in the risk assessment for Site 3. Potential receptors included construction workers and future residents. Exposure assumptions for construction workers were previously presented in Table 3-14. Potential exposure pathways are summarized in Table 6-7.

Construction workers could come into contact with groundwater while excavating building foundations. In such an instance, construction workers could be exposed to the groundwater via dermal contact.

Potential exposure pathways for future adult residents exposed to groundwater included ingestion, dermal contact, and inhalation of volatile emissions. As previously discussed, future residential receptors are not potential receptors under current land use and are included only to provide an indication of potential risks if the facility were to close and then be developed for residential use.

As discussed in Section 3.4, the maximum detected concentration and average concentration were used for the exposure point concentrations for the RME and CTE, respectively. Exposure point concentrations for Site 3 are presented in Table 6-8.

The results of the HHRA indicated that risks and hazard indices exceeded USEPA and CTDEP and CTDEP acceptable for future adult residents exposed to groundwater. Even though the calculations were not performed, cancer risks and hazard indices for future child residents will not change the conclusions of the HHRA.

6.6.3 Risk Characterization

Potential ICRs and HIs were calculated for construction workers and future residents exposed to groundwater using the methodology presented in Section 3.4. The results are summarized in Tables 6-9 and 6-10 and are discussed below. Sample calculations and chemical-specific risks in RAGS Part D format are provided in Appendix C.

The results of the HHRA indicated that risks and hazard indices exceeded USEPA and CTDEP and CTDEP acceptable levels for future adult residents exposed to groundwater. Even though the calculations were not performed, cancer risks and hazard indices for future child residents will not change the conclusions of the HHRA.

Carcinogenic Risks

ICRs for construction workers exposed to groundwater were 2.0×10^{-7} and 2.2×10^{-8} for the RME and CTE scenarios, respectively, which were less than USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures.

The ICR for future adult residents exposed to groundwater was 7.8×10^{-4} for the RME scenario, which exceeds USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. The ICR for future adult residents was 1.6×10^{-5} for the CTE scenario, which was within USEPA's target risk range but exceeded CTDEP's acceptable risk level for cumulative exposures. The chemical-specific ICR for arsenic, benzo(a)pyrene, and vinyl chloride under the RME scenario

Potential exposure pathways for future adult residents exposed to groundwater included ingestion, dermal contact, and inhalation of volatile emissions. As previously discussed, future residential receptors are not potential receptors under current land use and are included only to provide an indication of potential risks if the facility were to close and then be developed for residential use.

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6.6.3 Risk Characterization

Potential ICRs and HIs were calculated for construction workers and future residents exposed to groundwater using the methodology presented in Section 3.4. The results are summarized in Tables 6-9 and 6-10 and are discussed below. Sample calculations and chemical-specific risks in RAGS Part D format are provided in Appendix C.

The results of the human health risk assessment indicate that cancer risks and hazard indices exceed USEPA and CTDEP acceptable levels for future adult residents exposed to groundwater. Even though the calculations were not per performed, cancer risks and hazard indices for future child residents would also be expected to exceed USEPA and CTDEP acceptable levels.

Carcinogenic Risks

ICRs for construction workers exposed to groundwater were 2.0×10^{-7} and 2.2×10^{-8} for the RME and CTE scenarios, respectively, which were less than USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures.

The ICR for future adult residents exposed to groundwater was 7.8×10^{-4} for the RME scenario, which exceeds USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. The ICR for future adult residents was 1.6×10^{-5} for the CTE scenario, which was within USEPA's target risk range but exceeded CTDEP's acceptable risk level for cumulative exposures. The chemical-specific ICR for arsenic, benzo(a)pyrene, and vinyl chloride under the RME scenario exceeded USEPA's and CTDEP's acceptable risk levels. The chemical-specific ICR for TCE under the RME scenario also exceeded CTDEP's target level of 1×10^{-6} for individual chemicals. The chemical-specific ICR for arsenic, benzo(a)pyrene, and vinyl chloride under the CTE scenario exceeded CTDEP's target level of 1×10^{-6} for individual chemicals.

Noncarcinogenic Risks

HIs for construction workers exposed to groundwater were 0.001 and 0.0007 for the RME and CTE scenarios, respectively, which were less than EPA's and CTDEP's acceptable level of 1.0.

The HI for adult residents exposed to groundwater was 2.7 under the RME scenario, which exceeds USEPA's and CTDEP's acceptable level of 1.0. Thallium (HQ = 1.7) was the major contributor to the HI under the RME scenario. The HI for adult residents exposed to groundwater was 0.4 under the CTE scenario, which was less than USEPA's and CTDEP's acceptable level of 1.0.

6.6.4 Summary of Previous Risk Assessments

Three potential receptor groups were considered for the Phase II RI baseline risk assessment: older child trespassers, construction workers, and adult and child recreational users. However, groundwater was considered to be a potential medium of exposure for the construction worker only. An evaluation of risks associated with dermal contact with groundwater during intrusive activities was conducted for the construction worker under CTE and RME scenarios.

The noncarcinogenic risk associated with dermal exposure to groundwater for the construction worker under the CTE scenario was less than the USEPA acceptable level of 1. However, the noncarcinogenic risk for this route of exposure under the RME scenario was 9.2. Antimony and manganese were the primary contributors to the noncarcinogenic hazards; the HQs associated with dermal contact with groundwater for the construction worker for these two chemicals under RME were 7.5 and 1.4, respectively.

The incremental cancer risks associated with dermal contact with groundwater for the construction worker were within USEPA's target risk range (1×10^{-4} to 1×10^{-6}) and less than the CTDEP target cancer risk (1×10^{-5}) for both the RME and CTE scenarios. Carcinogenic risks associated with dermal exposure to groundwater for the construction worker were largely attributed to the sporadic presence of vinyl chloride in shallow wells and 1,1,2,2-tetrachloroethane in deep wells.

6.6.5 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment, in general, was presented in Section 3.4.5. Site-specific uncertainties for Sites 3 and 14 are discussed below.

Elimination of Chemicals as COPCs on the Basis of Background

In accordance with U.S. Navy policy, chemicals were eliminated as COPCs on the basis of comparison to background. Chromium and manganese were the only chemicals in groundwater with maximum detected concentrations that exceeded their respective direct contact screening criteria but were not retained as COPCs on the basis of background. Dermal exposure to groundwater by construction workers was the only exposure pathway evaluated for this receptor. Potential risks from exposures to manganese in water are negligible (USEPA, 2000e); consequently, the elimination of manganese as a COPC on the basis of background does not affect the risk estimates for construction workers at Sites 3 and 14. If exposures to chromium in groundwater by a construction worker were evaluated in the HHRA, then the resulting HQ for chromium would be 0.008 and the total HI would be 0.009 which is less than the USEPA and CTDEP acceptable level of 1.0. If exposures to chromium and manganese by a future resident were evaluated in the HHRA, then the resulting HQs for chromium and manganese would be 0.23 and 2.7, respectively, and the total HI would be 5.1, which exceeds the USEPA and CTDEP acceptable level.

Exceedance of Groundwater Volatilization Criteria by Vinyl Chloride

Vinyl chloride was identified in Table 6-4 as a COPC for the migration from groundwater to indoor air. Vinyl chloride was detected in only 2 of 25 groundwater samples at Site 3, although both detected concentrations (4.65 µg/L and 31.3 µg/L) exceeded the CTDEP groundwater volatilization criteria (2 µg/L). All detection limits (1 µg/L) were below the volatilization criteria. In addition, the average concentration (1.9 µg/L) and 95 percent UCL concentration (1.6 µg/L) were below the volatilization criteria. The area near the wells with the vinyl chloride detections is used as a firing range. There are no inhabitable structures in this area nor are there expected to be any in the future. Therefore, there are no significant risks expected from exposures resulting from the migration of vinyl chloride from groundwater into indoor air since there are no buildings in the area and vinyl chloride was detected infrequently in groundwater.

6.7 SUMMARY AND RECOMMENDATIONS

6.7.1 Nature and Extent of Contamination

Several volatile organics were identified as COPCs for groundwater, including chloroform, cis-1,2-DCE, TCE, and vinyl chloride. The detections were disperse and generally low concentration, with the exceptions of cis-1,2-DCE (12.2 µg/L) and vinyl chloride (31.3 µg/L) in well 2DMW29S. None of the other VOC detections exceeded 10 µg/L in any of the monitoring wells sampled.

One semivolatile organic, benzo(a)pyrene, was identified as a COPC based on a single positive detection in the monitoring wells sampled.

Trace levels of 4,4'-DDD and 4,4'-DDT were the only pesticides detected in groundwater from the overburden aquifer at Site 3. These compounds were only detected in the sample collected from monitoring well 2DMW30S, and high levels of total dissolved solids were measured in this well and are the likely cause of the detections of DDD and DDT.

For metals, arsenic and thallium were identified as COPCs for groundwater based on the sampling results. There was only a single, low-concentration positive detection of arsenic and two detections of thallium (all less than 7 µg/L), indicating that metals contamination of groundwater is not a significant problem at Sites 3 or 14.

6.7.2 Contaminant Fate and Transport

TCE, cis-1,2-DCE, vinyl chloride, and chloroform are halogenated aliphatic hydrocarbons. Given the length of time since waste disposal activities were thought to occur and the mobilities of these compounds, it is expected that the observed concentrations of these chemicals likely are indicative of steady-state or slowly declining concentrations within the groundwater. A preliminary evaluation of natural attenuation data (i.e., hydrogeologic, chemistry, and geochemical data) indicated that multiple minor sources of petroleum and chlorinated hydrocarbons are impacting the Area A Downstream groundwater and biodegradation and other natural attenuation processes are acting to reduce organic contaminants to relatively insignificant levels in the Area A Downstream. Because there are multiple source areas and they are not thoroughly understood, a collective recommendation for pursuing monitored natural attenuation for Area A Downstream could not be made at this time. It is likely that monitored natural attenuation would be viable for the source area impacting 2DMW29S.

The only semivolatile organic detected above screening levels in groundwater, benzo(a)pyrene, is a PAH. PAHs are generally considered relatively immobile in the environment. The single, low-level detection of benzo(a)pyrene is not considered to be indicative of a PAH problem in groundwater.

Arsenic and thallium were identified as COPCs in groundwater, based on a combined total of three, low-concentration detections. Metals are persistent in the environment but generally not very mobile, due to their low solubilities and affinities for binding to soil particles. A slightly acidic pH of the groundwater (as is characteristic of northern area groundwater) generally serves to enhance the mobility of metals. The low concentrations of metals detected and the lack of detectable levels over much of Area A Downstream indicate that metals contamination of groundwater is not a significant concern.

6.7.3 Summary of Human Health Risk Assessment

The following items summarize the HHRA for Sites 3 and 14.

- The HHRA considered exposures to construction workers and future residents. Only exposures to groundwater were evaluated. For the construction worker, the only exposure pathway was dermal contact with groundwater. For the future resident, exposure pathways included ingestion, dermal contact, and inhalation.

- The maximum detected concentrations of chloroform, cis-1,2-dichloroethene, TCE, vinyl chloride, benzo(a)pyrene, arsenic, and thallium exceeded their direct contact risk-based COPC screening levels and were retained for evaluation in the HHRA.

- The maximum detected concentration of arsenic exceeded its CTDEP screening criteria for protection of migration of groundwater to surface water.

- The maximum detected concentration of vinyl chloride exceeded its CTDEP screening criteria for the protection of migration from groundwater to indoor air.

- ICRs and HIs for construction workers exposed to groundwater at Sites 3 and 14 were within USEPA and CTDEP acceptable levels.

- The ICR for future adult residents exposed to groundwater at Sites 3 and 14 under the RME scenario exceeded USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for arsenic, benzo(a)pyrene, TCE, and vinyl chloride exceeded CTDEP's target level of 1×10^{-6} for individual chemicals.

- The ICR for future adult residents exposed to groundwater at Sites 3 and 14 under the CTE scenario was within USEPA's target risk range of 10^{-4} to 10^{-6} but exceeded CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for arsenic, benzo(a)pyrene, and vinyl chloride exceeded CTDEP's target level of 1×10^{-6} for individual chemicals.

- The HI for future adult residents exposed to groundwater at Sites 3 and 14 exceeded USEPA's and CTDEP's acceptable level of 1.0 under the RME scenario. Thallium was the major contributor to the HI.
- The results of the human health risk assessment indicate that cancer risks and hazard indices exceed USEPA and CTDEP acceptable risk levels for future adult residents exposed to groundwater. Even

though the calculations were not performed, cancer risks and hazard indices for future child residents would also be expected to exceed USEPA and CTDEP acceptable levels.

- The maximum detected concentrations of chromium and manganese in groundwater exceeded their respective screening criteria but were within background levels, consequently chromium and manganese were not retained as COCs in the HHRA. ICRs and HIs for construction workers would have been within USEPA and CTDEP target levels if these compounds had been evaluated in the HHRA. HIs for adult residents exposed to manganese in groundwater would exceed the acceptable level of 1 if manganese were evaluated in the HHRA.

6.7.4 Recommendations

A significant remedial action was completed for Site 3 soil and sediment in 2000. Approximately 18,050 tons of soil and sediment contaminated with pesticides and metals were excavated from Site 3 waterbodies. The excavated material was disposed off site, and each water body has been restored. A previously unknown source area was discovered during the remedial action at Site 3. It is located north of Stream 5 and east of the Small Arms Range. It is recommended that the soil operable unit associated with this source area be investigated further and addressed independently of this BGOURI. It is likely that a removal action will be appropriate for this source area.

The Navy intends to address contaminated soil and rubble present at the OBDANE through a non-time-critical removal action. The removal action is scheduled for the spring of 2001.

The objectives of the BGOURI at Sites 3 and 14 were to further characterize the nature and extent of groundwater contamination and to quantify the risks to human receptors from the groundwater. Groundwater sampling results for Sites 3 and 14 indicate that the water quality is generally good, with only sporadic, low-concentration detections of VOCs and metals in site monitoring wells. The major contaminant of concern in the soil and sediment, DDTR, was detected in only one groundwater sample and it is likely that the detection is associated with high levels of suspended solids in the groundwater sample versus dissolved pesticides. The groundwater data indicate that there are multiple minor sources of chlorinated solvents that are leaching to groundwater, but the sources are not significant enough to create discernible contaminant plumes. A preliminary evaluation of natural attenuation data indicated that biodegradation and other natural attenuation processes are acting to reduce organic contaminants to relatively insignificant levels in the Area A Downstream and that it is likely that monitored natural attenuation would be viable for the source area impacting 2DMW29S.

The HHRA determined that risks posed by exposure of construction workers to groundwater at Sites 3 and 14 are within USEPA and CTDEP acceptable levels, assuming that the workers are exposed to the

maximum observed concentrations of site contaminants. The HHRA also determined that risks posed by exposure of hypothetical future residents to groundwater at Sites 3 and 14 are outside USEPA and CTDEP acceptable levels, assuming the residents are exposed to the maximum observed concentrations of site contaminants. Arsenic, benzo(a)pyrene, TCE, and vinyl chloride were the major contributors to the ICRs and thallium was the major contributor to the HIs. It should be noted that the groundwater is classified by CTDEP as GB groundwater (i.e., not suitable for direct human consumption without treatment) and it is not likely that it will be used for human consumption in the forseeable future.

Even though contaminant concentrations were generally low and risks are acceptable under the current land use scenario, it is recommended that an FS be prepared for the groundwater operable unit associated with Sites 3 and 14. The FS should evaluate, at a minimum, land use controls and monitoring for the sites. This recommendation is made for the following reasons:

- The source areas are not fully understood, but the current groundwater data (i.e., concentrations and extent) do not indicate that the sources are significant and therefore they warrant further investigation to completely characterize them.

- A limited groundwater monitoring program would verify the trend in groundwater contaminant concentrations and determine the impact of any changes in site/source area conditions in the future.

- A change in land use would potentially result in the site groundwater causing unacceptable risks.

TABLE 6-1

SUMMARY OF THE SAMPLING AND ANALYTICAL PROGRAM FOR SITES 3 AND 14 BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION NSB-NLON, GROTON, CONNECTICUT

Sample ID	VOCs	SVOCs	Metals	Misc[1]	Pesticide PCBs	Dissolved Gas
GROUNDWATER SAMPLES						
FD0609001	X					
FD0802001	X	X	X	X	X	X
S32DMW10D01	X	X	X	X	X	X
S32DMW10D01-F			X			
S32DMW11S01	X	X	X	X	X	X
S32DMW15D01	X	X	X	X	X	X
S32DMW16D01	X	X	X	X	X	X
S32DMW16S01	X	X	X	X	X	X
S32DMW16S01-F			X			
S32DMW23D01	X	X	X	X	X	X
S32DMW24D01	X	X	X	X	X	X
S32DMW24S01	X	X	X	X	X	X
S32DMW25D01	X	X	X	X	X	X
S32DMW25S01	X	X	X	X	X	X
S32DMW26D01	X	X	X	X	X	X
S32DMW26S01	X	X	X	X	X	X
S32DMW27D01	X	X	X	X	X	X
S32DMW28D01	X	X	X	X	X	X
S32DMW28S01	X	X	X	X	X	X
S3MW29S03	X					
S32DMW29S04	X	X	X	X	X	X
S32DMW30S01	X	X	X	X	X	X
S3MW14S01	X			X		X
S14MW01S	X		X			
S3TW0101	X					
S3TW0401	X					
S3TW1001	X					
S3TW1501	X					
S3TW1701	X					
S3TW2201	X					
S3TW2501	X					
3MW12D	X	X	X	X	X	
SOIL SAMPLES						
S3SB14S3234[2]				X		
S3SB29D0911[3]				X		
S3SB29D1012[2]				X		

1 Miscellaneous parameters include TSS, TDS, and natural attenuation parameters (see Section 3.3.4 for a detailed list), except when noted otherwise.
2 Miscellaneous parameters include only TOC.
3 Miscellaneous parameters include pH, porosity, and bulk density.

TABLE 6-2

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS FOR TEMPORARY WELLS AT SITE 3
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	3TW01	3TW4	3TW10	3TW15	3TW17	3TW22	3TW22	3TW25
nsample	S3TW0101	S3TW0401	S3TW1001	S3TW1501	S3TW1701	S3TW2201	S3TW2201-D	S3TW2501
sample	S3TW0101	S3TW0401	S3TW1001	S3TW1501	S3TW1701	S3TW2201	FD0609001	S3TW2501
sample_date	6/10/00	6/10/00	6/10/00	6/9/00	6/9/00	6/9/00	6/9/00	6/11/00
Volatile Organics (ug/L)								
ACETONE	1 UR	1 UR	1 UR	1 UR	1 UR	28.9 J	27.8 J	1 UR
CIS-1,2-DICHLOROETHENE	1.71	1 U	1 U	1 U	1 U	1 U	1 U	1 U
VINYL CHLORIDE	4.65	1 U	1 U	1 U	1 U	1 U	1 U	1 U

TABLE 6-3

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITES 3 AND 14
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location nsample sample sample_dat	2DMW10D S32DMW10D01 S32DMW10D01 8/2/00	2DMW11S S32DMW11S01 S32DMW11S01 8/3/00	2DMW11D 2GW11D-2 2GW11D-2 7/9/94	2DMW15D S32DMW15D01 S32DMW15D01 8/2/00	2DMW16D S32DMW16D01 S32DMW16D01 7/31/00	2DMW16S S32DMW16S01 S32DMW16S01 7/31/00	2DMW23D S32DMW23D01 S32DMW23D01 7/25/00	2DMW24D S32DMW24D01 S32DMW24D01 8/2/00
Volatile Organics (ug/L)								
CHLOROFORM	1 U	1 U	10 U	1 U	1 U	1 U	2.11	1 U
CIS-1,2-DICHLOROETHENE	1 U	1 U	10 U	1 U	3.3	1 U	1 U	1 U
TRICHLOROETHENE	1.88	1 U	10 U	1 U	3.17	3.88	2.2	1 U
VINYL CHLORIDE	1 U	1 U	10 U	1 U	1 U	1 U	1 U	1 U
Dissolved Gases (ug/L)								
ETHANE	2 UJ	2 UJ		2 UJ	2 UJ	2 UJ	2 UJ	2 UJ
ETHENE	3 UJ	3 UJ		3 UJ	3 UJ	3 UJ	3 UJ	3 UJ
METHANE	1 U	1 U		30	21	98	1 U	63 J
Semivolatile Organics (ug/L)								
4-METHYLPHENOL	5 U	5 U	10 U	5 U	5 U	5 U	5 U	5 U
ANTHRACENE	0.05 U	0.05 U	10 U	0.05 U	0.05 U	0.04 J	0.05 U	0.05 U
BENZO(A)ANTHRACENE	0.05 U	0.05 U	10 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
BENZO(A)PYRENE	0.05 U	0.05 U	10 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
BENZO(B)FLUORANTHENE	0.1 U	0.1 U	10 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
BENZO(G,H,I)PERYLENE	0.1 U	0.1 U	10 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
BENZO(K)FLUORANTHENE	0.05 U	0.05 U	10 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
CHRYSENE	0.05 U	0.05 U	10 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
FLUORANTHENE	0.1 U	0.1 U	10 U	0.1 U	0.1 U	0.04 J	0.1 U	0.1 U
FLUORENE	0.1 U	0.1 U	10 U	0.1 U	0.1 U	0.04 J	0.1 U	0.1 U
INDENO(1,2,3-CD)PYRENE	0.05 U	0.05 U	10 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
PHENANTHRENE	0.05 U	0.05 U	10 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
PYRENE	0.05 U	0.05 U	10 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Pesticides/PCBs (ug/L)								
4,4'-DDD	0.02 U	0.02 U		0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
4,4'-DDT	0.02 U	0.02 U		0.02 U	0.02 U	0.02 U	0.02 U	0.02 U

TABLE 6-3

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITES 3 AND 14
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	2DMW10D	2DMW11S	2DMW11D	2DMW15D	2DMW16D	2DMW16S	2DMW23D	2DMW24D
nsample	S32DMW10D01	S32DMW11S01	2GW11D-2	S32DMW15D01	S32DMW16D01	S32DMW16S01	S32DMW23D01	S32DMW24D01
sample	S32DMW10D01	S32DMW11S01	2GW11D-2	S32DMW15D01	S32DMW16D01	S32DMW16S01	S32DMW23D01	S32DMW24D01
sample_dat	8/2/00	8/3/00	7/9/94	8/2/00	7/31/00	7/31/00	7/25/00	8/2/00
Total Metals (ug/L)								
ALUMINUM	2.6 U	2.6 U	52.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U
ARSENIC	2.3 U	2.3 U	5 UJ	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U
BARIUM	26	21.1 U	79.1	36.8	75.9	22.7 U	19.4 U	58.3
CADMIUM	0.25 U	0.25 U	2 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
CALCIUM	14800	25600	39800	9760	155000	31700	7040	21800
CHROMIUM	25.3	6.2 U	3 U	6.2 U	6.2 U	6.2 U	6.2 U	6.2 U
COBALT	4.5 J	4.2 U	5 J	5.3 J	4.2 U	4.2 U	4.2 U	4.2 U
COPPER	6.8 U	6.8 U	5.5	6.8 U	6.8 U	6.8 U	6.8 U	6.8 U
IRON	16000	48.6 U	60200	13300	34600	697	268	7990
LEAD	1.8 U	1.8 U	3.8 U	1.8 U	2.2 J	1.8 U	1.8 U	1.8 U
MAGNESIUM	2810	9740	10100	3340	23000	6770	1240	5960
MANGANESE	392	674	1690	1370	1060	792	84.6	769
NICKEL	26.4	9.2 U	8.4 J	9.2 U	9.2 U	9.2 U	9.2 U	9.2 U
POTASSIUM	3390	5840	6870	4040	11600	3960	857	3730
SILVER	5.5 J	5.2 U	2.1 J	5.2 U	7.6 J	5.2 U	5.2 U	5.2 U
SODIUM	30200 J	131000 J	177000	59400 J	298000 J	49400 J	5700 J	75100 J
THALLIUM	4.4 J	3 U	5 U	3 U	3 U	3 U	3 U	3 U
ZINC	10.9 U	4.6 U	11.8 U	53.1	19 U	17.7 U	12.3 U	6.5 U
CALCIUM, FILTERED	12200		40100			32500		
CHROMIUM, FILTERED	6.2 U		4.8 U			8.3 J		
COBALT, FILTERED	4.2 U		3.1 U			4.5 J		
COPPER, FILTERED	12.1 J		2.3 U			6.8 U		
IRON, FILTERED	8990		14500 J			430		
MAGNESIUM, FILTERED	2320		10300			6900		
MANGANESE, FILTERED	320		1640			783		
NICKEL, FILTERED	10.3 J		7 U			9.2 U		
POTASSIUM, FILTERED	2970		7410			4000		
SODIUM, FILTERED	25500 J		178000			50400 J		
THALLIUM, FILTERED	3 U		5 U			3.2 J		

TABLE 6-3

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITES 3 AND 14
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	2DMW10D	2DMW11S	2DMW11D	2DMW15D	2DMW16D	2DMW16S	2DMW23D	2DMW24D
nsample	S32DMW10D01	S32DMW11S01	2GW11D-2	S32DMW15D01	S32DMW16D01	S32DMW16S01	S32DMW23D01	S32DMW24D01
sample	S32DMW10D01	S32DMW11S01	2GW11D-2	S32DMW15D01	S32DMW16D01	S32DMW16S01	S32DMW23D01	S32DMW24D01
sample_dat	8/2/00	8/3/00	7/9/94	8/2/00	7/31/00	7/31/00	7/25/00	8/2/00
Miscellaneous Parameters (mg/L)								
ALKALINITY	34	101		71	209	150	12 J	46
AMMONIA	0.12 J	0.27 J		0.12 J	0.2 J	0.26 J	0.15 J	0.15 J
CHLORIDE	50.9	159		53.8	495	47.1	6.17	126
HARDNESS as CaCO3	48.5	46.5		38.1	482	107	22.7	79
SULFATE	6.25	70.3		47.8	66.8	14.7	15.5	27.5
TOTAL DISSOLVED SOLIDS	126 J	481 J		238 J	1688 J	374 J	55 J	311 J
TOTAL ORGANIC CARBON	1.3	1.9 J		3.6	3.5	4.1	1.8 J	1.5
TOTAL SUSPENDED SOLIDS	20 J	5 UJ		19 J	66 J	5 UJ	5 UJ	6 J

TABLE 6-3

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITES 3 AND 14
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	2DMW24D	2DMW24S	2DMW25D	2DMW25S	2DMW26D	2DMW26S	2DMW27D	2DMW28D
nsample	S32DMW24D01-D	S32DMW24S01	S32DMW25D01	S32DMW25S01	S32DMW26D01	S32DMW26S01	S32DMW27D01	S32DMW28D01
sample	FD0802001	S32DMW24S01	S32DMW25D01	S32DMW25S01	S32DMW26D01	S32DMW26S01	S32DMW27D01	S32DMW28D01
sample_dat	8/2/00	8/2/00	7/22/00	7/22/00	7/22/00	7/22/00	8/3/00	7/23/00
Volatile Organics (ug/L)								
CHLOROFORM	1 U	1 U	3.53	3.08	1 U	5.72	1 U	1 U
CIS-1,2-DICHLOROETHENE	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TRICHLOROETHENE	1 U	1 U	1 U	3.45 J	1 U	2.41 J	1 U	8.76 J
VINYL CHLORIDE	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dissolved Gases (ug/L)								
ETHANE	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ	2 UJ
ETHENE	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ	3 UJ
METHANE	46 J	260	95	1 U	170	2 J	2 U	3
Semivolatile Organics (ug/L)								
4-METHYLPHENOL	5 U	5 U	5 U	5 U	2 J	5 U	5 U	5 U
ANTHRACENE	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
BENZO(A)ANTHRACENE	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
BENZO(A)PYRENE	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
BENZO(B)FLUORANTHENE	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
BENZO(G,H,I)PERYLENE	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
BENZO(K)FLUORANTHENE	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
CHRYSENE	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
FLUORANTHENE	0.1 UJ	0.06 J	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
FLUORENE	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
INDENO(1,2,3-CD)PYRENE	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
PHENANTHRENE	0.05 UJ	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
PYRENE	0.05 UJ	0.06	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Pesticides/PCBs (ug/L)								
4,4'-DDD	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
4,4'-DDT	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U

TABLE 6-3

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITES 3 AND 14
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	2DMW24D	2DMW24S	2DMW25D	2DMW25S	2DMW26D	2DMW26S	2DMW27D	2DMW28D
nsample	S32DMW24D01-D	S32DMW24S01	S32DMW25D01	S32DMW25S01	S32DMW26D01	S32DMW26S01	S32DMW27D01	S32DMW28D01
sample	FD0802001	S32DMW24S01	S32DMW25D01	S32DMW25S01	S32DMW26D01	S32DMW26S01	S32DMW27D01	S32DMW28D01
sample_dat	8/2/00	8/2/00	7/22/00	7/22/00	7/22/00	7/22/00	8/3/00	7/23/00
Total Metals (ug/L)								
ALUMINUM	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U
ARSENIC	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U
BARIUM	59.3	38.9	37.9 U	43.9 U	48.5 U	13.4 U	4.1 U	19.9 U
CADMIUM	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
CALCIUM	22800	18700	7450	6550	21000	8840	32300	53800
CHROMIUM	6.2 U	6.2 U	6.2 U	6.2 U	6.2 U	6.2 U	15.1	6.2 U
COBALT	4.2 U	4.2 U	4.5 U	4.2 U	4.2 U	4.2 U	4.2 U	6 U
COPPER	6.8 U	6.8 U	6.8 U	6.8 U	6.8 U	6.8 U	6.8 U	6.8 U
IRON	8480	12800	12100	159 U	7480	270 U	319	7930
LEAD	1.8 U	1.8 U	1.8 U	6.5	1.8 U	1.8 U	1.8 U	1.9 J
MAGNESIUM	6130	4700	1910	1550	5050	1770	2710	5380
MANGANESE	805	1130	213	50.9	496	5.6 U	97.5	2380
NICKEL	9.2 U	9.2 U	9.2 U	9.2 U	9.2 U	9.2 U	16.1 J	9.2 U
POTASSIUM	3890	3930	2260	1980	4210	2540	2270	2960
SILVER	5.2 U	5.2 U	5.2 UR	5.2 UR	5.2 UR	5.2 UR	5.2 U	5.2 UR
SODIUM	77900 J	85800 J	30800	28800	58100	45200	20000 J	18900
THALLIUM	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U
ZINC	17.4	18.9 U	28.6 U	15.8 U	20.1 U	17.3 U	73.9	18.5 U
CALCIUM, FILTERED								
CHROMIUM, FILTERED								
COBALT, FILTERED								
COPPER, FILTERED								
IRON, FILTERED								
MAGNESIUM, FILTERED								
MANGANESE, FILTERED								
NICKEL, FILTERED								
POTASSIUM, FILTERED								
SODIUM, FILTERED								
THALLIUM, FILTERED								

TABLE 6-3

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITES 3 AND 14
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	2DMW24D	2DMW24S	2DMW25D	2DMW25S	2DMW26D	2DMW26S	2DMW27D	2DMW28D
nsample	S32DMW24D01-D	S32DMW24S01	S32DMW25D01	S32DMW25S01	S32DMW26D01	S32DMW26S01	S32DMW27D01	S32DMW28D01
sample	FD0802001	S32DMW24S01	S32DMW25D01	S32DMW25S01	S32DMW26D01	S32DMW26S01	S32DMW27D01	S32DMW28D01
sample_dat	8/2/00	8/2/00	7/22/00	7/22/00	7/22/00	7/22/00	8/3/00	7/23/00
Miscellaneous Parameters (m								
ALKALINITY	48.5	65.5	23.5 J	10.5 J	65.5 J	33 J	72	94 J
AMMONIA	0.15 J	1.04 J	0.4 J	0.26 J	0.22 J	0.1 UJ	0.11 J	0.17 J
CHLORIDE	126	170	52.4	48.1	79.5	44.4	31.9	62.8
HARDNESS as CaCO3	82.2	66	26.5	22.7	73.2	29.4	91.8	156
SULFATE	26.5	9.7	7.94	14.2	21.9	26.3	14.4	16.5
TOTAL DISSOLVED SOLIDS	332 J	328 J	132 J	121 J	246 J	164 J	161 J	332 J
TOTAL ORGANIC CARBON	1.7	4.2	1.2	1.3	2.2	1.4	1.2	1.3
TOTAL SUSPENDED SOLIDS	18 J	13 J	13 J	5 UJ	8 J	5 UJ	5 UJ	7 J

TABLE 6-3

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITES 3 AND 14
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	2DMW28S	2DMW29S	2DMW30S	3MW12D	3MW14S	S14MW01S
nsample	S32DMW28S01	S32DMW29S04	S32DMW30S01	3GWD-04	S3MW14S01	S14MW01S-01
sample	S32DMW28S01	S32DMW29S04	S32DMW30S01	3GWD-04	S3MW14S01	S14MW01S-01
sample_dat	7/23/00	7/12/00	7/12/00	7/31/00	7/25/00	8/5/00
Volatile Organics (ug/L)						
CHLOROFORM	1 U	1 U	1 U	1 U	1 U	1 U
CIS-1,2-DICHLOROETHENE	1 U	12.2	1 U	1 U	1 U	1 U
TRICHLOROETHENE	1 U	5.47	1 U	1 U	6.22 J	1 U
VINYL CHLORIDE	1 U	31.3	1 U	1 U	1 U	1 U
Dissolved Gases (ug/L)						
ETHANE	2 UJ	12	2 U		2 UJ	
ETHENE	3 UJ	13	3 U		3 UJ	
METHANE	1 U	400 J	9 J		1	
Semivolatile Organics (ug/L)						
4-METHYLPHENOL	5 U	5 U	5 U	5 U		
ANTHRACENE	0.05 U	0.05 U	0.05 U	1.1 U		
BENZO(A)ANTHRACENE	0.05 U	0.05 U	0.06	0.16 U		
BENZO(A)PYRENE	0.05 U	0.05 U	0.08	0.16 U		
BENZO(B)FLUORANTHENE	0.1 U	0.1 U	0.05 J	0.16 U		
BENZO(G,H,I)PERYLENE	0.1 U	0.1 U	0.09 J	0.16 U		
BENZO(K)FLUORANTHENE	0.05 U	0.05 U	0.03 J	0.16 U		
CHRYSENE	0.05 U	0.05 U	0.04 J	0.16 U		
FLUORANTHENE	0.1 U	0.1 U	0.1	1.1 U		
FLUORENE	0.1 U	0.1 U	0.1 U	1.1 U		
INDENO(1,2,3-CD)PYRENE	0.05 U	0.05 U	0.06	0.16 U		
PHENANTHRENE	0.05 U	0.05 U	0.03 J	1.1 U		
PYRENE	0.05 U	0.05 U	0.13	1.1 U		
Pesticides/PCBs (ug/L)						
4,4'-DDD	0.02 U	0.02 U	0.019 J	0.021 U		
4,4'-DDT	0.02 U	0.02 U	0.034 J	0.021 U		

TABLE 6-3

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITES 3 AND 14
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	2DMW28S	2DMW29S	2DMW30S	3MW12D	3MW14S	S14MW01S
nsample	S32DMW28S01	S32DMW29S04	S32DMW30S01	3GWD-04	S3MW14S01	S14MW01S-01
sample	S32DMW28S01	S32DMW29S04	S32DMW30S01	3GWD-04	S3MW14S01	S14MW01S-01
sample_dat	7/23/00	7/12/00	7/12/00	7/31/00	7/25/00	8/5/00
Total Metals (ug/L)						
ALUMINUM	2.6 U	2.6 U	2.6 U	69.1 U		93.6 U
ARSENIC	2.3 U	6.1	2.3 U	2.7 U		2.3 U
BARIUM	170	17.6 U	31.7	57		48.8
CADMIUM	0.71	0.25 U	0.25 U	0.5 U		0.25 U
CALCIUM	21300	12500	15100	65900		6890
CHROMIUM	6.2 U	6.2 U	16.1	1.3 U		6.2 U
COBALT	4.2 U	7.1 J	8.9	9.4		4.2 U
COPPER	6.8 U	6.8 U	12 J	3 U		6.8 U
IRON	37.2 U	6630	1920	44500		1330
LEAD	1.8 U	4	4.9	1.9 U		1.8 U
MAGNESIUM	2610	3330	3630	47300		3060
MANGANESE	10.2 U	186	259	6580		88.2
NICKEL	9.2 U	9.2 U	20.4	6.3 U		9.2 U
POTASSIUM	3390	3480	3280	17000 J		2780
SILVER	5.2 UR	5.2 U	5.2 U	1.1 U		5.2 U
SODIUM	131000	59700	50200	447000		31500
THALLIUM	3 U	3 U	3 U	5 U		3.0 U
ZINC	10.5 U	29.2	28.8	5.8 U		20.0 U
CALCIUM, FILTERED						
CHROMIUM, FILTERED						
COBALT, FILTERED						
COPPER, FILTERED						
IRON, FILTERED						
MAGNESIUM, FILTERED						
MANGANESE, FILTERED						
NICKEL, FILTERED						
POTASSIUM, FILTERED						
SODIUM, FILTERED						
THALLIUM, FILTERED						

TABLE 6-3

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITES 3 AND 14
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	2DMW28S	2DMW29S	2DMW30S	3MW12D	3MW14S	S14MW01S
nsample	S32DMW28S01	S32DMW29S04	S32DMW30S01	3GWD-04	S3MW14S01	S14MW01S-01
sample	S32DMW28S01	S32DMW29S04	S32DMW30S01	3GWD-04	S3MW14S01	S14MW01S-01
sample_dat	7/23/00	7/12/00	7/12/00	7/31/00	7/25/00	8/5/00
Miscellaneous Parameters (m						
ALKALINITY	18.5 J	21.5	29.8	39	26 J	
AMMONIA	0.24 J	0.13	0.38		0.1 UJ	
CHLORIDE	231	120	83.1	813 J	38.6	
HARDNESS as CaCO3	63.9	44.9	52.6	359	2 U	
SULFATE	21.6	24.6	29.1	70.5	27	
TOTAL DISSOLVED SOLIDS	525 J	229	249	1760		122 J
TOTAL ORGANIC CARBON	1.1	18	2.6	3.7	1.8	
TOTAL SUSPENDED SOLIDS	5 J	5 U	751	38		5 UJ

Notes:

1. Metals results for filtered samples correspond to the dissolved state. Metals results for unfiltered samples correspond to total metals.
2. Monitoring well 2DMW11D was not sampled because it was likely destroyed by remedial activities. The results presented here for 2DMW11D are from the Phase II RI. These data were not used in the statistical analyses for Sites 3 and 14.

TABLE 6-4

CHEMICALS RETAINED AS COPCs IN SITES 3 AND 14 GROUNDWATER
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Direct Contact	Migration Pathways	
		Surface Water	Volatilization
Volatile Organic Compounds			
Chloroform	X		
cis-1,2-Dichloroethene	X		
Trichloroethene	X		
Vinyl Chloride	X		X
Semivolatile Organic Compounds			
Benzo(a)pyrene	X		
Metals			
Arsenic	X	X	
Thallium	X		

Notes:
X - Chemical is retained as a COC.

TABLE 6-5

OCCURRENCE, DISTRIBUTION, AND SELECTIONOF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITES 3 AND 14
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Downstream (Site 3)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																
67-64-1	ACETONE	27.8	J	28.9	J	ug/L	S3TW2201	1/5	5 - 13.4	28.9	NA	61 N	700 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
67-66-3	CHLOROFORM	2.11		5.72		ug/L	S32DMW26S01	4/27	1	5.72	NA	0.16 C	6 80 100	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
156-59-2	CIS-1,2-DICHLOROETHENE	1.71		12.2		ug/L	S32DMW29S04	3/27	1	12.2	NA	6.1 N	70 70 70	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
79-01-6	TRICHLOROETHENE	1.88		8.76	J	ug/L	S32DMW28D01	9/27	1	8.76	NA	1.6 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
75-01-4	VINYL CHLORIDE	4.65		31.3		ug/L	S32DMW29S04	2/27	1	31.3	NA	0.041 C	2 2 2	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
Dissolved Gases																
74-84-0	ETHANE	12		12		ug/L	S32DMW29S04	1/18	2	12	NA	NA	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
74-85-1	ETHENE	13		13		ug/L	S32DMW29S04	1/18	3	13	NA	NA	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
74-82-8	METHANE	1		400	J	ug/L	S32DMW29S04	12/18	1 - 2	400	NA	NA	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
Semivolatile Organics																
106-44-5	4-METHYLPHENOL	2	J	2	J	ug/L	S32DMW26D01	1/18	5	2	NA	18 N	35 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
120-12-7	ANTHRACENE	0.04	J	0.04	J	ug/L	S32DMW16S01	1/18	0.05 - 1.1	0.04	NA	180 N	2000 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
56-55-3	BENZO(A)ANTHRACENE	0.06		0.06		ug/L	S32DMW30S01	1/18	0.05 - 0.16	0.06	NA	0.092 C	0.06 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
50-32-8	BENZO(A)PYRENE	0.08		0.08		ug/L	S32DMW30S01	1/18	0.05 - 0.16	0.08	NA	0.0092 C	0.2 0.2 NA	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
205-99-2	BENZO(B)FLUORANTHENE	0.05	J	0.05	J	ug/L	S32DMW30S01	1/18	0.1 - 0.16	0.05	NA	0.092 C	0.08 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.09	J	0.09	J	ug/L	S32DMW30S01	1/18	0.1 - 0.16	0.09	NA	18 (7) N	210 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.03	J	0.03	J	ug/L	S32DMW30S01	1/18	0.05 - 0.16	0.03	NA	0.92 C	0.5 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
218-01-9	CHRYSENE	0.04	J	0.04	J	ug/L	S32DMW30S01	1/18	0.05 - 0.16	0.04	NA	9.2 C	4.8 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
206-44-0	FLUORANTHENE	0.04	J	0.1		ug/L	S32DMW30S01	3/18	0.1 - 1.1	0.1	NA	150 N	280 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL

TABLE 6-5

OCCURRENCE, DISTRIBUTION, AND SELECTIONOF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITES 3 AND 14
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Downstream (Site 3)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
86-73-7	FLUORENE	0.04	J	0.04	J	ug/L	S32DMW16S01	1/18	0.1 - 1.1	0.04	NA	24	N	280 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.06		0.06		ug/L	S32DMW30S01	1/18	0.05 - 0.16	0.06	NA	0.092	C	0.5 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
85-01-8	PHENANTHRENE	0.03	J	0.03	J	ug/L	S32DMW30S01	1/18	0.05 - 1.1	0.03	NA	18 (7)	N	200 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
129-00-0	PYRENE	0.06		0.13		ug/L	S32DMW30S01	2/18	0.05 - 1.1	0.13	NA	18	N	200 NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Pesticides/PCBs																	
72-54-8	4,4'-DDD	0.019	J	0.019	J	ug/L	S32DMW30S01	1/18	0.02 - 0.021	0.019	NA	0.28	C	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
50-29-3	4,4'-DDT	0.034	J	0.034	J	ug/L	S32DMW30S01	1/18	0.02 - 0.021	0.034	NA	0.2	C	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Total Metals																	
7429-90-5	ALUMINUM	517		983		ug/L	S32DMW23D01	3/19	50.5 - 338	983	3560	3600	N	NA 50-200 NA	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI, BKG
7440-38-2	ARSENIC	6.1		6.1		ug/L	S32DMW29S04	1/19	2.3	6.1	1.92	0.045	C	50 50(9) 50	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-39-3	BARIUM	26		170		ug/L	S32DMW28S01	9/19	4.1 - 48.5	170	227	260	N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-43-9	CADMIUM	0.71		0.71		ug/L	S32DMW28S01	1/19	0.25 - 0.5	0.71	ND	1.8	N	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-70-2	CALCIUM	6550		155000		ug/L	S32DMW16D01	19/19	0	155000	188000	NA		NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-47-3	CHROMIUM	15.1		25.3		ug/L	S32DMW10D01	3/19	1.3 - 6.2	25.3	49.9	11 (8)	N	NA 100 50	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
7440-48-4	COBALT	4.5	J	9.4		ug/L	3MW12D	5/19	4.2 - 6	9.4	48.6	220	N	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-50-8	COPPER	12	J	12	J	ug/L	S32DMW30S01	1/19	3 - 6.8	12	107	140	N	1300 1300 NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON	268		44500		ug/L	3MW12D	15/19	37.2 - 270	44500	28200	1100	N	NA 300 NA	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI
7439-92-1	LEAD	1.9	J	6.5		ug/L	S32DMW25S01	5/19	1.8 - 1.9	6.5	6.63	NA		15 15 NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-95-4	MAGNESIUM	1240		47300		ug/L	3MW12D	19/19	0	47300	191000	NA		NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7439-96-5	MANGANESE	50.9		6580		ug/L	3MW12D	17/19	5.6 - 10.2	6580	11700	88	N	NA 50 NA	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG

TABLE 6-5

OCCURRENCE, DISTRIBUTION, AND SELECTIONOF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITES 3 AND 14
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Downstream (Site 3)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7440-02-0	NICKEL	16.1	J	26.4		ug/L	S32DMW10D01	3/19	6.3 - 9.2	26.4	32.2	73 N	100 NA 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-09-7	POTASSIUM	857		17000	J	ug/L	3MW12D	19/19	0	17000	70800	NA	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-22-4	SILVER	5.5	J	7.6	J	ug/L	S32DMW16D01	2/13	1.1 - 5.2	7.6	ND	18 N	36 100 50	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
7440-23-5	SODIUM	5700	J	447000		ug/L	3MW12D	19/19	0	447000	1900000	NA	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-28-0	THALLIUM	4.4	J	4.4	J	ug/L	S32DMW10D01	1/19	3 - 5	4.4	ND	0.24 N	5 2 2	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-66-6	ZINC	17.4		73.9		ug/L	S32DMW27D01	5/19	4.6 - 28.6	73.9	131	1100 N	5000 5000 NA	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL, BKG
Dissolved Metals																
7440-70-2	CALCIUM, FILTERED	12200		32500		ug/L	S32DMW16S01-F	2/2	0	32500	152000	NA	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-47-3	CHROMIUM, FILTERED	8.3	J	8.3	J	ug/L	S32DMW16S01-F	1/2	6.2	8.3	16	11 (8) N	NA 100 50	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-48-4	COBALT, FILTERED	4.5	J	4.5	J	ug/L	S32DMW16S01-F	1/2	4.2	4.5	43.3	220 N	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-50-8	COPPER, FILTERED	12.1	J	12.1	J	ug/L	S32DMW10D01-F	1/2	6.8	12.1	39.4	140 N	1300 1300 NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON, FILTERED	430		8990		ug/L	S32DMW10D01-F	2/2	0	8990	25300	1100 N	NA 300 NA	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI
7439-95-4	MAGNESIUM, FILTERED	2320		6900		ug/L	S32DMW16S01-F	2/2	0	6900	150000	NA	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7439-96-5	MANGANESE, FILTERED	320		783		ug/L	S32DMW16S01-F	2/2	0	783	9400	73 N	NA 50 NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
7440-02-0	NICKEL, FILTERED	10.3	J	10.3	J	ug/L	S32DMW10D01-F	1/2	9.2	10.3	15.3	88 N	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-09-7	POTASSIUM, FILTERED	2970		4000		ug/L	S32DMW16S01-F	2/2	0	4000	60000	NA	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-23-5	SODIUM, FILTERED	25500	J	50400	J	ug/L	S32DMW16S01-F	2/2	0	50400	1580000	NA	NA NA NA	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-28-0	THALLIUM, FILTERED	3.2	J	3.2	J	ug/L	S32DMW16S01-F	1/2	3	3.2	ND	0.24 N	5 2 2	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL

TABLE 6-5

OCCURRENCE, DISTRIBUTION, AND SELECTIONOF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITES 3 AND 14
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Downstream (Site 3)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Miscellaneous Parameters																
E-14506	ALKALINITY	10.5	J	239		mg/L	S32DMW16D01	19/19	0	239	1950	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
7664-41-7	AMMONIA	0.11	J	1.04	J	mg/L	S32DMW24S01	16/18	0	1.04	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
000-02-0	CHLORIDE	6.17		813	J	mg/L	S32DMW16D01	19/19	813	813	4540	N/A	N/A 250 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
E-11778	HARDNESS as CaCO3	22.7		482		mg/L	S32DMW16D01	17/18	2	482	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
14808-79-8	SULFATE	6.25		70.5		mg/L	S32DMW11S01	19/19	0	70.5	45.2	N/A	N/A 250 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
000-09-0	TOTAL DISSOLVED SOLIDS	55	J	1760		mg/L	S32DMW16D01	19/19	0	1760	6260	N/A	N/A 500 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
	TOTAL ORGANIC CARBON	1.1		18		mg/L	S32DMW29S04	18/18	0	18	37.7	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
000-08-9	TOTAL SUSPENDED SOLIDS	5	J	751		mg/L	S32DMW30S01	10/18	5	751	236	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Footnotes:
1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 The risk-based COPC screening level for tap water use is presented. The value is based on a target Hazard quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
7 Pyrene is used as a surrogate for phenanthrene.
8 Value is for hexavalent chromium.
9 The US EPA has approved a new MCL for arsenic of 10 ug/L. The MCL goes into effect in 2006. *The reduction of the MCL does not impact the human health risk assessment.*

Associated Samples:

S3TW0101	S32DMW10D01	S32DMW24D01	S32DMW28D01
S3TW0401	S32DMW10D01-F	S32DMW24D01-D	S32DMW28S01
S3TW1001	S32DMW11S01	S32DMW24S01	S32DMW29S04
S3TW1501	S32DMW15D01	S32DMW25D01	S32DMW30S01
S3TW1701	S32DMW16D01	S32DMW25S01	S3MW14S01
S3TW2201	S32DMW16S01	S32DMW26D01	S14MW01S01
S3TW2201-D	S32DMW16S01-F	S32DMW26S01	3MW12D
S3TW2501	S32DMW23D01	S32DMW27D01	

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
N/A = Not Applicable.
FED-MCL = Federal Maximum Contaminant Level (USEPA, August 2000).
FED-SMCL = Federal Secondary Maximum Contaminant Level (USEPA, August 2000).
FED-AL = Federal Action Level (USEPA, August 2000).
CTDEP-RSR = Connecticut DEP Remediation Standard Regulations, 1996.
CTDEP-MCL = Connecticut Maximum Contaminant Level.

Rationale Codes:
For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No Toxicity Information.
EPAI = USEPA Region 1 does not advocate evaluation of this chemical.

TABLE 6-6

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITES 3 AND 14
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Downstream (Site 3)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Surface Water Protection Criteria(5)	Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organics															
67-64-1	ACETONE	27.8	J	29	J	ug/L	S3TW2201	1/5	5 - 13.4	29	NA	NA	50000	NO	BSL
67-66-3	CHLOROFORM	2.11		5.72		ug/L	S32DMW26S01	4/27	1	5.72	NA	14100	287	NO	BSL
156-59-2	CIS-1,2-DICHLOROETHENE	1.71		12.2		ug/L	S32DMW29S04	3/27	1	12.2	NA	NA	NA	NO	NTX
79-01-6	TRICHLOROETHENE	1.88		9	J	ug/L	S32DMW28D01	9/27	1	9	NA	2340	219	NO	BSL
75-01-4	VINYL CHLORIDE	4.65		31.3		ug/L	S32DMW29S04	2/27	1	31.3	NA	15750	2	YES	ASL
Dissolved Gases															
74-84-0	ETHANE	12		12		ug/L	S32DMW29S04	1/18	2	12	NA	NA	NA	NO	NTX
74-85-1	ETHENE	13		13		ug/L	S32DMW29S04	1/18	3	13	NA	NA	NA	NO	NTX
74-82-8	METHANE	1		400	J	ug/L	S32DMW29S04	12/18	1 - 2	400	NA	NA	NA	NO	NTX
Semivolatile Organics															
106-44-5	4-METHYLPHENOL	2	J	2	J	ug/L	S32DMW26D01	1/18	5	2	NA	NA	NA	NO	NTX
120-12-7	ANTHRACENE	0.04	J	0.04	J	ug/L	S32DMW16S01	1/18	0.05 - 1.1	0.04	NA	1100000	NA	NO	BSL
56-55-3	BENZO(A)ANTHRACENE	0.06		0.06		ug/L	S32DMW30S01	1/18	0.05 - 0.16	0.06	NA	0.3	NA	NO	BSL
50-32-8	BENZO(A)PYRENE	0.08		0.08		ug/L	S32DMW30S01	1/18	0.05 - 0.16	0.08	NA	0.3	NA	NO	BSL
205-99-2	BENZO(B)FLUORANTHENE	0.05	J	0.05	J	ug/L	S32DMW30S01	1/18	0.1 - 0.16	0.05	NA	0.3	NA	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.09	J	0.09	J	ug/L	S32DMW30S01	1/18	0.1 - 0.16	0.09	NA	NA	NA	NO	NTX
207-08-9	BENZO(K)FLUORANTHENE	0.03	J	0.03	J	ug/L	S32DMW30S01	1/18	0.05 - 0.16	0.03	NA	0.3	NA	NO	BSL
218-01-9	CHRYSENE	0.04	J	0.04	J	ug/L	S32DMW30S01	1/18	0.05 - 0.16	0.04	NA	NA	NA	NO	NTX
206-44-0	FLUORANTHENE	0.04	J	0.10		ug/L	S32DMW30S01	3/18	0.1 - 1.1	0.1	NA	3700	NA	NO	BSL
86-73-7	FLUORENE	0.04	J	0.04	J	ug/L	S32DMW16S01	1/18	0.1 - 1.1	0.04	NA	140000	NA	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.06		0.06		ug/L	S32DMW30S01	1/18	0.05 - 0.16	0.06	NA	NA	NA	NO	NTX
85-01-8	PHENANTHRENE	0.03	J	0.03	J	ug/L	S32DMW30S01	1/18	0.05 - 1.1	0.03	NA	0.3	NA	NO	BSL
129-00-0	PYRENE	0.06		0.13		ug/L	S32DMW30S01	2/18	0.05 - 1.1	0.13	NA	110000	NA	NO	BSL
Pesticides/PCBs															
72-54-8	4,4'-DDD	0.019	J	0.019	J	ug/L	S32DMW30S01	1/18	0.02 - 0.021	0	NA	NA	NA	NO	NTX
50-29-3	4,4'-DDT	0.034	J	0.034	J	ug/L	S32DMW30S01	1/18	0.02 - 0.021	0.034	NA	NA	NA	NO	NTX
Total Metals															
7429-90-5	ALUMINUM	517		983		ug/L	S32DMW23D01	3/19	50.5 - 338	983	3560	NA	NA	NO	BKG
7440-38-2	ARSENIC	6.1		6.1		ug/L	S32DMW29S04	1/19	2.3	6.1	1.92	4	NA	YES	ASL
7440-39-3	BARIUM	26		170		ug/L	S32DMW28S01	9/19	4.1 - 48.5	170	227	NA	NA	NO	BKG
7440-43-9	CADMIUM	0.71		1		ug/L	S32DMW28S01	1/19	0.25 - 0.5	0.71	ND	6	NA	NO	BKG
7440-70-2	CALCIUM	6550		155000		ug/L	S32DMW16D01	19/19	0	155000	188000	NA	NA	NO	BKG
7440-47-3	CHROMIUM	15.1		25.3		ug/L	S32DMW10D01	3/19	1.3 - 6.2	25.3	49.9	110	NA	NO	BSL
7440-48-4	COBALT	4.5	J	9.4		ug/L	3MW12D	5/19	4.2 - 6	9.4	48.6	NA	NA	NO	NTX
7440-50-8	COPPER	12	J	12	J	ug/L	S32DMW30S01	1/19	3 - 6.8	12	107	48	NA	NO	BSL
7439-89-6	IRON	268		44,500		ug/L	3MW12D	15/19	37.2 - 270	44500	28200	NA	NA	NO	NTX
7439-92-1	LEAD	1.9	J	6.5		ug/L	S32DMW25S01	5/19	1.8 - 1.9	6.5	6.63	13	NA	NO	BSL, BKG
7439-95-4	MAGNESIUM	1240		47,300		ug/L	3MW12D	19/19	0	47300	191000	NA	NA	NO	BKG
7439-96-5	MANGANESE	50.9		6580		ug/L	3MW12D	17/19	5.6 - 10.2	6580	11700	NA	NA	NO	BKG
7440-02-0	NICKEL	16.1	J	26.4		ug/L	S32DMW10D01	3/19	6.3 - 9.2	26.4	32.2	880	NA	NO	BSL, BKG
7440-09-7	POTASSIUM	857		17,000	J	ug/L	3MW12D	19/19	0	17000	70800	NA	NA	NO	BKG
7440-22-4	SILVER	5.5	J	7.6	J	ug/L	S32DMW16D01	2/13	1.1 - 5.2	7.6	ND	12	NA	NO	BSL
7440-23-5	SODIUM	5700	J	447000		ug/L	3MW12D	19/19	0	447000	1900000	NA	NA	NO	BKG
7440-28-0	THALLIUM	4.4	J	4	J	ug/L	S32DMW10D01	1/19	3 - 5	4.4	ND	63	NA	NO	BSL
7440-66-6	ZINC	17		74		ug/L	S32DMW27D01	5/19	4.6 - 28.6	73.9	131	123	NA	NO	BSL, BKG
Dissolved Metals															
7440-70-2	CALCIUM, FILTERED	12200		32,500		ug/L	S32DMW16S01-F	2/2	0	32500	152000	NA	NA	NO	BKG
7440-47-3	CHROMIUM, FILTERED	8.3	J	8.3	J	ug/L	S32DMW16S01-F	1/2	6.2	8.3	16	110	NA	NO	BSL, BKG
7440-48-4	COBALT, FILTERED	4.5	J	4.5	J	ug/L	S32DMW16S01-F	1/2	4.2	4.5	43.3	NA	NA	NO	BKG
7440-50-8	COPPER, FILTERED	12.1	J	12	J	ug/L	S32DMW10D01-F	1/2	6.8	12.1	39.4	48	NA	NO	BSL, BKG
7439-89-6	IRON, FILTERED	430		8990		ug/L	S32DMW10D01-F	2/2	0	8990	25300	NA	NA	NO	BKG
7439-95-4	MAGNESIUM, FILTERED	2320		6900		ug/L	S32DMW16S01-F	2/2	0	6900	150000	NA	NA	NO	BKG

TABLE 6-6

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITES 3 AND 14
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Downstream (Site 3)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Surface Water Protection Criteria(5)	Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
7439-96-5	MANGANESE, FILTERED	320		783		ug/L	S32DMW16S01-F	2/2	0	783	9400	NA	NA	NO	BKG
7440-02-0	NICKEL, FILTERED	10	J	10	J	ug/L	S32DMW10D01-F	1/2	9.2	10.3	15.3	880	NA	NO	BSL, BKG
7440-09-7	POTASSIUM, FILTERED	2970		4000		ug/L	S32DMW16S01-F	2/2	0	4000	60000	NA	NA	NO	BKG
7440-23-5	SODIUM, FILTERED	25500	J	50,400	J	ug/L	S32DMW16S01-F	2/2	0	50400	1580000	NA	NA	NO	BKG
7440-28-0	THALLIUM, FILTERED	3	J	3	J	ug/L	S32DMW16S01-F	1/2	3	3.2	ND	63	NA	NO	BSL
Miscellaneous Parameters															
E-14506	ALKALINITY	11	J	239		mg/L	S32DMW16D01	19/19	0	239	1950	NA	NA	NO	BKG
7664-41-7	AMMONIA	0	J	1	J	mg/L	S32DMW24S01	16/18	0	1.04	ND	NA	NA	NO	NTX
000-02-0	CHLORIDE	6		813	J	mg/L	S32DMW16D01	19/19	0	813	4540	NA	NA	NO	BKG
E-11778	HARDNESS as CaCO3	23		482		mg/L	S32DMW16D01	17/18	2	482	ND	NA	NA	NO	NTX
14808-79-8	SULFATE	6		70.5		mg/L	S32DMW11S01	19/19	0	70.5	15.2	NA	NA	NO	NTX
000-09-0	TOTAL DISSOLVED SOLIDS	55	J	1,760		mg/L	S32DMW16D01	19/19	0	1760	6260	NA	NA	NO	BKG
	TOTAL ORGANIC CARBON	1		18		mg/L	S32DMW29S04	18/18	0	18	37.7	NA	NA	NO	BKG
000-08-9	TOTAL SUSPENDED SOLIDS	5	J	751		mg/L	S32DMW30S01	10/18	5	751	236	NA	NA	NO	NTX

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data .
5 Connecticut DEP Surface Water Protection criteria.
6 Connecticut DEP Volatilization criteria for residential exposures.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the CTDEP surface water protection or volatilization criteria.

Associated Samples:

S3TW0101	S32DMW10D01	S32DMW24D01	S32DMW28D01
S3TW0401	S32DMW10D01-F	S32DMW24D01-D	S32DMW28S01
S3TW1001	S32DMW11S01	S32DMW24S01	S32DMW29S04
S3TW1501	S32D[illegible]5D01	S32DMW25D01	S32DMW30S01
S3TW1701	S32[illegible]D01	S32DMW25S01	S3MW14S01
S3TW2201	S32[illegible]16S01	S32DMW26D01	S14MW01S01
S3TW2201-D	S32DMW16S01-F	S32DMW26S01	3GW12D04
S3TW2501	S32DMW23D01	S32DMW27D01	

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:

For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No Toxicity Information.

TABLE 6-7

SELECTION OF EXPOSURE PATHWAYS FOR SITES 3 AND 14
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Groundwater	Overburden/Bedrock Aquifer	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	None Quant	Construction workers may have dermal contact with groundwater during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers do not have contact with groundwater.
				Residents	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Groundwater may be used as a potable water source in the future.
					Child	Ingestion Dermal	On-Site On-Site	None None	Exposures to a child resident are less than those for an adult resident.
		Air	Overburden/Bedrock Aquifer	Construction Workers	Adult	Inhalation	On-site	None	Construction workers exposure via volatilization is expected to be insignificant due to dilution with outdoor air.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers do not have contact with site groundwater.
				Residents	Adult	Inhalation	On-site	Quant	On-site residents may be exposed to volatile from groundwater while showering.
					Child	Inhalation	On-site	None	Exposures to a child resident are less than those for an adult resident.

TABLE 6-8

EXPOSURE POINT CONCENTRATIONS FOR SITES 3 AND 14
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Groundwater	
	RME[1]	CTE[1]
	(ug/L)	(ug/L)
Volatile Organic Compounds		
Chloroform	5.72	0.96
cis-1,2-Dichloroethene	12.2	1.08
Trichloroethene	8.76	1.72
Vinyl Chloride	31.3	1.79
Semivolatile Organic Compounds		
Benzo(a)pyrene	0.08	0.031
Inorganics		
Arsenic	6.10	1.42
Thallium	4.40	1.71

Notes:
1 - The maximum detected concentration is used for the RME scenario and the average concentration is used for the CTE scenario.

TABLE 6-9

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITES 3 AND 14
REASONABLE MAXIMUM EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	2.0E-07	- -	- -	- -	0.001	- -
Adult Resident	Groundwater	Ingestion	3.8E-04	Arsenic, Vinyl Chloride	- -	Benzo(a)pyrene, Trichloroethene	2.7	Thallium
		Dermal Contact	1.3E-04	Benzo(a)pyrene	Vinyl Chloride	- -	0.02	- -
		Inhalation (1)	2.7E-04	Vinyl Chloride	- -	Trichloroethene	0.06	- -
		Total	7.8E-04	Arsenic, Benzo(a)pyrene, Vinyl Chloride	- -	Trichloroethene	2.7	Thallium

Notes:
1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

TABLE 6-10

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITES 3 AND 14
CENTRAL TENDENCY EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	2.2E-08	- -	- -	- -	0.0007	- -
Adult Resident	Groundwater	Ingestion	6.1E-06	- -	- -	Arsenic, Vinyl Chloride	0.4	- -
		Dermal Contact	7.7E-06	- -	- -	Benzo(a)pyrene	0.01	- -
		Inhalation (1)	2.2E-06	- -	- -	Vinyl Chloride	0.01	- -
		Total	1.6E-05	- -	- -	Arsenic, Benzo(a)pyrene, Vinyl Chloride	0.4	- -

Notes:
1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

LEGEND

- 3TW1 — GROUNDWATER OU RI WELL
- 2DMW25D — PHASE I MONITORING WELL
- 2DMW26D — PHASE II MONITORING WELL
- 2WSD1-1 — SEDIMENT SAMPLE
- 7TB1 — TEST BORING
- 2WSW2 — SURFACE WATER SAMPLE
- 2DSS1 — SURFACE SOIL SAMPLE
- 2DSW/SD1 — SURFACE WATER/SEDIMENT SAMPLE
- 10 — TOPOGRAPHIC CONTOUR
- 123 — BUILDING No.
- WATERCOURSE
- STM — STORM SEWER AND CATCH BASIN
- EXPOSED BEDROCK
- FENCE

NOTES

1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON AND PHASE II RI WORK PLAN, (ATLANTIC, MAY 1993).
3. *-2DMW10S AND 2DMW15S WERE NOT COMPLETED DUE TO A LACK OF GROUNDWATER. SOIL SAMPLES WERE COLLECTED FROM THESE BORINGS.
4. TW WELLS (e.g. 3TW1) WERE TEMPORARY WELLS.
5. WELL 2DMW11D WAS NOT SAMPLED SINCE IT WAS DESTROYED DURING REMEDIAL ACTIVITIES.

0 100 200
SCALE IN FEET

ACAD: 7856CM24.dwg 08/01/01 DT

REV.	DESCRIPTION	PREP BY	DATE	APPRVD

Tetra Tech N.U.S., Inc.
PITTSBURGH, PA 15220

DSGN: DC DR: DLT CH. ENG:
SUPV: OPIC:
SUBMITTED BY: (PRINCIPAL ENGINEER) (TITLE) (DATE) 8-7-01
NORTHDIV DN: HD: HD: DR:
OFFICER IN CHARGE APPROVED DATE

DEPARTMENT OF THE NAVY
NAVAL BASE
NAVAL SUBMARINE BASE, NEW LONDON

NAVAL FACILITIES ENGINEERING COMMAND
PHILADELPHIA, PA
GROTON, CONNECTICUT

NORTHERN DIVISION

SAMPLE LOCATIONS SITE 3 – AREA A DOWNSTREAM WATERCOURSES/OBDA AND SITE 14 – OBDANCE

NORTHDIV FOR COMMANDER, NAVFAC

APPROVED DATE

SEAL AREA

SAT TO DATE

CODE I.D. NO. 80091
SCALE :
SPEC. NO. 04 -
CONSTRN. CONTR. NO. N62472- -C-
NAVFAC DRAWING NO.

SHEET OF
SIZE: D
DIS. SH. NO. FIG. 6-1

LEGEND:

× 3TW1	TEMPORARY WELL
⊕ 2DMW25D	PHASE I MONITORING WELL
⊕ 2DMW26D	PHASE II MONITORING WELL
⊖ B325-MW1	SITE CHARACTERIZATION MONITORING WELL
◐ SG-4	PHASE II STAFF GAUGE
—10—	TOPOGRAPHIC CONTOUR
123	BUILDING No.
—·—·—	WATERCOURSE
—STM—⊡	STORM SEWER AND CATCH BASIN
	EXPOSED BEDROCK
—×—×—	FENCE
U	NONDETECT
J	ESTIMATED
R	REJECTED
NA	NOT AVAILABLE
ug/L	MICROGRAMS PER LITER

NOTES:

1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON AND PHASE II RI WORK PLAN, (ATLANTIC, MAY 1993).
3. * – 2DMW10S AND 2DMW15S WERE NOT COMPLETED DUE TO A LACK OF GROUNDWATER SOIL SAMPLES WERE PREVIOUSLY COLLECTED FROM THESE BORINGS DURING THE PHASE II RI.

Tetra Tech NUS, Inc. 661 ANDERSON DRIVE PITTSBURGH, PA. 15220

DSGN: DR: HJP CHK:
SUPV: CH. ENG:
SUBMITTED BY: (TITLE) (DATE)
(RISK MEDIUM)
NORTHDIV HD: HD:
DM: DR:
PRE:
OFFICER IN CHARGE DATE
APPROVED

REV.	DESCRIPTION	PREP BY	DATE	APPRVD

NAVAL FACILITIES ENGINEERING COMMAND
LESTER, PA
GROTON, CONNECTICUT

DEPARTMENT OF THE NAVY
NORTHERN DIVISION
NAVAL BASE
NAVAL SUBMARINE BASE, NEW LONDON

SITE 3 – AREA DOWNSTREAM WATERCOURSES/OBDA AND SITE 14 – OBDANE

NORTHDIV FOR COMMANDER, NAVFAC
APPROVED DATE

SEAL AREA

SAT TO DATE
CODE I.D. NO. 80091
SCALE :
SPEC. NO. 04 –
CONSTRN. CONTR. NO. N62472– –C–
NAVFAC DRAWING NO.
SHEET OF
SIZE: D
DIS. SH. NO. FIG. 6-2

ACAD: T6569GT09.dwg 02/20/01 HJP

7.0 SITE 7 – TORPEDO SHOPS

7.1 SITE DESCRIPTION

The Torpedo Shops (Site 7) are located in the northern portion of NSB-NLON on the northern side of Triton Avenue. Figure 7-1 shows the general site arrangement. The site location with respect to other IRP sites at NSB-NLON is shown on Figure 1-2. The site is bordered on the east and north by 60-foot-high bedrock cliffs. The remainder of the site slopes to the southwest towards the Area A Downstream Watercourses. An earthen berm extends along the base of the eastern portion of the exposed rock face. Three buildings (325, 450, and 477) exist at the site.

Building 325 is a torpedo overhaul facility. It was built in 1955 and had an on-site septic system until 1983, when all of the building's plumbing facilities were connected to sanitary sewers. The original septic leach field for Building 325 is located southwest of the building, adjacent to Triton Road. This leach field became clogged in 1975 and was abandoned. A new leach field (south leach field) was constructed next to the original leach field and was used until sanitary sewers were installed in 1983.

Atlantic personnel performed a visual inspection of Building 325 on March 20, 1989. According to interviews with on-site personnel, a variety of fuels, solvents, and petroleum products have been used in the building. Otto Fuel II [which comprises propylene glycol dinitrate (76 percent), 2-nitrodiphenylamine (1.5 percent), and di-n-butyl sebacate (22.5 percent) and produces hydrogen cyanide when burned], high-octane alcohol (190 proof grain alcohol), and TH-Dimer (jet rocket fuel) were observed in maintenance areas. Solvents including mineral spirits, alcohol, and 1,1,1-trichloroethane, as well as petroleum products such as motor oil and grease, were used in this building. A sink in one area was previously used for film development, and another sink was used for the overhaul of alkaline batteries. This plumbing drained into the on-site septic system until 1983. A maintenance area has a shallow sump that is covered with a flush-mounted steel grating. The area surrounding this sump was previously a washdown/blowdown area for weapons. It is not known where this sump drains, although there is a fair probability that it drains into the south leach field. Two underground No. 2 fuel oil tanks were located on the southern side of this building. One of the tanks was closed in 1995. A third tank, which was located above ground adjacent to the building, was used for temporary storage of No. 2 fuel oil but, based on field reconnaissance, had been removed as of March 15, 1995.

A smaller building attached to the east side of Building 325 was also inspected by Atlantic personnel. It was previously used as an assembly shop for torpedoes and was a paint shop at the time of the inspection. A storage closet in this building included containers of 1,1,1-trichloroethane and methyl ethyl ketone (2-butanone). Drums and cylinders were stored outside on the eastern side of this building. The

vessels were labeled as containing propane, isobutane, 2-butanone, xylot, methylene chloride, propellant, and zinc chromate. An addition to the northern side of Building 325 was under construction at the time of the Atlantic 1989 inspection and has since been completed. This addition is also used as a torpedo shop.

Building 450 is the primary MK-48 torpedo overhaul/assembly facility. It was built in 1974 and was served by its own septic system until 1983, when it was connected to sanitary sewers. Only domestic wastewater from toilets, lavatories, and showers in Building 450 had been directed to the septic field (north leach field). Torpedo overhaul/assembly operations of Building 450 generate fuels, solvents, and petroleum products as wastes. An Otto fuel and seawater mixture is drained from the torpedoes, which are then replenished with fresh fuel. The IAS Report indicated that Building 450 generates approximately 3,000 gallons of Otto fuel wastewater per month. This building was constructed with a waste collection system that collected waste products from floor drains and discharged to an underground waste tank/sump with a capacity of approximately 1,500 gallons. The waste tank was pumped periodically and the contents were disposed off site. Otto fuel product was previously stored in a 4,000-gallon underground tank south of Building 450.

Building 477, approximately 65 feet east of Building 450, was formerly used to store Otto fuel in drums. On-site personnel report that solvents including 1,1,1-trichloroethane, TCE, toluene, mineral spirits, alcohol, and bulk freon have been used at this facility. Petroleum products including TL-250 motor oil and hydraulic fluid have also been used in this building for torpedo maintenance. In the past, only domestic wastewater from toilets, lavatories, and showers in Building 450 was directed to the septic field (north system).

Atlantic personnel performed a site inspection of Building 450 on March 20, 1989. The former septic leach field is located southwest of this building in a flat, elevated area. The hazardous waste sump was no longer in use and, reportedly, was decommissioned in 1987. It was replaced with three 1,000-gallon above-ground tanks located south of the building. The floor drains were sealed and replaced with a new system for pumping waste products to the new tanks. A 4,000-gallon above-ground Otto fuel storage tank replaced the previous tank and is located south of the building. No construction is planned for the immediate future at Building 450.

7.2 SITE INVESTIGATIONS

The details of all investigations, including historical and current, conducted at the Torpedo Shops are provided in the following subsections.

7.2.1 Phase I Remedial Investigation (Atlantic, 1992)

An investigation of 11 sites was completed at NSB-NLON by Atlantic Environmental Services from 1990 through 1992. Site 7 was one of the sites investigated. The Phase I RI for this site focused primarily on subsurface soils because the source being investigated at that time was the subsurface leach fields. Atlantic personnel performed a visual inspection of Building 325 on March 20, 1989. The investigation began with a soil gas survey of the area surrounding Buildings 450 and 325. These results were used to guide the installation of monitoring wells and the collection of soil samples from the well and test borings.

Three monitoring wells were installed, including an upgradient well (7MW1) installed in bedrock, as a result of the shallow depth to bedrock in the area, and an overburden well (7MW2 and 7MW3) in each of the two leach field areas. One groundwater sample was collected from each of the monitoring wells. A field duplicate was also collected from 7MW1. The groundwater samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals (total). The field duplicate was not analyzed for pesticides/PCBs.

One surface (from a depth of less than 2 feet) and nine subsurface soil samples including one field duplicate were collected from the three monitoring well borings and six additional test borings. All soil samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals (total), and TCLP metals.

One sediment sample and one surface water sample were also collected west (downstream) of the buildings and analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals (total).

The Phase I RI concluded that there were negligible health risks associated with the Torpedo Shops and that this site should proceed to Step II of the IR Program.

7.2.2 Site Characterization Report for OT-10, Building 325 and Building 89 (B&R Environmental, 1996a)

In 1995, B&R Environmental performed an investigation to determine whether the two fuel oil tanks (R01R1 and R02) at Building 325 in the Torpedo Shop Area had impacted the soil surrounding the site. A secondary objective of the investigation was to install permanent leak detection systems at Building 325 so that environmental conditions at the site could be monitored over the lifetime of the tanks. Data from the investigation were used to support closure of Tank R01R1 and to establish that Tank R02 was operating properly and could remain in service.

During the investigation, 11 soil samples and four groundwater samples were collected and analyzed for BTEX and TPH. Soils around Tank R01R1 that were contaminated with TPH and exceeded the direct exposure cleanup standard of 500 mg/kg were excavated and removed at Building 325. The soils were replaced with clean sand and gravel fill. The investigation concluded that no further action was necessary at this site; however, continued monitoring of the groundwater was suggested.

7.2.3 Phase II Remedial Investigation (B&R Environmental, 1997a)

A Phase II RI at 13 sites at NSB-NLON was conducted by B&R Environmental from 1995 through 1997. Site 7 was one of the sites investigated in this Phase II RI. Soil sampling conducted during the Phase II RI was expanded to cover the entire area surrounding the three buildings, as well as the area downgradient of the buildings and their associated leach fields. As with the Phase I RI, the Phase II RI began with a soil gas survey. Forty-five soil gas samples were collected from a gridded area surrounding Buildings 325 and 450. All samples were field screened for acetone, benzene, freon 113, m- and p-xylenes, o-xylenes, toluene, PCE, and TCE. Soil sampling locations were then selected to collect confirmatory samples for the soil gas survey and to expand on the Phase I RI. Nineteen soil samples and two duplicates were obtained during the Phase II RI; six surface soil samples (from depths of less than 2 feet) and 13 subsurface soil samples (from depths of greater than 2 feet) were collected from eight monitoring wells and nine test borings.

Eight shallow overburden monitoring wells and three bedrock wells were installed during the Phase II RI. Each of the new wells and three previously installed wells were sampled during two rounds of sampling. Fifteen samples (including one field duplicate sample) were collected during each sampling round. All 30 groundwater samples were analyzed for TCL VOCs, TCL SVOCs, and TAL metals (total and dissolved). In addition, seven samples were analyzed for TPH, and eight samples were analyzed for BOD, COD, TOC, oil and grease (hydrocarbon fraction), hardness, suspended solids, ammonia, and total phosphorus.

A downstream surface water sample (7SW1) and two sediment samples (7SD2 and 7SD3) were collected during the Phase II RI. 7SD2 was the most upstream sediment sample, followed by 7SD3. These samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, and TAL metals (total). In addition, the two sediment samples were analyzed for grain size distribution, moisture content, specific gravity, organic content, cation exchange capacity, pH, and TOC.

Phase II RI sampling results included notable detections of contamination in soil and groundwater near the abandoned leach field. A human health risk assessment showed that non-cancer risks were below acceptable levels except for the construction worker and future resident, and cancer risks were below acceptable levels except for a hypothetical future resident. The Phase II RI recommended that further

characterization of the Torpedo Shops should be completed prior to determining whether or not the site should proceed to the FS stage.

7.2.4 Basewide Groundwater OU RI

During the BGOURI, both soil and groundwater samples were collected from Site 7 to further characterize the site. The soil and groundwater sampling and analytical program for Site 7 is summarized in Table 7-1. The sampling locations are shown on Figure 7-1. No surface soil samples were collected at Site 7 during the BGOURI; however, five subsurface soil samples were collected, four of which were analyzed for VOCs, SVOCs, and metals. The fifth sample was analyzed for groundwater fate and transport parameters (i.e., bulk density, pH, and porosity).

Thirteen overburden groundwater samples (including two field duplicate pairs) were collected from the permanent monitoring wells and analyzed for VOCs, SVOCs, metals, total dissolved solids, total suspended solids, and miscellaneous parameters during the BGOURI. One of these overburden groundwater samples was also analyzed for dissolved metals. Additionally, ten overburden groundwater samples (including one field duplicate pair) were collected from temporary monitoring wells. Seven of these samples were analyzed for VOCs only. The remaining three samples were analyzed for VOCs, SVOCs, metals, total dissolved solids, total suspended solids, and miscellaneous parameters during the BGOURI.

Groundwater samples were also collected from four permanent bedrock monitoring wells and analyzed for VOCs, SVOCs, metals, and miscellaneous parameters during the BGOURI. One of these bedrock groundwater samples was also analyzed for dissolved metals.

7.3 PHYSICAL CHARACTERISTICS

This section presents a summary of site physical characteristics for the Torpedo Shops based on information generated during the Phase I, Phase II, and BGOU RIs. Topography and surface features, surface water, soils, geology, and hydrogeology are discussed in the subsections that follow.

7.3.1 Topography and Surface Features

Figure 1-3 shows the topography and surface features of the Torpedo Shops. The Torpedo Shops site is surrounded on the north and east by an exposed bedrock cliff. The cliff is the result of quarry activity along the northern bedrock high. The ground surface slopes gently to the southwest. There is an earthen berm along the eastern boundary of the site.

Three buildings are located within the fenced area that encompasses the Torpedo Shops. Buildings 450 and 477 are located at an approximate ground elevation of 60 feet msl. Building 325 is located at a slightly lower ground elevation of approximately 50 feet msl. According to the Phase I RI Report (Atlantic, 1992), an addition was constructed on the northern side of Building 325. There are drainage swales on the southern side of Buildings 325 and 450. On the southern side of Building 450, there are three 1,000-gallon above-ground waste storage tanks and one 4,000-gallon above-ground Otto fuel storage tank.

7.3.2 Surface Water Features

Surface runoff from the Torpedo Shops flows southwestward to drainage swales and storm sewers located on the southern side of Buildings 325 and 450. Runoff contained by the berm, as well as the storm sewer system, drains through culverts under Triton Avenue into the Area A Downstream Watercourses and eventually into the Thames River.

7.3.3 Soil Characteristics

The SCS Soils Map (SCS, 1983) classifies the soil at the Torpedo Shops as Udorthents-Urban land. This soil type is defined as excessively drained to moderately drained soils that have been disturbed by cutting and filling. The area within and outside the Torpedo Shops has a history of quarrying and filling activity. Native soils have been replaced by fill.

7.3.4 Geology and Hydrogeology

Geology

The geology of the Torpedo Shops consists of a southwestward-thickening wedge of overburden materials overlying metamorphic bedrock. The surficial deposits underlying Site 7 consist of fill material that varies in thickness from 2 to 10 feet. The fill consists primarily of sand and gravel. The fill either lies directly on bedrock (in the northeastern portion of the site) or is underlain by up to 30 feet of silty sand (along the southwestern edge of the site). The Torpedo Shops area has a history of quarrying and filling; therefore, the silty sand is natural alluvium.

The Torpedo Shops area is bordered to the north and east by a steep bedrock escarpment. In the northeastern portion of the site, the bedrock surface is relatively flat and has a mild slope toward the southwest. The bedrock surface in this area has been altered by quarry activity. Overburden thickness is typically less than 6 feet in this area (7TB8, 7TB9, 7TB10, 7TB12, 7TB13, 7MW7S, and 7MW2D). Southwest of 7MW7S and 7MW2D and southeast of 7TB10, the bedrock slopes to the west and

southwest more steeply from elevations of 40 to 45 feet msl to elevations of 15 to 20 feet msl. The overburden thickness increases to 30 to 40 feet in this area (7TB15, 7MW3D).

The bedrock at the Torpedo Shops has been identified as the Mamacoke Formation. The bedrock surface between 7MW1D and 7MW7S slopes at a grade of approximately 2 percent. The bedrock surface between 7MW7S and 7MW3D slopes at a steeper grade of approximately 14 percent. Figures 4-8 and 4-9 show subsurface cross sections that pass through portions of Site 7.

Hydrogeology

Groundwater was encountered in both the overburden and bedrock underlying the Torpedo Shops. Depths to groundwater average less than 10 feet across the site. Within the overburden, the water table was generally encountered near the fill/alluvium interface, where both units were present. Figures 4-2 and 4-4 show the overburden groundwater flow pattern across the Torpedo Shops, based on June and August 2000 water-level data (Tables 2-2 and 2-3). The general direction of shallow groundwater flow is to the west-southwest, toward the Area A Downstream Watercourses. Groundwater flow directions in the shallow bedrock, based on data from wells 7MW1D, 7MW2D, 7MW4S, 7MW5D, and 7MW7S, which are screened in the bedrock, are to the west and southwest (Figures 4-3 and 4-5). In the overburden, the hydraulic gradient across the site is approximately 0.02. Within the bedrock, the flow gradient appears to be slightly lower, at 0.015.

Downward vertical gradients were consistently observed at the Torpedo Shops. Well clusters 7MW2S/2D (alluvium/bedrock), 7MW3S/3D (combined fill and alluvium/deep alluvium), and 7MW5S/5D (combined overburden and bedrock/deeper bedrock) all had downward vertical gradients, indicating that the Torpedo Shops area is a local recharge area for groundwater.

Slug tests have been performed in three alluvium and 2 bedrock wells at Site 7 over the course of the various RI field investigations. The estimated site-specific average hydraulic conductivity for the alluvium, based on the slug test results, is 11.4 ft/day. Using a hydraulic gradient of 0.02 and a measured porosity of 0.37, the estimated groundwater seepage velocity in the alluvium at the site is 0.62 ft/day. The hydraulic conductivity value is somewhat higher than the overall average hydraulic conductivity calculated for the alluvium; therefore, the seepage velocity may be somewhat overestimated.

7.4 NATURE AND EXTENT OF CONTAMINATION

This section presents an evaluation of the nature and extent of soil and groundwater contamination at Site 7. The discussion includes historical soil and groundwater data collected during the Phase I and Phase II RIs and soil and groundwater (total and dissolved) data collected during the BGOURI.

7.4.1 Historic Site Investigations

Soil and groundwater sampling was conducted at the Torpedo Shops site during the Phase I and Phase II RIs. Based upon the results of these investigations, the nature and extent of contamination of the soil and groundwater at the Torpedo Shops are discussed on a matrix-specific basis in the following subsections. The complete analytical database for historic soil and groundwater samples is contained in Appendix D, which presents descriptive statistics and associated COPC screening criteria for each analyte detected at least once in soil and groundwater samples collected from the Torpedo Shops.

7.4.1.1 Soil

Nine VOCs, including three chlorinated aliphatics, three monocyclic aromatics, two ketones, and carbon disulfide, were detected in the soil samples. Most were detected infrequently and at low concentrations. Methylene chloride, a common laboratory contaminant, was detected most frequently (in 14 of 27 samples) at concentrations ranging from 0.003 mg/kg to 0.42 mg/kg. Benzene, toluene, and total xylenes were each detected in from one to six of 37 samples at concentrations ranging from 0.0005 mg/kg to 0.011 mg/kg. 1,1-Dichloroethene, 2-butanone, acetone, carbon disulfide, and PCE were each detected in from one to five of 27 samples. With the exception of acetone, which was detected at a maximum concentration of 0.17 mg/kg, these remaining VOCs were detected at trace concentrations, ranging from 0.003 mg/kg to 0.032 mg/kg.

Twenty-five SVOCs, including 17 PAHs, four phthalate esters, 4-methylphenol, benzoic acid, carbazole, and dibenzofuran, were detected in soil samples collected from the Torpedo Shops site. PAHs were detected most frequently and, with one exception, at the greatest concentrations. Reported concentrations of PAHs ranged from 0.018 mg/kg (fluoranthene) to 4.3 mg/kg (phenanthrene). Diethyl phthalate was detected at a concentration of 14 mg/kg in the soil sample collected at a depth interval of 1 to 3 feet bgs from boring 7MW7S, located along the drainage swale south of Building 450. Maximum concentrations of nine SVOCs (all PAHs) were associated with the soil sample collected from a depth interval of 1 to 3 feet bgs from test boring 7TB10, located south of Building 325. Maximum concentrations of an additional nine SVOCs were associated with the soil sample collected from a depth interval of 1 to 3 feet bgs from well boring 7MW4S, located near the southeastern corner of Building 325.

Eight pesticides and one PCB were detected in the Torpedo Shops soil samples. 4,4'-DDT and its breakdown products, 4,4'-DDD and 4,4'-DDE, were detected most frequently, with each being detected in four or five of 23 samples. Concentrations of these three pesticides ranged from 0.0044 mg/kg to 0.21 mg/kg. Aroclor 1254 was detected in a single soil sample, collected at a depth interval of 2 to 4 feet bgs from well boring 7MW2S, at a concentration of 0.66 mg/kg. Endrin ketone (0.0068 mg/kg),

heptachlor (0.0047 mg/kg), and methoxychlor (0.032 mg/kg) were detected in the soil sample collected from a depth interval of 1 to 3 feet bgs from well boring 7MW4S, located near the southeastern end of Building 325. The remaining two pesticides (endosulfan sulfate and endrin aldehyde) were each detected in two samples at concentrations ranging from 0.0055 mg/kg to 0.035 mg/kg.

Twenty-three metals were detected in the Torpedo Shops soil samples, although mercury, selenium, and thallium were each detected in from only one to five of 27 samples. Maximum concentrations of 11 metals were detected in the soil sample collected from a depth interval of 5 to 7 feet bgs from well boring 7MW6S, located along the western side of Building 325.

TCLP extraction followed by analysis for metals was performed for 10 soil samples collected from the Torpedo Shops site. In addition, the TCLP leachate of one of these samples was also analyzed for TCLP organics (VOCs, SVOCs, pesticides, and herbicides). No organic compounds were detected in this leachate. Arsenic, barium, cadmium, and selenium were detected in the TCLP leachate samples. Barium was detected in all 10 leachates at concentrations ranging from 0.145 mg/L to 0.49 mg/L. Arsenic was detected in seven of the leachates at concentrations ranging from 0.13 mg/L to 0.38 mg/L. Selenium was detected in two leachates at concentrations of 0.11 mg/L and 0.14 mg/L, and cadmium was detected in a single leachate at a concentration of 0.0095 mg/L.

TPH was detected in 12 of 20 soil samples at concentrations ranging from 28 mg/kg to 898 mg/kg. The maximum TPH concentration was detected in the soil sample collected from a depth interval of 4 to 8 feet bgs from well boring 7MW8S, located along Triton Road in the western portion of the site. Analyses for TOC were performed for five soil samples. Reported results for these five samples range from 2,740 mg/kg to 18,800 mg/kg.

7.4.1.2 Groundwater

Groundwater samples from both overburden and bedrock wells were collected at the Torpedo Shops site.

Overburden Wells

Eight VOCs, including six chlorinated aliphatics, 2-butanone, and carbon disulfide, were detected in groundwater samples collected from the Torpedo Shops overburden wells. 1,1,1-Trichloroethane and 1,1-dichloroethane were each detected in six of 20 groundwater samples, at concentrations ranging from 2 µg/L to 42 µg/L. 1,1-Dichloroethene was detected in four groundwater samples at concentrations ranging from 1 µg/L to 2 µg/L. The remaining VOCs were detected in one or two samples at concentrations ranging from 1 µg/L to 10 µg/L. Maximum concentrations of all VOCs except 2-butanone,

chlorobenzene, and methylene chloride were associated with samples collected from well 7MW3S, located west of Building 325 in the south leach field.

Thirteen SVOCs, including six PAHs, three phthalates, 1,4-dichlorobenzene, benzoic acid, dibenzofuran, and phenol, were detected in the 20 groundwater samples collected from overburden wells. Benzoic acid and di-n-butyl phthalate were detected in six and four samples, respectively. The remaining SVOCs were each detected in only one or two of 20 samples. With the exception of bis(2-ethylhexyl)phthalate, which was detected in a single groundwater sample at a concentration of 380 µg/L, all SVOC concentrations ranged from 0.5 µg/L to 9 µg/L. Maximum concentrations of eight SVOCs were associated with groundwater samples collected from well 7MW8S, located along Triton Road in the western portion of the site.

The two groundwater samples collected during the Phase I RI were analyzed for pesticides and PCBs. Neither pesticides nor PCBs were detected in either of these samples.

Twenty-two metals were detected in unfiltered groundwater samples collected from the overburden wells, and 15 metals were detected in the corresponding filtered groundwater samples. In general, maximum concentrations reported for metals in unfiltered and filtered samples were relatively similar (i.e., at the same order of magnitude). Close to half of the maximum concentrations of metals were associated with groundwater samples collected from well 7MW3D, located near Triton Road and west of the south leach field. Notable results include the maximum concentrations reported for antimony (108 µg/L), manganese (1,780 µg/L), and silver (38.9 µg/L).

Analyses for oil and grease were performed for four of the groundwater samples, resulting in a concentration of 600 µg/L reported for one sample (from well 7MW3D). TPH analyses were performed for nine of the groundwater samples collected from overburden wells. TPH was detected in two samples (both collected from well 7MW8S) at concentrations of 700 µg/L and 1200 µg/L. This well is located along Triton Road, downstream of the three buildings.

Analyses for COD, hardness, total phosphorus, and TSS were also performed for selected groundwater samples collected from the overburden wells.

Bedrock Wells

Minimal organic contamination was detected in the groundwater samples collected from the Torpedo Shops bedrock wells. 1,1,1-Trichloroethane (2 µg/L), methylene chloride (1 µg/L), benzoic acid (0.7 µg/L), and phenol (0.8 µg/L) were detected in one or the other of two samples collected from well 7MW5D. 4-Methyl-2-pentanone (21 µg/L) was detected in a groundwater sample collected from well

7MW4S, methylene chloride (1 µg/L) was detected in a groundwater sample collected from well 7MW2D, and total xylenes (1.2 µg/L) was detected in a groundwater sample collected from well B325-MW2. No other VOCs, SVOCs, pesticides, or PCBs were detected in the groundwater samples collected from Torpedo Shops bedrock wells.

Twenty-four metals were detected in unfiltered groundwater samples collected from the bedrock wells, and 14 metals were detected in the corresponding filtered groundwater samples. Maximum concentrations reported for barium, copper, iron, lead, and zinc in unfiltered samples were more than five times greater than maximum concentrations of respective metals reported for filtered samples. This indicates that concentrations of these metals in the unfiltered samples may be caused by the presence of suspended sediments and may not actually represent contamination of the groundwater. More than half of the maximum concentrations of metals were associated with groundwater samples collected from well 7MW5D, located near the southwestern corner of Building 450. In addition, several maximum concentrations were associated with groundwater samples collected from well 7MW4S, located near the southeastern corner of Building 325. Notable results include the maximum concentrations reported for aluminum (56,200 µg/L), arsenic (112 µg/L), barium (585 µg/L), chromium (104 µg/L), copper (797 µg/L), manganese (7830 µg/L), nickel (94 µg/L), and zinc (412 µg/L).

Analyses for ammonia, COD, hardness, TOC, total phosphorus, and TSS were also performed for selected groundwater samples collected from the bedrock wells.

7.4.2 Basewide Groundwater OU RI

A summary of the BGOURI sampling and analytical program for Site 7 is presented in Table 7-1. A complete summary of the Site 7 analytical data set is provided in Appendix B. Table 7-2 presents a summary of positive soil analytical results for Site 7. Table 7-3 presents a summary of positive groundwater (total and dissolved) analytical results for temporary monitoring wells at Site 7, and Table 7-4 presents a summary of positive groundwater (total and dissolved) analytical results for permanent monitoring wells at Site 7.

COPCs selected through the risk assessment screening process are summarized in Tables 7-5 (direct contact exposures) and 7-6 (potential migration pathways). As part of the HHRA, descriptive statistics (i.e., frequency of detections, minimum and maximum concentrations, range of detection limits, and the associated sample numbers) and the COPC screening criteria for each analyte detected at least once in groundwater at Site 7 were tabulated. Analytical results for soil samples are summarized and screened in Tables 7-7 and 7-8 (surface soils) and Tables 7-9 and 7-10 (subsurface soils). Analytical results for groundwater are summarized and screened in Tables 7-11 and 7-12. Different exposure scenarios (i.e., direct exposure and migration) are considered in each table. Tag maps of the chemicals determined to

be COPCs based on the screening assessment were created to show the horizontal extent of contamination. Figures 7-2 (soil inorganics), 7-3 (soil organics), and 7-4 (groundwater) show COPCs that exceeded direct exposure or migration screening criteria. The analytical detection limit for COPCs is presented on the tag maps if the COPC was not detected in a sample.

Figures 7-2 and 7-3 show both the historical soil data and the soil data collected as part of the BGOURI field investigation. Since soil data is not as dynamic as groundwater data, it is believed that the soil data sets can be combined for the assessment of risks. In contrast, only the most recent groundwater data collected during the BGOURI is presented on Figure 7-4 because groundwater conditions are more dynamic.

7.4.2.1 Soil Samples

2-Butanone, acetone, carbon disulfide, chlorobenzene, and toluene were detected in the four subsurface soil samples. These compounds were detected in from two to three of four samples. The maximum detected concentrations of these compounds were less than both the direct contact screening criteria and the CTDEP pollutant mobility criteria.

Pyrene was the only detected SVOC and it was detected only in sample S7SB100607 at a concentration of 25 µg/L. This concentration is below both the direct contact criteria and the CTDEP pollutant mobility criteria.

Twenty metals were detected in the four BGOURI soil samples. Eighteen of these 20 metals were detected in all four samples. Antimony was detected in only two of four samples and thallium was detected only in sample S7SB100607. Most of the maximum detected concentrations of these 20 metals were in samples S7SB090809 and S7SB100607. Of the detected metals, the maximum detected concentrations of antimony, arsenic, copper iron, lead, and potassium were less than background, and the maximum detected concentrations of the remaining metals were in excess of background. Only maximum detected concentrations of manganese and thallium were additionally in excess of direct contact screening criteria. None of the metals detections were present at concentrations in excess of the CTDEP pollutant mobility criteria.

7.4.2.2 Temporary Overburden Wells

1,4-Dichlorobenzene, benzene, and chlorbenzene were the only VOCs detected in the 10 temporary monitoring wells. 1,4-Dichlorobenzene was detected in samples S7TW0801, S7TW0901, and S7TW1001 at concentrations of 1.83 µg/L, 9.21 µg/l, and 90.5 µg/L, respectively. Benzene was detected in only sample S7TW1001 at a concentration of 2 µg/L. Chlorobenzene was detected in samples

S7TW0901 and S7TW1001 at concentrations of 6.66 µg/L and 165 µg/L, respectively. The maximum detected concentrations of these VOCs were all in excess of their respective direct contact screening criteria but did not exceed any CTDEP pollutant migration criteria. The potential sources of VOCs are discussed further in Section 7.5.2.1.

Three of the 10 temporary monitoring wells were analyzed for SVOCs. Bis(2-ethylhexyl)phthalate was the only SVOC detected in the temporary monitoring wells. Bis(2-ethylhexyl)phthalate was detected in samples S7TW0801 and S7TW0901 at concentrations of 44 µg/L and 49 µg/L, respectively. These concentrations of bis(2-ethylhexyl)phthalate were in excess of direct contact screening criteria but not in excess of CTDEP pollutant mobility criteria.

Three of the 10 temporary monitoring wells were also analyzed for total metals. Seventeen metals were detected in the groundwater samples collected from Site 7 temporary monitoring wells. Maximum detected concentrations of all these metals were found in S7TW0901. Arsenic, barium, chromium, cobalt, copper, nickel, silver, vanadium, and zinc were detected in only S7TW0901. Calcium, magnesium, manganese, potassium, and sodium were detected in all three samples. Aluminum, iron, and lead were detected in two of three samples. Of these detected metals, aluminum, arsenic, barium, chromium, iron, lead, nickel, silver, vanadium, and zinc were detected at concentrations in excess of background. In addition, aluminum, arsenic, barium, chromium, iron, lead, and vanadium were detected at concentrations in excess of direct contact criteria. Arsenic, barium, lead, silver, and zinc were also present at concentrations in excess of CTDEP pollutant mobility criteria. The total suspended solids content in sample S7TW0901 was two orders of magnitude higher than in the other two samples; this may account for the elevated levels of metals in this sample.

7.4.2.3 Permanent Overburden Wells

1,3-Dichlorobenzene, 1,4-dichlorobenzene, and TCE were the only VOCs detected in the 13 permanent overburden monitoring wells. 1,3-Dichlorobenzene and 1,4-dichlorobenzene were detected only in S7MW03S01 at 2 µg/L, which is in excess of the direct contact criteria for these compounds. However, the concentrations of these compounds were not in excess of CTDEP pollutant mobility criteria. TCE was detected in S7B325MW0101, S7B325MW0301, S7MW07S01, and S7MW09S01 at concentrations of 1.93 µg/L, 1.39 µg/L, 2.03 µg/L, and 23 µg/L, respectively. The majority of these TCE concentrations were in excess of the 1.6 µg/L direct contact screening criteria. However, these concentrations were well below the CTDEP pollutant mobility criteria.

Bis(2-ethylhexyl) phthalate, fluorene, hexachlorobenzene, and phenanthrene were the only SVOCs detected in these 13 monitoring wells. Bis(2-ethylhexyl) phthalate and phenanthrene were detected in only sample S7MW08S01, at concentrations of 190 µg/L and 6.5 µg/L, respectively. Hexachlorobenzene

was detected only in sample S7MW09S01 at a concentration of 3 µg/L. Fluorene was detected in samples S7MW05S01 and S7MW08S01 at concentrations of 0.26 µg/L and 6.5 µg/L, respectively. Concentrations of bis(2-ethylhexyl) phthalate and hexachlorobenzene were in excess of both direct contact criteria and CTDEP pollutant mobility criteria. The concentration of phenanthrene was in excess of only the CTDEP pollutant mobility criteria. Concentrations of fluorene were below both direct contact criteria and CTDEP pollutant mobility criteria.

Seventeen inorganics were detected in the unfiltered groundwater samples collected from Site 7 permanent bedrock monitoring wells. Maximum detected concentrations of these metals were scattered among the 13 wells. Arsenic, cadmium, chromium, selenium, and vanadium were detected in only one of 13 samples. Aluminum, copper, iron, and lead were detected in from four to five of 13 samples. Barium, cobalt, and zinc were detected in eight of 13 samples. Manganese was detected in eleven of thirteen samples. Calcium, magnesium, potassium, and sodium were detected in all thirteen samples. Of these detected metals, arsenic, cadmium, lead, selenium, and zinc were detected at concentrations in excess of background. In addition, arsenic, which was detected at a concentration of 2.9 µg/L, is in excess of direct contact criteria but not in excess of CTDEP pollutant mobility criteria. Zinc, which was detected at a maximum concentration of 194 µg/L, was the only analyte present at a concentration in excess of CTDEP pollutant mobility criteria.

The field duplicate pair (S7MW10S01-F and S7MW10S01-F-D) was filtered and analyzed for dissolved metals. Barium, calcium, copper, magnesium, potassium, sodium, and zinc were detected in this field duplicate pair. Concentrations of these metals were all below background, direct contact criteria, and CTDEP pollutant mobility criteria. Concentrations of barium and copper were higher in the filtered analyses than in the total analysis. Concentrations of the remaining metals were similar in both the total and dissolved analyses.

7.4.2.4 Permanent Bedrock Wells

TCE was the only VOC detected in the four bedrock groundwater samples collected. TCE was detected in samples S7MW01D01, S7MW02D01, and S7MW05D01 at concentrations of 4.09 µg/L, 1.54 µg/L, and 7.58 µg/L, respectively, which are all in excess of direct contact criteria but below CTDEP pollutant mobility criteria. TCE was also detected in overburden groundwater samples.

No semivolatiles were detected in the bedrock groundwater samples at Site 7.

Eleven metals were detected in the unfiltered groundwater samples collected from the bedrock aquifer at Site 7. The majority of the maximum detected concentrations of these 11 metals were divided between samples S7MW03D01 and S7MW05D01. Calcium, magnesium, potassium, and sodium were the only

metals detected in all four bedrock groundwater samples. Copper and nickel were only detected in sample S7MW05D01. The remaining detected metals were present in from two to three of the four samples collected. The concentrations of lead, nickel, and zinc were in excess of background but were below their respective direct contact screening criteria. Only the maximum detected concentration of zinc (157 µg/L in S7MW01D01) was in excess of CTDEP pollutant mobility criteria. The total dissolved solids and total suspended solids contents in samples S7MW03D01 and S7MW05D01 were similar and were higher than those of the other two bedrock monitoring wells.

Sample S7MW01D01-F was filtered and analyzed for dissolved metals. Calcium, magnesium, manganese, potassium, sodium, and zinc were the only dissolved metals detected in this sample. The concentrations of these dissolved metals were similar to those detected in the total metals analysis of this sample. Concentrations of these metals were all below background, direct contact criteria, and CTDEP pollutant mobility criteria.

7.5 CONTAMINANT FATE AND TRANSPORT

7.5.1 Chemical-Specific Evaluation

Nine classes of chemicals were detected in soil and groundwater samples collected at Site 7 in the Phase II RI and BGOURI. These classes were distributed as follows:

- Surface Soil - monocyclic aromatics, halogenated aliphatics, PAHs, metals.
- Subsurface Soil - ketones, monocyclic aromatics, halogenated aliphatics, PAHs, pesticides, PCBs, phthalate esters, and metals.
- Groundwater - monocyclic aromatics, halogenated aliphatics, PAHs, phthalate esters, metals, and miscellaneous volatiles (carbon disulfide).

Ketones

Two ketones (acetone and 2-butanone) were detected in subsurface soil at Site 7 at concentrations well below screening levels. These ketones were also detected in surface and subsurface soil samples in the Phase II RI. The presence of ketones at the site is likely a result of their use as solvents. 2-Butanone was found in storage drums at the site in previous investigations. One ketone, 4-methyl-2-pentanone, was detected in one groundwater sample in the Phase II RI. Ketones are highly volatile and soluble and do not readily adsorb to soil. The fact that ketones were not detected in surface soil at Site 7 is in keeping with the nature of ketones, which would be expected to volatilize from surface soil or to migrate

to subsurface soil as leachate in rainwater. Hydrolysis is generally not a significant fate process for this class of chemicals nor is bioconcentration significant. Once in the groundwater, ketones may slowly degrade. Acetone and 2-butanone are also common laboratory and field contaminants often detected in environmental samples.

Monocyclic Aromatic Compounds

Several types of monocyclic aromatic compounds were detected at Site 7 in the Phase II RI and in the BGOURI. Fuel-related compounds (i.e., benzene, toluene, and xylenes) were detected in soil and groundwater. Chlorinated aromatics (mono- and di-chlorobenzenes) were detected in subsurface soil and groundwater, and hexachlorobenzene was detected in groundwater. The fact that chlorobenzenes were only detected in subsurface soil and groundwater indicates that these constituents were probably released directly to the subsurface, from the septic systems, for example. 4-Methylphenol (p-cresol) was detected in subsurface soil. Hexachorobenzene was detected in two of 20 groundwater samples in the BGOURI but was not detected in the Phase II RI. The monocyclic aromatics were generally detected at low frequencies. For example, benzene was detected in two of 35 subsurface soil samples. With the exception of hexachlorobenzene, the monocyclic aromatic compounds detected at Site 7 are not considered to be persistent in the environment, particularly in comparison to chemicals such as PAHs and PCBs. They may migrate through the soil column when solubilized by infiltrating precipitation. Some portion of these chemicals is retained by the soil, but most of them will continue migrating downward until they reach the water table. Bioconcentration in aquatic animals is not expected to be significant for monocyclic aromatics. They are subject to degradation via the action of both soil and aquatic microorganisms. Although these compounds are amenable to microbial degradation, it is not anticipated that degradation will occur at an appreciable rate, although macronutrient availability is not known.

The source of hexachlorobenzene at Site 7 has not been identified. It may have been released to the environment from its use as a fungicide or it may have been released to the environment as a waste product in the production of several chlorinated hydrocarbons and pesticides. Hexachlorobenzene is expected to be immobile in soils, based upon log K_{oc} values in the range of 3.6 to 5.5 measured in soils and sediment. Volatilization of hexachlorobenzene from dry soil surfaces is not expected based upon the vapor pressure of this compound. Volatilization from moist soil surfaces is expected based on the Henry's Law constant of 1.32×10^{-3} atm-m^3/mole at 25ºC, but this process may be attenuated due to adsorption. Hexachlorobenzene is not expected to biodegrade based on a measured half-life in soil of over 1,500 days. In water, hexachlorobenzene is expected to adsorb to sediment or particulate matter based on its high measured K_{oc} values. This compound is expected to volatilize from water surfaces given its Henry's Law constant, but adsorption may offset this process. Estimated volatilization half-lives for a model river and model lake are 7 and 180 hours, respectively, when neglecting adsorption. The volatilization half-life from a model pond (2 m deep) is approximately 5 years if adsorption is considered.

Biodegradation is not expected in water based on aerobic and anaerobic biodegradation half-lives on the order of several years in fresh waters. Bioconcentration in aquatic organisms is very high based on BCF values in the range of 1,600 to 20,000 measured in fish.

The occurrence, possible sources and transport processes, of 1,3- and 1,4-dichlorobenzene, chlorobenzene, and benzene are discussed in Section 7.5.2.1, "Chemicals of Concern."

Halogenated Aliphatics

Several halogenated aliphatics (e.g., TCE and PCE) were detected in soil and groundwater at Site 7 in both the BGOURI and the Phase II RI. These constituents were found mainly in subsurface soil and groundwater. Only one halogenated aliphatic, methylene chloride, was detected in surface soil at concentrations ranging from 3 to 14 µg/kg. Methylene chloride is also a common laboratory contaminant and its presence may be attributable to laboratory contamination. Halogenated aliphatic hydrocarbons are relatively water soluble and have a low capacity for retention by soil organic carbon. Therefore, they are frequently detected in groundwater. They may migrate through the soil column after being released by a spill event or by a subsurface release when solubilized by infiltrating precipitation. Some portion of halogenated aliphatic may be retained by the soil, but most of the chemical will continue migrating downward until it reaches the water table. At that time, migration is primarily with the hydraulic gradient. The most recent data collected at the site do not indicate that significant migration of halogenated aliphatics has occurred because they were detected at low frequencies in soil and groundwater samples. They can migrate to surface water and sediment, but attenuation and dilution factors, such as volatilization, generally result in their disappearance. It does not appear that appreciable degradation of halogenated aliphatics has occurred at Site 7 since few degradation products have been detected. Only one potential degradation product of PCE and TCE, 1,1-DCE, was detected in 1 subsurface soil sample in the Phase II RI. No degradation products were detected in groundwater in the BGOURI, although several degradation products were detected in groundwater during the Phase II RI, at low frequencies.

Polynuclear Aromatic Hydrocarbons (PAHs)

Low-molecular-weight and high-molecular-weight PAHs were detected in surface and subsurface soil samples at Site 7. Only low-molecular-weight PAHs (phenanthrene and fluorene) were detected in BGOURI groundwater samples. The occurrence of the low-molecular-weight and high-molecular-weight PAHs is similar to findings of the Phase II RI. As in the Phase II RI, the maximum BGOURI concentrations of PAHs in subsurface soil were reported in shallow subsurface soil samples (i.e., 1 to 4 feet bgs). PAHs are generally considered to be fairly immobile in the environment. As noted in Section 3.3, PAHs have very low solubilities, vapor pressures, and Henry's Law constants and high K_{oc}s and K_{ow}s. The low-molecular-weight PAHs (e.g., acenaphthene, anthracene, fluorene, and phenanthrene) are

more mobile (higher solubilities, etc.) than the high-molecular-weight PAHs [e.g., benzo(a)pyrene, benz(a)anthracene, chrysene, etc.]. PAHs in soil are much more likely to bind to soil and be transported via mass transport mechanisms than go into solution. PAHs can be degraded via aerobic bacteria, but may be relatively persistent in the absence of microbial population or macronutrients such as phosphorous and nitrogen.

Polychlorinated Biphenyls (PCBs)

One PCB, Aroclor 1254, was detected in one subsurface soil sample at Site 7 in the Phase II RI but was not detected in the BGOURI. The source of the PCB has not been established. No PCBs were detected in surface soil or groundwater. PCBs are considered to be very persistent organic chemicals. In soil, Aroclor 1254 will become tightly adsorbed to the soil particles. In the presence of organic solvents, Aroclor 1254 will have a greater tendency to leach through soil. Screening studies indicate that Aroclor 1254 is susceptible to biodegradation in soils. Biodegradation is the only process known to transform PCBs under environmental conditions, and only the lighter compounds are measurably biodegraded. Although the volatilization rate of Aroclor 1248 may be low from soil surfaces due to tight adsorption and low vapor pressure, the total loss by volatilization over time may be significant because of the persistence and stability of Aroclor 1254. Volatilization from water surfaces is expected to be an important fate process based upon Aroclor 1254's estimated Henry's Law constant values ranging from 2.2×10^{-4} to 3.4×10^{-4} atm-m^3/mole. Estimated volatilization half-lives for a model river and model lake will range from 5.5 to 6.2 hours and 8.8 to 9.4 days, respectively. However, volatilization from water surfaces is expected to be offset by adsorption to suspended solids and sediment in the water column. Aroclor 1254 is expected to undergo anaerobic biodegradation in sediments. Aroclor 1254 is known to bioconcentrate significantly in aquatic organisms, with measured BCFs ranging from 26,000 to 102,000 L/kg.

Pesticides

Eight pesticides were detected in soil at Site 7. 4,4'-DDT and its metabolites were detected most frequently (5 of 21 samples). Most of the pesticide detections occurred in surface soil samples collected in the Phase II RI. Five of the pesticides (endosulfan sulfate, endrin aldehyde, endrin ketone, heptachlor, and methoxychlor) were detected in one or two samples in the Phase II RI but not in the BGOURI. Whether pesticides are sprayed, dusted, or applied directly to the soil, the soil is the ultimate sink for these chemicals. They are expected to be generally immobile or only slightly mobile in soil. Surface soil runoff may carry pesticides to adjacent surface water bodies where adsorption to sediment is expected to be a major fate process. Pesticides have been detected in groundwater in the United States, indicating that movement to groundwater can occur. Soil volatility tests have found that some pesticides can volatilize significantly from soil surfaces, particularly moist soil surfaces; however, shallow incorporation into soil will greatly restrict volatile losses. They are highly lipophilic and therefore readily bioaccumulate.

Phthalate Esters

Four phthalate esters were detected in soil samples at Site 7 in the Phase II RI but none were reported in samples collected in the BGOURI. One phthalate, bis(2-ethylhexyl) phthalate was detected in shallow groundwater samples in the Phase II RI and the BGOURI at low frequencies. Phthalate esters are considered to be relatively persistent chemicals in the environment. Volatilization is not expected to be an important process from wet or dry soil surfaces based on vapor pressures and Henry's Law constants for these compounds. Biodegradation is expected to be an important process in both water and soil under aerobic conditions. If released into water, soil/sediment K_{oc} values indicate that bis(2-ethylhexyl) phthalate will adsorb to suspended solids and sediment in the water column. Volatilization from water surfaces is not expected to occur based upon the estimated Henry's Law constant. Measured BCFs for phthalates indicate bioconcentration in aquatic organisms will be high. However, experiments with rainbow trout showed that the majority of bis(2-ethylhexyl) phthalate did not reach the systemic circulation of the fish but was present in the exposure water as metabolites as a result of presystemic branchial metabolism of this compound. If released to air, phthalates will exist in both the vapor and particulate phases in the ambient atmosphere. The vapor phases will be degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals. Particulate-phase phthalates will be physically removed from the atmosphere by wet and dry deposition. Phthalates are also common laboratory and field blank contaminants, and their presence may be the result of equipment or laboratory contamination.

Metals

Twenty-three metals were detected in soil and groundwater at Site 7. As noted in Section 3.3, metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. The major fate mechanisms for metals are adsorption to the soil matrix (as compared to being part of the soil structure) and bioaccumulation.

Under normal conditions, metals are not very mobile in the environment. Because metals frequently remain bound to particulate matter, the major transport mechanism for metals is bulk movement processes (erosion). However, metals can become mobile in the environment under certain conditions. The mobility of metals is influenced primarily by their physical or chemical properties, in conjunction with the physical and chemical properties of the soil matrix. Factors that assist in predicting the mobility of metals are the soil/pore water pH, REDOX potential, and cation exchange capacity. The mobility of metals generally increases with decreasing soil pH and cation exchange capacity. The effect of REDOX potential varies for each metal.

7.5.2 Natural Attenuation Evaluation

This section contains the site-specific natural attenuation evaluation. The procedure used to conduct the evaluation is summarized in Section 3.3.4. This evaluation is preliminary, and it is understood that additional data collection activities and data evaluation would be necessary prior to selecting monitored natural attenuation as a remedial alternative.

As stated in Section 3.3.4, the goals of the assessment are as follows:

- To determine if natural attenuation of petroleum and chlorinated hydrocarbons is currently occurring in the groundwater.
- To determine the process by which natural attenuation is occurring in the groundwater.
- To determine if natural attenuation and/or bioremediation are viable processes for remediation of petroleum and chlorinated hydrocarbons in the groundwater.

The three lines of evidence that can be used to estimate natural attenuation of petroleum and chlorinated hydrocarbons are as follows:

- Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points.
- Hydrogeological and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the site, and the rate at which such processes will reduce contaminant concentrations to required levels.
- Data from field or microcosm studies that directly demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern.

The first and second lines of evidence are used to assess natural attenuation in this RI. The following natural attenuation evaluation is segregated into three subsections (i.e., hydrogeology, chemicals of concern, and geochemical). These three subsections provide the necessary information to prove or disprove that natural attenuation is occurring via the two lines of evidence discussed above. The results of the assessment are summarized in a conclusions section.

7.5.2.1 Evaluation

Hydrogeology

Hydrogeologic data are important in natural attenuation assessments to show groundwater flow directions and possible contaminant migration pathways from source areas to downgradient receptors. The data can also be incorporated into a groundwater contaminant fate and transport model to predict the effects of natural attenuation in the future. For this assessment, the data will only be used to show groundwater flow directions and possible contaminant migration pathways.

Two rounds of water-level measurements were taken at select monitoring wells in the Northern Region during this RI. Measurements were taken in overburden and bedrock monitoring wells. The measurements were used to create potentiometric surface maps for the overburden and bedrock aquifers. Figures 4-2 and 4-4 depict the June 2000 and August 2000 overburden potentiometric surface maps, respectively. Figures 4-3 and 4-5 depict the June 2000 and August 2000 bedrock potentiometric surface maps, respectively.

From the figures, it is evident that the overall groundwater flow direction is from east to west toward the Thames River. The overburden and bedrock maps show that groundwater flows from the upland hills to the south and north toward the valley and then toward the Thames River. The effect of the Area A Wetland is also evident on the potentiometric surface maps. Another observation that can be made from the figures is that water levels were generally higher in June 2000 than in August 2000.

Water levels were measured in several overburden/bedrock well clusters during both the June and August measurement events. There is a downward flow gradient in monitoring well clusters 7MW2S/D, 7MW5S/D, and 2DMW24S/D, which are located along the fringe of the valley near the toe of the upland hills. An upward flow gradient was detected in well cluster 2DMW28S/D during both sampling events. This cluster is located in the middle of the valley at the downgradient end.

The only potential source area located upgradient of the Torpedo Shops is the Area A Weapons Center. This site is shown on the potentiometric surface maps. A recent memorandum regarding the use, storage, and disposal of hazardous materials and waste at Naval Submarine Base New London Weapons Complex is included in Appendix F.

Chemicals of Concern

Analytical data for groundwater samples are summarized in Tables 7-11 and 7-12. Groundwater COPCs for the Torpedo Shops are depicted on Figure 7-4. From the tables and figure, it can be seen that TCE

and chlorinated benzenes (i.e., chlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and hexachlorobenzene) were detected in groundwater and both types of compounds are susceptible to biodegradation.

TCE was detected in 7 of 27 groundwater samples at concentrations ranging from 1.4 to 23 µg/L. The highest concentration was detected in downgradient monitoring well 7MW9S. TCE was also detected in upgradient locations such as bedrock monitoring wells 7MW1D and 7MW5D and overburden monitoring wells B325-MW1 and B325-MW3. Historically, TCE was detected less frequently (one detection in 7MW3S) and at lower concentrations (1 µg/L) in the groundwater at the Torpedo Shops than during this RI (see Appendix D). No daughter products generated during biodegradation of TCE were detected in groundwater samples. These data suggest that TCE is not biodegrading at detectable rates in the groundwater.

Based on the distribution of TCE detections and groundwater flow directions, it appears that there are multiple, low-level sources of the compound. The data suggest that there are possibly three source areas. The first area is upgradient and north of Building 450. This unknown source is contributing to the TCE detections in bedrock monitoring wells 7MW1D, 7MW5D, and 7MW2D. Building 477, which is located in close proximity to 7MW1D, has been used as a solvent storage area, and a spill may have occurred in this area in the past. The second area is upgradient of Building 325 and is contributing to the TCE detections in the overburden monitoring wells B325-MW1 and B325-MW3 along the southern side of this building. PCE was detected in a historical soil sample collected during the installation of 7MW4S, and the location of this well indicates that it is close to the probable source area. TCE is a daughter product of PCE and therefore the PCE in the soil may be the source of the TCE in the downgradient groundwater. The third source area may be the historical south leach field. This leach field is located upgradient of overburden monitoring wells 7MW8S and 7MW9S, which both had detections of TCE. The third source area may also be contaminated soil in the vicinity of these wells. PCE was detected in historical soil samples collected during the installation of 7MW8S, 7MW9S, 7TB14, and 7TB15. As discussed above, TCE is a daughter product of tetrachloroethene.

A small isolated plume of chlorinated benzenes was detected in groundwater west of Building 325. The source appears to be located near the northwestern corner of Building 325. Historically, a septic tank was located in this area, and currently a storm sewer is located in this area. These compounds have been shown to biodegrade under aerobic and anaerobic conditions. The highly chlorinated benzenes (i.e., hexachlorobenzene) degrade under anaerobic conditions via reductive dechlorination, and the less chlorinated benzenes (i.e., chlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene) degrade under aerobic conditions via aerobic oxidation.

Chlorobenzene was detected in temporary monitoring wells 7TW9 and 7TW10 at concentrations ranging from 6.7 to 165 J µg/L. Chlorobenzene was also detected in soil samples collected during the installation of 7TW09 and 7TW18. Chlorobenzene was only detected once (3 J µg/L) in a single monitoring well (3MW3S) during previous investigations. Chlorobenzene is primarily used as a solvent for pesticide formulations and degreasing. Chlorobenzene is also a degradation compound of more highly chlorinated benzenes (i.e., 1,3-dichlorobenzene and 1,4-dichlorobenzene). 1,3-Dichlorobenzene was detected in monitoring well 7MW3S at a concentration of 1.7 µg/L. This compound is typically used as a fumigant, an insecticide, and a chemical intermediate. 1,4-Dichlorobenzene was detected in monitoring wells 7MW3S, 7TW8, 7TW9, and 7TW10 at concentrations ranging from 1.7 to 90.5 J µg/L. This compound is used principally as a space deodorant for toilets and refuse containers and as a fumigant for control of moths, molds, and mildews. Hexachlorobenzene was detected in one groundwater sample from 7MW9S. Hexachlorobenzene is typically produced as a by-product or impurity in the manufacture of chlorinated solvents. Because this compound was only detected once in a downgradient well, its detection seems to be unrelated to the chlorinated benzene plume west of Building 325.

Geochemical

The analytical results for the geochemical parameters collected for this natural attenuation assessment are summarized in Table 4-3. The sample numbers for the Torpedo Shops begin with "S7." Tag maps of the significant geochemical parameters were also prepared and are presented on Figures 4-18 through 4-30.

Dissolved oxygen concentrations ranged from 0.05 to 7.0 mg/L. Dissolved oxygen concentrations indicative of anaerobic conditions were detected in monitoring wells 7MW3S, 7MW3D, 7MW6S, 7MW8S, 7MW11S, B325-MW3, and 7TW08. The dissolved oxygen concentrations detected in monitoring wells 7MW2S and B325-MW1 were slightly above the criteria for anaerobic conditions (0.5 mg/L). The dissolved oxygen concentrations in bedrock wells indicate that groundwater is aerobic. Low dissolved oxygen concentrations correspond fairly well with the detection of organic contaminants, with the exception of the dissolved oxygen concentrations detected in 7TW09 and 7TW10. These wells have the highest concentrations of chlorinated benzenes but had dissolved oxygen concentrations indicative of aerobic conditions.

REDOX potentials measured in Site 7 groundwater ranged from -151 mV to 162 mV. REDOX potentials indicative of anaerobic, reductive conditions were measured in groundwater at monitoring wells 7MW02S, 7MW05D, 7MW6S, 7MW8S, 7MW11S, 7TW08, 7TW09, and 7TW10. About half of these wells correlate with the list of wells with low dissolved oxygen concentrations. Therefore, it is probable that reductive conditions exist at monitoring wells 7MW02S, 7MW06S, 7MW08S, 7MW11S, and 7TW08. The cause of the reductive conditions at 7TW08 may be biological activity related to the low levels of organic

contamination detected at this well. The cause of the reductive conditions at the other wells is not apparent.

Nitrate concentrations detected in Torpedo Shops groundwater samples were all below 0.5 mg/L, with the exception of the concentration detected in the sample from 7MW11S (0.55 mg/L). Nitrate was not detected in 7MW09S. Low concentrations of nitrite were detected in most Site 7 groundwater samples; the exceptions were 7MW01D, 7MW03D, 7MW9S, 7MW11S, 7TW08 and 7TW10. The concentrations ranged from 0.001 to 0.008 mg/L. Ammonia was also detected at low concentrations in most groundwater samples, and detected concentrations ranged from 0.1 to 0.54 J mg/L. Ammonia was not detected in 7MW04S and B325-MW03. Based on the low concentrations of nitrate and the positive detections of nitrite and ammonia, it appears that limited denitrification is occurring within the Torpedo Shops.

Divalent iron [Iron (II)] was detected in monitoring wells 7MW02S, 7MW6S, 7MW8S, 7MW11S, 7TW08, 7TW09, and 7TW10. The concentrations ranged from 0.6 mg/L to 3.5 mg/L. Monitoring wells 7MW02S, 7MW06S, 7MW08S, 7MW11S, and 7TW08 also had low dissolved oxygen concentrations and negative REDOX potentials, which confirms reducing conditions are present in the groundwater in the vicinity of these wells.

Soluble manganese [Mn (II)] was detected at low concentrations in groundwater samples from the Torpedo Shops; however, none of the concentrations exceeded the screening criterion of 1 mg/L. These data indicates that manganese reduction is not occurring at a significant rate in the Torpedo Shops groundwater.

Analytical data suggest that sulfate reduction is occurring within a limited area of the Torpedo Shop groundwater. Sulfate was detected in all groundwater samples at concentrations ranging from 3.46 mg/L to 71.6 J mg/L. Hydrogen sulfide was detected in groundwater samples from 7MW3D and 7TW10. Sulfide was also detected in 7TW10 at 0.07 mg/L, confirming that sulfate reduction is occurring in the vicinity of this temporary well.

Significant concentrations of methane (i.e., greater than 200 µg/L) were not detected in any of the groundwater samples from the Torpedo Shops. Concentrations in the wells ranged from nondetect to 41 J µg/L. These data suggest that methanogenesis is not occurring in the groundwater in the Torpedo Shops. Carbon dioxide measurements were generally uniform in all Torpedo Shop wells, ranging from nondetect to 50 mg/L, with most concentrations between 17 mg/L and 50 mg/L. Because methanogenesis does not seem to be occurring, no correlation between low carbon dioxide concentrations and high methane concentrations is expected.

Ethane and ethene, which are end products of dechlorination of chlorinated solvents, were not detected in any groundwater samples collected at the Torpedo Shops. This information correlates with the low-level detections of a parent chlorinated solvent (TCE) in the Torpedo Shops groundwater and the lack of daughter products (i.e., 1,2-DCE or vinyl chloride). It suggests that, although conditions may be amenable to reductive dechlorination, definitive evidence of complete dechlorination was not detected.

Chloride concentrations ranged from 5.84 mg/L to 155 J mg/L. The highest concentrations of chloride (i.e., greater than 120 mg/L) were detected in 7MW04S, 7MW05D, 7MW09S, and 7MW10S. Of these wells, 7MW09S was the only well with a detection of a chlorinated solvent, but no degradation compounds were detected in this well. Therefore, these data are inconclusive regarding reductive dechlorination.

The pH of the Torpedo Shops groundwater was slightly acidic to near neutral, with values ranging from 5.79 to 7.23. This range is similar to values measured in upgradient monitoring well 2DMW23D and monitoring wells from the Area A Weapons Center. The pH range is within the optimal range for bioactivity. Alkalinity and pH values correlate fairly well throughout the Torpedo Shops. The pH and alkalinity data do not suggest that there are any significant areas of biological activity in the Torpedo Shop groundwater.

TOC concentrations in the groundwater at the Torpedo Shops ranged from 0.9 mg/L to 120 mg/L. The concentration of TOC detected in 7MW07S (120 mg/L) strongly suggests that a significant source of carbon is present in the vicinity of this well. Analytical data do not indicate that the source is anthropogenic. The concentrations of TOC detected in 7TW08 and 7TW09 indicate that a weak source of carbon is present in the vicinity of these wells. The analytical data indicate that the source may be anthropogenic.

7.5.2.2 Conclusion

Hydrogeologic and groundwater analytical data from this RI suggest that there are multiple minor sources of chlorinated hydrocarbons impacting the Torpedo Shops groundwater. The data suggest that there are possibly three TCE source areas. The first area is likely near Building 477, which has been used as a solvent storage area. The second area is upgradient of Building 325. The third source area may be the historical south leach field or contaminated soil. A small plume of chlorinated benzenes was detected in groundwater west of Building 325. The source appears to be located near the northwestern corner of Building 325. Historically, a septic tank was located in this area, and currently a storm sewer is located in this area.

Chemical data are not conclusive regarding biodegradation as a significant natural attenuation process that is occurring in the Torpedo Shops groundwater. No daughter products of TCE were detected in any groundwater sample. This indicates that TCE is not biodegrading at a significant rate. Hexachlorobenzene, 1,4-dichlorobenzene, 1,3-dichlorobenzene, and chlorobenzene were all detected in groundwater samples from the Torpedo Shops. Chlorobenzene was detected at the highest concentration of any chlorinated benzene. It is possible that chlorobenzene was the original product released since one of its uses is a degreaser and degreasers are used at the Torpedo Shops. However, it is also possible that it is present in the groundwater as a result of biodegradation of more highly chlorinated benzenes (e.g., dichlorobenzene). Because there is no definitive information available regarding the original source of chlorinated benzenes, it is uncertain whether biodegradation is a significant natural attenuation process for chlorinated benzenes at Site 7. The geochemical data collected during the RI indicate that biodegradation processes are occurring to a limited extent in the Torpedo Shops groundwater. The processes identified include denitrification, iron reduction, and sulfate reduction. Biological activity related to the chlorinated benzenes west of Building 325 is probably the cause of sulfate reduction. It is not evident that denitrification and iron reduction are occurring as a result of biological activity related to chlorinated hydrocarbons.

Overall the hydrogeologic, chemistry, and geochemical data indicate that multiple sources of chlorinated hydrocarbons are impacting the Torpedo Shops groundwater and biodegradation is not a significant natural attenuation process that is acting to reduce organic contaminant concentrations. It is likely that other natural attenuation processes such as dilution, dispersion, and volatilization are acting to reduce contaminant levels in the Torpedo Shops groundwater. Because of this information, it is not recommended that a monitored natural attenuation alternative be pursued for the Torpedo Shops.

7.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific HHRA for the identified exposure scenarios for Site 7. The risk assessment methodology was described in Section 3.4, and detailed calculations including RAGS Part D tables are presented in Appendix C. A summary of previous HHRAs for the site is also presented.

7.6.1 Data Evaluation

COPCs were identified for Site 7 using the risk-based screening levels, as discussed in Section 3.4.1. Tables 7-5 and 7-6 summarize the COPCs retained for Site 7. A discussion of direct contact exposure COPCs (i.e., those chemicals detected at concentrations in excess of USEPA and CTDEP direct contact exposure criteria) and additional COPCs is provided below. Additional COPCs are identified on chemical migration tendencies: migration from soil to groundwater, migration from groundwater to surface water, and migration of volatiles from soil and groundwater through building foundations into indoor air. These

additional COPCs are not quantitatively evaluated in the HHRA because they are not considered to be significant contributors to the direct contact exposure pathways identified for potential human receptors.

Surface Soil (0 to 2 feet)

A comparison of the maximum detected concentrations in surface soil to risk-based screening criteria for direct contact exposure is presented in Table 7-7. The maximum detected concentrations of the following chemicals in surface soil exceeded the direct contact risk-based COPC screening levels and were retained as COPCs for surface soil:

- SVOCs-benzo(a)pyrene and dibenzo(a,h)anthracene
- Inorganics-antimony, cadmium, and manganese

The maximum detected concentrations of benz (a)pyrene, dibenzo(a,h)anthracene, and cadmium exceeded their respective USEPA PRGs but were below their respective CTDEP RSRs for residential exposures. The maximum detected concentration of arsenic exceeded its respective USEPA Region IX PRG but was within background levels; consequently, arsenic was not retained as a COPC for surface soil.

The maximum detected concentrations of all chemicals were less than the USEPA SSLs for soil to air; therefore, exposures through inhalation of fugitive dust and volatiles were not retained for evaluation in the risk assessment for surface soils at Site 7.

A comparison of the maximum detected concentration in surface soil to migration criteria is presented in Table 7-8. The maximum detected concentrations of the following chemicals exceeded their respective screening criteria, indicating a potential for these chemicals to migrate to groundwater:

- Inorganics-antimony

The maximum detected concentration of antimony in soil exceeded the USEPA SSL for migration from soil to groundwater, although it should be noted that antimony was not detected in groundwater at Site 7.

The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from soil to indoor air.

Subsurface Soil (2 to 10 feet)

A comparison of the maximum detected concentrations in subsurface soil to risk-based screening criteria for direct contact exposure is presented in Table 7-9. The maximum detected concentrations of the

following chemicals in subsurface soil exceeded the direct contact risk-based COPC screening levels and were retained as COPCs for subsurface soil:

- SVOCs-benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene.
- PCBs-aroclor 1254.
- Inorganics-antimony, arsenic, cadmium, chromium, manganese, nickel, silver, thallium, and vanadium.

The above chemicals will also be retained as COPCs in surface soil for those receptors that are exposed to both surface soil and subsurface soil. The maximum detected concentrations of benz (a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, Aroclor 1254, antimony, arsenic, cadmium, chromium, nickel, silver, thallium, and vanadium exceeded their respective USEPA PRGs but were below their respective CTDEP RSRs for residential exposures.

The maximum detected concentrations of all chemicals were less than the USEPA SSLs for soil to air; therefore, exposures through inhalation of fugitive dust and volatiles were not retained for evaluation in the risk assessment for subsurface soil at Site 7.

A comparison of the maximum detected concentration in subsurface soil to migration criteria is presented in Table 7-10. The maximum detected concentrations of the following chemicals exceeded their respective screening criteria, indicating a potential for these chemicals to migrate to groundwater:

- VOCs-methylene chloride.
- SVOCs-benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, carbazole, chrysene, and indeno(1,2,3-cd)pyrene.
- PCBs-Aroclor 1254.
- Inorganics-antimony, chromium, and thallium

Chromium was the only chemical with a maximum detected concentration exceeding migration from soil to groundwater criteria that was detected in groundwater.

The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from soil to indoor air.

Groundwater

A comparison of the maximum detected concentrations in groundwater to direct contact risk-based screening criteria is presented in Table 7-11. The maximum detected concentrations of the following chemicals in groundwater exceeded the direct contact risk-based COPC screening levels and were retained as COPCs for groundwater:

- VOCs-1,4-dichlorobenzene, chlorobenzene, 1,3-dichlorobenzene, benzene, and TCE.
- SVOCs-bis(2-ethylhexyl) phthalate and hexachlorobenzene.
- Metals-arsenic, barium, chromium, lead, and vanadium.

The maximum detected concentration of manganese exceeded its USEPA Region IX PRG but was within background levels; consequently, manganese was not retained as a COPC.

A comparison of the maximum detected concentration in groundwater to migration criteria is presented in Table 7-12. The maximum detected concentrations of the following chemicals exceeded their respective screening criteria for protection of migration to surface water:

- SVOCs-bis(2-ethylhexyl) phthalate, hexachlorobenzene, and phenanthrene
- Metals-arsenic, lead, silver, and zinc

The maximum detected concentration of copper exceeded its CTDEP surface water protection RSR but was within background levels; consequently, copper was not retained as a COPC.

The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from groundwater to indoor air.

7.6.2 Exposure Assessment

Potential receptors for exposures to soil at Site 7 included construction workers, full-time employees, and future residents. Potential receptors for exposures to groundwater at Site 7 included construction workers and future adult residents. Exposure assumptions for these receptors were presented in Table 3-14. Potential exposure pathways are summarized in Table 7-13.

Construction workers were assumed to be exposed to surface and subsurface soil. Potential exposure pathways included incidental ingestion and dermal contact. Construction workers could come into contact with groundwater while excavating building foundations. In such an instance, workers could be exposed to the groundwater via dermal contact.

Full-time employees may be exposed to site media while performing site inspections or daily duties. This receptor was only evaluated for exposures to surface soil. Potential exposure pathways included incidental ingestion and dermal contact.

Future child and adult residents were assumed to be exposed to surface soil and subsurface soil. Also, future adult residents were assumed to be exposed to groundwater. Potential exposure pathways for soil included incidental ingestion and dermal contact. Potential exposure pathways for groundwater included ingestion, dermal contact, and inhalation of volatile emissions. As previously discussed, future residential receptors were included in the baseline risk assessment at the direction of USEPA and CTDEP. These receptors are not potential receptors under current land use and are included only to provide an indication of potential risks if the facility were to close and then be developed for residential use.

Exposure point concentrations for Site 7 are presented in Table 7-14. As discussed in Section 3.4, since fewer than 10 surface soil samples were collected, the maximum detected concentration and average concentration were used for the exposure point concentrations for surface soil under the RME and CTE, respectively. The 95 percent UCL was used as the exposure point concentration for exposures to subsurface soil under the RME and CTE scenarios. The maximum detected concentration and average concentration were used for the exposure point concentrations for groundwater under the RME and CTE, respectively.

7.6.3 Risk Characterization

Potential ICRs and HIs were calculated for construction workers, full-time employees, and future residents exposed to soil and groundwater using the methodology presented in Section 3.4. The results are summarized in Tables 7-15 and 7-16 and are discussed below. Sample calculations and chemical-specific risks in RAGS Part D format are provided in Appendix C.

The results of the human health risk assessment indicate that cancer risks and hazard indices exceed USEPA and CTDEP acceptable levels for future adult residents exposed to groundwater. Even though the calculations were not per performed, cancer risks and hazard indices for future child residents would also be expected to exceed USEPA and CTDEP acceptable levels.

Carcinogenic Risks

Soil

ICRs for Site 7 ranged from 1.1×10^{-7} for full-time workers (CTE) to 4.8×10^{-6} for child residents (RME). All ICRs for exposures to soil at Site 7 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6}

and less than CTDEP's acceptable level of 1 x 10^{-5} for cumulative exposures. Although all ICRs were less than CDTEP's target level for cumulative exposures, chemical-specific ICRs for arsenic (child residents) and benzo(a)pyrene (full-time workers and child residents) exceeded CTDEP's target level of 1 x 10^{-6} for individual chemicals. It should be noted that the maximum detected concentrations of benzo(a)pyrene and arsenic were less than their respective CTDEP RSRs for residential exposures.

Groundwater

ICRs for a construction workers exposed to groundwater were 4 x 10^{-7} and 1 x 10^{-7} for the RME and CTE scenarios, respectively, which were less than USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures.

The ICR for an adult resident exposed to groundwater was 5.8 x 10^{-4} under the RME scenario, which exceeds USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for arsenic, benzene, bis(2-ethylhexyl) phthalate, hexachlorobenzene, and TCE exceeded CTDEP's target level of 1 x 10^{-6} for individual chemicals. The ICR for an adult resident exposed to groundwater was 4.4 x 10^{-5} under the CTE scenario, which was within USEPA's target risk range of 10^{-4} to 10^{-6} but exceeded CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for arsenic, benzene, bis(2-ethylhexyl) phthalate, and hexachlorobenzene exceeded CTDEP's target level of 1 x 10^{-6} for individual chemicals. Chemical-specific ICRs for arsenic and hexachlorobenzene exceeded USEPA's target risk range.

Noncarcinogenic Risks

Soil

All HIs for exposure to soil at Site 7 were less than USEPA's and CTDEPs acceptable level of 1.0. HIs for Site 7 ranged from 0.002 for full-time employees (CTE) and adult residents (CTE) to 0.5 for child residents (RME).

Groundwater

HIs for a construction workers exposed to groundwater were 0.09 and 0.05 for the RME and CTE scenarios, respectively, which were less than USEPA's and CTDEP's acceptable level of 1.0.

The HI for adult residents exposed to groundwater was 5.3 under the RME scenario, which exceeds USEPA's and CTDEP's acceptable level of 1.0. Arsenic (HQ = 1.0), bis(2-ethylhexyl) phthalate (HQ = 0.65), chromium (HQ = 1.4), and hexachlorobenzene (HQ = 0.52) were the major contributors to the HI. The HI for adult residents exposed to groundwater was 1.1 under the CTE scenario, which slightly

exceeds the USEPA's and CTDEP's acceptable level of 1.0, although the chemical-specific HQs for the individual target organs were all less than 1.0.

Lead

Lead was identified as a COPC in groundwater at Site 7. Lead was detected at a maximum concentration of 32.8 µg/L, which exceeds the Safe Drinking Water Act action level and CTDEP RSR of 15 µg/L.

USEPA's IEUBK model was used to evaluate exposures to lead in groundwater by future child residents. As recommended by the model, the average concentrations of lead in groundwater of 3.92 µg/L and in soil of 8.5 mg/kg were used as the exposure point concentrations. Default parameters were used for the rest of the model input parameters. IEUBK model outputs are included in Appendix C. The estimated geometric mean blood-lead level for children exposed to lead in groundwater was 1.6 µg/dL, which is less than the level of concern of 10 µg/dL. The IEUBK Model estimates that approximately 100 percent of children are expected to have blood-lead levels less than 10 µg/dL. These results indicate that no adverse effects are anticipated for hypothetical future child residents exposed to lead in groundwater at Site 7.

7.6.4 Summary of Previous Risk Assessments

The baseline human health risk assessment conducted during the Phase II RI for the Torpedo Shops site considered the potential exposure of three receptor groups, including full-time employees, construction workers, and future potential residents. In accordance with USEPA Region I guidance, CTE and RME exposure scenarios were considered for each receptor. Groundwater was not considered to be a potential medium for exposure for the full-time employee. Dermal contact with groundwater was evaluated as a potential route of exposure for the construction worker. Exposures to groundwater through direct ingestion, dermal contact while showering/bathing, and inhalation of volatiles while showering/bathing were evaluated for future potential residents.

Noncarcinogenic risks associated with exposure to groundwater exceeded the USEPA acceptable level of one for the construction worker under the RME scenario and for the future resident under the RME and CTE scenarios. The noncarcinogenic risks for the construction worker are attributable to potential exposure to manganese in groundwater. Elevated noncarcinogenic risks for the future resident are a result of groundwater exposure to bis(2-ethylhexyl) phthalate and several metals (antimony, arsenic, manganese, and thallium).

Incremental cancer risk associated with exposure to groundwater was less than USEPA and CTDEP target cancer risks for the CTE construction worker. For the RME construction worker, incremental cancer risk associated with exposure to groundwater was less than the CTDEP target cancer risk of 1×10^{-5} and was within USEPA's acceptable target risk range of 1×10^{-6} to 1×10^{-4}. Incremental cancer risk associated with exposure to groundwater for the CTE future potential resident was also within the USEPA target risk range; however, this value exceeded the CTDEP target cancer risk. Carcinogenic risk associated with exposure to groundwater exceeded 1×10^{-5} and 1×10^{-4} for the RME future resident. Bis(2-ethylhexyl) phthalate and arsenic contributed significantly to the carcinogenic risks for this receptor; chemical-specific incremental cancer risks for these chemicals via direct ingestion of groundwater and dermal contact with groundwater exceeded 1×10^{-4}.

7.6.5 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment, in general, was presented in Section 3.4.5. Site-specific uncertainties for Site 7 are discussed below.

Elimination of Chemicals as COPCs on the Basis of Background

In accordance with U.S. Navy policy, chemicals were eliminated as COPCs on the basis of comparison to background. Arsenic in surface soil and manganese in groundwater were the only chemicals with maximum detected concentrations that exceeded their respective direct contact screening criteria but, they were not retained as a COPC on the basis of background. Arsenic was retained as a COPC in subsurface soil and therefore was retained as a COPC for those receptors that were exposed to both surface and subsurface soil (construction workers, child residents, and adult residents). Consequently, full-time workers were the only receptor groups that were impacted by the elimination of arsenic as a COPC in surface soil on the basis of background. If arsenic was retained as a COPC in surface soil, then the ICR from exposures to arsenic would be 1.4×10^{-6} and the cumulative ICR from exposures to all COPCs in surface soil would be 3.3×10^{-6}. The ICR is within USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures, although the individual ICR for exposure to arsenic exceeds CTDEP's target level of 1×10^{-6} for individual chemicals.

Potential risks from dermal exposures to manganese in water are insignificant (USEPA, 2000d); consequently the elimination of manganese as a COPC on the basis of background does not affect the risk estimates for the construction worker since this receptor was only evaluated for dermal exposures to groundwater. Future adult residents were evaluated for ingestion and dermal contact with groundwater; therefore, the estimated risks would be higher for the future adult resident if exposures to manganese were evaluated in the HHRA. If exposures to manganese in groundwater by a future adult resident were

evaluated in the HHRA, then the resulting HQ for manganese would be 1.4 and the total HI would be 6.8, which exceeds the USEPA and CTDEP acceptable level of 1.0.

7.7 SUMMARY AND RECOMMENDATIONS

7.7.1 Nature and Extent of Contamination

Several VOCs were identified as COPCs for groundwater at Site 7, including TCE, benzene, chlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene. The detections were disperse and generally of low concentration, with the exception of chlorobenzene and 1,4-dichlorobenzene in temporary well 7TW10. All the other VOC detections in groundwater were less than 10 µg/L.

Six SVOCs, all PAHs, were identified as COPCs for Site 7 soil based on historic sampling data. Only one semivolatile (pyrene) was detected in the BGOURI samples, at a concentration below applicable screening criteria. Even though PAHs are commonly found in the vicinity of roadways, because they are a major component of road tars/asphalt, the results were evaluated in the RI to be conservative.

Three SVOCs [bis(2-ethylhexyl) phthalate, hexachlorobenzene, and phenanthrene] were identified as COPCs for Site 7 groundwater based on sampling data. Bis(2-ethylhexyl) phthalate was detected in two samples, and hexachlorobenzene and phenanthrene were detected at trace (less than 4 µg/L) concentrations in one sample each. Given the low frequency of detections and the low mobilities of these compounds, groundwater contamination by SVOCs does not appear to be a significant concern at Site 7.

A number of metals were identified as COPCs for soil (primarily for subsurface soil) based on a combination of historic and BGOURI sampling results. Most of the highest soil concentrations for inorganics in general were in soil samples collected from the western side of Building 325; however, the highest concentrations of inorganic COPCs were found at various locations across the site. Metals detected most frequently at levels above background include manganese, antimony, and cadmium. No clear pattern of contamination was apparent, and most detections exceeding background were only marginally higher than the background concentration.

For metals in groundwater, there were only four sampling locations with detections above background. Two of the four points had a single detection above background. Another point had two detections in excess of backgrounds. Temporary well TW09 located along the western edge of Building 325, had six exceedances of background. Aside from three above-background detections of zinc and two of lead, no metal was found at above-background levels more than once. The locations with background exceedances were scattered over the site, which, in combination with the marginal levels, suggests that

the elevated metals concentrations in groundwater are localized and do not constitute a plume of any magnitude.

7.7.2 Contaminant Fate and Transport

TCE and methylene chloride are the only two halogenated aliphatic hydrocarbons identified as COPCs in soil or groundwater. Given the length of time since waste disposal activities were thought to occur and the mobilities of these compounds, it is expected that the observed concentrations of these chemicals likely are indicative of steady-state or slowly declining concentrations within the groundwater. Several types of monocyclic aromatic compounds were identified as COPCs at Site 7 in soil and/or groundwater. Chlorinated aromatics (mono- and di-chlorobenzenes) were detected in subsurface soil and groundwater, and hexachlorobenzene was detected in groundwater. The fact that chlorobenzenes were only detected in subsurface soil and groundwater indicates that these constituents were probably released directly to the subsurface, possibly from the septic systems. A preliminary evaluation of natural attenuation data (i.e., hydrogeologic, chemistry, and geochemical data) indicated that multiple sources of chlorinated hydrocarbons are impacting the groundwater at the Torpedo Shops and biodegradation is not a significant natural attenuation process that is acting to reduce organic contaminant concentrations. Because of this information, it is not recommended that a monitored natural attenuation alternative be pursued for the Torpedo Shops.

Several low-molecular-weight and high-molecular-weight PAHs were identified as COPCs for surface and/or subsurface soil samples at Site 7. Only one low-molecular-weight PAH (phenanthrene) was identified as a COPC for Site 7 groundwater. PAHs are generally considered to be fairly immobile in the environment.

One PCB, Aroclor 1254, was identified as a COPC based on a detection in one subsurface soil sample at Site 7 in the Phase II RI. PCBs are considered to be very persistent organic chemicals.

One phthalate, bis(2-ethylhexyl) phthalate was identified as a groundwater COPC. Phthalate esters are considered to be relatively persistent chemicals in the environment.

Seven metals for soil and seven metals for groundwater metals were identified as COPCs for Site 7. Three of the metals were COPCs common to both media, with four metals identified as COPCs for one medium but not the other. Metals are persistent in the environment but generally not very mobile, due to their low solubilities and affinities for binding to soil particles.

7.7.3 Summary of Human Health Risk Assessment

The following is a summary of the HHRA for Site 7:

- The HHRA for Site 7 considered exposures to soil by construction workers, full-time employees, and future residents and exposures to groundwater by construction workers and future adult residents. Potential exposure pathways for soil included incidental ingestion and dermal contact for all receptors. Potential exposure pathways for groundwater included dermal contact for construction workers and incidental ingestion, dermal contact, and inhalation of volatile emissions for future adult residents. The maximum detected concentrations of all chemicals in surface and subsurface soil were less than USEPA SSLs for migration from soil to air. Consequently, potential exposures via inhalation of fugitive dust and volatiles were not evaluated.

- The maximum detected concentrations of benzo(a)pyrene, dibenzo(a)anthracene, cadmium, and manganese in surface soil exceeded their respective direct contact screening criteria and were retained for quantitative evaluation in the HHRA. It should be noted that the maximum detected concentrations of all chemicals except manganese exceeded their respective USEPA PRGs but were below their respective CTDEP RSRs for residential exposures.

- The maximum detected concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, Aroclor 1254, antimony, arsenic, barium, cadmium, chromium, manganese, nickel, silver, thallium, and vanadium in subsurface soil exceeded their respective direct contact screening criteria and were retained for quantitative evaluation in the HHRA. It should be noted that the maximum detected concentrations of all chemicals except manganese exceeded their respective USEPA PRGs but were below their respective CTDEP RSRs for residential exposures.

- Maximum detected concentrations of antimony in surface soil and methylene chloride, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, carbazole, chrysene, and indeno(1,2,3-cd)pyrene, Aroclor 1254, antimony, chromium, and thallium in subsurface soil exceeded the screening criteria for migration from soil to groundwater. Chromium was the only chemical detected in groundwater with a maximum detected concentration in soil exceeding the screening criteria for migration from soil to groundwater.

- The maximum detected concentrations of all chemicals in surface and subsurface soil were less than the CTDEP criteria for migration from soil to indoor air.

- Both ICRs and HIs for direct contact soil exposure were within acceptable ranges for both construction workers and hypothetical future residents.

- The maximum detected concentrations of 1,4-dichlorobenzene, chlorobenzene, 1,3-dichlorobenzene, benzene, TCE, bis(2-ethylhexyl) phthalate, hexachlorobenzene, arsenic, barium, chromium, lead, and vanadium exceeded the direct contact risk-based COPC screening levels for groundwater and were retained for evaluation in the HHRA.

- Maximum detected concentrations of bis(2-ethylhexyl) phthalate, hexachlorobenzene, phenanthrene, arsenic, lead, silver, and zinc exceeded CTDEP's screening criteria for protection of migration of groundwater to surface water.

- The maximum detected concentrations of all chemicals in groundwater were less than the CTDEP criteria for migration from groundwater to indoor air.

- ICRs and HIs for construction workers exposed to groundwater at Site 7 were within USEPA and CTDEP acceptable levels.

- The ICR for future adult residents exposed to groundwater under the RME scenario exceeded USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for arsenic, benzene, bis(2-ethylhexyl) phthalate, hexachlorobenzene, and TCE exceeded CTDEP's target level of 1×10^{-6} for individual chemicals.

- The ICR for future adult residents exposed to groundwater under the CTE scenario was within USEPA's target risk range of 10^{-4} to 10^{-6} but exceeded CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for arsenic, bis(2-ethylhexyl) phthalate, and hexachlorobenzene exceeded CTDEP's target level of 1×10^{-6} for individual chemicals.

- HIs for future adult residents exposed to groundwater at Site 7 exceeded USEPA's and CTDEP's acceptable level of 1.0 under the RME scenario. Arsenic and chromium were the major contributors to the HI, based on a single above-background detection of each.

- The results of the human health risk assessment indicate that cancer risks and hazard indices exceed USEPA and CTDEP acceptable risk levels for future adult residents exposed to groundwater. Even though the calculations were not performed, cancer risks and hazard indices for future child residents would also be expected to exceed USEPA and CTDEP acceptable levels.

- There was one detected concentration of lead in groundwater that exceeded the Safe Drinking Water Act action level and CTDEP RSR of 15 µg/L. The IEUBK model was used to evaluate exposures lead in groundwater by hypothetical residential children. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in groundwater at Site 7.

- The maximum detected concentration of arsenic in surface soil and manganese in groundwater exceeded their respective screening criteria but were within background levels, consequently arsenic and manganese were not retained as COCs in the HHRA. ICRs and HIs for all receptors would have been within USEPA and CTDEP target levels if arsenic had been evaluated in the HHRA. HIs for adult residents exposed to manganese in groundwater would exceed the acceptable level of 1 if manganese were evaluated in the HHRA.

7.7.4 Recommendations

A small soil removal action was completed at the Torpedo Shops to address TPH contamination from a UST. This removal action was performed under the CTDEP's UST Program and not CERCLA. Soil adjacent to Building 325 with TPH concentrations in excess of 500 mg/kg was excavated and disposed at an off-site location. The leach fields that were historically used at Site 7 for wastewater disposal and were the primary suspected sources for releases have been permanently decommissioned. All the buildings at Site 7 are connected to public water and sewer, essentially cutting off this potential migration pathway for contaminants.

The objectives of the BGOURI at Site 7 were to further characterize the nature and extent of soil and groundwater contamination in the vicinity of the abandoned septic system and to quantify the risks to human receptors from the soil and groundwater. Organic contaminant detections in soils were scattered and were primarily PAHs. Metals detections above background were scattered and were in general only slightly above the background concentrations. Of the seven metals identified as COPCs based on screening criteria, only three were also COPCs for groundwater, and only one of these three was detected in groundwater at a concentration above screening criteria (chromium, in one well), indicating that soils are not impacting groundwater to any significant degree. Groundwater sampling results for the Torpedo Shops indicate that there are only sporadic, low-concentration detections of contaminants in site monitoring wells. There are no discernible contaminant plumes of any size, indicating that there are no significant sources leaching contamination to groundwater at Site 7. Several wells located within the western portion of Site 7 had several MCL exceedances in groundwater; however, the exceedances varied from well to well. Aside from three exceedances of the MCL for bis(2-ethylhexyl) phthalate and two exceedances for TCE, no compound was detected above the MCL in groundwater more than once. A preliminary evaluation of natural attenuation indicated that biodegradation is not a significant natural attenuation process that is acting to reduce organic contaminant concentrations. Because of this

information, it was not recommended that a monitored natural attenuation alternative be pursued for the Torpedo Shops.

Cumulative carcinogenic and noncarcinogenic risks posed by exposure to soils at Site 7 were either less than or within USEPA and CTDEP acceptable risk ranges, indicating that soils do not pose an unacceptable risk via direct contact exposures. The HHRA determined that risks posed by exposure of construction workers to groundwater at Site 7 are within USEPA and CTDEP acceptable levels, assuming that the workers are exposed to the maximum observed concentrations of site contaminants. The HHRA evaluated future residential groundwater usage, and calculated risks were marginally above the acceptable risk range based on maximum concentrations. The groundwater, however, is classified by CTDEP as GB groundwater (i.e., not suitable for direct human consumption without treatment) and it is not expected that it will be used for human consumption in the foreseeable future.

Because the risks associated with Site 7 soil are within USEPA and CTDEP acceptable risk ranges, an FS for the soil operable unit at Site 7 is not necessary. A no-further-action decision document should be prepared for this operable unit. However, even though contaminant concentrations were generally low and risks are acceptable under the current land use scenario, it is recommended that an FS be prepared for the groundwater operable unit associated with Site 7. The FS should evaluate, at a minimum, land use controls and monitoring for the site. This recommendation is made for the following reasons:

- The source areas are not fully understood, but the current groundwater data (i.e., extent of contamination and concentrations) do not indicate that the sources are significant and warrant further investigation to completely characterize them.

- A limited groundwater monitoring program would verify the trend in groundwater contaminant concentrations and determine the impact of any changes in site/source area conditions in the future.

- A change in land use would potentially result in unacceptable risks to potential receptors.

TABLE 7-1

SUMMARY OF THE SAMPLING AND ANALYTICAL PROGRAM FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Sample ID	VOCs	SVOCs	Metals	Misc
GROUNDWATER SAMPLES				
FD0611001	X			
FD0707001	X	X	X	X
FD0707001-F			X	
FD0710001	X	X	X	X
S7B325MW0101	X	X	X	X
S7B325MW0301	X	X	X	X
S7B325MW0401	X	X	X	X
S7MW01D01	X	X	X	X
S7MW01D01-F			X	
S7MW02D01	X	X	X	X
S7MW02S01	X	X	X	X
S7MW03D01	X	X	X	X
S7MW03S01	X	X	X	X
S7MW04S01	X	X	X	X
S7MW05D01	X	X	X	X
S7MW05S01	X	X	X	X
S7MW06S01	X	X	X	X
S7MW07S01	X	X	X	X
S7MW08S01	X	X	X	X
S7MW09S01	X	X	X	X
S7MW10S01	X	X	X	X
S7MW10S01-F			X	
S7MW11S01	X	X	X	X
S7TW0101	X			
S7TW0201	X			
S7TW0301	X			
S7TW0401	X			
S7TW0501	X			
S7TW0601	X			
S7TW0701	X			
S7TW0801	X	X	X	X
S7TW0901	X	X	X	X
S7TW1001	X	X	X	X
SOIL SAMPLES				
S7SB010912				X
S7SB080607	X	X	X	
S7SB090809	X	X	X	
S7SB100607	X	X	X	
S7SB180506	X	X	X	

Notes:
1 Miscellaneous groundwater parameters include all natural attenuation parameters plus TDS, TSS and perchlorate.
2 Miscellaneous soil parameters include bulk density, pH, and porosity.
3 Samples with a "F" suffix are filtered metals samples.

TABLE 7-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	7MW2S	7TB1	7TB1	7TB2	7TB5	7MW1DSS	7TB3	7MW3S	7TB4
nsample	080990-7MW2(2-4)	080990-7TB1(2-4)	080990-7TB1(2-4)-D	080990-7TB2(2-4)	081090-7TB5(6-8)	081390-7MW1(0-2)	081390-7TB3(4-6)	081490-7MW3(6-8)	081490-7TB4(4-6)
sample	7MW2(2-4)	7TB1(2-4)	7TB7(2-4)	7TB2(2-4)	7TB5(6-8)	7MW1(0-2)	7TB3(4-6)	7MW3(6-8)	7TB4(4-6)
top_depth	2	2	2	2	6	0	4	6	4
bottom_dep	4	4	4	4	8	2	6	8	6
sample_dat	8/9/90	8/9/90	8/9/90	8/9/90	8/10/90	8/13/90	8/13/90	8/14/90	8/14/90
duplicate			080990-7TB1(2-4)						
Volatile Organics (ug/kg)									
1,1-DICHLOROETHENE	6 U	6 U	6 U	6 U	8 U	7 U	6 U	6 U	6 U
2-BUTANONE	12 U	12 U	13 U	12 U	32	14 U	12 U	11 U	12 U
ACETONE	12 U	12 U	13 U	12 U	170	41 U	12 U	11 U	12 U
BENZENE	6 U	6 U	6 U	6 U	4 J	7 U	6 U	6 U	6 U
CARBON DISULFIDE	6 U	6 U	6 U	6 U	5 J	7 U	6 U	6 U	6 U
CHLOROBENZENE	6 U	6 U	6 U	6 U	8 U	7 U	6 U	6 U	6 U
METHYLENE CHLORIDE	4 J	6 U	3 J	3 J	3 J	7 U	6 U	6 U	6 U
TETRACHLOROETHENE	6 U	6 U	6 U	6 U	8 U	7 U	6 U	6 U	6 U
TOLUENE	6 U	6 U	6 U	6 U	8 U	7 U	6 U	6 U	6 U
XYLENES, TOTAL	6 U	6 U	6 U	6 U	8 U	7 U	6 U	6 U	6 U
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	400 U	410 U	420 U	400 U	500 U	450 U	390 U	370 U	410 U
4-METHYLPHENOL	560	410 U	420 U	400 U	500 U	450 U	390 U	370 U	410 U
ACENAPHTHENE	47 J	410 U	420 U	400 U	500 U	450 U	390 U	370 U	410 U
ACENAPHTHYLENE	400 U	410 U	420 U	400 U	500 U	450 U	390 U	370 U	410 U
ANTHRACENE	55 J	410 U	420 U	400 U	500 U	450 U	390 U	370 U	410 U
BENZO(A)ANTHRACENE	210 J	410 U	420 U	400 U	500 U	270 J	390 U	370 U	410 U
BENZO(A)PYRENE	290 J	410 U	420 U	400 U	500 U	570	40 J	370 U	410 U
BENZO(B)FLUORANTHENE	270 J	410 U	420 U	400 U	500 U	610	61 J	370 U	410 U
BENZO(G,H,I)PERYLENE	190 J	410 U	420 U	400 U	500 U	540	390 U	370 U	410 U
BENZO(K)FLUORANTHENE	290 J	410 U	420 U	400 U	500 U	510	48 J	370 U	410 U
BENZOIC ACID	86 J	2000 U	2000 U	2000 U	2400 U	2200 U	90 J	1800 U	2000 U
BIS(2-ETHYLHEXYL)PHTHALATE	130 J	180 J	140 J	190 J	500 U	170 U	740 J	370 U	410 U
BUTYLBENZYL PHTHALATE	400 U	410 U	420 U	400 U	500 U	450 U	390 U	370 U	410 U
CARBAZOLE									
CHRYSENE	280 J	410 U	420 U	400 U	500 U	380 J	44 J	370 U	410 U
DI-N-BUTYL PHTHALATE	60 J	100 J	420 U	400 U	65 J	450 U	130 J	370 U	170 J
DIBENZO(A,H)ANTHRACENE	400 U	410 U	420 U	400 U	500 U	63 J	390 U	370 U	410 U
DIBENZOFURAN	400 U	410 U	420 U	400 U	500 U	450 U	390 U	370 U	410 U
DIETHYL PHTHALATE	400 U	410 U	420 U	400 U	94 J	450 U	390 U	370 U	410 U
FLUORANTHENE	580	410 U	420 U	43 J	500 U	390 J	60 J	370 U	410 U
FLUORENE	43 J	410 U	420 U	400 U	500 U	450 U	390 U	370 U	410 U
INDENO(1,2,3-CD)PYRENE	230 J	410 U	420 U	400 U	500 U	540	390 U	370 U	410 U
NAPHTHALENE	400 U	410 U	420 U	400 U	500 U	450 U	390 U	370 U	410 U
PHENANTHRENE	560	410 U	420 U	400 U	500 U	170 J	390 U	370 U	410 U
PYRENE	550	410 U	420 U	41 J	500 U	330 J	46 J	370 U	410 U
Pesticides/PCBs (ug/kg)									
4,4'-DDD	20 U	20 U	20 U	20 U	24 U	21 U	21 U	20 U	22 U
4,4'-DDE	20 U	20 U	20 U	20 U	24 U	21 U	210	20 U	22 U
4,4'-DDT	20 U	20 U	20 U	20 U	24 U	21 U	21 U	20 U	22 U
AROCLOR-1254	660	200 U	200 U	200 U	240 U	210 U	210 U	200 U	220 U

TABLE 7-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	7MW2S	7TB1	7TB1	7TB2	7TB5	7MW1DSS	7TB3	7MW3S	7TB4
nsample	080990-7MW2(2-4)	080990-7TB1(2-4)	080990-7TB1(2-4)-D	080990-7TB2(2-4)	081090-7TB5(6-8)	081390-7MW1(0-2)	081390-7TB3(4-6)	081490-7MW3(6-8)	081490-7TB4(4-6)
sample	7MW2(2-4)	7TB1(2-4)	7TB7(2-4)	7TB2(2-4)	7TB5(6-8)	7MW1(0-2)	7TB3(4-6)	7MW3(6-8)	7TB4(4-6)
top_depth	2	2	2	2	6	0	4	6	4
bottom_dep	4	4	4	4	8	2	6	8	6
sample_dat	8/9/90	8/9/90	8/9/90	8/9/90	8/10/90	8/13/90	8/13/90	8/14/90	8/14/90
duplicate			080990-7TB1(2-4)						
ENDOSULFAN SULFATE	20 U	20 U	20 U	20 U	24 U	21 U	21 U	20 U	22 U
ENDRIN ALDEHYDE									
ENDRIN KETONE	20 U	20 U	20 U	20 U	24 U	21 U	21 U	20 U	22 U
HEPTACHLOR	9.8 U	10 U	10 U	9.8 U	12 U	11 U	10 U	10 U	11 U
METHOXYCHLOR	98 U	100 U	100 U	98 U	120 U	110 U	100 U	100 U	110 U
Inorganics (mg/kg)									
ALUMINUM	13100	16900	19700	13500	19800	13700	10200	8460	11000
ANTIMONY	14.5 UJ	15.2 UJ	15 UJ	19.4 J	18.2 UJ	19.4 J	17.9 J	14.2 J	17.3 J
ARSENIC	2.3 J	1.9 J	2.1 J	2.1 J	2.8	1.4	1.4	2.2	2.7
BARIUM	80.4	55.2	63.1	68.3	47.4	159	64.4	56.1	35.2
BERYLLIUM	0.61	0.75	1	0.68	0.87	0.58	0.52	0.46	0.57
CADMIUM	4.4	3.3	5.1	3.2	4.7	4.6	2.9	2.1	2.5
CALCIUM	1380 J	600 J	848 J	1100 J	1510 J	5830	1680	1540	909
CHROMIUM	15.7	16.7	19.5	16.9	24.9	18.4 J	14 J	13.6 J	18
COBALT	6.7	7.6	6.3	8.1	7.5	14.8	7	6.6	5.5
COPPER	21 J	12.2 J	11.6	20 J	9.7 J	39.8 J	23.7 J	19 J	17.1
IRON	14500 J	16100 J	16200 J	13800 J	14000 J	21600	13600	10600	12100
LEAD	12.2 J	9.7 J	7.6 J	11.9 J	11.1 J	7.1 J	9.2 J	11.2 J	3.4 J
MAGNESIUM	4140 J	2610 J	2890 J	3240 J	3120 J	6440	4190	3590	3010
MANGANESE	277 J	239 J	289 J	273 J	138 J	300 J	364 J	229 J	141 J
MERCURY	0.11 U	0.11 U	0.13 U	0.11 U	0.14 U	0.12 U	0.11 U	0.11 U	0.12 U
NICKEL	12.9 J	15 J	12.3 J	14.4 J	13.8 J	14.4 J	8.4 J	10 J	11.2 J
POTASSIUM	2710	625	866	1940	793	5360 J	2600 J	2440 J	1080 J
SELENIUM	0.48 U	0.5 U	0.51 U	0.47 U	0.77	0.5 U	0.44 U	0.45 U	0.48 U
SILVER	1.9 U	2 U	2 U	3	2.4 U	5.5 J	4.7 J	4.9 J	5.3 J
SODIUM	117 J	54.8 J	105	118 J	192 J	366 J	112 J	108 J	87.6 J
THALLIUM	0.97 U	0.99 U	1 U	0.94 U	1.2 U	1 U	0.87 U	0.91 U	0.95 U
VANADIUM	32.3	32.7	32.6	31	35.1	45.8	28.5	22.7	25.6
ZINC	48.4 J	43 J	37.3 J	46.9 J	33.7 J	62.9 J	46.9 J	35.2 J	26.8 J
Miscellaneous Parameters (mg/kg)									
TPH									
TOTAL ORGANIC CARBON									

TABLE 7-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	7TB6	7TB10	7MW4S	7MW6S	7MW6S	7MW10S	7MW11S	7MW5S	7MW7S	7MW8S
nsample	081490-7TB6(6-8)	7 SO 10 0103	7 SO 4S 0103	7 SO 6S 0305	7 SO 6S 0507	7MW10S-0608	7MW11S-0507	7MW5S-1011	7MW7S-0103	7MW8S-0408
sample	7TB6(6-8)	7 SO 10 0103	7 SO 4S 0103	7 SO 6S 0305	7 SO 6S 0507	7MW10S-0608	7MW11S-0507	7MW5S-1011	7MW7S-0103	7MW8S-0408
top_depth	6	1	1	3	5	6	5	10	1	4
bottom_dep	8	3	3	5	7	8	7	11	3	8
sample_dat	8/14/90	3/6/94	3/6/94	3/6/94	3/6/94	2/8/94	3/9/94	3/8/94	3/7/94	2/6/94
duplicate										
Volatile Organics (ug/kg)										
1,1-DICHLOROETHENE	7 U	11 U	3 J	12 U	11 U	12 U	24 U	11 UJ	11 U	61 U
2-BUTANONE	14 U	11 U	11 U	12 U	11 U	12 U	24 U	11 U	11 U	61 U
ACETONE	77	11 U	11 J	12 U	11 U	12 U	24 U	11 UJ	11 U	270 U
BENZENE	7 U	11 U	11 U	12 U	11 U	12 U	24 U	11 U	11 U	61 U
CARBON DISULFIDE	3 J	11 U	11 U	12 U	11 U	12 U	24 U	11 U	11 U	61 U
CHLOROBENZENE	7 U	11 U	11 U	12 U	11 U	12 U	24 U	11 U	11 U	61 U
METHYLENE CHLORIDE	7 U	11 U	11 J	12 U	11 U	12 U	10 J	14 J	11 U	420 J
TETRACHLOROETHENE	7 U	11 U	11 J	12 U	11 U	12 U	24 U	11 UJ	11 U	18 J
TOLUENE	7 U	6 J	4 J	12 U	11 U	12 U	24 U	11 UJ	3 J	61 U
XYLENES, TOTAL	7 U	11 U	11 J	12 U	11 U	12 U	24 U	11 UJ	11 U	61 U
Semivolatile Organics (ug/kg)										
2-METHYLNAPHTHALENE	480 U	110 J	170 J	410 U	380 U	380 U	470 U	370 U	350 U	400 U
4-METHYLPHENOL	480 U	360 U	350 U	410 U	380 U	380 U	470 U	370 U	350 U	400 U
ACENAPHTHENE	480 U	720	790	410 U	380 U	380 U	470 U	370 U	350 U	220 J
ACENAPHTHYLENE	480 U	55 J	28 J	410 U	380 U	380 U	470 U	370 U	350 U	400 U
ANTHRACENE	480 U	1300	1100	410 U	380 U	380 U	470 U	21 J	350 U	220 J
BENZO(A)ANTHRACENE	480 U	2700	2400	410 U	380 U	380 U	470 U	55 J	350 U	89 J
BENZO(A)PYRENE	480 U	1900	1700	33 J	380 U	380 U	190 J	48 J	350 U	81 J
BENZO(B)FLUORANTHENE	480 U	3200 J	2800	410 U	380 U	380 U	470 U	57 J	350 U	77 J
BENZO(G,H,I)PERYLENE	480 U	1200	1300 J	21 J	380 U	380 U	470 U	20 J	350 U	56 J
BENZO(K)FLUORANTHENE	480 U	360 U	350 U	24 J	380 U	380 U	470 U	49 J	350 U	84 J
BENZOIC ACID	2300 U	110 J	130 J	2000 U	1800 U	2000 U	51 J	28 J	1700 U	2000 U
BIS(2-ETHYLHEXYL)PHTHALATE	480 U	360 U	350 U	410 U	380 U	380 U	470 U	370 U	350 U	400 U
BUTYLBENZYL PHTHALATE	480 U	360 U	350 U	410 U	380 U	380 U	470 U	370 U	350 U	400 U
CARBAZOLE		640	660	410 U	380 U	380 U	470 U	370 U	350 U	400 U
CHRYSENE	480 U	2400	2000	410 U	380 U	380 U	470 U	58 J	350 U	94 J
DI-N-BUTYL PHTHALATE	88 J	360 U	20 J	410 U	380 U	380 U	470 U	370 U	350 U	400 U
DIBENZO(A,H)ANTHRACENE	480 U	360 U	350 U	410 U	380 U	380 U	470 U	370 U	350 U	400 U
DIBENZOFURAN	480 U	340 J	350 J	410 U	380 U	380 U	470 U	370 U	350 U	400 U
DIETHYL PHTHALATE	480 U	360 U	350 U	410 U	380 U	380 U	470 U	370 U	14000	400 U
FLUORANTHENE	480 U	3800 J	3700 J	410 U	380 U	380 U	470 U	130 J	18 J	210 J
FLUORENE	480 U	660	710	410 U	380 U	380 U	470 U	370 U	350 U	600
INDENO(1,2,3-CD)PYRENE	480 U	1200	1100 J	24 J	380 U	380 U	470 U	24 J	350 U	48 J
NAPHTHALENE	480 U	260 J	310 J	410 U	380 U	380 U	470 U	370 U	350 U	400 U
PHENANTHRENE	480 U	4100 J	4300 J	410 U	380 U	380 U	470 U	97 J	350 U	1800
PYRENE	480 U	4200 J	3900 J	410 U	380 U	380 U	470 U	110 J	23 J	230 J
Pesticides/PCBs (ug/kg)										
4,4'-DDD	26 U	36 U	35 U	41 UJ	37 U		47 U	37 U	25 J	40 U
4,4'-DDE	26 U	36 U	35 U	41 UJ	37 U		47 U	37 U	10 J	40 U
4,4'-DDT	26 U	36 U	6.7 J	41 UJ	37 U		47 U	4.9 J	5.4 J	40 U
AROCLOR-1254	260 U	360 U	350 U	410 U	370 U		470 U	370 U	350 U	400 U

TABLE 7-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	7TB6	7TB10	7MW4S	7MW6S	7MW6S	7MW10S	7MW11S	7MW5S	7MW7S	7MW8S
nsample	081490-7TB6(6-8)	7 SO 10 0103	7 SO 4S 0103	7 SO 6S 0305	7 SO 6S 0507	7MW10S-0608	7MW11S-0507	7MW5S-1011	7MW7S-0103	7MW8S-0408
sample	7TB6(6-8)	7 SO 10 0103	7 SO 4S 0103	7 SO 6S 0305	7 SO 6S 0507	7MW10S-0608	7MW11S-0507	7MW5S-1011	7MW7S-0103	7MW8S-0408
top_depth	6	1	1	3	5	6	5	10	1	4
bottom_dep	8	3	3	5	7	8	7	11	3	8
sample_dat	8/14/90	3/6/94	3/6/94	3/6/94	3/6/94	2/8/94	3/9/94	3/8/94	3/7/94	2/6/94
duplicate										
ENDOSULFAN SULFATE	26 U	13 J	35 U	41 UJ	37 U		47 U	37 U	35 J	40 U
ENDRIN ALDEHYDE		36 U	35 U	41 UJ	37 U		47 U	37 U	35 U	40 U
ENDRIN KETONE	26 U	36 U	6.8 J	41 UJ	37 U		47 U	37 U	35 U	40 U
HEPTACHLOR	13 U	18 U	4.7 J	21 UJ	19 U		24 U	19 U	18 U	21 U
METHOXYCHLOR	130 U	180 U	32 J	210 UJ	190 U		240 U	190 U	180 U	210 U
Inorganics (mg/kg)										
ALUMINUM	12300	4450	9480	12600	20000	6990	18000	8220	7450	11300
ANTIMONY	16.6 J	3 U	3.2 U	7.6 U	10 U	3.4 UJ	8.6	3.4	3 U	3.5 UJ
ARSENIC	2.6	1.1 J	1.6 J	1.1 J	0.82 J	4.5	3.6 J	2 J	1.8 J	3
BARIUM	32.5	42.2	99.6 J	102 J	506	30.6	64.4	98.6	104 J	31.6
BERYLLIUM	0.54	0.2 U	0.35	0.38 J	0.35 J	0.23 U	0.72	0.35	0.21 J	0.47
CADMIUM	2.3	0.4 U	0.48	0.67 J	0.64 J	0.68 U	0.56 U	0.45 U	0.4 U	0.71 U
CALCIUM	1040	849 J	1960	1910	2810	1110	1110	1550	1970	1320
CHROMIUM	20.7 J	7	17.5	13.7	61.1	9.1 J	25.6	12	8.3 J	18.1 J
COBALT	6	2.9 U	6.6 J	7.2 J	19.2 J	6.1	6.9	6.8	4.7 J	3.9 U
COPPER	14.5 J	10.6	20.6	24.9	18.1	11.7	10	26.7	12.1	13.6
IRON	10400	6950	15200	20800	32900	6930	12500	14800	12100	8820
LEAD	3.6 J	10.5 J	11.7 J	3.3 J	3.7 J	2.5 U	7.8 J	14.7 J	4 J	9.1 U
MAGNESIUM	2740	2340	5390	6260	19500	2200 J	3350	4790	4370	3080
MANGANESE	103 J	184	367	437	725	171	119	317	215	106
MERCURY	0.11 U	0.1 UJ	0.11 UJ	0.28 J	0.16 J	1.2 J	0.14 U	0.11 U	0.11 J	0.12 UJ
NICKEL	8.2 J	5.1	8	9.4	42.1 J	12.4	12.7	8.4	5.4 J	10
POTASSIUM	575 J	2100 J	4810 J	5690 J	18400 J	1380	809	4540	3710 J	991
SELENIUM	0.5 U	0.6 U	0.65 U	0.71 U	0.6 U	0.68 UJ	0.85 UJ	0.67 UJ	0.6 U	0.71 UJ
SILVER	5.4 J	0.4 UJ	0.65 U	0.47 UJ	0.4 UJ	0.46 U	0.56 U	0.88	0.4 UJ	0.47 U
SODIUM	167 J	340 J	708	221 J	240 J	103 U	203	109	207 J	270
THALLIUM	1 U	0.2 U	0.26	0.38 J	1 J	0.23 U	0.28 U	0.36 U	0.2 U	0.24 U
VANADIUM	27.8	14.3 U	31.9 U	38.4 U	86.7	12.3	26.8	24.8	28.9 U	23.6
ZINC	28.6 J	48.7 J	133 J	78.6 J	84.2 J	18.7	31.4	101	48.7 J	30.2
Miscellaneous Parameters (mg/kg)										
TPH						11.6 UJ	14.2 U			898 J
TOTAL ORGANIC CARBON			18800					9370		2740

TABLE 7-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	7MW9S	7MW9S	7TB12	7TB13	7TB13	7TB14	7TB15	7TB16	7TB7	7TB8	7TB8
nsample	7MW9S-0608	7MW9S-0608-D	7TB12-0204	7TB13-0001	7TB1301.5 03.5	7TB14-0507	7TB15-0608	7TB160305	7TB7-0406	7TB8-0202.9	7TB8-0202.9-D
sample	7MW9S-0608	7MW9S-0608D	7TB12-0204	7TB13-0001	7TB1301.5 03.5	7TB14-0507	7TB15-0608	7TB160305	7TB7-0406	7TB8-0202.9	7TB8-0202.9D
top_depth	6	6	2	0	1.5	5	6	3	4	2	2
bottom_dep	8	8	4	1	4	7	8	5	6	2.9	2.9
sample_dat	2/6/94	2/6/94	3/8/94	3/8/94	3/8/94	2/6/94	2/7/94	3/7/94	3/14/94	3/15/94	3/15/94
duplicate		7MW9S-0608									7TB8-0202.9
Volatile Organics (ug/kg)											
1,1-DICHLOROETHENE	12 U	12 U	11 U		11 U	12 U	12 U	13 U	11 U	13 U	13 U
2-BUTANONE	12 U	12 U	11 U		11 U	12 U	12 U	13 U	11 U	13 U	13 U
ACETONE	28 U	43 U	11 U		27 J	48 U	29 U	13 U	11 U	44 U	13 U
BENZENE	12 U	12 U	11 U		11 U	12 U	12 U	13 U	11 U	13 U	13 U
CARBON DISULFIDE	12 U	12 U	11 U		11 U	12 U	12 U	13 U	11 U	13 U	13 U
CHLOROBENZENE	12 U	12 U	11 U		11 U	12 U	12 U	13 U	11 U	13 U	13 U
METHYLENE CHLORIDE	62 J	60 J	8 J		8 J	60 J	60 J	13 U	11 U	13 U	23 U
TETRACHLOROETHENE	5 J	6 J	11 U		11 U	4 J	3 J	13 U	11 U	13 U	13 U
TOLUENE	12 U	12 U	5 J		4 J	12 U	12 U	8 J	11 U	13 U	13 U
XYLENES, TOTAL	12 U	12 U	3 J		11 U	12 U	12 U	13 U	11 U	13 U	13 U
Semivolatile Organics (ug/kg)											
2-METHYLNAPHTHALENE	400 U	400 U	380 U		23 J	390 U	400 U	430 U	380 U	420 U	420 U
4-METHYLPHENOL	400 U	400 U	380 U		380 U	390 U	400 U	430 U	380 U	420 U	420 U
ACENAPHTHENE	400 U	400 U	43 J		380 U	390 U	400 U	430 U	380 U	420 U	420 U
ACENAPHTHYLENE	400 U	400 U	20 J		380 U	390 U	400 U	430 U	380 U	420 U	420 U
ANTHRACENE	400 U	400 U	180 J		380 U	390 U	400 U	430 U	380 U	420 U	420 U
BENZO(A)ANTHRACENE	400 U	400 U	650		36 J	390 U	400 U	430 U	65 J	420 U	420 U
BENZO(A)PYRENE	400 U	400 U	800		61 J	390 U	400 U	430 U	94 J	420 U	420 U
BENZO(B)FLUORANTHENE	400 U	400 U	980		48 J	390 U	400 U	430 U	120 J	21 J	420 U
BENZO(G,H,I)PERYLENE	400 U	400 U	590		57 J	390 U	400 U	430 U	84 J	420 U	420 U
BENZO(K)FLUORANTHENE	400 U	400 U	520		35 J	390 U	400 U	430 U	100 J	420 U	420 U
BENZOIC ACID	2000 U	2000 U	44 J		57 J	1900 U	2000 U	2100 U	27 J	31 J	23 J
BIS(2-ETHYLHEXYL)PHTHALATE	400 U	400 U	380 U		380 U	390 U	400 U	430 U	380 U	420 U	420 U
BUTYLBENZYL PHTHALATE	400 U	400 U	380 U		380 U	390 U	400 U	430 U	26 J	420 U	420 U
CARBAZOLE	400 U	400 U	92 J		380 U	390 U	400 U	430 U	27 J	420 U	420 U
CHRYSENE	400 U	400 U	720		38 J	390 U	400 U	430 U	120 J	25 J	420 U
DI-N-BUTYL PHTHALATE	400 U	400 U	380 U		22 J	390 U	400 U	430 U	22 J	25 J	25 J
DIBENZO(A,H)ANTHRACENE	400 U	400 U	380 U		380 U	390 U	400 U	430 U	380 U	420 U	420 U
DIBENZOFURAN	400 U	400 U	27 J		380 U	390 U	400 U	430 U	380 U	420 U	420 U
DIETHYL PHTHALATE	400 U	400 U	380 U		380 U	390 U	400 U	430 U	380 U	420 U	420 U
FLUORANTHENE	400 U	400 U	960		70 J	390 U	400 U	21 J	220 J	44 J	22 J
FLUORENE	400 U	400 U	66 J		380 U	390 U	400 U	430 U	380 U	420 U	420 U
INDENO(1,2,3-CD)PYRENE	400 U	400 U	560		50 J	390 U	400 U	430 U	40 J	420 U	420 U
NAPHTHALENE	400 U	400 U	380 U		380 U	390 U	400 U	430 U	380 U	420 U	420 U
PHENANTHRENE	400 U	400 U	570		63 J	390 U	400 U	430 U	100 J	25 J	420 U
PYRENE	400 U	400 U	860		64 J	390 U	400 U	21 J	180 J	40 J	22 J
Pesticides/PCBs (ug/kg)											
4,4'-DDD			14 J		6.1 J			4.4 J	37 U	42 U	42 U
4,4'-DDE			6.4 J		37 U			5.4 J	37 U	42 U	42 U
4,4'-DDT			18 J		37 U			26 J	37 U	42 U	42 U
AROCLOR-1254			370 U		370 U			430 U	370 U	420 U	420 U

TABLE 7-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	7MW9S	7MW9S	7TB12	7TB13	7TB13	7TB14	7TB15	7TB16	7TB7	7TB8	7TB8
nsample	7MW9S-0608	7MW9S-0608-D	7TB12-0204	7TB13-0001	7TB1301.5 03.5	7TB14-0507	7TB15-0608	7TB160305	7TB7-0406	7TB8-0202.9	7TB8-0202.9-D
sample	7MW9S-0608	7MW9S-0608D	7TB12-0204	7TB13-0001	7TB1301.5 03.5	7TB14-0507	7TB15-0608	7TB160305	7TB7-0406	7TB8-0202.9	7TB8-0202.9D
top_depth	6	6	2	0	1.5	5	6	3	4	2	2
bottom_dep	8	8	4	1	4	7	8	5	6	2.9	2.9
sample_dat	2/6/94	2/6/94	3/8/94	3/8/94	3/8/94	2/6/94	2/7/94	3/7/94	3/14/94	3/15/94	3/15/94
duplicate		7MW9S-0608									7TB8-0202.9
ENDOSULFAN SULFATE			37 U		37 U			43 U	37 U	42 U	42 U
ENDRIN ALDEHYDE			37 U		37 U			43 U	5.5 J	5.5 J	42 U
ENDRIN KETONE			37 U		37 U			43 U	37 U	42 U	42 U
HEPTACHLOR			19 U		19 U			22 U	19 U	22 U	22 U
METHOXYCHLOR			190 U		190 U			220 U	190 U	220 U	220 U
Inorganics (mg/kg)											
ALUMINUM	10700	11200	13900		9830	5220	10900	7030	15800	19300	12700
ANTIMONY	9.6 J	6.8 R	5.2 R		5.6	5.1 J	6 J	3 U	3.4 UJ	3.7 UJ	3.4 UJ
ARSENIC	8.1	7.5	3.4 J		3 J	3.3	4.3	2 J	1.6 U	4.6 U	3 U
BARIUM	34.3	39.9	154		58.1	17.4 J	42.2	18.8 J	155	86.8	69.1
BERYLLIUM	0.44	0.37	0.6		0.54	0.42 J	0.41 J	0.26 J	0.44 J	0.79	0.51
CADMIUM	0.75 UJ	0.74 U	0.47 U		0.46 U	0.72 U	0.74 U	0.47 J	0.61 U	1 U	0.5 U
CALCIUM	1830	1700	1670		1230	882	1420	666 J	1240	2810	2070
CHROMIUM	18.2 J	17.8 J	23.5		14	9.3 J	20.2 J	10.7	26.6	23.3	16.9
COBALT	5.6	5.9	10.4		5.5	3.5 U	6.1	1.8 U	9	7.8	6.9
COPPER	14.2	15.6	39.9		31.1	8.7	16.2	7.6	45	37.4	32
IRON	20800	16400	18200		11200	8230	12300	6750	19700	17300	14700
LEAD	4.4 U	3.6 U	27.5 J		16.8 J	4.7 U	4.6 U	4.7 J	15.8 J	22.4 J	22.2 J
MAGNESIUM	3370	3810	6910		3410	1660	4030	1780 J	7310	5120	3790
MANGANESE	161	140	329		155	208	194	60.7	357 J	230 J	194 J
MERCURY	0.12 UJ	0.12 UJ	0.13		0.11 U	0.12 UJ	0.12 UJ	0.1 UJ	0.11 U	0.12 U	0.11 U
NICKEL	12.9	12.9	16 J		9.9	5.8	12.6 J	5.4	18.3	16.6	12.8
POTASSIUM	1490	1680	5130		1910	848	1990	744 J	5960	2910	2390
SELENIUM	0.75 UJ	0.74 UJ	0.7 UJ		0.68 UJ	0.72 UJ	0.74 UJ	0.6 U	0.67 UJ	0.74 UJ	0.68 UJ
SILVER	0.73 U	0.5 UJ	0.86 J		0.46 U	0.48 U	0.49 U	0.4 UJ	1.4	0.97 J	0.46 U
SODIUM	252	265	121 J		68.2	210	214	191 J	187	204	212
THALLIUM	0.25 U	0.25 U	0.44 U		0.23 U	0.24 U	0.25 UJ	0.2 U	0.34 J	0.25 UJ	0.23 UJ
VANADIUM	21.9	21.3 J	33.7		20.1	18.5 J	26.4 J	15.7 U	56	37.9	26
ZINC	25.9	28.3	66		38.2	23.5	33.4	47.4 J	87.5	44.2	35.7
Miscellaneous Parameters (mg/kg)											
TPH	12 UJ	12.2 UJ	160		238	11.8 UJ	12.2 UJ				
TOTAL ORGANIC CARBON			8390	4740							

TABLE 7-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	7TB9	B325-MW1	B325-MW1	B325-MW3	B325-MW3	B325-MW4	B325-MW4	B325-SB5	B325-SB5
nsample	7TB9-0002	B325-SO01-0204	B325-SO01-0406	B325-SO03-0002	B325-SO03-0408	B325-SO04-0406	B325-SO04-0608	B325-SO05-0002	B325-SO05-0406
sample	7TB9-0002	B325-MW01-0204	B325-MW01-0406	B325-MW03-0002	B325-MW03-0408	B325-MW04-0406	B325-MW04-0608	B325-MW05-0002	B325-MW05-0406
top_depth	0	2	4	0	4	4	6	0	4
bottom_dep	2	4	6	2	8	6	8	2	6
sample_dat	3/8/94	11/4/94	11/4/94	11/4/94	11/4/94	11/4/94	11/4/94	11/5/94	11/5/94
duplicate									
Volatile Organics (ug/kg)									
1,1-DICHLOROETHENE	11 U								
2-BUTANONE	11 U								
ACETONE	11 UJ								
BENZENE	11 U	1.07 U	1.11 U	1.09 U	1.07 U	1.22 U	1.32 U	1.12 U	1.2 U
CARBON DISULFIDE	11 U								
CHLOROBENZENE	11 U								
METHYLENE CHLORIDE	5 J								
TETRACHLOROETHENE	11 U								
TOLUENE	11 U	1.07 U	1.11 U	1.09 U	1.07 U	1.22 U	1.32 U	1.12 U	1.2 U
XYLENES, TOTAL	11 U	1.07 U	1.11 U	1.09 U	1.07 U	1.22 U	1.32 U	1.34	0.96 J
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	360 U								
4-METHYLPHENOL	360 U								
ACENAPHTHENE	360 U								
ACENAPHTHYLENE	360 U								
ANTHRACENE	360 U								
BENZO(A)ANTHRACENE	360 U								
BENZO(A)PYRENE	360 U								
BENZO(B)FLUORANTHENE	360 U								
BENZO(G,H,I)PERYLENE	360 U								
BENZO(K)FLUORANTHENE	360 U								
BENZOIC ACID	1700 U								
BIS(2-ETHYLHEXYL)PHTHALATE	360 U								
BUTYLBENZYL PHTHALATE	360 U								
CARBAZOLE	360 U								
CHRYSENE	360 U								
DI-N-BUTYL PHTHALATE	360 U								
DIBENZO(A,H)ANTHRACENE	360 U								
DIBENZOFURAN	360 U								
DIETHYL PHTHALATE	360 U								
FLUORANTHENE	360 U								
FLUORENE	360 U								
INDENO(1,2,3-CD)PYRENE	360 U								
NAPHTHALENE	360 U								
PHENANTHRENE	360 U								
PYRENE	360 U								
Pesticides/PCBs (ug/kg)									
4,4'-DDD	36 U								
4,4'-DDE	36 U								
4,4'-DDT	36 U								
AROCLOR-1254	360 U								

TABLE 7-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	7TB9	B325-MW1	B325-MW1	B325-MW3	B325-MW3	B325-MW4	B325-MW4	B325-SB5	B325-SB5
nsample	7TB9-0002	B325-SO01-0204	B325-SO01-0406	B325-SO03-0002	B325-SO03-0408	B325-SO04-0406	B325-SO04-0608	B325-SO05-0002	B325-SO05-0406
sample	7TB9-0002	B325-MW01-0204	B325-MW01-0406	B325-MW03-0002	B325-MW03-0408	B325-MW04-0406	B325-MW04-0608	B325-MW05-0002	B325-MW05-0406
top_depth	0	2	4	0	4	4	6	0	4
bottom_dep	2	4	6	2	8	6	8	2	6
sample_dat	3/8/94	11/4/94	11/4/94	11/4/94	11/4/94	11/4/94	11/4/94	11/5/94	11/5/94
duplicate									
ENDOSULFAN SULFATE	36 U								
ENDRIN ALDEHYDE	36 U								
ENDRIN KETONE	36 U								
HEPTACHLOR	18 U								
METHOXYCHLOR	180 U								
Inorganics (mg/kg)									
ALUMINUM	3730								
ANTIMONY	3.3 U								
ARSENIC	3.5 J								
BARIUM	23.2								
BERYLLIUM	0.22 U								
CADMIUM	0.44 U								
CALCIUM	1230								
CHROMIUM	6.8								
COBALT	3.5 U								
COPPER	9.2								
IRON	4580								
LEAD	4.5 J								
MAGNESIUM	1510								
MANGANESE	87.7								
MERCURY	0.11 U								
NICKEL	7.5								
POTASSIUM	1020								
SELENIUM	0.66 UJ								
SILVER	0.5								
SODIUM	60.9								
THALLIUM	0.22 U								
VANADIUM	7.7								
ZINC	13.8								
Miscellaneous Parameters (mg/kg)									
TPH		28.9	11.1 U	131	386	12.2 U	13.2 U	28	70.9
TOTAL ORGANIC CARBON									

TABLE 7-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	B325-SB6	B325-SB6	B325-SB7	B325SS	B325SW	7SB8	7SB9	7SB10	7SB18
nsample	B325-SO06-0002	B325-SO06-0002-D	B325-SO07-0003	B325SS-0203	B325SW-0203	S7SB080607	S7SB090809	S7SB100607	S7SB180506
sample	B325-MW06-0002	DUP-02	B325-MW07-0003	B325SS-0203	B325SW-0203	S7SB080607	S7SB090809	S7SB100607	S7SB180506
top_depth	0	0	0	2	2	6	8	6	5
bottom_dep	2	2	3	3	3	7	9	7	6
sample_dat	11/5/94	11/5/94	11/5/94	12/2/95	12/2/95	6/13/00	6/13/00	6/13/00	6/13/00
duplicate		B325-SO06-0002							
Volatile Organics (ug/kg)									
1,1-DICHLOROETHENE						7 U	6 U	7 U	7 U
2-BUTANONE						8 J	11 U	9 J	3 J
ACETONE						68	14 U	61	49
BENZENE	1.11 U	1.1 U	1.05 U			7 U	6 U	7 U	7 U
CARBON DISULFIDE						6 J	6 U	25	7 U
CHLOROBENZENE						7 U	1 J	7 U	6 J
METHYLENE CHLORIDE						7 U	8 U	7 U	8 U
TETRACHLOROETHENE						7 U	6 U	7 U	7 U
TOLUENE	1.11 U	1.1 U	1.05 U			2 J	3 J	7 U	2 J
XYLENES, TOTAL	0.78 J	1.1 U	0.53 J			21 U	17 U	20 U	20 U
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE						220 U	200 U	220 U	220 U
4-METHYLPHENOL						230 U	200 U	220 U	220 U
ACENAPHTHENE						220 U	200 U	220 U	220 U
ACENAPHTHYLENE						220 U	200 U	220 U	220 U
ANTHRACENE						220 U	200 U	220 U	220 U
BENZO(A)ANTHRACENE						220 U	200 U	220 U	220 U
BENZO(A)PYRENE						220 U	200 U	220 U	220 U
BENZO(B)FLUORANTHENE						220 U	200 U	220 U	220 U
BENZO(G,H,I)PERYLENE						220 UJ	200 UJ	220 UJ	220 UJ
BENZO(K)FLUORANTHENE						220 U	200 U	220 U	220 U
BENZOIC ACID									
BIS(2-ETHYLHEXYL)PHTHALATE						460 U	410 U	450 U	460 U
BUTYLBENZYL PHTHALATE						220 U	200 U	220 U	220 U
CARBAZOLE						220 U	200 U	220 U	220 U
CHRYSENE						220 U	200 U	220 U	220 U
DI-N-BUTYL PHTHALATE						460 U	410 U	450 U	460 U
DIBENZO(A,H)ANTHRACENE						220 UJ	200 UJ	220 UJ	220 UJ
DIBENZOFURAN						220 U	200 U	220 U	220 U
DIETHYL PHTHALATE						220 U	200 U	220 U	220 U
FLUORANTHENE						220 U	200 U	220 U	220 U
FLUORENE						220 U	200 U	220 U	220 U
INDENO(1,2,3-CD)PYRENE						220 UJ	200 UJ	220 UJ	220 UJ
NAPHTHALENE						220 U	200 U	220 U	220 U
PHENANTHRENE						220 U	200 U	220 U	220 U
PYRENE						220 U	200 U	25 J	220 U
Pesticides/PCBs (ug/kg)									
4,4'-DDD									
4,4'-DDE									
4,4'-DDT									
AROCLOR-1254									

TABLE 7-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	B325-SB6	B325-SB6	B325-SB7	B325SS	B325SW	7SB8	7SB9	7SB10	7SB18
nsample	B325-SO06-0002	B325-SO06-0002-D	B325-SO07-0003	B325SS-0203	B325SW-0203	S7SB080607	S7SB090809	S7SB100607	S7SB180506
sample	B325-MW06-0002	DUP-02	B325-MW07-0003	B325SS-0203	B325SW-0203	S7SB080607	S7SB090809	S7SB100607	S7SB180506
top_depth	0	0	0	2	2	6	8	6	5
bottom_dep	2	2	3	3	3	7	9	7	6
sample_dat	11/5/94	11/5/94	11/5/94	12/2/95	12/2/95	6/13/00	6/13/00	6/13/00	6/13/00
duplicate		B325-SO06-0002							
ENDOSULFAN SULFATE									
ENDRIN ALDEHYDE									
ENDRIN KETONE									
HEPTACHLOR									
METHOXYCHLOR									
Inorganics (mg/kg)									
ALUMINUM						16600	13400	18500	13500
ANTIMONY						0.62 UJ	0.71 J	0.92 J	0.67 U
ARSENIC						3.1	2.1	1.2 J	2 J
BARIUM						43.6	65.9	81.2	36
BERYLLIUM						0.55	0.6	0.81	0.46
CADMIUM						0.12 U	0.12 U	0.11 U	0.13 U
CALCIUM						1300	2230	1500	1040
CHROMIUM						18.6	27.9	25.2	20.5
COBALT						6.6	9.4	7.2	5.1
COPPER						12.2 J	13.2 J	16.1	8.8 J
IRON						13800	12600	16200	13500
LEAD						9.2	4.6	6.2	4.5
MAGNESIUM						2760	4270	4120	2740
MANGANESE						238	203	181	107
MERCURY						0.14 U	0.07 U	0.06 U	0.1 U
NICKEL						8.1	13.8	11.9	7.3
POTASSIUM						1080	1770	1320	780
SELENIUM						0.62 U	0.61 U	0.55 U	0.67 U
SILVER						3.8	3.6	3.9	3.7
SODIUM						184	232	197	173
THALLIUM						0.48 U	0.48 U	0.55 J	0.52 U
VANADIUM						31.9	29.3	38.4	27.3
ZINC						39.2	42.5	40.3	29.1
Miscellaneous Parameters (mg/kg)									
TPH	367	298	253	92.4	157				
TOTAL ORGANIC CARBON									

TABLE 7-3

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR TEMPORARY WELLS AT SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location sample sacode sample_dat	7TW1 S7TW0101 NORMAL 6/11/00	7TW2 S7TW0201 NORMAL 6/11/00	7TW3 S7TW0301 NORMAL 6/11/00	7TW4 S7TW0401 NORMAL 6/11/00	7TW5 S7TW0501 NORMAL 6/11/00	7TW6 S7TW0601 NORMAL 6/11/00	7TW7 S7TW0701 DUP 6/11/00	7TW7 FD0611001 DUP 6/11/00	7TW8 S7TW0801 NORMAL 6/24/00	7TW9 S7TW0901 NORMAL 6/24/00	7TW10 S7TW1001 NORMAL 6/25/00
Volatile Organics (ug/L)											
1,4-DICHLOROBENZENE	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.83	9.21	90.5 J
BENZENE	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 J
CHLOROBENZENE	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	6.66	165 J
Dissolved Gases (ug/L)											
METHANE									19	8	6
Semivolatile Organics (ug/L)											
BIS(2-ETHYLHEXYL)PHTHALATE									44	49	5 U
Total Metals (ug/L)											
ALUMINUM									891	57500	50.5 U
ARSENIC									2.3 U	11.4	2.3 U
BARIUM									38.6 U	434	20.5 U
CALCIUM									23900	37000	12800
CHROMIUM									6.2 U	127	6.2 U
COBALT									4.2 U	31.3	4.2 U
COPPER									6.8 U	73.2	6.8 U
IRON									4370	59400	282 U
LEAD									1.8 U	32.8	1.8 U
MAGNESIUM									5130	19500	3080
MANGANESE									836	1250	650
NICKEL									9.2 U	52.8 J	9.2 U
POTASSIUM									6060	11600	4410
SILVER									5.2 U	16.3	5.2 U
SODIUM									64100	67500	29600
VANADIUM									6.3 U	151	6.3 U
ZINC									21 U	164	15.6 U

TABLE 7-3

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR TEMPORARY WELLS AT SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location sample sacode sample_dat	7TW1 S7TW0101 NORMAL 6/11/00	7TW2 S7TW0201 NORMAL 6/11/00	7TW3 S7TW0301 NORMAL 6/11/00	7TW4 S7TW0401 NORMAL 6/11/00	7TW5 S7TW0501 NORMAL 6/11/00	7TW6 S7TW0601 NORMAL 6/11/00	7TW7 S7TW0701 DUP 6/11/00	7TW7 FD0611001 DUP 6/11/00	7TW8 S7TW0801 NORMAL 6/24/00	7TW9 S7TW0901 NORMAL 6/24/00	7TW10 S7TW1001 NORMAL 6/25/00
Miscellaneous Parameters (mg/L)											
ALKALINITY									82.6	76.4	50.3
AMMONIA, AS NITROGEN									0.43	0.43	0.2
AMMONIUM									0.44	0.3	0.3
CHLORIDE									92	69.8	41.2
HARDNESS as CaCO3									80.7	173	44.7
PERCHLORATE									0.004 U	0.004 U	0.004 U
SULFATE									29.8	34.6	13.9
SULFIDE									0.05 U	0.05 U	0.07
TOTAL DISSOLVED SOLIDS									275	266	158
TOTAL ORGANIC CARBON									14	17	9
TOTAL SUSPENDED SOLIDS									29	2950	5 U

TABLE 7-4

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	B325-MW1	B325-MW3	B325-MW4	7MW1D	7MW1D	7MW2D	7MW2S	7WM3D	7MW3S
sample	S7B325MW0101	S7B325MW0301	S7B325MW0401	S7MW01D01	S7MW01D01-F	S7MW02D01	S7MW02S01	S7MW03D01	S7MW03S01
sacode	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
sample_dat	7/9/00	7/9/00	7/10/00	7/7/00	7/7/00	7/8/00	7/8/00	6/24/00	7/11/00
Aquifer	Overburden	Overburden	Overburden	Bedrock		Becrodk	Overburden	Overburden	Overburden
Volatile Organics (ug/L)									
1,3-DICHLOROBENZENE	1 U	1 U	1 U	1 U		1 U	1 U	1 UJ	1.73
1,4-DICHLOROBENZENE	1 U	1 U	1 U	1 U		1 U	1 U	1 UJ	1.71
TRICHLOROETHENE	1.93	1.39	1 U	4.09		1.54	1 U	1 UJ	1 U
Dissolved Gases (ug/L)									
METHANE	1 U	1 U	1 UJ	1 U		1 U	1 U	1	20 J
Semivolatile Organics (ug/L)									
BIS(2-ETHYLHEXYL)PHTHALATE	5 U	5 U	10 U	5 U		5 U	5 U	5 U	5 U
FLUORENE	0.05 U	0.05 U	0.1 U	0.05 U		0.05 U	0.05 U	0.1 U	0.1 U
HEXACHLOROBENZENE	5 U	5 U	10 U	5 U		5 U	5 U	5 U	5 U
PHENANTHRENE	0.03 U	0.03 U	0.05 U	0.03 U		0.03 U	0.03 U	0.05 U	0.05 U
Total Metals (ug/L)									
ALUMINUM	72.4 J	246	815	50.5 U		93.9 J	105	1140	50.5 U
ARSENIC	2.3 U	2.3 U	2.3 U	2.3 U		2.3 U	2.3 U	2.3 U	2.3 U
BARIUM	39	35.7	21 U	17.7 U		9.3 U	9.3 U	39.9	33.5
CADMIUM	0.25 U	0.25 U	0.25 U	0.25 U		0.25 U	0.25 U	0.25 U	0.27 J
CALCIUM	26000	23400	20500	15100		8350	5480	21900	17000
CHROMIUM	6.2 U	6.2 U	7.6 J	8.8 U		6.2 U	6.2 U	11.7 J	6.2 U
COBALT	4.4 J	4.2 U	5.3 J	4.2 U		4.2 U	14.5	13.9 U	7.1 J
COPPER	11.5 U	6.8 U	10.7 J	11.6 U		10.5 U	6.8 U	6.8 U	11.8 J
IRON	101 U	196 U	648	759 U		75.4 U	13500 J	1440	119 U
LEAD	6.7	1.8 U	1.8 U	7.8		4.2	1.8 U	1.8 U	1.8 U
MAGNESIUM	6170 J	5350 J	3070	1230 J		1420 J	1250 J	8560	5810
MANGANESE	33.2 J	9.2 J	35	9.3 J		2.7 UJ	295 J	958	748
NICKEL	9.2 U	9.2 U	9.2 U	9.2 U		9.2 U	9.2 U	9.2 U	9.2 U
POTASSIUM	7010	7140	6090	1460		1290	1310	4900	3010
SELENIUM	2.8 U	2.8 U	2.8 U	2.8 U		2.8 U	2.8 U	2.8 U	2.8 U
SODIUM	76600	76000	44600	4020		7280	5240	91600	76500
VANADIUM	6.3 U	6.3 U	6.3 U	6.3 U		6.3 U	6.3 U	6.3 U	6.3 U
ZINC	18.1 U	12.8 U	20.5	157 J		17.3 U	7.4 U	16.4 U	17.1

TABLE 7-4

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	B325-MW1	B325-MW3	B325-MW4	7MW1D	7MW1D	7MW2D	7MW2S	7WM3D	7MW3S
sample	S7B325MW0101	S7B325MW0301	S7B325MW0401	S7MW01D01	S7MW01D01-F	S7MW02D01	S7MW02S01	S7MW03D01	S7MW03S01
sacode	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
sample_dat	7/9/00	7/9/00	7/10/00	7/7/00	7/7/00	7/8/00	7/8/00	6/24/00	7/11/00
Aquifer	Overburden	Overburden	Overburden	Bedrock		Becrodk	Overburden	Overburden	Overburden
Dissolved Metals (ug/L)									
BARIUM					18.7 U				
CALCIUM					17600				
COPPER					6.8 U				
MAGNESIUM					1470				
MANGANESE					7.8 J				
POTASSIUM					1730				
SODIUM					4690				
ZINC					173				
Miscellaneous Parameters (mg/L)									
ALKALINITY	68.5 J	67 J	66.5 J	39.7 J		19 J	15.5 J	59.2	75.7
AMMONIA			0.18 J						0.16
AMMONIA, AS NITROGEN	0.11	0.1 U		0.54 J		0.13	0.14	0.22	
AMMONIUM	0.2 U	0.2 U	0.2 U	0.2 U		0.2 U	0.2 U	0.4	0.2 U
CHLORIDE	96.8 J	95 J	59.5	5.84 J		8.84 J	8.26 J	104	85.1
HARDNESS as CaCO3	90.3	80.4	63.8	42.8		26.7	18.8	89.8	66.4
SULFATE	49.9 J	43 J	21.5	14.1 J		13.5 J	16.3 J	65.4	48.9
TOTAL DISSOLVED SOLIDS	158 U	302 J	211 J	111 U		66.2 U	90 U	355	289
TOTAL ORGANIC CARBON	5 U	5 U	3.5	6		5 U	6	8	1.4
TOTAL SUSPENDED SOLIDS	5 UJ	26 J	41 J	5 UJ		5 UJ	10 J	57	5 U

TABLE 7-4

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	7MW4S	7MW5D	7MW5S	7MW5S	7MW6S	7MW7S	7MW8S	7MW9S	7MW10S
sample	S7MW04S01	S7MW05D01	S7MW05S01	FD0710001	S7MW06S01	S7MW07S01	S7MW08S01	S7MW09S01	S7MW10S01
sacode	NORMAL	NORMAL	DUP	DUP	NORMAL	NORMAL	NORMAL	NORMAL	DUP
sample_dat	7/9/00	7/11/00	7/10/00	7/10/00	7/11/00	7/10/00	7/8/00	7/11/00	7/7/00
Aquifer	Bedrock	Bedrock	Overburden		Overburden	Bedrock	Overburden	Overburden	Overburden
Volatile Organics (ug/L)									
1,3-DICHLOROBENZENE	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-DICHLOROBENZENE	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TRICHLOROETHENE	1 U	7.58	1 U	1 U	1 U	2.03	1 U	23	1 U
Dissolved Gases (ug/L)									
METHANE	1 U	1 UJ	1 UJ	1 U	41 J	1 UJ	1 U	2 U	1 U
Semivolatile Organics (ug/L)									
BIS(2-ETHYLHEXYL)PHTHALATE	5 U	5 U	5 U	5 U	5 U	10 U	190	5 U	5 U
FLUORENE	0.05 U	0.1 U	0.26 J	0.1 U	0.1 U	0.1 U	6.5	0.1 U	0.05 U
HEXACHLOROBENZENE	5 U	5 U	5 U	5 U	5 U	10 U	5 UJ	3 J	5 U
PHENANTHRENE	0.03 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	3.7	0.05 U	0.03 U
Total Metals (ug/L)									
ALUMINUM	50.5 U	598	54.2 U	50.5 U	50.5 U	50.5 U	124	430 U	50.5 U
ARSENIC	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.3 U	2.9 J	2.3 U
BARIUM	34.1	55.1	11.7 U	11.4 U	39.4	16.5 U	8.6 U	37.8	33.6
CADMIUM	0.38 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
CALCIUM	28300	103000	6780	6770	18300	17700	13800	24900	20600
CHROMIUM	6.2 U	47	6.2 U	6.2 U	6.2 U	6.2 U	6.2 U	6.2 U	6.2 U
COBALT	4.2 U	4.2 U	7.1 J	5.3 J	5.3 J	4.4 J	4.2 U	8.9	4.2 U
COPPER	8 U	10.7 J	7.1 J	8.9 J	9.7 J	8.9 J	6.8 U	6.8 U	6.8 U
IRON	72.5 U	996	36.5 U	39.5 U	2330	45.1 U	2150 J	14600	37.3 U
LEAD	1.8 U	6.5	1.8 U	1.8 U	2.1 J	1.8 U	1.8 U	5.5	1.8 U
MAGNESIUM	6530 J	6950	882	871	4000	2410	1390 J	4010	6280 J
MANGANESE	4.6 J	96.6	2.7 U	2.7 U	428	10.7	64.3 J	1000	2.7 UJ
NICKEL	9.2 U	34.3	9.2 U	9.2 U	9.2 U	9.2 U	9.2 U	9.2 U	9.2 U
POTASSIUM	6090	6920	917	1080	5520	3070	2340	4880	3340
SELENIUM	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	3.2 J	2.8 U	2.8 U	2.8 U
SODIUM	76900	30000	5140	5100	41600	23200	17700	55100	43500
VANADIUM	6.3 U	6.3 U	6.3 U	6.3 U	6.3 U	6.3 U	6.3 U	7.6 J	6.3 U
ZINC	72.8 J	18.6	20.6	21.4	13.4	10.3	27.1 U	8.4 J	194 J

TABLE 7-4

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	7MW4S	7MW5D	7MW5S	7MW5S	7MW6S	7MW7S	7MW8S	7MW9S	7MW10S
sample	S7MW04S01	S7MW05D01	S7MW05S01	FD0710001	S7MW06S01	S7MW07S01	S7MW08S01	S7MW09S01	S7MW10S01
sacode	NORMAL	NORMAL	DUP	DUP	NORMAL	NORMAL	NORMAL	NORMAL	DUP
sample_dat	7/9/00	7/11/00	7/10/00	7/10/00	7/11/00	7/10/00	7/8/00	7/11/00	7/7/00
Aquifer	Bedrock	Bedrock	Overburden		Overburden	Bedrock	Overburden	Overburden	Overburden
Dissolved Metals (ug/L)									
BARIUM									
CALCIUM									
COPPER									
MAGNESIUM									
MANGANESE									
POTASSIUM									
SODIUM									
ZINC									
Miscellaneous Parameters (mg/L)									
ALKALINITY	83.5 J	124	10 J	10 J	64	58 J	57.3 J	71.6	71.3 J
AMMONIA		0.15	0.18 J	0.17 J	0.44	0.48 J		0.26	
AMMONIA, AS NITROGEN	0.1 U						0.1		0.42 J
AMMONIUM	0.2 U	0.2 U	0.2 U	0.2 U	0.4	0.2 U	0.2	0.2 U	0.2 U
CHLORIDE	153 J	142	7.14	7	40.6	35.1	16.5 J	123	155 J
HARDNESS as CaCO3	97.4	285	20.5	20.5	62.2	54.1	40.2	78.7	77.4
SULFATE	50.2 J	62.5	13.8	13.8	43.5	22.2	3.46 J	30.2	71.6 J
TOTAL DISSOLVED SOLIDS	359 J	464	50 J	63.8 J	205	139 J	114 U	251	279 J
TOTAL ORGANIC CARBON	5 U	1.5	0.9	1.1	3.7	120	5 U	2.6	7
TOTAL SUSPENDED SOLIDS	5 UJ	108	5 UJ	5 UJ	5 U	5 UJ	5 UJ	17	5 UJ

TABLE 7-4

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location sample sacode sample_dat Aquifer	7MW10S FD0707001 DUP 7/7/00 Overburden	7MW10S S7MW10S01-F DUP 7/7/00	7MW10S FD0707001-F DUP 7/7/00	7MW11S S7MW11S01 NORMAL 7/11/00 Overburden
Volatile Organics (ug/L)				
1,3-DICHLOROBENZENE	1 U			1 U
1,4-DICHLOROBENZENE	1 U			1 U
TRICHLOROETHENE	1 U			1 U
Dissolved Gases (ug/L)				
METHANE	1 U			7 J
Semivolatile Organics (ug/L)				
BIS(2-ETHYLHEXYL)PHTHALATE	5 U			5 U
FLUORENE	0.05 U			0.1 U
HEXACHLOROBENZENE	5 U			5 U
PHENANTHRENE	0.03 U			0.05 U
Total Metals (ug/L)				
ALUMINUM	50.5 U			50.5 U
ARSENIC	2.3 U			2.3 U
BARIUM	35.7			40.5
CADMIUM	0.25 U			0.25 U
CALCIUM	22600			23500
CHROMIUM	6.2 U			6.2 U
COBALT	7.8 J			4.2 U
COPPER	7 U			6.8 U
IRON	31.1 U			298
LEAD	1.8 U			1.9 J
MAGNESIUM	6960 J			5300
MANGANESE	2.7 UJ			481
NICKEL	9.2 U			9.2 U
POTASSIUM	3630			6050
SELENIUM	2.8 U			2.8 U
SODIUM	47300			61000
VANADIUM	6.3 U			6.3 U
ZINC	72.8 J			4.6 U

TABLE 7-4

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location sample sacode sample_dat Aquifer	7MW10S FD0707001 DUP 7/7/00 Overburden	7MW10S S7MW10S01-F DUP 7/7/00	7MW10S FD0707001-F DUP 7/7/00	7MW11S S7MW11S01 NORMAL 7/11/00 Overburden
Dissolved Metals (ug/L)				
BARIUM		35.5	36.9	
CALCIUM		22200	23400	
COPPER		18	14	
MAGNESIUM		6890	7280	
MANGANESE		2.7 UJ	2.7 UJ	
POTASSIUM		3480	3520	
SODIUM		45900	47600	
ZINC		67.4	56.4	
Miscellaneous Parameters (mg/L)				
ALKALINITY	41.9 J			66
AMMONIA				0.26
AMMONIA, AS NITROGEN	0.25 J			
AMMONIUM	0.2 U			0.2 U
CHLORIDE	77.8 J			71.4
HARDNESS as CaCO3	85			80.5
SULFATE	44.7 J			40.3
TOTAL DISSOLVED SOLIDS	269 J			274
TOTAL ORGANIC CARBON	1 U			2.4
TOTAL SUSPENDED SOLIDS	5 UJ			5 U

TABLE 7-5

CHEMICALS RETAINED AS COPCs FOR SITE 7
DIRECT CONTACT EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

	Surface Soil		Subsurface Soil		Groundwater	
Chemical	Direct Contact	Soil to Air	Direct Contact	Soil to Air	Direct Contact	Groundwater to Indoor Air
Volatile Organic Compounds						
1,4-Dichlorobenzene					X	
Chlorobenzene					X	
1,3-Dichlorobenzene					X	
Benzene					X	
Trichloroethene					X	
Semivolatile Organic Compounds						
Benzo(a)anthracene			X			
Benzo(a)pyrene	X		X			
Benzo(b)fluoranthene			X			
Dibenzo(a,h)anthracene	X					
Bis(2-ethylhexyl)phthalate					X	
Hexachlorobenzene					X	
Indeno(1,2,3-cd)pyrene			X			
PCBs						
Aroclor-1254			X			
Metals						
Antimony			X			
Arsenic			X		X	
Cadmium	X		X			
Chromium			X		X	
Lead					X	
Manganese	X		X			
Thallium			X			
Vanadium			X		X	

Notes:
X - Chemical is retained as a COPC.

TABLE 7-6

CHEMICALS RETAINED AS COPCs FOR SITE 7
POTENTIAL MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

	Surface Soil		Subsurface Soil		Groundwater	
Chemical	Soil to Groundwater	Soil to Indoor Air	Soil to Groundwater	Soil to Indoor Air	Groundwater to Surface Water	Groundwater to Indoor Air
Volatile Organic Compounds						
Methylene Chloride			X			
Semivolatile Organic Compounds						
Benzo(a)anthracene			X			
Benzo(a)pyrene			X			
Benzo(b)fluoranthene			X			
Bis(2-ethylhexyl)phthalate					X	
Carbazole			X			
Chrysene			X			
Hexachlorobenzene					X	
Indeno(1,2,3-cd)pyrene			X			
Phenanthrene					X	
Pesticides/PCBs						
Aroclor-1248			X			
Metals						
Antimony	X		X			
Arsenic					X	
Chromium			X			
Lead					X	
Silver					X	
Thallium			X			
Zinc					X	

Notes:
X - Chemical is retained as a COPC.

TABLE 7-7

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL AT SITE 7
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																
75-09-2	METHYLENE CHLORIDE	0.005	J	0.005	J	mg/kg	7TB9-0002	1/2	0.007	0.005	NA	8.9 C	13 82	SSL-INH CTRESSOIL	NO	BSL
1330-20-7	XYLENES, TOTAL	0.00053	J	0.00134		mg/kg	B325-SO05-0002	3/6	0.00109 - 0.011	0.00134	NA	210 sat	410 500	SSL-INH CTRESSOIL	NO	BSL
Semivolatile Organics																
56-55-3	BENZO(A)ANTHRACENE	0.27	J	0.27	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.27	NA	0.62 C	N/A 1	SSL-INH CTRESSOIL	NO	BSL
50-32-8	BENZO(A)PYRENE	0.57		0.57		mg/kg	081390-7MW1(0-2)	1/2	0.36	0.57	NA	0.062 C	N/A 1	SSL-INH CTRESSOIL	YES	ASL
205-99-2	BENZO(B)FLUORANTHENE	0.61		0.61		mg/kg	081390-7MW1(0-2)	1/2	0.36	0.61	NA	0.62 C	N/A 1	SSL-INH CTRESSOIL	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.54		0.54		mg/kg	081390-7MW1(0-2)	1/2	0.36	0.54	NA	230 (7) N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.51		0.51		mg/kg	081390-7MW1(0-2)	1/2	0.36	0.51	NA	6.2 C	N/A 8.4	SSL-INH CTRESSOIL	NO	BSL
218-01-9	CHRYSENE	0.38	J	0.38	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.38	NA	62 C	N/A 84	SSL-INH CTRESSOIL	NO	BSL
53-70-3	DIBENZO(A,H)ANTHRACENE	0.063	J	0.063	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.063	NA	0.062 C	N/A 1	SSL-INH CTRESSOIL	YES	ASL
206-44-0	FLUORANTHENE	0.39	J	0.39	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.39	NA	230 N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.54		0.54		mg/kg	081390-7MW1(0-2)	1/2	0.36	0.54	NA	0.62 C	N/A 1	SSL-INH CTRESSOIL	NO	BSL
85-01-8	PHENANTHRENE	0.17	J	0.17	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.17	NA	230 (7) N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
85-01-8	PYRENE	0.33	J	0.33	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.33	NA	230 N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
Inorganics																
7429-90-5	ALUMINUM	3730		13,700		mg/kg	081390-7MW1(0-2)	2/2	NA	13700	17600	7600 N	N/A N/A	SSL-INH CTRESSOIL	NO	BKG, EPAI
7440-36-0	ANTIMONY	19.4	J	19.4	J	mg/kg	081390-7MW1(0-2)	1/2	3.3	19.4	2.05	3.1 N	N/A 27	SSL-INH CTRESSOIL	YES	ASL
7440-38-2	ARSENIC	1.4		3.5	J	mg/kg	7TB9-0002	2/2	NA	3.5	3.6	0.39 C	750 10	SSL-INH CTRESSOIL	NO	BKG
7440-39-3	BARIUM	23.2		159		mg/kg	081390-7MW1(0-2)	2/2	NA	159	39	540 N	690000 4700	SSL-INH CTRESSOIL	NO	BSL
7440-41-7	BERYLLIUM	0.58		0.58		mg/kg	081390-7MW1(0-2)	1/2	0.22	0.58	0.72	15 N	1300 2	SSL-INH CTRESSOIL	NO	BSL, BKG
7440-43-9	CADMIUM	4.6		5		mg/kg	081390-7MW1(0-2)	1/2	0.44	4.6	0.24	3.7 N	1800 34	SSL-INH CTRESSOIL	YES	ASL
7440-70-2	CALCIUM	1230		5830		mg/kg	081390-7MW1(0-2)	2/2	NA	5830	314	N/A	N/A N/A	SSL-INH CTRESSOIL	NO	NUT
7440-47-3	CHROMIUM	6.8		18.4	J	mg/kg	081390-7MW1(0-2)	2/2	NA	18.4	19.3	30 (8) C	270 100	SSL-INH CTRESSOIL	NO	BSL, BKG
7440-48-4	COBALT	14.8		14.8		mg/kg	081390-7MW1(0-2)	1/2	3.5	14.8	7	470 N	N/A N/A	SSL-INH CTRESSOIL	NO	BSL
7440-50-8	COPPER	9.2		40	J	mg/kg	081390-7MW1(0-2)	2/2	NA	39.8	17.9	290 N	N/A 2500	SSL-INH CTRESSOIL	NO	BSL
7439-89-6	IRON	4580		21600		mg/kg	081390-7MW1(0-2)	2/2	NA	21600	16800	2300 N	N/A N/A	SSL-INH CTRESSOIL	NO	EPAI

TABLE 7-7

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL AT SITE 7
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7439-92-1	LEAD	4.5	J	7.1	J	mg/kg	081390-7MW1(0-2)	2/2	NA	7.1	17.5	400 (9)	N/A 500	SSL-INH CTRESSOIL	NO	BSL, BKG
7439-95-4	MAGNESIUM	1510		6440		mg/kg	081390-7MW1(0-2)	2/2	NA	6440	2460	N/A	N/A N/A	SSL-INH CTRESSOIL	NO	NUT
7439-96-5	MANGANESE	87.7		300	J	mg/kg	081390-7MW1(0-2)	2/2	NA	300	172	180 N	N/A N/A	SSL-INH CTRESSOIL	YES	ASL
7440-02-0	NICKEL	7.5		14.4	J	mg/kg	081390-7MW1(0-2)	2/2	NA	14.4	5	160 N	13000 1400	SSL-INH CTRESSOIL	NO	BSL
7440-09-7	POTASSIUM	1020		5360	J	mg/kg	081390-7MW1(0-2)	2/2	NA	5360	669	N/A	N/A N/A	SSL-INH CTRESSOIL	NO	NUT
7440-22-4	SILVER	0.5		5.5	J	mg/kg	081390-7MW1(0-2)	2/2	NA	5.5	0.385	39 N	N/A 340	SSL-INH CTRESSOIL	NO	BSL
7440-23-5	SODIUM	60.9		366	J	mg/kg	081390-7MW1(0-2)	2/2	NA	366	16.56	N/A	N/A N/A	SSL-INH CTRESSOIL	NO	NUT
7440-62-2	VANADIUM	7.7		45.8		mg/kg	081390-7MW1(0-2)	2/2	NA	45.8	33.3	55 N	N/A 470	SSL-INH CTRESSOIL	NO	BSL
7440-66-6	ZINC	13.8		62.9	J	mg/kg	081390-7MW1(0-2)	2/2	NA	62.9	25.6	2300 N	N/A 20000	SSL-INH CTRESSOIL	NO	BSL

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COPC.
5 The risk-based COPC screening level for residential land use is presented. The value is based on a target Hazard Quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
7 Pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.
8 Hexavalent Chromium.
9 OSWER soil screening level for residential land use (USEPA, July 1994).

Associated Samples:

081390-7MW1(0-2)	B325-SO05-0002
7TB13-0001	B325-SO06-0002
7TB9-0002	B325-SO06-0002-D
B325-SO03-0002	B325-SO07-0003

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
SSL-INH = Soil Screening Level for transfers from soil to air (Inhalation) (USEPA, May 1996).
CTRESSOIL - CTDEP direct contact criteria for residential exposures to soil.

Rationale Codes:

For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No criteria available.
EPAI = USEPA Region 1 does not advocate evaluation of this chemical.

TABLE 7-8

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL AT SITE 7
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	EPA SSL-Soil to GW(5)	CTDEP Mobility Criteria(6)	CTDEP Soil Vapor Volatilization(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organics (mg/kg)																
75-09-2	METHYLENE CHLORIDE	0.005	J	0.005	J	mg/kg	7TB9-0002	1/2	0.007	0.005	NA	0.02	1	1200	NO	BSL
1330-20-7	XYLENES, TOTAL	0.00053	J	0.00134		mg/kg	B325-SO05-0002	3/6	0.00109 - 0.011	0.00134	NA	190	19.5	500	NO	BSL
Semivolatile Organics (mg/kg)																
56-55-3	BENZO(A)ANTHRACENE	0.27	J	0.27	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.27	NA	2	1	N/A	NO	BSL
50-32-8	BENZO(A)PYRENE	0.57		0.57		mg/kg	081390-7MW1(0-2)	1/2	0.36	0.57	NA	8	1	N/A	NO	BSL
205-99-2	BENZO(B)FLUORANTHENE	0.61		0.61		mg/kg	081390-7MW1(0-2)	1/2	0.36	0.61	NA	NA	1	N/A	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.54		0.54		mg/kg	081390-7MW1(0-2)	1/2	0.36	0.54	NA	4200 (B)	42	N/A	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.51		0.51		mg/kg	081390-7MW1(0-2)	1/2	0.36	0.51	NA	49	1	N/A	NO	BSL
218-01-9	CHRYSENE	0.38	J	0.38	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.38	NA	160	1	N/A	NO	BSL
53-70-3	DIBENZO(A,H)ANTHRACENE	0.063	J	0.063	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.063	NA	2	1	N/A	NO	BSL
206-44-0	FLUORANTHENE	0.39	J	0.39	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.39	NA	4300	56	N/A	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.54		0.54		mg/kg	081390-7MW1(0-2)	1/2	0.36	0.54	NA	14	1	N/A	NO	BSL
85-01-8	PHENANTHRENE	0.17	J	0.17	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.17	NA	4200 (B)	40	N/A	NO	BSL
85-01-8	PYRENE	0.33	J	0.33	J	mg/kg	081390-7MW1(0-2)	1/2	0.36	0.33	NA	4200	40	N/A	NO	BSL
Inorganics (mg/kg)																
7429-90-5	ALUMINUM	3730		13,700		mg/kg	081390-7MW1(0-2)	2/2	NA	13700	17600	N/A	N/A	N/A	NO	BKG
7440-36-0	ANTIMONY	19.4	J	19.4	J	mg/kg	081390-7MW1(0-2)	1/2	3.3	19.4	2.05	5	N/A	N/A	YES	ASL
7440-38-2	ARSENIC	1.4		3.5	J	mg/kg	7TB9-0002	2/2	NA	3.5	3.6	29	N/A	N/A	NO	BSL, BKG
7440-39-3	BARIUM	23.2		159		mg/kg	081390-7MW1(0-2)	2/2	NA	159	39	1600	N/A	N/A	NO	BSL
7440-41-7	BERYLLIUM	0.58		0.58		mg/kg	081390-7MW1(0-2)	1/2	0.22	0.58	0.72	63	N/A	N/A	NO	BSL, BKG
7440-43-9	CADMIUM	4.6		5		mg/kg	081390-7MW1(0-2)	1/2	0.44	4.6	0.24	8	N/A	N/A	NO	BSL
7440-70-2	CALCIUM	1230		5830		mg/kg	081390-7MW1(0-2)	2/2	NA	5830	314	N/A	N/A	N/A	NO	NTX
7440-47-3	CHROMIUM	6.8		18.4	J	mg/kg	081390-7MW1(0-2)	2/2	NA	18.4	19.3	38	N/A	N/A	NO	BSL, BKG
7440-48-4	COBALT	14.8		14.8		mg/kg	081390-7MW1(0-2)	1/2	3.5	14.8	7	N/A	N/A	N/A	NO	NTX
7440-50-8	COPPER	9.2		40	J	mg/kg	081390-7MW1(0-2)	2/2	NA	39.8	17.9	N/A	N/A	N/A	NO	NTX
7439-89-6	IRON	4580		21600		mg/kg	081390-7MW1(0-2)	2/2	NA	21600	16800	N/A	N/A	N/A	NO	NTX
7439-92-1	LEAD	4.5	J	7.1	J	mg/kg	081390-7MW1(0-2)	2/2	NA	7.1	17.5	N/A	N/A	N/A	NO	BKG
7439-95-4	MAGNESIUM	1510		6440		mg/kg	081390-7MW1(0-2)	2/2	NA	6440	2460	N/A	N/A	N/A	NO	NTX
7439-96-5	MANGANESE	87.7		300	J	mg/kg	081390-7MW1(0-2)	2/2	NA	300	172	N/A	N/A	N/A	NO	NTX
7440-02-0	NICKEL	7.5		14.4	J	mg/kg	081390-7MW1(0-2)	2/2	NA	14.4	5	130	N/A	N/A	NO	BSL
7440-09-7	POTASSIUM	1020		5360	J	mg/kg	081390-7MW1(0-2)	2/2	NA	5360	669	N/A	N/A	N/A	NO	NTX
7440-22-4	SILVER	0.5		5.5	J	mg/kg	081390-7MW1(0-2)	2/2	NA	5.5	0.385	34	N/A	N/A	NO	BSL
7440-23-5	SODIUM	60.9		366	J	mg/kg	081390-7MW1(0-2)	2/2	NA	366	16.56	N/A	N/A	N/A	NO	NTX
7440-62-2	VANADIUM	7.7		45.8		mg/kg	081390-7MW1(0-2)	2/2	NA	45.8	33.3	6000	N/A	N/A	NO	BSL
7440-66-6	ZINC	13.8		62.9	J	mg/kg	081390-7MW1(0-2)	2/2	NA	62.9	25.6	12000	N/A	N/A	NO	BSL

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

TABLE 7-8

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL AT SITE 7
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COPC.
5 USEPA Soil Screening Level Guidance, May 1996.
6 CTDEP Remediation Standard Regulations, 1996.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
8 Pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.

Associated Samples:

081390-7MW1(0-2)	B325-SO05-0002
7TB13-0001	B325-SO06-0002
7TB9-0002	B325-SO06-0002-D
B325-SO03-0002	B325-SO07-0003

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:

For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
NTX = No criteria available.

TABLE 7-9

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SUBSURFACE SOIL AT SITE 7
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																	
75-35-4	1,1-DICHLOROETHENE	0.003	J	0.003	J	mg/kg	7 SO 4S 0103	1/29	0.006 - 0.061	0.003	NA	0.054	C	0.07 1	SSL-INH CTRESSOIL	NO	BSL
78-93-3	2-BUTANONE	0.003		0.032		mg/kg	081090-7TB5(6-8)	2/29	0.011 - 0.061	0.032	NA	730	N	N/A 500	SSL-INH CTRESSOIL	NO	BSL
67-64-1	ACETONE	0.011	J	0.17		mg/kg	081090-7TB5(6-8)	7/29	0.011 - 0.27	0.17	NA	160	N	100000 500	SSL-INH CTRESSOIL	NO	BSL
71-43-2	BENZENE	0.004	J	0.004	J	mg/kg	081090-7TB5(6-8)	1/35	0.00107 - 0.07	0.004	NA	0.65	C	0.8 21	SSL-INH CTRESSOIL	NO	BSL
75-15-0	CARBON DISULFIDE	0.003	J	0.025	J	mg/kg	081090-7TB5(6-8)	4/29	0.006 - 0.061	0.005	NA	36	N	720 500	SSL-INH CTRESSOIL	NO	BSL
108-90-7	CHLOROBENZENE	0.001	J	0.006	J	mg/kg	S7SB180506	2/29	0.006 - 0.061	0.006	NA	15	N	130 500	SSL-INH CTRESSOIL	NO	BSL
75-09-2	METHYLENE CHLORIDE	0.003	J	0.42	J	mg/kg	7MW8S-0408	13/29	0.006 - 0.023	0.42	NA	8.9	C	13 82	SSL-INH CTRESSOIL	NO	BSL
127-18-4	TETRACHLOROETHENE	0.003	J	0.018	J	mg/kg	7MW8S-0408	5/29	0.006 - 0.024	0.018	NA	5.7	C	11 12	SSL-INH CTRESSOIL	NO	BSL
108-88-3	TOLUENE	0.002	J	0.008	J	mg/kg	7TB160305	9/35	0.00107 - 0.061	0.008	NA	520	sat	650 500	SSL-INH CTRESSOIL	NO	BSL
1330-20-7	XYLENES, TOTAL	0.00096	J	0.011	J	mg/kg	7 SO 4S 0103	3/35	0.00107 - 0.061	0.011	NA	210	sat	410 500	SSL-INH CTRESSOIL	NO	BSL
Semivolatile Organics																	
91-57-6	2-METHYLNAPHTHALENE	0.023	J	0.17	J	mg/kg	7 SO 4S 0103	3/29	0.2 - 0.5	0.17	NA	5.6 (7)	N	N/A 474	SSL-INH CTRESSOIL	NO	BSL
106-44-5	4-METHYLPHENOL	0.56		0.56		mg/kg	080990-7MW2(2-4)	1/29	0.2 - 0.5	0.56	NA	31	N	N/A 340	SSL-INH CTRESSOIL	NO	BSL
83-32-9	ACENAPHTHENE	0.043	J	0.79		mg/kg	7 SO 4S 0103	5/29	0.2 - 0.5	0.79	NA	370	N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
208-96-8	ACENAPHTHYLENE	0.02	J	0.055	J	mg/kg	7 SO 10 0103	3/29	0.2 - 0.5	0.055	NA	230 (8)	N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
120-12-7	ANTHRACENE	0.021	J	1.3		mg/kg	7 SO 10 0103	6/29	0.2 - 0.5	1.3	NA	2200	N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
56-55-3	BENZO(A)ANTHRACENE	0.036	J	2.7		mg/kg	7 SO 10 0103	8/29	0.2 - 0.5	2.7	NA	0.62	C	N/A 1	SSL-INH CTRESSOIL	YES	ASL
50-32-8	BENZO(A)PYRENE	0.033	J	1.9		mg/kg	7 SO 10 0103	11/29	0.2 - 0.5	1.9	NA	0.062	C	N/A 1	SSL-INH CTRESSOIL	YES	ASL
205-99-2	BENZO(B)FLUORANTHENE	0.021	J	3.2	J	mg/kg	7 SO 10 0103	10/29	0.2 - 0.5	3.2	NA	0.62	C	N/A 1	SSL-INH CTRESSOIL	YES	ASL
191-24-2	BENZO(G,H,I)PERYLENE	0.02	J	1.3	J	mg/kg	7 SO 4S 0103	9/29	0.2 - 0.5	1.3	NA	230 (8)	N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.024	J	0.52		mg/kg	7TB12-0204	8/29	0.2 - 0.5	0.52	NA	6.2	C	N/A 8.4	SSL-INH CTRESSOIL	NO	BSL
65-85-0	BENZOIC ACID	0.023	J	0.13	J	mg/kg	7 SO 4S 0103	10/25	1.7 - 2.4	0.13	NA	100000	max	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	0.13	J	0.74	J	mg/kg	081390-7TB3(4-6)	4/29	0.35 - 0.5	0.74	NA	35	C	31000 44	SSL-INH CTRESSOIL	NO	BSL
85-68-7	BUTYLBENZYL PHTHALATE	0.026	J	0.026	J	mg/kg	7TB7-0406	1/29	0.2 - 0.5	0.026	NA	1200	N	930 1000	SSL-INH CTRESSOIL	NO	BSL
86-74-8	CARBAZOLE	0.027	J	0.66		mg/kg	7 SO 4S 0103	4/21	0.2 - 0.47	0.66	NA	24	C	N/A 31	SSL-INH CTRESSOIL	NO	BSL
218-01-9	CHRYSENE	0.025	J	2.4		mg/kg	7 SO 10 0103	10/29	0.2 - 0.5	2.4	NA	62	C	N/A 84	SSL-INH CTRESSOIL	NO	BSL
84-74-2	DI-N-BUTYL PHTHALATE	0.02	J	0.17	J	mg/kg	081490-7TB4(4-6)	10/29	0.35 - 0.47	0.17	NA	610	N	2300 1000	SSL-INH CTRESSOIL	NO	BSL

TABLE 7-9

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SUBSURFACE SOIL AT SITE 7
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
132-64-9	DIBENZOFURAN	0.027	J	0.35	J	mg/kg	7 SO 4S 0103	3/29	0.2 - 0.5	0.35	NA	29	N	N/A 270	SSL-INH CTRESSOIL	NO	BSL
84-66-2	DIETHYL PHTHALATE	0.094	J	14		mg/kg	7MW7S-0103	2/29	0.2 - 0.48	14	NA	4900	N	2000 1000	SSL-INH CTRESSOIL	NO	BSL
206-44-0	FLUORANTHENE	0.018	J	3.8	J	mg/kg	7 SO 10 0103	13/29	0.2 - 0.5	3.8	NA	230	N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
86-73-7	FLUORENE	0.043	J	0.71		mg/kg	7 SO 4S 0103	5/29	0.2 - 0.5	0.71	NA	260	N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
193-39-5	INDENO(1,2,3 CD)PYRENE	0.024	J	1.2		mg/kg	7 SO 10 0103	9/29	0.2 - 0.5	1.2	NA	0.62	C	N/A 1	SSL-INH CTRESSOIL	YES	ASL
91-20-3	NAPHTHALENE	0.26	J	0.31	J	mg/kg	7 SO 4S 0103	2/29	0.2 - 0.5	0.31	NA	5.6	N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
85-01-8	PHENANTHRENE	0.025	J	4.3	J	mg/kg	7 SO 4S 0103	9/29	0.2 - 0.5	4.3	NA	230 (8)	N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
85-01-8	PYRENE	0.021	J	4.2	J	mg/kg	7 SO 10 0103	14/29	0.2 - 0.5	4.2	NA	230	N	N/A 1000	SSL-INH CTRESSOIL	NO	BSL
Pesticides/PCBs																	
72-54-8	4,4'-DDD	0.0044	J	0	J	mg/kg	7MW7S-0103	4/21	0.02 - 0.047	0.025	NA	2.4	C	N/A 2.6	SSL-INH CTRESSOIL	NO	BSL
72-55-9	4,4'-DDE	0.0054	J	0.21		mg/kg	081390-7TB3(4-6)	4/21	0.02 - 0.047	0.21	NA	1.7	C	N/A 1.8	SSL-INH CTRESSOIL	NO	BSL
50-29-3	4,4'-DDT	0.0049	J	0.026	J	mg/kg	7TB160305	5/21	0.02 - 0.047	0.026	NA	1.7	C	N/A 1.8	SSL-INH CTRESSOIL	NO	BSL
11097-69-1	AROCLOR-1254	0.66		0.66		mg/kg	080990-7MW2(2-4)	1/21	0.2 - 0.47	0.66	NA	0.22	C	N/A 1	SSL-INH CTRESSOIL	YES	ASL
1031-07-8	ENDOSULFAN SULFATE	0.013	J	0.035	J	mg/kg	7MW7S-0103	2/21	0.02 - 0.047	0.035	NA	37 (9)	N	N/A 410	SSL-INH CTRESSOIL	NO	BSL
7421-93-4	ENDRIN ALDEHYDE	0.0055	J	0	J	mg/kg	TB7-0406, 7TB8-0202	2/13	0.035 - 0.047	0.0055	NA	1.8 (10)	N	N/A 20	SSL-INH CTRESSOIL	NO	BSL
53494-70-5	ENDRIN KETONE	0.0068	J	0.0068	J	mg/kg	7 SO 4S 0103	1/21	0.02 - 0.047	0.0068	NA	1.8 (10)	N	N/A 20	SSL-INH CTRESSOIL	NO	BSL
76-44-8	HEPTACHLOR	0.0047	J	0.0047	J	mg/kg	7 SO 4S 0103	1/21	0.0098 - 0.024	0.0047	NA	0.11	C	4 0.1	SSL-INH CTRESSOIL	NO	BSL
72-43-5	METHOXYCHLOR	0.032	J	0.032	J	mg/kg	7 SO 4S 0103	1/21	0.098 - 0.24	0.032	NA	31	N	N/A 340	SSL-INH CTRESSOIL	NO	BSL
Inorganics																	
7429-90-5	ALUMINUM	4450		20,000		mg/kg	7 SO 6S 0507	29/29	NA	20000	17600	7 600	N	N/A N/A	SSL-INH CTRESSOIL	NO	EPAI
7440-36-0	ANTIMONY	3.4		19.4	J	mg/kg	080990-7TB2(2-4)	13/28	0.62 - 18.2	19.4	2.05	3.1	N	N/A 27	SSL-INH CTRESSOIL	YES	ASL
7440-38-2	ARSENIC	0.82	J	8.1		mg/kg	7MW9S-0608	27/29	1.6 - 4.6	8.1	3.6	0.39	C	750 10	SSL-INH CTRESSOIL	YES	ASL
7440-39-3	BARIUM	17.4	J	506		mg/kg	7 SO 6S 0507	29/29	NA	506	57.2	540	N	690000 4700	SSL-INH CTRESSOIL	NO	BSL
7440-41-7	BERYLLIUM	0.21	J	1		mg/kg	080990-7TB1(2 4) D	27/29	0.2 - 0.23	1	0.72	15	N	1300 2	SSL-INH CTRESSOIL	NO	BSL
7440-43-9	CADMIUM	0.47	J	5		mg/kg	080990-7TB1(2-4)-D	12/29	0.11 - 1	5.1	0.24	3.7	N	1800 34	SSL-INH CTRESSOIL	YES	ASL
7440-70-2	CALCIUM	600	J	2810		mg/kg	7TB8-0202.9, 7 SO 6S 0507	29/29	NA	2810	499	N/A		N/A N/A	SSL-INH CTRESSOIL	NO	NUT
7440-47-3	CHROMIUM	7		61.1		mg/kg	7 SO 6S 0507	29/29	NA	61.1	21.5	30 (11)	C	270 100	SSL-INH CTRESSOIL	YES	ASL

TABLE 7-9

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SUBSURFACE SOIL AT SITE 7
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7440-48-4	COBALT	4.7	J	19.2	J	mg/kg	7 SO 6S 0507	25/29	1.8 - 3.9	19.2	8	470	N	N/A N/A	SSL-INH CTRESSOIL	NO	BSL
7440-50-8	COPPER	7.6		45		mg/kg	7TB7-0406	29/29	NA	45	25.6	290	N	N/A 2500	SSL-INH CTRESSOIL	NO	EPAI
7439-89-6	IRON	6750		32900		mg/kg	7 SO 6S 0507	29/29	NA	32900	17200	2300	N	N/A N/A	SSL-INH CTRESSOIL	NO	EPAI
7439-92-1	LEAD	3.3	J	27.5	J	mg/kg	7TB12-0204	24/29	2.5 - 9.1	27.5	17.5	400 (12)		N/A 500	SSL-INH CTRESSOIL	NO	BSL
7439-95-4	MAGNESIUM	1660		19500		mg/kg	7 SO 6S 0507	29/29	NA	19500	3650	N/A		N/A N/A	SSL-INH CTRESSOIL	NO	NUT
7439-96-5	MANGANESE	60.7		725		mg/kg	7 SO 6S 0507	29/29	NA	725	188	180	N	N/A N/A	SSL-INH CTRESSOIL	YES	ASL
7439-97-6	MERCURY	0.11	J	1.2	J	mg/kg	7MW10S-0608	5/29	0.06 - 0.14	1.2	0.05	2.3	N	10 20	SSL-INH CTRESSOIL	NO	BSL
7440-02-0	NICKEL	5.1		42.1	J	mg/kg	7 SO 6S 0507	29/29	NA	42.1	5.95	160	N	13000 1400	SSL-INH CTRESSOIL	NO	BSL
7440-09-7	POTASSIUM	575	J	18400	J	mg/kg	7 SO 6S 0507	29/29	NA	18400	2580	N/A		N/A N/A	SSL-INH CTRESSOIL	NO	NUT
7782-49-2	SELENIUM	0.77		0.77		mg/kg	081090-7TB5(6-8)	1/29	0.44 - 0.85	0.77	0.445	39	N	N/A 340	SSL-INH CTRESSOIL	NO	BSL
7440-22-4	SILVER	0.86	J	5.4	J	mg/kg	081490-7TB6(6-8)	13/29	0.4 - 2.4	5.4	0.385	39	N	N/A 340	SSL-INH CTRESSOIL	NO	BSL
7440-23-5	SODIUM	54.8	J	708		mg/kg	7 SO 4S 0103	28/29	103	708	20.56	N/A		N/A N/A	SSL-INH CTRESSOIL	NO	NUT
7440-28-0	THALLIUM	0.26		1	J	mg/kg	7 SO 6S 0507	5/29	0.2 - 1.2	1	0.29	0.52	N	N/A 5.4	SSL-INH CTRESSOIL	YES	ASL
7440-62-2	VANADIUM	12.3		86.7		mg/kg	7 SO 6S 0507	24/29	14.3 - 38.4	86.7	35.1	55	N	N/A 470	SSL-INH CTRESSOIL	YES	ASL
7440-66-6	ZINC	18.7		133	J	mg/kg	7 SO 4S 0103	29/29	NA	133	31.3	2300	N	N/A 20000	SSL-INH CTRESSOIL	NO	BSL

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COPC.
5 The risk-based COPC screening level for residential land use is presented. The value is based on a target Hazard Quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
SSL-INH = Soil Screening Level for transfers from soil to air (Inhalation) (USEPA, May 1996).
CTRESSOIL - CTDEP direct contact criteria for residential exposures to soil.

Rationale Codes:

For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

TABLE 7-9

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SUBSURFACE SOIL AT SITE 7
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)

7 Value is for naphthalene.
8 Pyrene is used as a surrogate for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.
9 Value is for endosulfan.
10 Value is for endrin.
11 Hexavalent Chromium.
12 OSWER soil screening level for residential land use (USEPA, July 1994).

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No criteria available.
EPAI = USEPA Region I does not advocate evaluation of this chemical.

Associated Samples:

080990-7MW2(2-4)	7 SO 4S 0103	7TB13-0001	B325-SO03-0002	S7SB080607
080990-7TB1(2-4)-AVG	7 SO 6S 0305	7TB1301.5 03.5	B325-SO03-0408	S7SB090809
080990-7TB2(2-4)	7 SO 6S 0507	7TB14-0507	B325-SO04-0406	S7SB100607
081090-7TB5(6-8)	7MW10S-0608	7TB15-0608	B325-SO04-0608	S7SB180506
081390-7MW1(0-2)	7MW11S-0507	7TB160305	B325-SO05-0002	
081390-7TB3(4-6)	7MW5S-1011	7TB7-0406	B325-SO05-0406	
081490-7MW3(6-8)	7MW7S-0103	7TB8-0202.9-AVG	B325-SO06-0002-AVG	
081490-7TB4(4-6)	7MW8S-0408	7TB9-0002	B325-SO07-0003	
081490-7TB6(6-8)	7MW9S-0608-AVG	B325-SO01-0204	B325SS-0203	
7 SO 10 0103	7TB12-0204	B325-SO01-0406	B325SW-0203	

TABLE 7-10

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SUBSURFACE SOIL AT SITE 7
MIGRATION PATHWAYS
BASEWIDE GROUDNWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	EPA SSL-Soil to GW(5)	CTDEP Mobility Criteria(6)	CTDEP Soil Vapor Volatilization(8)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organics																
75-35-4	1,1-DICHLOROETHENE	0.003	J	0.003	J	mg/kg	7 SO 4S 0103	1/29	0.006 - 0.061	0.003	N/A	0.06	1.4	1	NO	BSL
78-93-3	2-BUTANONE	0.003		0.032		mg/kg	081090-7TB5(6-8)	2/29	0.011 - 0.061	0.032	N/A	N/A	80	2400	NO	BSL
67-64-1	ACETONE	0.011	J	0.17		mg/kg	081090-7TB5(6-8)	7/29	0.011 - 0.27	0.17	N/A	16	140	2400	NO	BSL
71-43-2	BENZENE	0.004	J	0.004	J	mg/kg	081090-7TB5(6-8)	1/35	0.00107 - 0.07	0.004	N/A	0.03	0.2	1	NO	BSL
75-15-0	CARBON DISULFIDE	0.003	J	0.025	J	mg/kg	081090-7TB5(6-8)	4/29	0.006 - 0.061	0.005	N/A	32	140	N/A	NO	BSL
108-90-7	CHLOROBENZENE	0.001	J	0.006	J	mg/kg	S7SB180506	2/29	0.006 - 0.061	0.006	N/A	1	20	31	NO	BSL
75-09-2	METHYLENE CHLORIDE	0.003	J	0.42	J	mg/kg	7MW8S-0408	13/29	0.006 - 0.023	0.42	N/A	0.02	1	1200	YES	ASL
127-18-4	TETRACHLOROETHENE	0.003	J	0.018	J	mg/kg	7MW8S-0408	5/29	0.006 - 0.024	0.018	N/A	0.06	1	11	NO	BSL
108-88-3	TOLUENE	0.002	J	0.008	J	mg/kg	7TB160305	9/35	0.00107 - 0.061	0.008	N/A	12	67	780	NO	BSL
1330-20-7	XYLENES, TOTAL	0.00096	J	0.011	J	mg/kg	7 SO 4S 0103	3/35	0.00107 - 0.061	0.011	N/A	190	19.5	500	NO	BSL
Semivolatile Organics																
91-57-6	2-METHYLNAPHTHALENE	0.023	J	0.17	J	mg/kg	7 SO 4S 0103	3/29	0.2 - 0.5	0.17	N/A	N/A	9.8	N/A	NO	BSL
106-44-5	4-METHYLPHENOL	0.56		0.56		mg/kg	080990-7MW2(2-4)	1/29	0.2 - 0.5	0.56	N/A	N/A	7	N/A	NO	BSL
83-32-9	ACENAPHTHENE	0.043	J	0.79		mg/kg	7 SO 4S 0103	5/29	0.2 - 0.5	0.79	N/A	570	84	N/A	NO	BSL
208-96-8	ACENAPHTHYLENE	0.02	J	0.055	J	mg/kg	7 SO 10 0103	3/29	0.2 - 0.5	0.055	N/A	N/A	84	N/A	NO	BSL
120-12-7	ANTHRACENE	0.021	J	1.3		mg/kg	7 SO 10 0103	6/29	0.2 - 0.5	1.3	N/A	12000	400	N/A	NO	BSL
56-55-3	BENZO(A)ANTHRACENE	0.036	J	2.7		mg/kg	7 SO 10 0103	8/29	0.2 - 0.5	2.7	N/A	2	1	N/A	YES	ASL
50-32-8	BENZO(A)PYRENE	0.033	J	1.9		mg/kg	7 SO 10 0103	11/29	0.2 - 0.5	1.9	N/A	8	1	N/A	YES	ASL
205-99-2	BENZO(B)FLUORANTHENE	0.021	J	3.2	J	mg/kg	7 SO 10 0103	10/29	0.2 - 0.5	3.2	N/A	N/A	1	N/A	YES	ASL
191-24-2	BENZO(G,H,I)PERYLENE	0.02	J	1.3	J	mg/kg	7 SO 4S 0103	9/29	0.2 - 0.5	1.3	N/A	4200 (8)	42	N/A	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.024	J	0.52		mg/kg	7TB12-0204	8/29	0.2 - 0.5	0.52	N/A	49	1	N/A	NO	BSL
65-85-0	BENZOIC ACID	0.023	J	0.13	J	mg/kg	7 SO 4S 0103	10/25	1.7 - 2.4	0.13	N/A	400	10000	N/A	NO	BSL
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	0.13	J	0.74	J	mg/kg	081390-7TB3(4-6)	4/29	0.35 - 0.5	0.74	N/A	3600	11	N/A	NO	BSL
85-68-7	BUTYLBENZYL PHTHALATE	0.026	J	0.026	J	mg/kg	7TB7-0406	1/29	0.2 - 0.5	0.026	N/A	930	200	N/A	NO	BSL
86-74-8	CARBAZOLE	0.027	J	0.66		mg/kg	7 SO 4S 0103	4/21	0.2 - 0.47	0.66	N/A	0.6	1	N/A	YES	ASL
218-01-9	CHRYSENE	0.025	J	2.4		mg/kg	7 SO 10 0103	10/29	0.2 - 0.5	2.4	N/A	160	1	N/A	YES	ASL
84-74-2	DI-N-BUTYL PHTHALATE	0.02	J	0.17	J	mg/kg	081490-7TB4(4-6)	10/29	0.35 - 0.47	0.17	N/A	2300	140	N/A	NO	BSL
132-64-9	DIBENZOFURAN	0.027	J	0.35	J	mg/kg	7 SO 4S 0103	3/29	0.2 - 0.5	0.35	N/A	N/A	5.6	N/A	NO	BSL
84-66-2	DIETHYL PHTHALATE	0.094	J	14		mg/kg	7MW7S-0103	2/29	0.2 - 0.48	14	N/A	470	1100	N/A	NO	BSL
206-44-0	FLUORANTHENE	0.018	J	3.8	J	mg/kg	7 SO 10 0103	13/29	0.2 - 0.5	3.8	N/A	4300	56	N/A	NO	BSL
86-73-7	FLUORENE	0.043	J	0.71		mg/kg	7 SO 4S 0103	5/29	0.2 - 0.5	0.71	N/A	560	56	N/A	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.024	J	1.2		mg/kg	7 SO 10 0103	9/29	0.2 - 0.5	1.2	N/A	14	1	N/A	YES	ASL
91-20-3	NAPHTHALENE	0.26	J	0.31	J	mg/kg	7 SO 4S 0103	2/29	0.2 - 0.5	0.31	N/A	84	56	N/A	NO	BSL
85-01-8	PHENANTHRENE	0.025	J	4.3	J	mg/kg	7 SO 4S 0103	9/29	0.2 - 0.5	4.3	N/A	4200 (8)	40	N/A	NO	BSL
85-01-8	PYRENE	0.021	J	4.2	J	mg/kg	7 SO 10 0103	14/29	0.2 - 0.5	4.2	N/A	4200	40	N/A	NO	BSL
Pesticides/PCBs																
72-54-8	4,4'-DDD	0.0044	J	0	J	mg/kg	7MW7S-0103	4/21	0.02 - 0.047	0.025	N/A	16	N/A	N/A	NO	BSL
72-55-9	4,4'-DDE	0.0054	J	0.21		mg/kg	081390-7TB3(4-6)	4/21	0.02 - 0.047	0.21	N/A	54	N/A	N/A	NO	BSL
50-29-3	4,4'-DDT	0.0049	J	0.026	J	mg/kg	7TB160305	5/21	0.02 - 0.047	0.026	N/A	32	N/A	N/A	NO	BSL
11097-69-1	AROCLOR-1254	0.66		0.66		mg/kg	080990-7MW2(2-4)	1/21	0.2 - 0.47	0.66	N/A	N/A	0.005	N/A	YES	ASL
1031-07-8	ENDOSULFAN SULFATE	0.013	J	0.035	J	mg/kg	7MW7S-0103	2/21	0.02 - 0.047	0.035	N/A	18 (9)	8.4	N/A	NO	BSL
7421-93-4	ENDRIN ALDEHYDE	0.0055	J	0	J	mg/kg	B7-0406, 7TB8-0202	2/13	0.035 - 0.047	0.0055	N/A	1 (10)	N/A	N/A	NO	BSL
53494-70-5	ENDRIN KETONE	0.0068	J	0.0068	J	mg/kg	7 SO 4S 0103	1/21	0.02 - 0.047	0.0068	N/A	1 (10)	N/A	N/A	NO	BSL
76-44-8	HEPTACHLOR	0.0047	J	0.0047	J	mg/kg	7 SO 4S 0103	1/21	0.0098 - 0.024	0.0047	N/A	23	0.013	N/A	NO	BSL
72-43-5	METHOXYCHLOR	0.032	J	0.032	J	mg/kg	7 SO 4S 0103	1/21	0.098 - 0.24	0.032	N/A	160	8	N/A	NO	BSL
Inorganics																
7429-90-5	ALUMINUM	4450		20,000		mg/kg	7 SO 6S 0507	29/29	N/A	20000	17600	N/A	N/A	N/A	NO	NTX
7440-36-0	ANTIMONY	3.4		19.4	J	mg/kg	080990-7TB2(2-4)	13/28	0.62 - 18.2	19.4	2.05	5	N/A	N/A	YES	ASL
7440-38-2	ARSENIC	0.82	J	8.1		mg/kg	7MW9S-0608	27/29	1.6 - 4.6	8.1	3.6	29	N/A	N/A	NO	BSL
7440-39-3	BARIUM	17.4	J	506		mg/kg	7 SO 6S 0507	29/29	N/A	506	57.2	1600	N/A	N/A	NO	BSL
7440-41-7	BERYLLIUM	0.21	J	1		mg/kg	080990-7TB1(2-4)-D	27/29	0.2 - 0.23	1	0.72	63	N/A	N/A	NO	BSL

TABLE 7-10

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SUBSURFACE SOIL AT SITE 7
MIGRATION PATHWAYS
BASEWIDE GROUDNWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	EPA SSL-Soil to GW(5)	CTDEP Mobility Criteria(6)	CTDEP Soil Vapor Volatilization(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
7440-43-9	CADMIUM	0.47	J	5		mg/kg	080990-7TB1(2-4)-D	12/29	0.11 - 1	5.1	0.24	8	N/A	N/A	NO	BSL
7440-70-2	CALCIUM	600	J	2810		mg/kg	7TB8-0202.9, 7 SO 6S 0507	29/29	N/A	2810	499	N/A	N/A	N/A	NO	NTX
7440-47-3	CHROMIUM	7		61.1		mg/kg	7 SO 6S 0507	29/29	N/A	61.1	21.5	38	N/A	N/A	YES	ASL
7440-48-4	COBALT	4.7	J	19.2	J	mg/kg	7 SO 6S 0507	25/29	1.8 - 3.9	19.2	8	N/A	N/A	N/A	NO	NTX
7440-50-8	COPPER	7.6		45		mg/kg	7TB7-0406	29/29	N/A	45	25.6	N/A	N/A	N/A	NO	NTX
7439-89-6	IRON	6750		32900		mg/kg	7 SO 6S 0507	29/29	N/A	32900	17200	N/A	N/A	N/A	NO	NTX
7439-92-1	LEAD	3.3	J	27.5	J	mg/kg	7TB12-0204	24/29	2.5 - 9.1	27.5	17.5	N/A	N/A	N/A	NO	NTX
7439-95-4	MAGNESIUM	1660		19500		mg/kg	7 SO 6S 0507	29/29	N/A	19500	3650	N/A	N/A	N/A	NO	NTX
7439-96-5	MANGANESE	60.7		725		mg/kg	7 SO 6S 0507	29/29	N/A	725	188	N/A	N/A	N/A	NO	NTX
7439-97-6	MERCURY	0.11	J	1.2	J	mg/kg	7MW10S-0608	5/29	0.06 - 0.14	1.2	0.05	2	N/A	N/A	NO	BSL
7440-02-0	NICKEL	5.1		42.1	J	mg/kg	7 SO 6S 0507	29/29	N/A	42.1	5.95	130	N/A	N/A	NO	BSL
7440-09-7	POTASSIUM	575	J	18400	J	mg/kg	7 SO 6S 0507	29/29	N/A	18400	2580	N/A	N/A	N/A	NO	NTX
7782-49-2	SELENIUM	0.77		0.77		mg/kg	081090-7TB5(6-8)	1/29	0.44 - 0.85	0.77	0.445	5	N/A	N/A	NO	BSL
7440-22-4	SILVER	0.86	J	5.4	J	mg/kg	081490-7TB6(6-8)	13/29	0.4 - 2.4	5.4	0.385	34	N/A	N/A	NO	BSL
7440-23-5	SODIUM	54.8	J	708		mg/kg	7 SO 4S 0103	28/29	103	708	20.56	N/A	N/A	N/A	NO	NTX
7440-28-0	THALLIUM	0.26		1	J	mg/kg	7 SO 6S 0507	5/29	0.2 - 1.2	1	0.29	0.7	N/A	N/A	YES	ASL
7440-62-2	VANADIUM	12.3		86.7		mg/kg	7 SO 6S 0507	24/29	14.3 - 38.4	86.7	35.1	6000	N/A	N/A	NO	BSL
7440-66-6	ZINC	18.7		133	J	mg/kg	7 SO 4S 0103	29/29	N/A	133	31.3	12000	N/A	N/A	NO	BSL

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COPC.
5 USEPA Soil Screening Level Guidance, May 1996.
6 CTDEP Remediation Standard Regulations, 1996.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
8 Pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene
9 Value is for endosulfan.
10 Value is for endrin.

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:

For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
NTX = No criteria available.

TABLE 7-10

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SUBSURFACE SOIL AT SITE 7
MIGRATION PATHWAYS
BASEWIDE GROUDNWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	EPA SSL-Soil to GW(5)	CTDEP Mobility Criteria(6)	CTDEP Soil Vapor Volatilization(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
	Associated Samples:															
	080990-7MW2(2-4)	7 SO 4S 0103		7TB13-0001		B325-SO03-0002		S7SB080607								
	080990-7TB1(2-4)-AVG	7 SO 6S 0305		7TB1301.5 03.5		B325-SO03-0408		S7SB090809								
	080990-7TB2(2-4)	7 SO 6S 0507		7TB14-0507		B325-SO04-0406		S7SB100607								
	081090-7TB5(6-8)	7MW10S-0608		7TB15-0608		B325-SO04-0608		S7SB180506								
	081390-7MW1(0-2)	7MW11S-0507		7TB160305		B325-SO05-0002										
	081390-7TB3(4-6)	7MW5S-1011		7TB7-0406		B325-SO05-0406										
	081490-7MW3(6-8)	7MW7S-0103		7TB8-0202.9-AVG		B325-SO06-0002-AVG										
	081490-7TB4(4-6)	7MW8S-0408		7TB9-0002		B325-SO07-0003										
	081490-7TB6(6-8)	7MW9S-0608-AVG		B325-SO01-0204		B325SS-0203										
	7 SO 10 0103	7TB12-0204		B325-SO01-0406		B325SW-0203										

TABLE 7-11

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITE 7
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																
106-46-7	1,4-DICHLOROBENZENE	1	J	90.5	J	ug/L	S7TW1001	1/30	1	90.5	N/A	0.5 C	75 75 N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
108-90-7	CHLOROBENZENE	6.66		165	J	ug/L	S7TW1001	7/30	1	165	N/A	11 N	100 100 100	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
541-73-1	1,3-DICHLOROBENZENE	1.73		1.73		ug/L	S7MW03S01	1/27	1 - 5	1.73	N/A	0.55 N	600 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
71-43-2	BENZENE	2	J	2	J	ug/L	S7TW1001	2/27	1	2	N/A	0.35 C	1 5 5	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
79-01-6	TRICHLOROETHENE	1.39		23		ug/L	S7MW09S01	7/27	1	23	N/A	1.6 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
Dissolved Gases																
74-82-8	METHANE	1		41	J	ug/L	S7MW06S01	7/20	1 - 2	41	N/A	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
Semivolatile Organics																
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	44		190		ug/L	S7MW08S01	3/20	5 - 10	190	N/A	4.8 C	2 6 N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
118-74-1	HEXACHLOROBENZENE	3	J	3	J	ug/L	S7MW09S01	2/20	5 - 10	3	N/A	0.042 C	1 1 N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
85-01-8	PHENANTHRENE	3.7		3.7		ug/L	S7MW08S01	1/20	0.03 - 5	3.7	N/A	18 (7) N	200 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
86-73-7	FLUORENE	0.26	J	6.5		ug/L	S7MW08S01	1/20	0.05 - 5	6.5	N/A	24 N	280 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
Total Metals																
7429-90-5	ALUMINUM	72.4	J	57500		ug/L	S7TW0901	10/20	50.5 - 430	57500	3560	3600 N	N/A 50 to 200 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI
7440-38-2	ARSENIC	2.9	J	11.4		ug/L	S7TW0901	2/20	2.3	11.4	1.92	0.045 C	50 50 50	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-39-3	BARIUM	33.5		434		ug/L	S7TW0901	11/20	8.6 - 38.6	434	227	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-43-9	CADMIUM	0.27	J	0.27	J	ug/L	S7MW03S01	1/20	0.25 - 0.38	0.27	ND	1.8 N	5 5(9) 5	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-70-2	CALCIUM	5480		103000		ug/L	S7MW05D01	20/20	N/A	103000	188000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-47-3	CHROMIUM	7.6	J	127		ug/L	S7TW0901	4/20	6.2 - 8.8	127	49.9	110 (8) N	50 100 N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-48-4	COBALT	4.4	J	31.3		ug/L	S7TW0901	10/20	4.2 - 13.9	31.3	48.6	220 N	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-50-8	COPPER	7.1	J	73.2		ug/L	S7TW0901	7/20	6.8 - 11.6	73.2	107	140 N	1300 1300 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG

TABLE 7-11
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITE 7
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7439-89-6	IRON	298		59400		ug/L	S7TW0901	10/20	31.1 - 759	59400	28200	1100 N	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI
7439-92-1	LEAD	1.9	J	32.8		ug/L	S7TW0901	8/20	1.8	32.8	6.63	N/A	15 15 N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7439-95-4	MAGNESIUM	871		19500		ug/L	S7TW0901	20/20	N/A	19500	191000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7439-96-5	MANGANESE	4.6	J	1250		ug/L	S7TW0901	17/20	2.7	1250	11700	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-02-0	NICKEL	34.3		52.8	J	ug/L	S7TW0901	2/20	9.2	52.8	32.2	73 N	100 N/A 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-09-7	POTASSIUM	917		11600		ug/L	S7TW0901	20/20	N/A	11600	70800	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7782-49-2	SELENIUM	3.2	J	3.2	J	ug/L	S7MW07S01	1/20	2.8	3.2	3.19	18 N	50 50 50	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-22-4	SILVER	16.3		16.3		ug/L	S7TW0901	1/20	5.2 - 5.8	16.3	ND	18 N	36 100 50	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
7440-23-5	SODIUM	4020		91600		ug/L	S7MW03D01	20/20	N/A	91600	1900000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-62-2	VANADIUM	7.6	J	151		ug/L	S7TW0901	2/20	6.3	151	10.2	26 N	50 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-66-6	ZINC	8.4	J	194	J	ug/L	S7MW10S01	11/20	4.6 - 27.1	194	131	1100 N	5000 5000 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
Dissolved Metals																
7440-39-3	BARIUM, FILTERED	35.5		36.9		ug/L	S7MW10S01-F-D	1/2	18.7	36.9	124	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-70-2	CALCIUM, FILTERED	17600		23400		ug/L	S7MW10S01-F-D	2/2	N/A	23400	152000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-50-8	COPPER, FILTERED	14		18		ug/L	S7MW10S01-F	1/2	6.8	18	39.4	140 N	1300 1300 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-95-4	MAGNESIUM, FILTERED	1470		7280		ug/L	S7MW10S01-F-D	2/2	N/A	7280	150000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7439-96-5	MANGANESE, FILTERED	7.8	J	7.8	J	ug/L	S7MW01D01-F	1/2	2.7	7.8	9400	88 N	N/A 50 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-09-7	POTASSIUM, FILTERED	1730		3520		ug/L	S7MW10S01-F-D	2/2	N/A	3520	60000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-23-5	SODIUM, FILTERED	4690		47600		ug/L	S7MW10S01-F-D	2/2	N/A	47600	1580000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-66-6	ZINC, FILTERED	56.4		173		ug/L	S7MW01D01-F	2/2	N/A	173	109	1100 N	5000 5000 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL

TABLE 7-11
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITE 7
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Miscellaneous Parameters																
E-14506	ALKALINITY	10	J	124		mg/L	S7MW05D01	20/20	N/A	124	1950	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
7664-41-7	AMMONIA	0.15		0.48	J	mg/L	S7MW07S01	8/8	N/A	0.48	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
7664-41-7	AMMONIA, AS NITROGEN	0.1		0.54	J	mg/L	S7MW01D01	10/12	N/A	0.54	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
7664-41-7	AMMONIUM	0.2		0.44		mg/L	S7TW0801	6/20	N/A	0.44	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
000-02-0	CHLORIDE	5.84	J	155	J	mg/L	S7MW10S01	20/20	N/A	155	4540	N/A	N/A 250 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL, BKG
E-11778	HARDNESS as CaCO3	18.8		285		mg/L	S7MW05D01	20/20	N/A	285	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
14808-79-8	SULFATE	3.46	J	71.6	J	mg/L	S7MW10S01	20/20	N/A	71.6	45.2	N/A	N/A 250 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
18496-25-8	SULFIDE	0.07		0.07		mg/L	S7TW1001	1/12	0.05 - 2	0.07	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
000-09-0	TOTAL DISSOLVED SOLIDS	50	J	464		mg/L	S7MW05D01	15/20	66.2 - 158	464	6260	N/A	N/A 500 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL, BKG
7440-44-0	TOTAL ORGANIC CARBON	0.9		120		mg/L	S7MW07S01	15/20	1 - 5	120	37.7	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
000-08-9	TOTAL SUSPENDED SOLIDS	10	J	2950		mg/L	S7TW0901	8/20	5	2950	236	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 The risk-based COPC screening level for tap water use is presented. The value is based on a target hazard quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
7 Pyrene is used as a surrogate for phenanthrene.
8 Value is for hexavalent chromium.
9 The US EPA has approved a new MCL for arsenic of 10 ug/L. The new MCL goes into effect in 2006. The reduction of the MCL does not impact the human health risk assessment.

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
N/A = Not Applicable.
FED-MCL = Federal Maximum Contaminant Level (USEPA, August 2000).
FED-SMCL = Federal Secondary Maximum Contaminant Level (USEPA, August 2000).
FED-AL = Federal Action Level (USEPA, August 2000).
CTDEP-RSR = Connecticut DEP Remediation Standard Regulations, 1996.
CTDEP-MCL = Connecticut Maximum Contaminant Level.

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

TABLE 7-11
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITE 7
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)

Associated Samples:

S7B325MW0101	S7MW02S01	S7MW05S01-D	S7MW10S01-D	S7TW0301	S7TW0801
S7B325MW0301	S7MW03D01	S7MW06S01	S7MW10S01-F	S7TW0401	S7TW0901
S7B325MW0401	S7MW03S01	S7MW07S01	S7MW10S01-F-D	S7TW0501	S7TW1001
S7MW01D01	S7MW04S01	S7MW08S01	S7MW11S01	S7TW0601	
S7MW01D01-F	S7MW05D01	S7MW09S01	S7TW0101	S7TW0701	
S7MW02D01	S7MW05S01	S7MW10S01	S7TW0201	S7TW0701-D	

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No Toxicity Information.
EPAI = USEPA Region 1 does not advocate evaluation of this chemical.

TABLE 7-12

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITE 7
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Surface Water Protection Criteria(5)	Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organics															
106-46-7	1,4-DICHLOROBENZENE	1	J	90.5	J	ug/L	S7TW1001	1/30	1	90.5	N/A	26000	50000	NO	BSL
108-90-7	CHLOROBENZENE	6.66		165	J	ug/L	S7TW1001	7/30	1	165	N/A	420000	1800	NO	BSL
541-73-1	1,3-DICHLOROBENZENE	1.73		1.73		ug/L	S7MW03S01	1/27	1 - 5	1.73	N/A	26000	24200	NO	BSL
71-43-2	BENZENE	2	J	2	J	ug/L	S7TW1001	2/27	1	2	N/A	710	215	NO	BSL
79-01-6	TRICHLOROETHENE	1.39		23		ug/L	S7MW09S01	7/27	1	23	N/A	2340	219	NO	BSL
Dissolved Gases															
74-82-8	METHANE	1		41	J	ug/L	S7MW06S01	7/20	1 - 2	41	N/A	N/A	N/A	NO	NTX
Semivolatile Organics															
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	44		190		ug/L	S7MW08S01	3/20	5 - 10	190	N/A	59	N/A	YES	ASL
118-74-1	HEXACHLOROBENZENE	3	J	3	J	ug/L	S7MW09S01	2/20	5 - 10	3	N/A	0.077	N/A	YES	ASL
85-01-8	PHENANTHRENE	3.7		3.7		ug/L	S7MW08S01	1/20	0.03 - 5	3.7	N/A	0.3	N/A	YES	ASL
86-73-7	FLUORENE	0.26	J	6.5		ug/L	S7MW08S01	1/20	0.05 - 5	6.5	N/A	140000	N/A	NO	BSL
Total Metals															
7429-90-5	ALUMINUM	72.4	J	57500		ug/L	S7TW0901	10/20	50.5 - 430	57500	3560	N/A	N/A	NO	NTX
7440-38-2	ARSENIC	2.9	J	11.4		ug/L	S7TW0901	2/20	2.3	11.4	1.92	4	N/A	YES	ASL
7440-39-3	BARIUM	33.5		434		ug/L	S7TW0901	11/20	8.6 - 38.6	434	227	N/A	N/A	NO	NTX
7440-43-9	CADMIUM	0.27	J	0.27	J	ug/L	S7MW03S01	1/20	0.25 - 0.38	0.27	ND	6	N/A	NO	BSL
7440-70-2	CALCIUM	5480		103000		ug/L	S7MW05D01	20/20	N/A	103000	188000	N/A	N/A	NO	BKG
7440-47-3	CHROMIUM	7.6	J	127		ug/L	S7TW0901	4/20	6.2 - 8.8	127	49.9	N/A	N/A	NO	NTX
7440-48-4	COBALT	4.4	J	31.3		ug/L	S7TW0901	10/20	4.2 - 13.9	31.3	48.6	N/A	N/A	NO	BKG
7440-50-8	COPPER	7.1	J	73.2		ug/L	S7TW0901	7/20	6.8 - 11.6	73.2	107	48	N/A	NO	BKG
7439-89-6	IRON	298		59400		ug/L	S7TW0901	10/20	31.1 - 759	59400	28200	N/A	N/A	NO	NTX
7439-92-1	LEAD	1.9	J	32.8		ug/L	S7TW0901	8/20	1.8	32.8	6.63	13	N/A	YES	ASL
7439-95-4	MAGNESIUM	871		19500		ug/L	S7TW0901	20/20	N/A	19500	191000	N/A	N/A	NO	BKG
7439-96-5	MANGANESE	4.6	J	1250		ug/L	S7TW0901	17/20	2.7	1250	11700	N/A	N/A	NO	BKG
7440-02-0	NICKEL	34.3		52.8	J	ug/L	S7TW0901	2/20	9.2	52.8	32.2	880	N/A	NO	BSL
7440-09-7	POTASSIUM	917		11600		ug/L	S7TW0901	20/20	N/A	11600	70800	N/A	N/A	NO	BKG
7782-49-2	SELENIUM	3.2	J	3.2	J	ug/L	S7MW07S01	1/20	2.8	3.2	3.19	50	N/A	NO	BSL
7440-22-4	SILVER	16.3		16.3		ug/L	S7TW0901	1/20	5.2 - 5.8	16.3	ND	12	N/A	YES	ASL
7440-23-5	SODIUM	4020		91600		ug/L	S7MW03D01	20/20	N/A	91600	1900000	N/A	N/A	NO	BKG
7440-62-2	VANADIUM	7.6	J	151		ug/L	S7TW0901	2/20	6.3	151	10.2	N/A	N/A	NO	NTX
7440-66-6	ZINC	8.4	J	194	J	ug/L	S7MW10S01	11/20	4.6 - 27.1	194	131	123	N/A	YES	ASL
Dissolved Metals															
7440-39-3	BARIUM, FILTERED	35.5		36.9		ug/L	S7MW10S01-F-D	1/2	18.7	36.9	124	N/A	N/A	NO	BKG
7440-70-2	CALCIUM, FILTERED	17600		23400		ug/L	S7MW10S01-F-D	2/2	N/A	23400	152000	N/A	N/A	NO	BKG
7440-50-8	COPPER, FILTERED	14		18		ug/L	S7MW10S01-F	1/2	6.8	18	39.4	48	N/A	NO	BSL, BKG
7439-95-4	MAGNESIUM, FILTERED	1470		7280		ug/L	S7MW10S01-F-D	2/2	N/A	7280	150000	N/A	N/A	NO	BKG
7439-96-5	MANGANESE, FILTERED	7.8	J	7.8	J	ug/L	S7MW01D01-F	1/2	2.7	7.8	9400	N/A	N/A	NO	BKG
7440-09-7	POTASSIUM, FILTERED	1730		3520		ug/L	S7MW10S01-F-D	2/2	N/A	3520	60000	N/A	N/A	NO	BKG
7440-23-5	SODIUM, FILTERED	4690		47600		ug/L	S7MW10S01-F-D	2/2	N/A	47600	1580000	N/A	N/A	NO	BKG
7440-66-6	ZINC, FILTERED	56.4		173		ug/L	S7MW01D01-F	2/2	N/A	173	109	123	N/A	YES	ASL
Miscellaneous Parameters															
E-14506	ALKALINITY	10	J	124		mg/L	S7MW05D01	20/20	N/A	124	1950	N/A	NA	NO	BKG
7664-41-7	AMMONIA	0.15		0.48	J	mg/L	S7MW07S01	8/8	N/A	0.48	ND	N/A	NA	NO	NTX
7664-41-7	AMMONIA, AS NITROGEN	0.1		0.54	J	mg/L	S7MW01D01	10/12	N/A	0.54	ND	N/A	NA	NO	NTX
7664-41-7	AMMONIUM	0.2		0.44		mg/L	S7TW0801	6/20	N/A	0.44	ND	N/A	NA	NO	NTX
000-02-0	CHLORIDE	5.84	J	155	J	mg/L	S7MW10S01	20/20	N/A	155	4540	N/A	NA	NO	BKG
E-11778	HARDNESS as CaCO3	18.8		285		mg/L	S7MW05D01	20/20	N/A	285	ND	N/A	NA	NO	NTX
14808-79-8	SULFATE	3.46	J	71.6	J	mg/L	S7MW10S01	20/20	N/A	71.6	45.2	N/A	NA	NO	NTX
18496-25-8	SULFIDE	0.07		0.07		mg/L	S7TW1001	1/12	0.05 - 2	0.07	ND	N/A	NA	NO	NTX
000-09-0	TOTAL DISSOLVED SOLIDS	50	J	464		mg/L	S7MW05D01	15/20	66.2 - 158	464	6260	N/A	NA	NO	BKG

TABLE 7-12

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITE 7
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Torpedo Shops (Site 7)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Surface Water Protection Criteria(5)	Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
7440-44-0	TOTAL ORGANIC CARBON	0.9		120		mg/L	S7MW07S01	15/20	1 - 5	120	37.7	N/A	NA	NO	NTX
000-08-9	TOTAL SUSPENDED SOLIDS	10	J	2950		mg/L	S7TW0901	8/20	5	2950	236	N/A	NA	NO	NTX

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 Connecticut DEP Surface Water Protection criteria.
6 Connecticut DEP Volatilization criteria for residential exposures.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the CTDEP surface water protection or volatilization criteria.

Associated Samples:

S7B325MW0101	S7MW02S01	S7MW05S01-D	S7MW10S01-D	S7TW0301	S7TW0801
S7B325MW0301	S7MW03D01	S7MW06S01	S7MW10S01-F	S7TW0401	S7TW0901
S7B325MW0401	S7MW03S01	S7MW07S01	S7MW10S01-F-D	S7TW0501	S7TW1001
S7MW01D01	S7MW04S01	S7MW08S01	S7MW11S01	S7TW0601	
S7MW01D01-F	S7MW05D01	S7MW09S01	S7TW0101	S7TW0701	
S7MW02D01	S7MW05S01	S7MW10S01	S7TW0201	S7TW0701-D	

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:

For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No Toxicity Information.

TABLE 7-13

SELECTION OF EXPOSURE PATHWAYS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Soil	Surface Soil	Surface Soil	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction workers may have contact with surface soil during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Full-time employees may contact surface soil during normal work activities.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	Quant Quant	Trespassers may be exposed to surface soil while at the site.
		Air	Surface Soil	Construction Workers	Adult	Inhalation	On-site	None	No COPCs were identified in surface soil for the inhalation pathway.
				Full-time Employees	Adult	Inhalation	On-site	None	No COPCs were identified in surface soil for the inhalation pathway.
				Trespassers	Adolescents	Inhalation	On-Site	None	No COPCs were identified in surface soil for the inhalation pathway.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction workers may have contact with subsurface soil during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employees are not exposed to subsurface soil.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers are not exposed to subsurface soil.
		Air	Subsurface Soil	Construction Workers	Adult	Inhalation	On-site	Quant	Construction workers may be exposed to fugitive dust and volatile emissions during construction activities.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to subsurface soil.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers are not exposed to subsurface soil.
Future	Surface Soil	Surface Soil	Surface Soil	Residents	Child	Ingestion Dermal	On-Site On-Site	Quant Quant	Child residents may contact surface soil.
					Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Adult residents may contact surface soil.
		Air	Surface Soil	Residents	Child	Inhalation	On-site	Quant	Child residents may be exposed to fugitive dust and volatile emissions from surface soil.
					Adult	Inhalation	On-site	Quant	Adult residents may be exposed to fugitive dust and volatile emissions from surface soil.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	Residents	Child	Ingestion Dermal	On-Site On-Site	Quant Quant	Child residents may contact subsurface soil that has been brought to the surface.
					Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Adult residents may contact subsurface soil that has been brought to the surface.
		Air	Subsurface Soil	Residents	Child	Inhalation	On-site	Quant	Child residents may be exposed to fugitive dust and volatile emissions from subsurface soil that has been brought to the surface.
					Adult	Inhalation	On-site	Quant	Adult residents may be exposed to fugitive dust and volatile emissions from subsurface soil that has been brought to the surface.

TABLE 7-13

SELECTION OF EXPOSURE PATHWAYS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Groundwater	Overburden/Bedrock Aquifer	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	None Quant	Construction workers may have dermal contact with groundwater during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers do not have contact with groundwater.
				Residents	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Groundwater may be used as a potable water source in the future.
					Child	Ingestion Dermal	On-Site On-Site	None	Exposures to a child resident are less than those for an adult resident.
		Air	Overburden/Bedrock Aquifer	Construction Workers	Adult	Inhalation	On-site	None	Construction workers exposure via volatilization is expected to be insignificant due to dilution with outdoor air.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to chemicals volatilizing from groundwater.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers do not have contact with site groundwater.
				Residents	Adult	Inhalation	On-site	Quant	On-site residents may be exposed to volatile emissions from groundwater while showering.
					Child	Inhalation	On-site	None	Exposures to a child resident are less than those for an adult resident.

TABLE 7-14

EXPOSURE POINT CONCENTRATIONS FOR SITE 7
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Surface Soil		Subsurface Soil		Groundwater	
	RME[1] (mg/kg)	CTE[1] (mg/kg)	RME (mg/kg)	CTE (mg/kg)	RME[1] (ug/L)	CTE[1] (ug/L)
Volatile Organic Compounds						
1,3-Dichlorobenzene	NA	NA	NA	NA	1.73	0.546
1,4-Dichlorobenzene	NA	NA	NA	NA	90.5	4.25
Chlorobenzene	NA	NA	NA	NA	165	6.82
Benzene	NA	NA	NA	NA	2	0.556
Trichloroethene			NA	NA	23	1.91
Semivolatile Organic Compounds						
Benzo(a)anthracene	NA	NA	0.412	0.412	NA	NA
Benzo(a)pyrene	0.57	0.375	0.406	0.406	NA	NA
Benzo(b)fluoranthene	NA	NA	0.511	0.511	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	190	16.5
Dibenzo(a,h)anthracene	0.063	0.122	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	3	2.78
Indeno(1,2,3-cd)pyrene	NA	NA	0.373	0.373	NA	NA
PCBs						
Aroclor-1254	NA	NA	0.215	0.215	NA	NA
Inorganics						
Antimony	19.4	10.5	13.4	13.4	NA	NA
Arsenic	NA	NA	3.00	3.00	11.4	1.75
Barium	NA	NA	NA	NA	434	45.0
Cadmium	4.6	2.41	2.71	2.71	NA	NA
Chromium	NA	NA	21.7	21.7	127	12.2
Lead[2]	NA	NA	NA	NA	3.92	3.92
Manganese	300	194	282	282	NA	NA
Thallium	NA	NA	0.403	0.403	NA	NA
Vanadium	NA	NA	34.3	34.3	151	10.8

Notes:
All values are 95 percent UCL except where noted.
1 - The maximum detected concentration is used for the RME scenario and the average concentration is used for the CTE scenario.
2 - The average concentration is used for lead (USEPA, 1994).

TABLE 7-15

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 7
REASONABLE MAXIMUM EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Surface/Subsurface Soil	Ingestion	2.8E-07	- -	- -	- -	0.2	- -
		Dermal Contact	3.5E-08	- -	- -	- -	0.005	- -
		Total	3.2E-07	- -	- -	- -	0.2	- -
	Groundwater	Dermal Contact	4.2E-07	- -	- -	- -	0.09	- -
Full-Time Workers	Surface Soil	Ingestion	9.7E-07	- -	- -	- -	0.04	- -
		Dermal Contact	9.6E-07	- -	- -	- -	0.0008	- -
		Total	1.9E-06	- -	- -	Benzo(a)pyrene	0.04	- -
Child Resident	Surface/Subsurface Soil	Ingestion	4.2E-06	- -	- -	Arsenic, Benzo(a)pyrene	0.4	- -
		Dermal Contact	6.7E-07	- -	- -	- -	0.02	- -
		Total	4.8E-06	- -	- -	Arsenic, Benzo(a)pyrene	0.5	- -
Adult Resident	Surface/Subsurface Soil	Ingestion	1.8E-06	- -	- -	- -	0.05	- -
		Dermal Contact	3.7E-07	- -	- -	- -	0.002	- -
		Total	2.1E-06	- -	- -	- -	0.05	- -
	Groundwater	Ingestion	3.2E-04	Arsenic	Bis(2-ethylhexyl)phthalate, 1,4-Dichlorobenzene, Hexachlorobenzene	Benzene, Trichloroethene	3.8	Arsenic, Chromium
		Dermal Contact	2.9E-04	Hexachlorobenzene	Bis(2-ethylhexyl)phthalate, 1,4-Dichlorobenzene	- -	1.3	- -
		Inhalation (1)	3E-05	- -	1,4-Dichlorobenzene	Benzene, Trichloroethene	0.5	- -
		Total	6.4E-04	Arsenic, Hexachlorobenzene	Bis(2-ethylhexyl)phthalate, 1,4-Dichlorobenzene	Benzene, Trichloroethene	5.6	Arsenic, Chromium

Notes:
1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

TABLE 7-16

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 7
CENTRAL TENDENCY EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Surface/Subsurface Soil	Ingestion	9.5E-08	- -	- -	- -	0.06	- -
		Dermal Contact	2.3E-09	- -	- -	- -	0.0004	- -
		Total	9.7E-08	- -	- -	- -	0.06	- -
	Groundwater	Dermal Contact	1.0E-07	- -	- -	- -	0.05	- -
Full-Time Employees	Surface Soil	Ingestion	9.1E-08	- -	- -	- -	0.002	- -
		Dermal Contact	1.8E-08	- -	- -	- -	0.00004	- -
		Total	1.1E-07	- -	- -	- -	0.002	- -
Child Resident	Surface/Subsurface Soil	Ingestion	6.9E-07	- -	- -	- -	0.2	- -
		Dermal Contact	6.7E-08	- -	- -	- -	0.005	- -
		Total	7.6E-07	- -	- -	- -	0.2	- -
Adult Resident	Surface/Subsurface Soil	Ingestion	2.6E-07	- -	- -	- -	0.02	- -
		Dermal Contact	1.5E-08	- -	- -	- -	0.0003	- -
		Total	2.7E-07	- -	- -	- -	0.02	- -
	Groundwater	Ingestion	1.2E-05	- -	- -	Arsenic, Hexachlorobenzene	0.2	- -
		Dermal Contact	3.2E-05	- -	Hexachlorobenzene	- -	0.8	- -
		Inhalation (1)	8.5E-08	- -	- -	- -	0.02	- -
		Total	4.4E-05	- -	Hexachlorobenzene	Arsenic, Bis(2-ethylhexyl)phthalate	1.1	- -

Notes:
1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

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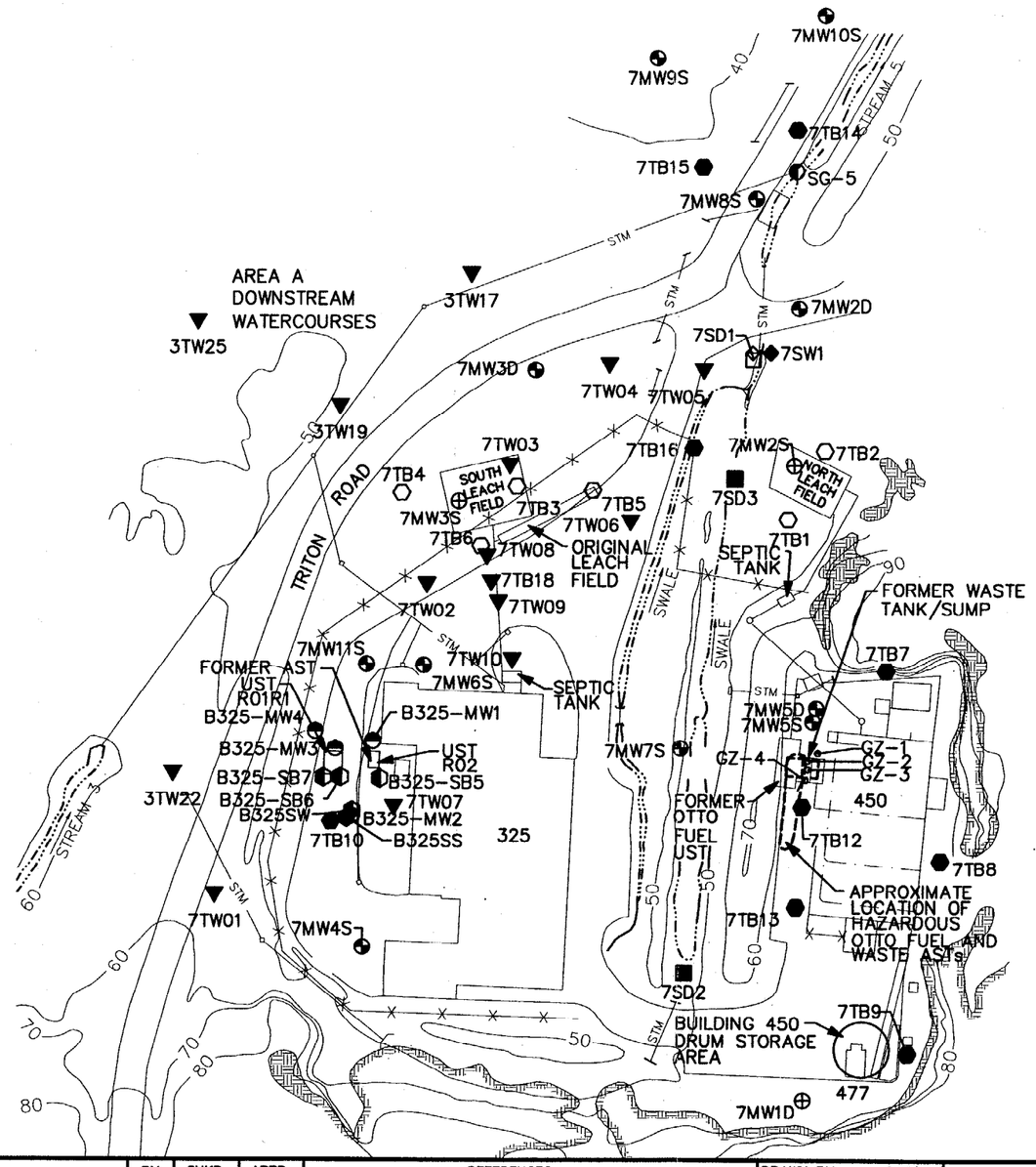


NOTES

1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON AND PHASE II RI WORK PLAN.

LEGEND

7MW2S	PHASE I MONITORING WELL
7MW7S	PHASE II MONITORING WELL
B325-MW1	SITE CHARACTERIZATION MONITORING WELL
7TB1	PHASE I TEST BORING
7TB12	PHASE II TEST BORING
B325-SB6	SITE CHARACTERIZATION SOIL BORING
7SW1	PHASE I EXISTING SURFACE WATER SAMPLE
7SW1	PHASE II SURFACE WATER SAMPLE
7SD1	PHASE I SEDIMENT SAMPLE
7SD3	PHASE II SEDIMENT SAMPLE
SG-5	PHASE II STAFF GAUGE
7TB17	GROUNDWATER OU RI TEST BORING LOCATION
7TW17	GROUNDWATER OU RI TEMPORARY WELL
10	TOPOGRAPHIC CONTOUR
123	BUILDING No.
	WATERCOURSE
STM	STORM SEWER AND CATCH BASIN
	EXPOSED BEDROCK
	FENCE

0 110 220
SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 2/13/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

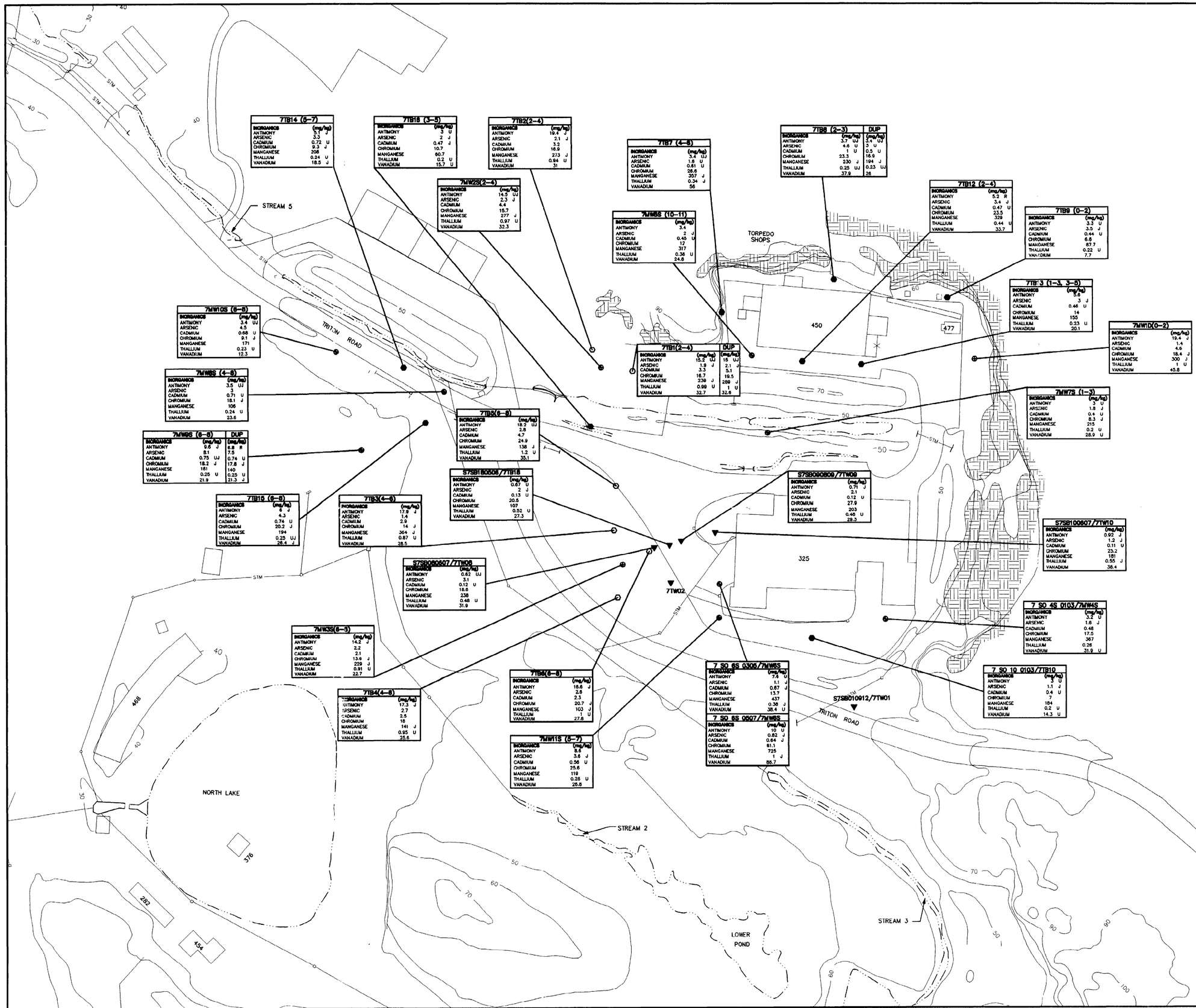
Tetra Tech NUS, Inc.

SAMPLING LOCATIONS
SITE 7 – TORPEDO SHOPS
NSB-NLON
GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY David Arcara DATE 8-7-01
APPROVED BY DATE
DRAWING NO. FIGURE 7-1
REV. 0

FORM CADD NO. TTNUS_BH.DGN – REV 0 – 1/20/98

10730103



LEGEND:

⊕ 7MW25	PHASE I MONITORING WELL LOCATION
⊕ 7MW7S	PHASE II MONITORING WELL LOCATION
○ 7TB1	PHASE 1 TEST BORING
● 7TB12	PHASE II TEST BORING
▼ 7TW02	GROUNDWATER OU RI GROUDWATER MONITORING POINT
—10—	EXISTING CONTOUR
123	BUILDING No.
—·····—	WATERCOURSE
—STM—□—	STORM SEWER AND CATCH BASIN
	EXPOSED BEDROCK
—×—×—	FENCE
U	NONDETECT
J	ESTIMATED
R	REJECTED
mg/kg	MILLIGRAMS PER KILOGRAM

NOTES:

UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.

BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON AND PHASE II RI WORK PLAN, (ATLANTIC, MAY 1993).

DEPTH INTERVALS INDICATED BY NUMBERS FOLLOWING SAMPLE LOCATION.

EXAMPLES:

A) 7TB8 (6-8) – SAMLE IS FROM 6-8 ft-bgs.
B) 7 SO 45 0103 – SAMPLE IS FROM 1-3 ft-bgs.

0 60 120
SCALE IN FEET

ACAD: 7858GT12.dwg 07/19/01 H.P.

Tetra Tech NUS, Inc.
TRIDENT POINTE, INC.
PITTSBURGH, PA 15220

DSGN: DR: H.P. CH. ENG: CHK:
SURV:
SUBMITTED BY: (FIRM NAME) (TITLE) 8-7-01 (DATE)
NORTHDIV HQ: HQ: HQ: DIR: DIR: DIR:
OFFICER IN CHARGE

REV. DESCRIPTION PREP BY DATE APPRVD

DEPARTMENT OF THE NAVY
NAVAL BASE
NAVAL SUBMARINE BASE, NEW LONDON
NAVAL FACILITIES ENGINEERING COMMAND
LESTER, PA.
GROTON, CONNECTICUT

NORTHERN DIVISION
COPCs IN SOIL – INORGANIC COMPOUNDS
SITE 7 – TORPEDO SHOPS

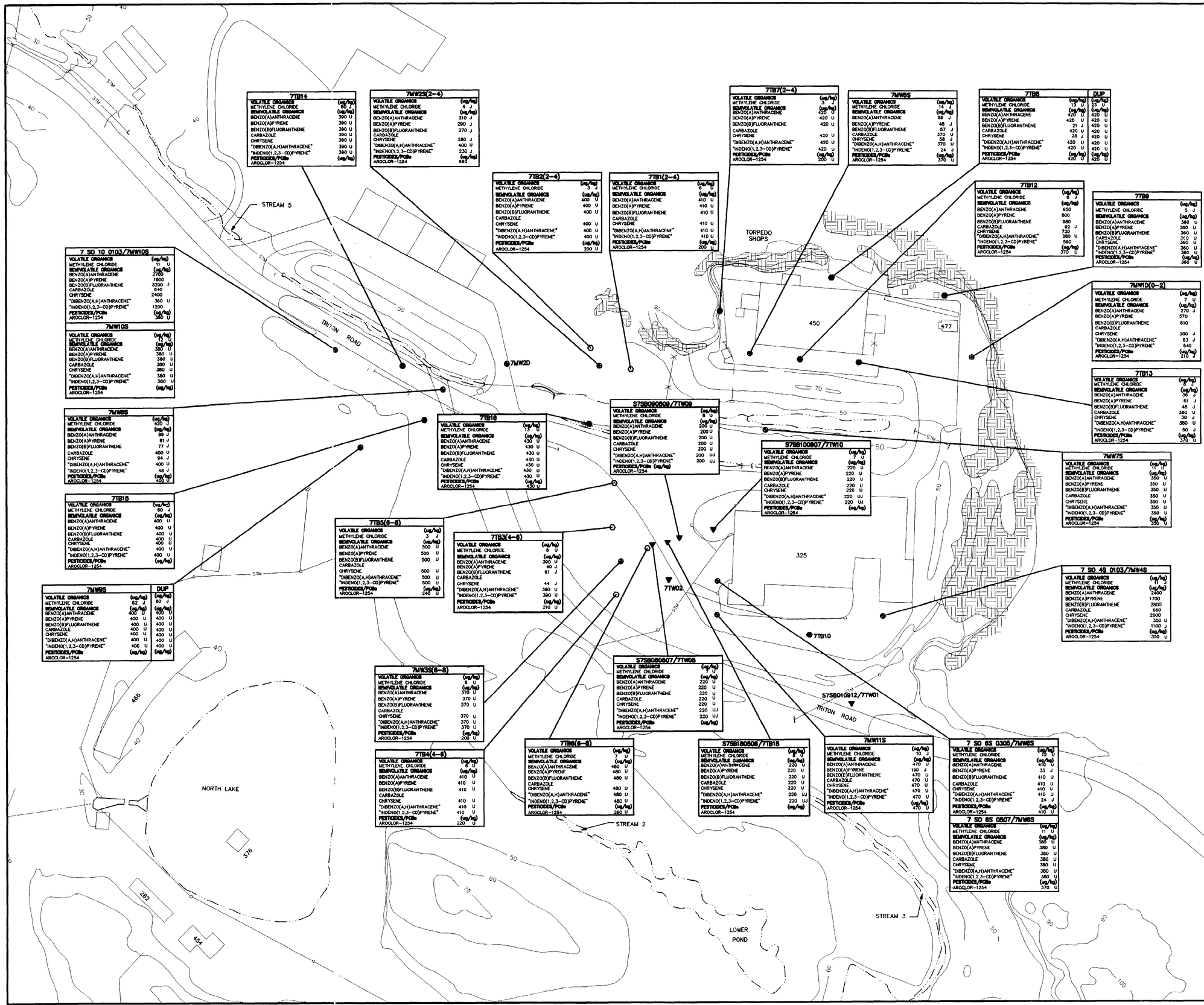
NORTHDIV FOR COMMANDER, NAVFAC

SEAL AREA

APPROVED DATE

SAT TO DATE

CODE I.D. NO. 80091
SCALE :
SPEC. NO. 04 –
CONSTRN. CONTR. NO. N62472– –C–
NAVFAC DRAWING NO.
SHEET OF
SIZE: D
DIS. SH. NO. FIG. 7–2



LEGEND:

⊕ 7MW25	PHASE I MONITORING WELL LOCATION
⊕ 7MW7S	PHASE II MONITORING WELL LOCATION
○ 7TB1	PHASE 1 TEST BORING
● 7TB12	PHASE II TEST BORING
▼ 7TW02	GROUNDWATER OU RI GROUDWATER MONITORING POINT
—10—	EXISTING CONTOUR
123	BUILDING No.
—·—·—	WATERCOURSE
—STM—□	STORM SEWER AND CATCH BASIN
	EXPOSED BEDROCK
—×—×—	FENCE
U	NONDETECT
J	ESTIMATED
ug/kg	MICROGRAMS PER KILOGRAM

NOTES:

UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.

BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON AND PHASE II RI WORK PLAN, (ATLANTIC, MAY 1993).

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Tetra Tech NUS, Inc. — FOSTER PLAZA VII, 661 ANDERSON DRIVE, PITTSBURGH, PA 15220

DSGN: DR: HJP CH: CHK: SUPV: CH ENG: SUBMITTED BY: (TITLE) (DATE)

NOR'NRW: HD: PM: RS: PPE: DR: OFFICER IN CHARGE

PREP BY DATE APPRVD

REV. DESCRIPTION DATE

NAVAL FACILITIES ENGINEERING COMMAND

DEPARTMENT OF THE NAVY — NORTHERN DIVISION

NAVAL BASE NAVAL SUBMARINE BASE, NEW LONDON — LESTER, PA. GROTON, CONNECTICUT

COPCs IN SOIL – ORGANIC COMPOUNDS SITE 7 – TROPEDO SHOPS

NORTHDIV FOR COMMANDER, NAVFAC

APPROVED DATE

SEAL AREA

SAT TO DATE

CODE I.D. NO. 80091

SCALE :

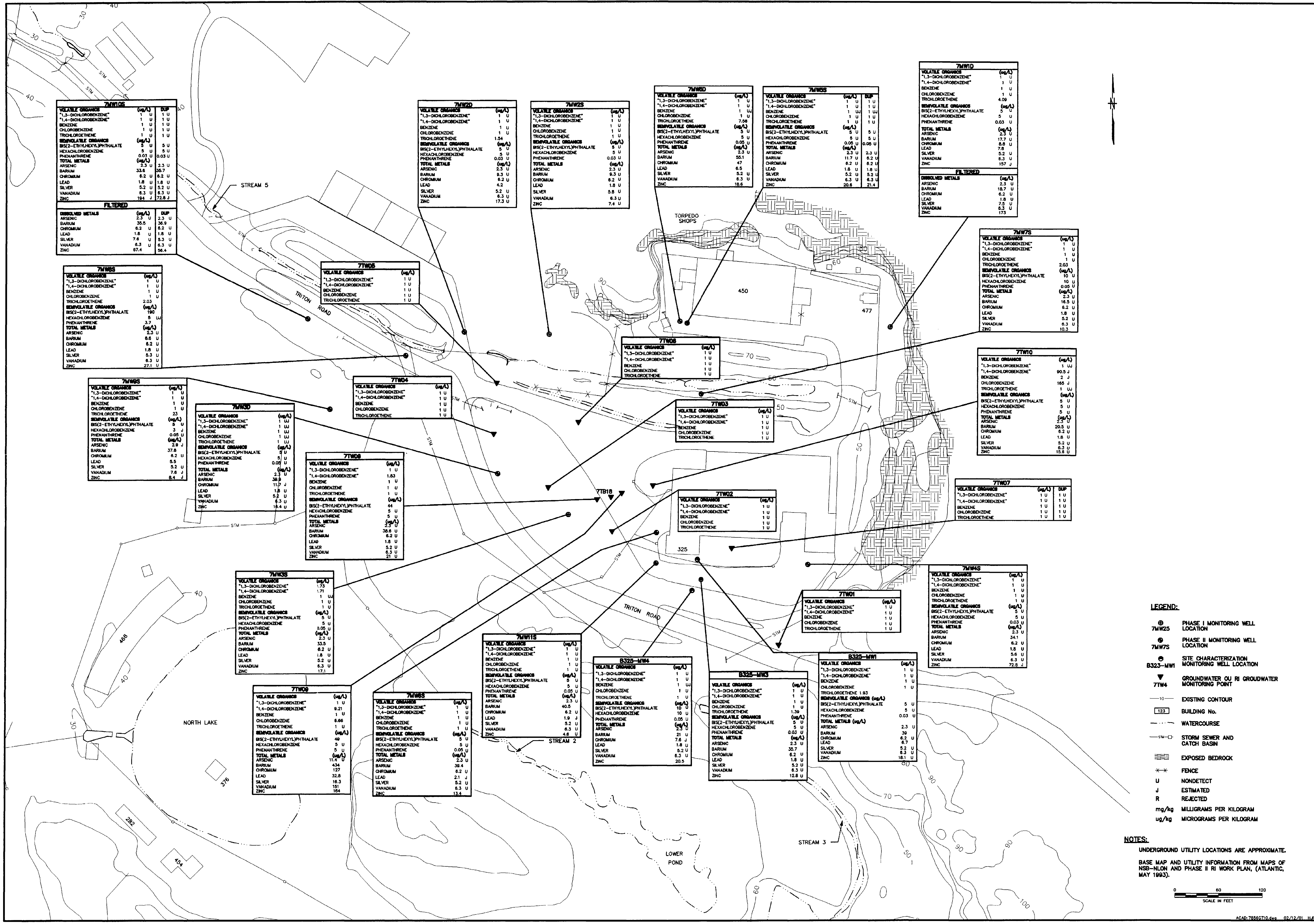
SPEC. NO. 04 –

CONSTRN. CONTR. NO. N62472– –C–

NAVFAC DRAWING NO.

SHEET OF

SIZE: D DIS. SH. NO. FIG. 7–3



7MW10S

	(ug/L)	DUP
VOLATILE ORGANICS	(ug/L)	DUP
"1,3-DICHLOROBENZENE"	1 U	1 U
"1,4-DICHLOROBENZENE"	1 U	1 U
BENZENE	1 U	1 U
CHLOROBENZENE	1 U	1 U
TRICHLOROETHENE	1 U	1 U
SEMIVOLATILE ORGANICS	(ug/L)	
BIS(2-ETHYLHEXYL)PHTHALATE	5 U	5 U
HEXACHLOROBENZENE	5 U	5 U
PHENANTHRENE	0.03 U	0.03 U
TOTAL METALS	(ug/L)	
ARSENIC	2.3 U	2.3 U
BARIUM	33.6	35.7
CHROMIUM	6.2 U	6.2 U
LEAD	1.8 U	1.8 U
SILVER	5.2 U	5.2 U
VANADIUM	6.3 U	6.3 U
ZINC	194 J	72.8 J
FILTERED		
DISSOLVED METALS	(ug/L)	DUP
ARSENIC	2.3 U	2.3 U
BARIUM	35.5	36.9
CHROMIUM	6.2 U	6.2 U
LEAD	1.8 U	1.8 U
SILVER	7.6 U	5.3 U
VANADIUM	6.3 U	6.3 U
ZINC	67.4	56.4

7MW6S

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	2.03
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	190
HEXACHLOROBENZENE	5 UJ
PHENANTHRENE	3.7
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	8.6 U
CHROMIUM	6.2 U
LEAD	1.8 U
SILVER	5.3 U
VANADIUM	6.3 U
ZINC	27.1 U

7MW9S

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	23
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	3 J
PHENANTHRENE	0.05 U
TOTAL METALS	(ug/L)
ARSENIC	2.9 J
BARIUM	37.8
CHROMIUM	6.2 U
LEAD	5.5
SILVER	5.2 U
VANADIUM	7.6 J
ZINC	8.4 J

7MW3D

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 UJ
"1,4-DICHLOROBENZENE"	1 UJ
BENZENE	1 UJ
CHLOROBENZENE	1 UJ
TRICHLOROETHENE	1 UJ
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	0.05 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	39.9
CHROMIUM	11.7 J
LEAD	1.8 U
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	18.4 U

7TW05

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U

7TW04

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U

7TW06

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1.83
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	44
HEXACHLOROBENZENE	5 U
PHENANTHRENE	5 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	38.6 U
CHROMIUM	6.2 U
LEAD	1.8 U
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	21 U

7MW2D

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1.54
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	0.03 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	9.3 U
CHROMIUM	6.2 U
LEAD	4.2
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	17.3 U

7MW2S

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	0.03 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	9.3 U
CHROMIUM	6.2 U
LEAD	1.8 U
SILVER	5.8 U
VANADIUM	6.3 U
ZINC	7.4 U

7MW5D

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 UJ
CHLOROBENZENE	1 U
TRICHLOROETHENE	7.58
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	0.05 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	55.1
CHROMIUM	47
LEAD	6.5
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	18.6

7MW5S

VOLATILE ORGANICS	(ug/L)	DUP
"1,3-DICHLOROBENZENE"	1 U	1 U
"1,4-DICHLOROBENZENE"	1 U	1 U
BENZENE	1 UJ	1 UJ
CHLOROBENZENE	1 U	1 U
TRICHLOROETHENE	1 U	1 U
SEMIVOLATILE ORGANICS	(ug/L)	
BIS(2-ETHYLHEXYL)PHTHALATE	5 U	5 U
HEXACHLOROBENZENE	5 U	5 U
PHENANTHRENE	0.05 U	0.05 U
TOTAL METALS	(ug/L)	
ARSENIC	2.3 U	2.3 U
BARIUM	11.7 U	6.2 U
CHROMIUM	6.2 U	6.2 U
LEAD	1.8 U	1.8 U
SILVER	5.2 U	5.2 U
VANADIUM	6.3 U	6.3 U
ZINC	20.6	21.4

7MW1D

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	4.09
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	0.03 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	17.7 U
CHROMIUM	8.8 U
LEAD	7.8
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	157 J
FILTERED	
DISSOLVED METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	18.7 U
CHROMIUM	6.2 U
LEAD	1.8 U
SILVER	7.5 U
VANADIUM	6.3 U
ZINC	173

7MW7S

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	2.03
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	10 U
HEXACHLOROBENZENE	10 U
PHENANTHRENE	0.05 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	16.5 U
CHROMIUM	6.2 U
LEAD	1.8 U
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	10.3

7TW08

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U

7TW10

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 UJ
"1,4-DICHLOROBENZENE"	90.5 J
BENZENE	2 J
CHLOROBENZENE	165 J
TRICHLOROETHENE	1 UJ
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	5 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	20.5 U
CHROMIUM	6.2 U
LEAD	1.8 U
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	15.6 U

7TW03

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U

7TW07

VOLATILE ORGANICS	(ug/L)	DUP
"1,3-DICHLOROBENZENE"	1 U	1 U
"1,4-DICHLOROBENZENE"	1 U	1 U
BENZENE	1 U	1 U
CHLOROBENZENE	1 U	1 U
TRICHLOROETHENE	1 U	1 U

7TW02

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U

7MW3S

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1.73
"1,4-DICHLOROBENZENE"	1.71
BENZENE	1 UJ
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	0.05 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	33.5
CHROMIUM	6.2 U
LEAD	1.8 U
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	17.1

7TW01

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U

7MW4S

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	0.03 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	34.1
CHROMIUM	6.2 U
LEAD	1.8 U
SILVER	5.6 U
VANADIUM	6.3 U
ZINC	72.8 J

7MW11S

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	0.05 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	40.5
CHROMIUM	6.2 U
LEAD	1.9 J
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	4.6 U

7TW09

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	9.21
BENZENE	1 U
CHLOROBENZENE	6.66
TRICHLOROETHENE	1 U
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	49
HEXACHLOROBENZENE	5 U
PHENANTHRENE	5 U
TOTAL METALS	(ug/L)
ARSENIC	11.4 U
BARIUM	434
CHROMIUM	127
LEAD	32.8
SILVER	16.3
VANADIUM	151
ZINC	164

7MW8S

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	0.05 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	39.4
CHROMIUM	6.2 U
LEAD	2.1 J
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	13.4

B325-MW4

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 UJ
CHLOROBENZENE	1 U
TRICHLOROETHENE	1 U
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	10 U
HEXACHLOROBENZENE	10 U
PHENANTHRENE	0.05 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	21 U
CHROMIUM	7.6 J
LEAD	1.8 U
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	20.5

B325-MW3

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1.39
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	0.03 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	35.7
CHROMIUM	6.2 U
LEAD	1.8 U
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	12.8 U

B325-MW1

VOLATILE ORGANICS	(ug/L)
"1,3-DICHLOROBENZENE"	1 U
"1,4-DICHLOROBENZENE"	1 U
BENZENE	1 U
CHLOROBENZENE	1 U
TRICHLOROETHENE	1.93
SEMIVOLATILE ORGANICS	(ug/L)
BIS(2-ETHYLHEXYL)PHTHALATE	5 U
HEXACHLOROBENZENE	5 U
PHENANTHRENE	0.03 U
TOTAL METALS	(ug/L)
ARSENIC	2.3 U
BARIUM	39
CHROMIUM	6.2 U
LEAD	6.7
SILVER	5.2 U
VANADIUM	6.3 U
ZINC	18.1 U

LEGEND:

⊕ 7MW25	PHASE I MONITORING WELL LOCATION
7MW7S	PHASE II MONITORING WELL LOCATION
B323-MW1	SITE CHARACTERIZATION MONITORING WELL LOCATION
▼ 7TW4	GROUNDWATER OU RI GROUDWATER MONITORING POINT
—10—	EXISTING CONTOUR
123	BUILDING No.
	WATERCOURSE
—STM—□	STORM SEWER AND CATCH BASIN
	EXPOSED BEDROCK
×—×	FENCE
U	NONDETECT
J	ESTIMATED
R	REJECTED
mg/kg	MILLIGRAMS PER KILOGRAM
ug/kg	MICROGRAMS PER KILOGRAM

NOTES:

UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.

BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON AND PHASE II RI WORK PLAN, (ATLANTIC, MAY 1993).

0 60 120
SCALE IN FEET

ACAD: 7856GT10.dwg 02/12/01 HJP

Tetra Tech NUS, Inc. FOSTER PLAZA VII, 661 ANDERSEN DRIVE, PITTSBURGH, PA 15220

DSGN: DR: HJP CHK:
SUPV: CH ENG:
SUBMITTED BY: (FIRM MEMBER) (TITLE) (DATE)
NORTHDIV HD: DM: HD: FPE: DIR:
OFFICER IN CHARGE
APPROVED DATE

REV. DESCRIPTION PREP BY DATE APPRVD
2-15-01

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
NORTHERN DIVISION LESTER, PA.
NAVAL BASE
NAVAL SUBMARINE BASE, NEW LONDON GROTON, CONNECTICUT

COPCs IN GROUNDWATER SITE 7 – TORPEDO SHOPS

APPROVED DATE NORTHDIV FOR COMMANDER, NAVFAC

SEAL AREA

SAT TO DATE
CODE I.D. NO. 80091
SCALE :
SPEC. NO. 04 –
CONSTRN. CONTR. NO. N62472– –C–
NAVFAC DRAWING NO.
SHEET OF
SIZE: D DIS. SH. NO. FIG. 7–4

8.0 SITE 20 – AREA A WEAPONS CENTER

8.1 SITE DESCRIPTION

Site 20, the Area A Weapons Center, consists of Building 524 and the weapons storage bunkers. The storage bunker area is divided into two portions (north and south areas) that were constructed at different times and are of different design. The site is located at the southeastern end of Triton Avenue and is adjacent to and on the northwestern side of the Area A Wetland. The general configuration of the Area A Weapons Center site is shown in Figure 8-1. The location of the site with respect to other IRP sites within NSB-NLON is shown on Figure 1-2.

The Area A Weapons Center (Building 524) is located near the top of a local topographic and bedrock high. Building 524 was constructed in 1990-1991. Portions of the site were blasted to remove bedrock to accommodate construction of the building. The weapons storage bunkers are located southeast and downhill of Building 524 and are adjacent to and at a slightly higher elevation than the Area A Wetland.

Prior to construction of the Area A Weapons Center, the site consisted of woodlands in the vicinity of Building 524. The bunker areas were part of the Area A Wetlands. Based on review of aerial photographs, the southern area of weapons storage bunkers was first evident in 1969. The northern area of weapons storage bunkers was first evident in February 1974.

Atlantic personnel inspected the Area Weapons Center on September 11, 1992. The following information was obtained during the site inspection. Building 524 is used for administration, minor torpedo assembly, and storage of simulator torpedoes. No weapons production takes place in this building. Small quantities of chemicals and chemical waste generated by activities in this building are stored in 1- to 5-gallon containers in seven metal storage cabinets located on a paved area south of the building. Chemicals include cleaning and lubricating compounds, paints, and adhesives. Many of these materials are classified as corrosive or flammable materials. The waste storage and management practices appeared to be good.

The weapons storage bunkers are located southeast of Building 524. Liquid fuels present in the weapons storage bunkers include Otto fuel, JP-10, and TH Dimer (kerosene). The group of southern area bunkers has been reconstructed in the last 10 years. A major part of the reconstruction involved removal of structurally unsuitable soil from the site.

Routine maintenance and security improvements for the Area A Weapons Center include grouting and waterproofing of bunkers, repaving of roads, installation of culverts, and regrading associated with these activities.

A ROD was signed for the soil and sediment operable units associated with Site 20 in June 2000. A minor (200 cubic yard) soil removal action is planned for Site 20 for the spring of 2001, to address PAH and metals contamination in soil and sediment. The remedial action is targeted towards mitigating direct contact exposures to soil and sediment.

The site is near the farthest upgrade end of the subase. There are no known contaminant sources existing upgradient of Site 20.

8.2 SITE INVESTIGATIONS

The details of all investigations, including historical and current, conducted at the Area A Weapons Center are provided in the following subsections.

8.2.1 Phase I Remedial Investigation (Atlantic, 1992)

This site was not investigated during the Phase I RI. Although samples were obtained in the vicinity of the site, these samples were collected as part of the Area A Wetland investigation. One groundwater sample was collected from bedrock monitoring well 2WMW4D, installed as part of the Phase I RI. Well 2WMW4S was drilled but not completed due to a lack of significant groundwater in the shallow overburden. One surface soil sample 2WMW4 (0 to 2 feet) was collected from the boring for 2WMW4S. The Phase I RI concluded that several exposure scenarios exceeded acceptable levels at this site and recommended that the Area A Weapons Center proceed to an FS.

8.2.2 Phase II Remedial Investigation (B&R Environmental, 1997a)

A Phase II RI at 13 sites at NSB-NLON was conducted by B&R Environmental from 1995 through 1997. The Area A Weapons Center was one of the sites investigated as part of the RI. Ten soil samples (plus two field duplicate samples) were collected from two monitoring well borings and eight test borings. Three samples (plus one field duplicate) were collected from depths of less than 2 feet (i.e., surface soils). Seven samples (plus one field duplicate) were collected from depths between 2 and 18 feet (i.e., subsurface soils). All soil samples were analyzed for TCL VOCs, TCL SVOCs, and TAL metals (total). In addition, eight of the soil samples (including both field duplicates) were also analyzed for TCL pesticides/PCBs, and one subsurface soil sample was also analyzed for TCLP metals.

Three new shallow overburden groundwater wells were installed and sampled. Additionally, bedrock well 2WMW4D from the Phase I RI was sampled. Two rounds of groundwater samples were collected and four samples (plus one field duplicate during Round 1 only, from well 2WCMW1S) were collected during each sampling round. All groundwater samples in both rounds were analyzed for TCL VOCs, TCL SVOCs, and TAL metals (total and dissolved). In addition, one groundwater sample in each round was analyzed for radiological parameters including gross alpha, gross beta, and a complete gamma spectrum analysis.

During the Phase II RI, 15 sediment samples plus one field duplicate sample were collected at the site. The sediment samples were collected from three distinct drainage areas. Two surface water samples were also collected from stormwater drainageways at the Area A Weapons Center. All sample locations are shown on Figure 8-1.

The Phase II RI concluded that, although there is minimal contamination of groundwater and surface water at the site, this area may be a contaminant source for the Area A Wetlands. The Phase II RI Report recommended that the Area A Weapons Center proceed to the FS stage.

8.2.3 Basewide Groundwater OU RI

As part of the field work conducted for the BGOURI, four existing monitoring wells at Site 20 were sampled to further characterize the site. A summary of the sampling and analytical program is presented in Table 8-1. The monitoring wells that were sampled are shown on Figure 8-1. One groundwater sample was analyzed for filtered metals. The methodology used to complete groundwater sampling was discussed in Section 2.3.

8.3 PHYSICAL CHARACTERISTICS

This section presents a summary of site physical characteristics for the Area A Weapons Center based on information generated during the Phase I, Phase II, and BGOURIs. Topography and surface features, surface water, soils, geology, and hydrogeology are discussed in the subsections that follow.

8.3.1 Topography and Surface Features

Figure 1-3 shows the topography and surface features of the Area A Weapons Center. The site consists of Building 524 and the weapons storage bunkers. The Area A Weapons Center is located along the southern side of the northern topographic and bedrock high. The ground surface generally slopes from the northern bedrock high across the site to the south toward the Area A Wetland. The 90-foot ground surface contour surrounds the site. The shape of this contour is consistent with the topography on the

historical surficial geology map (USGS, 1960). The ground surface across the Area A Weapons Center was altered (flattened) when the bedrock was blasted during construction of Building 524. To the west and southwest, the ground surface slopes to a ravine (Area A Downstream Watercourses) and toward the OBDANE.

8.3.2 Surface Water Features

Two drainage culverts (one along the northwestern side and one along the southeastern side of the site) collect runoff from the surrounding hillsides and from the Area A Weapons Center and discharge it to the Area A Wetland. The drainage culvert along the northwestern side eventually discharges to a storm sewer that passes along the southern side of the site and discharges into the Area A Wetland. The drainage culvert along the southeastern side collects runoff from the hillside north of the site and continues along the southeastern side of the site, eventually discharging to another drainage area of the Area A Wetland. The Area A Wetland discharges to the Area A Downstream Watercourses and subsequently into the Thames River. Water typically flows in these drainage culverts immediately following precipitation events.

8.3.3 Soil Characteristics

The SCS Soils Map (SCS, 1983) classifies the soil at the Area A Weapons Center as Udorthents-Urban land. This soil type is defined as excessively to moderately drained soils that have been disturbed by cutting and filling. The bedrock surface has been altered by blasting in some areas of the site. Other areas have been filled with dredge spoils. Native soils at the Area A Weapons Center were likely the same as those along the northern bedrock high. The SCS Map classifies this soil as the Hollis-Charlton-Rock complex, which is defined as stones and boulders intermingled with a dark, fine, sandy loam. Bedrock outcrops are prevalent.

8.3.4 Geology and Hydrogeology

Geology

The overburden materials at the Area A Weapons Center consist of 4 to 16 feet of coarse sand, gravel, and rock fill that is underlain by up to 17 feet of fine-grained dredge spoils. At the 2WCTB1 and 2WCTB4 test boring locations, 8 and 4 feet, respectively, of fill material rests directly on bedrock (Mamacoke Formation). These are the only test borings where bedrock was encountered and dredge spoils were not present. The overburden thickness generally increases to the south and east, toward the Area A Wetland. Geologic cross sections that include portions of Site 20 are shown on Figures 4-8 and 4-10.

The bedrock surface generally slopes to the southwest across the site, toward the valley occupied by the Area A Wetland. The bedrock elevations at the 2WCTB1 and 2WCTB4 test borings are higher than at the 2WCTB6 test boring, which indicates that the bedrock surface does not slope uniformly and that localized bedrock surface depression(s) are present. This identified depression is most likely the result of the blasting activities that occurred during the construction of the Area A Weapons Center. The historical surficial geology map (USGS, 1960) indicates that, prior to blasting/construction activities, the bedrock surface rose steeply to the 2WCTB1 and 2WCTB4 test borings and then rose gently to the 2WCTB6 test boring.

Hydrogeology

Groundwater is present in both the overburden and bedrock underlying the Area A Weapons Center. The saturated thickness of the overburden deposits is variable, ranging up to 25 feet or more. Overburden groundwater is primarily found within the dredge spoil materials, with only the lowermost few feet of the coarser-grained fill deposits saturated. Figures 4-2 and 4-4 show shallow overburden groundwater contours for the Area A Weapons Center and nearby areas, based on June and August 2000 rounds of water levels (Tables 2-2 and 2-3). Figures 4-3 and 4-5 show bedrock groundwater contours for the same area. Groundwater in both the overburden and bedrock flows across the weapons center to the west and southwest. Although overburden monitoring well 2WMW6S was dry during the August round of data collection, the June data indicate a downward gradient between 2WMW6S and adjacent bedrock well 2WMW6D, indicating downward flow from the overburden to the bedrock in this area.

The shallow overburden hydraulic gradient across the Area A Weapons Center varies considerably; it is steeper in the area of Building 524 and lower at the storage bunkers near the Area A Wetlands. The overall lateral groundwater flow gradient in the overburden, based on the June and August 2000 water-level data, averages approximately 0.04. Assuming an average horizontal hydraulic conductivity of 2.7 ft/day (based on the Area A Landfill pumping test) and a porosity of 0.30, the seepage velocity for overburden groundwater in this area is estimated to be about 0.36 ft/day.

8.4 NATURE AND EXTENT OF CONTAMINATION

8.4.1 Previous Investigations

Soil, sediment, groundwater, and surface water sampling was conducted at the Area A Weapons Center during the Phase I, Phase II, and BGOU RIs. Based upon the results of these investigations, the nature and extent of contamination of the soil and groundwater at the Area A Weapons Center are discussed on a matrix-specific basis in the following subsections.

8.4.1.1 Historic Soil Data

Five VOCs, including acetone, 2-butanone, carbon disulfide, toluene, and TCE, were infrequently detected in the Area A Weapons Center soil samples. Acetone and 2-butanone, which are both common laboratory contaminants, were detected at concentrations of 0.69 mg/kg and 0.24 mg/kg, respectively, in the soil sample collected from a depth interval of 8 to 10 feet bgs from boring 2WCTB6. The remaining VOC concentrations ranged from 0.002 mg/kg to 0.011 mg/kg. These analytical results do not indicate significant VOC contamination at this site.

SVOCs, particularly PAHs, were detected more frequently and at greater concentrations than VOCs. The soil sample collected from a depth interval of 0 to 2 feet bgs from boring 2WCTB2, located southwest of the bunkers along Triton Road, yielded the greatest concentrations of PAHs. For example, some of the PAHs and associated concentrations reported for this sample include fluoranthene (5.7 mg/kg), phenanthrene (4.2 mg/kg), pyrene (4 mg/kg), benzo(b)fluoranthene (3.2 mg/kg), chrysene (2.3 mg/kg), and benzo(a)anthracene (2.1 mg/kg). Concentrations of PAHs generally decreased with depth. The maximum concentration of any PAH reported for soil samples collected at depths greater than 2 feet bgs was 0.5 mg/kg (pyrene in the sample collected at a depth interval of 8 to 10 feet bgs from boring 2WCTB6, located in the central part of the complex).

Three phthalate esters, which are common field and laboratory contaminants, were also detected in the historic Area A Weapons Center soil samples. These compounds were detected infrequently (each in two or three of 11 samples) at concentrations ranging from 0.028 mg/kg to 0.36 mg/kg. Carbazole (0.4 mg/kg and 0.72 mg/kg) was also detected in the soil sample and field duplicate sample collected at a depth interval of 0 to 2 feet bgs from boring 2WCTB2. Dibenzofuran was detected at concentrations of 0.084 mg/kg and 0.031 mg/kg in soil samples (both 0 to 2 feet bgs) collected from borings 2WCTB2 and 2WCTB1, respectively. Benzoic acid, ranging in concentration from 0.047 mg/kg to 0.48 mg/kg, was detected in 5 of 11 soil samples.

Three pesticides were detected in the Area A Weapons Center soil samples. 4,4'-DDE was detected in one sample and its associated field duplicate sample at concentrations of 0.004 mg/kg and 0.0074 mg/kg. Endrin was detected in two samples at concentrations of 0.011 mg/kg and 0.014 mg/kg. Endrin aldehyde was detected in two samples at concentrations of 0.0064 mg/kg and 0.007 mg/kg. Maximum concentrations of these three pesticides were detected in the soil sample or field duplicate sample collected at a depth interval of 0 to 2 feet bgs from boring 2WCTB2, located along Triton Road. Aroclor 1260 was detected at a concentration of 0.05 mg/kg in the soil sample collected from boring 2WMW4S (0 to 2 feet bgs).

Twenty-two metals were detected in the Area A Weapons Center soil samples, although antimony, cadmium, mercury, and silver were each detected in only two or three samples. Maximum concentrations of 10 metals were reported for the soil sample collected from a depth interval of 4 to 6 feet bgs from boring 2WCTB3, located on the northwestern side of the northern bunkers. Maximum concentrations for six additional metals were reported for the soil sample collected from a depth interval of 16 to 18 feet bgs from boring 2WCMW3S, located south of the bunkers.

TCLP extraction followed by analysis for metals was performed for three Area A Weapons Center soil samples. Barium was detected in all three TCLP leachates at concentrations ranging from 0.0317 mg/L to 0.248 mg/L. Arsenic, chromium, and selenium were each detected in the TCLP leachate of the soil sample collected from a depth interval of 6 to 8 feet bgs from boring 2WCTB5.

8.4.1.2 Historic Groundwater Data

Groundwater samples from both overburden and bedrock wells were collected at the Area A Weapons Center. Appendix D presents descriptive statistics (frequency of detection, minimum and maximum concentrations, range of detection limits for nondetects, 95% UCL, and sample number and location associated with maximum concentration) and associated COPC screening criteria for each analyte detected at least once in groundwater samples collected from the Area A Weapons Center.

Overburden Wells

No overburden groundwater samples were collected from the Area A Weapons Center during the Phase I RI field investigation. Three overburden wells were installed and sampled during the Phase II RI field investigation; however, no VOCs were detected. Five SVOCs were detected at low concentrations. Bis(2-ethylhexyl) phthalate, a common field and laboratory contaminant, was detected in three of six samples at concentrations ranging from 2 µg/L to 3 µg/L. 1,3-Dichlorobenzene (0.6 µg/L), benzo(g,h,i)perylene (1 µg/L), dibenzo(a,h)anthracene (0.8 µg/L), and indeno(1,2,3-cd)pyrene (1 µg/L) were each detected in one or the other of two groundwater samples collected from well 2WCMW1S.

Nineteen metals were detected in unfiltered groundwater samples collected from the overburden wells. Sixteen metals were detected in the corresponding filtered groundwater samples. A majority of the maximum concentrations of metals were associated with groundwater samples collected from well 2WCMW3S, located south of the site along the drainageway into the Area A Wetland. Concentrations of metals in filtered and unfiltered samples were relatively similar (i.e., at the same order of magnitude). Notable concentrations reported for groundwater samples include the maximum concentrations of arsenic (19.9 µg/L), boron (3,810 µg/L), manganese (6,540 µg/L), and sodium (3,580,000 µg/L).

Analyses for hardness were performed for two filtered and six unfiltered groundwater samples. Reported results for hardness for the two filtered samples were 125 mg/L and 436 mg/L. Reported results for hardness for the six unfiltered groundwater samples ranged from 64 mg/L to 4,000 mg/L.

Bedrock Wells

Three groundwater samples were collected (during the Phase I RI and Rounds 1 and 2 of the Phase II RI) from a single Area A Weapons Center bedrock well (2WMW4D). Six VOCs were detected at concentrations ranging from 1 µg/L to 12 µg/L. These VOCs include three ketones and three halogenated aliphatics. Three SVOCs were detected at concentrations ranging from 2 µg/L to 7 µg/L. Benzoic acid and di-n-octyl phthalate were each detected in one of three samples, and bis(2-ethylhexyl) phthalate was detected in two of the samples.

Thirteen metals were detected in unfiltered groundwater samples collected from the bedrock. Seven metals were detected in the corresponding filtered groundwater samples. The maximum concentrations of a majority of metals in overburden well samples are more than an order of magnitude greater than respective maximum concentrations of metals detected in bedrock well samples.

Radionuclide analyses (gross alpha and gross beta) were performed for the three groundwater samples collected from bedrock well 2WMW4D. Gross alpha was detected at concentrations ranging from 10.1 pCi/L to 20 pCi/L, and gross beta was detected at concentrations ranging from 4.4 pCi/L to 22 pCi/L. Maximum concentrations of both parameters were associated with the sample collected during Round 2 of the Phase II RI. Complete gamma spectrum analyses performed for samples collected from this well during Rounds 1 and 2 of the Phase II RI detected no radionuclides.

Analyses for hardness were performed for one filtered and two unfiltered groundwater samples. The reported result for hardness for the filtered sample was 94 mg/L. Reported results for hardness for the two unfiltered groundwater samples were 92 mg/L and 118 mg/L.

8.4.1.3 Historic Sediment Data

During the Phase II RI, fifteen sediment samples (plus one field duplicate were collected at this site (B&R Environmental, 1997b). VOCs, SVOCs, pesticides and inorganics were detected at the Area A Weapons center at low concentrations. The potential exists for contaminants to migrate from the site to the Area A Wetland and impact ecological receptors. Although notable contamination has been detected in soils and sediment at the site, the most prevalent contaminants detected included phthalate esters and PAHs, which are relatively less soluble compounds, and are therefore less mobile. Elevated levels of PAHs were detected in one of the Area A Wetland sediment samples; however the data show that this

occurrence is limited in extent. The HHRA conducted on the samples indicated low human health risks. The Phase II RI concluded that little risk is posed to ecological receptors due to the current site conditions.

8.4.1.4 Historic Surface Water Data

During the Phase II RI two surface water samples were also collected from the stormwater drainageways at the Area A Weapons Center. The only organic compounds detected in surface water were di-n-octylphthalate and butylbenzylphthalate at a concentration of 2 µg/L or less. Several inorganics were detected in surface water at inconsequential concentrations. The HHRA and ecological risk assessments for surface water indicated no risk to receptors.

8.4.2 Basewide Groundwater OU RI

This section presents a discussion of the current nature and extent of groundwater contamination at the Area A Weapons Center site, based on groundwater data collected during the BGOURI. A summary of the groundwater sampling and analytical program is presented in Table 8-1. Table 8-2 presents a summary of the positive analytical detections at Site 8. As part of the HHRA (Section 8.6), a screening process for COPCs was performed. The analytes selected as COPCs for Site 20 groundwater are presented in Table 8-3. Tables 8-4 and 8-5 present descriptive statistics and the COPC screening criteria for each analyte detected in at least one groundwater sample at the Area A Weapons Center. The distribution of COPCs and their concentrations are presented in Figure 8-2. Chemicals that were not selected as COPCs are not presented on the tag map.

Overburden Wells

TCE and 4-methyl-2-pentanone were the only VOCs detected in the groundwater samples collected from the overburden wells. TCE and 4-methyl-2-pentanone were detected in one sample from well 2WCMW2S at concentrations of 5.02 µg/L and 1.29 J µg/L, respectively. VOCs were not detected in groundwater samples collected from the overburden aquifer during previous investigations.

PAHs and 4-methylphenol were the only SVOCs detected in groundwater samples collected from the overburden aquifer. PAHs were detected at trace levels in one groundwater sample from well 2WCMW2S at concentrations ranging from 0.03 J µg/L [benzo(k)fluoranthene] to 0.13 µg/L (fluoranthene). 4-Methylphenol was detected in one sample from well 2WCMW3S at a concentration of 9 µg/L. PAHs were also detected at low concentrations in groundwater samples collected during the previous investigations.

Sixteen metals were detected in unfiltered overburden groundwater samples and two metals (calcium and zinc) were detected in filtered overburden groundwater samples. The concentrations of the metals were higher in unfiltered samples than filtered samples. In general, metals were also detected at similar concentrations (i.e., at the same order of magnitude) in groundwater samples collected during the previous investigations.

Bedrock Well

TCE at a concentration of 3.8 J µg/L was the only VOC detected in the groundwater sample collected from the bedrock aquifer. TCE was also detected at similar concentrations in groundwater samples from the bedrock aquifer during previous investigations.

No SVOCs were detected in the groundwater sample collected from the bedrock aquifer. Benzoic acid, bis(2-ethylhexyl) phthalate, and di-n-octyl phthalate were detected at low concentrations in groundwater from the bedrock aquifer during previous investigations.

Calcium, magnesium, potassium, and sodium were the only metals detected in the groundwater sample from the bedrock aquifer. These metals were also detected at similar concentrations (i.e., at the same order of magnitude) in groundwater samples collected from the bedrock aquifer during the previous investigations.

8.5 CONTAMINANT FATE AND TRANSPORT

8.5.1 Contaminant Fate and Transport Processes

Five classes of chemicals were detected in groundwater at Site 20 in the BGOURI: ketones, halogenated aliphatics, phenols, PAHs, and metals. These classes, in general, correspond with those detected in the Phase II RI (B&R Environmental, 1997a), except for phenols (namely, 4-methylphenol), which were not detected in the Phase II RI, and phthalates, which were detected in the Phase II RI but not in the BGOURI.

No sites are upgradient of Site 20 and therefore any detections of COPCs at Site 20 are likely from historic, on-site activities. Site 20 is upgradient of the Area A Wetlands (Site 2) and the OBDA and Downstream Watercourses (Site 3). Historic groundwater data from downgradient monitoring well 2WMW6S and 2WMW6D do not show any potential for transport from the Area A Weapons Center.

Ketones

Several ketones have been detected in the groundwater at Site 20, all at concentrations below screening levels. The sources of the ketones have not been identified but it is likely that the sources are the solvents known to have been used at the Weapons Center. Ketones are highly volatile and soluble and do not readily adsorb to soil. Therefore, they are not considered to be persistent in the environment. Hydrolysis is generally not a significant fate process for this class of chemicals, nor is bioconcentration significant. Once in the groundwater, ketones may slowly degrade.

2-Butanone, 2-hexanone, and 4-methyl-2-pentanone were detected in one bedrock sample in the Phase II RI, and 4-methyl-2-pentanone was found in one overburden well sample in the BGOURI. Acetone and 2-butanone were detected in several soil samples collected in the Phase II RI, mainly in one subsurface soil sample collected from the 8 to 10-foot depth interval. This is in keeping with the nature of ketones, which would be expected to volatilize from surface soil or to migrate to subsurface soil as leachate in rainwater. Acetone and 2-butanone are also common laboratory and field contaminants often detected in environmental samples.

Halogenated Aliphatics

One halogenated aliphatic (TCE) was reported in one deep groundwater sample (S202WMW4D01) and in one shallow groundwater sample (S202WCMW2S01) at concentrations of 3.8 µg/L and 5.0 µg/L, respectively. TCE was also detected in one subsurface soil sample collected in the Phase II RI at a concentration of 3 µg/kg but was not detected in any surface soil samples. TCE was not detected in any shallow overburden wells in the Phase II RI but was detected in one bedrock sample at a low concentration (1.6 µg/L). Halogenated aliphatic hydrocarbons such as TCE are relatively water soluble and have a low capacity for retention by soil organic carbon. Therefore, TCE is frequently detected in groundwater. TCE may migrate through the soil column after being released by a spill event or by a subsurface release when solubilized by infiltrating precipitation. Some portion of TCE may be retained by the soil, but most of the chemical will continue migrating downward until it reaches the water table. At that time, migration is primarily lateral with the hydraulic gradient. The most recent groundwater data collected at the site do not indicate significant lateral transport because TCE was detected in the more upgradient wells but not in the downgradient wells and TCE was not detected in any downgradient Site 20 wells in the Phase II RI. Even through TCE was not detected in any Site 20 monitoring wells, it has been detected in monitoring wells in Sites 3 and 7 which are downgradient of Site 20. It remains possible that TCE releases from Site 20 have impacted downgradient groundwater. TCE can migrate to surface water and sediment, but attenuation and dilution factors, such as volatilization, generally result in its disappearance.

TCE is reportedly susceptible to degradation, primarily in anaerobic groundwater environments. It does not appear that appreciable degradation of halogenated aliphatics occurs in aerobic aquatic systems (USEPA, 1982) or in unsaturated soils (Lyman et al., 1990). There is little evidence that degradation is occurring in the groundwater at Site 20 since few degradation products have been detected. Low concentrations of two potential degradation products of TCE, 1,1,2-TCA and 1,2-DCA, were detected in the Phase II RI but none were found in groundwater samples collected in the BGOURI. The absence of degradation products may also be a reflection of the low concentrations of TCE present in the groundwater.

Phenols

One phenol (4-methylphenol) was detected in one shallow groundwater sample at the site at a concentration slightly above the quantitation limit. No phenols were detected in any soil or groundwater samples in the Phase II RI. Based on its water solubility and K_{oc} values, 4-methylphenol is expected to have moderate to high mobility in the environment. In water, 4-methylphenol may adsorb to suspended solids and sediment in the water column based upon the K_{oc} values. 4-Methylphenol is not expected to undergo hydrolysis. An estimated BCF of 16 suggests that the potential for bioconcentration of 4-methylphenol in aquatic organisms is low.

Polynuclear Aromatic Hydrocarbons (PAHs)

Both low-molecular-weight and high-molecular-weight PAHs were detected in one shallow groundwater sample (MW2S01) at Site 20. Only high-molecular-weight PAHs were detected in one overburden well (MW1S) in the Phase II RI. Eighteen PAHs were detected in soil samples in the Phase II RI. PAHs are generally considered to be fairly immobile in the environment. As noted in Section 3.3, PAHs have very low solubilities, vapor pressures, and Henry's Law constants and high K_{oc}s and K_{ow}s. The low-molecular-weight PAHs (e.g., acenaphthene, anthracene, fluorene, phenanthrene) are more mobile (higher solubilities, etc.) than the high-molecular-weight PAHs [e.g., benzo(a)pyrene, benzo(a)anthracene, chrysene, etc.]. PAHs in soil are much more likely to bind to soil and be transported via mass transport mechanisms than to go into solution. PAHs can be degraded via aerobic bacteria but may be relatively persistent in the absence of microbial population or macronutrients such as phosphorous and nitrogen.

PAHs have very low solubilities and generally do not enter into solution. However, the concentrations of the high-molecular-weight PAHs detected in groundwater exceed the published solubilities (See Table 3-5) for these compounds. These concentrations indicate that the PAHs detected in the one groundwater sample may be the result of adherence to the soil particles present in the groundwater sample (i.e., samples with high turbidity) rather than being present in the dissolved phase.

No PAHs were found in the deeper bedrock wells. The absence of these compounds at depth may be related to the fact that downward migration of PAHs from the surface is less likely because of their tendency to adhere to soil.

Metals

At Site 20, 18 metals were detected in shallow and deep groundwater samples. As noted in Section 3.3, metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. The major fate mechanisms for metals are adsorption to the soil matrix (as compared to being part of the soil structure) and bioaccumulation.

In addition, under normal conditions, metals are not very mobile in the environment. Because metals frequently remain bound to particulate matter, the major transport mechanism for metals is bulk movement processes (erosion). However, metals can become mobile in the environment under certain conditions. The mobility of metals is influenced primarily by their physical or chemical properties in conjunction with the physical and chemical properties of the soil matrix. Factors that assist in predicting the mobility of metals are the soil/pore water pH, REDOX potential, and cation exchange capacity. The mobility of metals generally increases with decreasing soil pH and cation exchange capacity. The effect of REDOX potential varies for each metal.

The list of metals detected in the BGOURI is similar to that of the Phase II RI. A notable exception is silver, which was detected in one filtered overburden groundwater sample in the RI at a concentration of 3.7 µg/L but was detected in two overburden wells in the BGOURI at concentrations of 114 and 326 µg/L. The published distribution coefficients (Kds) for silver range from 10 to 1,000 mL/g (Table 3-6), and it is likely that the silver detected at the site is bound to particulate matter. Silver was detected in three of 11 soil samples in the Phase II RI at concentrations less than SSLs for migration of groundwater.

8.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific HHRA for the identified exposure scenarios for Site 20. The risk assessment methodology was described in Section 3.4 and detailed calculations including RAGS Part D tables are presented in Appendix C. A summary of previous HHRAs for the site is also presented.

8.6.1 Data Evaluation

COPCs were identified for Site 20 using the risk-based screening levels, as discussed in Section 3.4.1. Table 8-3 summarizes the COPCs retained for Site 20. A discussion of direct contact exposure COPCs (i.e., those chemicals detected at concentrations in excess of USEPA and CTDEP direct contact

exposure criteria) and additional COPCs is provided below. Additional COPCs are identified on chemical migration tendencies: migration groundwater to surface water and migration of volatiles from groundwater through building foundations into indoor air. These additional COPCs are not quantitatively evaluated in the HHRA because they are not considered to be significant contributors to the direct contact exposure pathways identified for potential human receptors.

A comparison of the maximum detected concentrations in groundwater to direct contact risk-based screening criteria is presented in Table 8-4. The maximum detected concentrations of the following chemicals in groundwater exceeded the direct contact risk-based COPC screening levels and were retained as COPCs for groundwater:

- VOCs-TCE
- SVOCs-benzo(a)pyrene
- Metals-antimony, arsenic, nickel, silver, and thallium

The maximum detected concentration of manganese exceeded its USEPA Region IX PRG but was within background levels; consequently, manganese was not retained as a COPC.

A comparison of the maximum detected concentration in groundwater to migration criteria is presented in Table 8-5. The maximum detected concentrations of the following chemicals exceeded their respective screening criteria for protection of migration to surface water:

- Metals-arsenic, silver, and zinc

The maximum detected concentration of copper exceeded its CTDEP surface water protection RSR but was within background levels; consequently, copper was not retained as a COPC.

The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from groundwater to indoor air.

8.6.2 Exposure Assessment

Only groundwater samples were collected during the current investigation; consequently, only exposures to groundwater were evaluated in the HHRA for Site 20. Potential receptors included construction workers and future residents. Exposure assumptions for construction workers were presented in Table 3-14. Potential exposure pathways are summarized in Table 8-6.

Construction workers could come into contact with groundwater while excavating building foundations. In such an instance, construction workers could be exposed to the groundwater via dermal contact.

Potential exposure pathways for future adult residents exposed to groundwater included ingestion, dermal contact, and inhalation of volatile emissions. As previously discussed, future residential receptors are not potential receptors under current land use and are included only to provide an indication of potential risks if the facility were to close and be developed for residential use. As discussed in Section 3.4, the maximum detected concentration and average concentration were used for the exposure point concentrations for the RME and CTE, respectively. Exposure point concentrations for Site 20 are presented in Table 8-7.

8.6.3 Risk Characterization

Potential ICRs and HIs were calculated for construction workers and future adult residents exposed to groundwater using the methodology presented in Section 3.4. The results are summarized in Table 8-8 and Table 8-9 and are discussed below. Sample calculations and chemical-specific risks in RAGS Part D format are provided in Appendix C.

The results of the human health risks assessment indicated that cancer risks and hazard indices exceeded USEPA and CTDEP acceptable levels for future adult residents exposed to groundwater. Even though the calculations were not performed, cancer risks and hazard indices for future child residents would also be expected to exceed USEPA and CTDEP acceptable levels.

Carcinogenic Risks

ICRs for construction workers exposed to groundwater were 1.1×10^{-7} and 2.4×10^{-8} for the RME and CTE scenarios, respectively, which were less than USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures.

The ICR for future adult residents exposed to groundwater was 3.5×10^{-4} for the RME scenario, which exceeds USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. The ICR for future adult residents was 2.1×10^{-5} for the CTE scenario, which was within USEPA's target risk range but exceeded CTDEP's acceptable risk level for cumulative exposures. The chemical-specific ICR for arsenic under the RME scenario exceeded USEPA's and CTDEP's acceptable risk levels. The chemical-specific ICR for TCE and benzo(a)pyrene under the RME scenario also exceeded CTDEP's target level of 1×10^{-6} for individual chemicals. The chemical-specific ICR for arsenic and benzo(a)pyrene under the CTE scenario exceeded CTDEP's target level of 1×10^{-6} for

individual chemicals. It should be noted that the maximum detected concentrations of benzo(a)pyrene and arsenic were less than their respective CTDEP RSRs for residential exposures.

Noncarcinogenic Risks

HIs for construction workers exposed to groundwater were 0.0002 and 0.00008 for the RME and CTE scenarios, respectively, which were less than USEPA's and CTDEP's acceptable level of 1.0.

The HI for adult residents exposed to groundwater was 5.1 under the RME scenario, which exceeds USEPA's and CTDEP's acceptable level of 1.0 Arsenic (HQ = 1.4), silver (HQ = 1.8), and thallium (HQ = 1.5) were the major contributors to the HI under the RME scenario. It should be noted that the maximum detected concentrations of arsenic and thallium were less than their respective CTDEP RSRs for residential exposures. The HI for adult residents exposed to groundwater was 1.0 under the CTE scenario, which is equal to USEPA's and CTDEP's acceptable level of 1.0.

8.6.4 Summary of Previous Risk Assessments

Three potential receptor groups were considered during the Phase II RI risk assessment for Site 20 based on current and projected future land use. These included full-time employees, construction workers, and potential future residents. Both noncarcinogenic and carcinogenic risk estimates were generated for these receptor groups for both CTE and RME scenarios. Groundwater was not considered to be a potential medium for exposure for the full-time employee. Dermal contact with groundwater was evaluated as a potential route of exposure for the construction worker. Future residents were assumed to use groundwater as potable water; therefore, exposures to groundwater through direct ingestion, dermal contact while showering/bathing, and inhalation of volatiles while showering/bathing were evaluated for future potential residents.

The noncarcinogenic risk estimate associated with dermal contact with groundwater for the CTE construction worker was less than one. Noncarcinogenic risks for the RME construction worker and potential future residents (CTE and RME) exceeded the USEPA acceptable level of 1.0. The majority of the noncarcinogenic risks were associated with exposure to manganese in groundwater. Manganese is a commonly found naturally occurring metal. Arsenic and thallium were additional noncarcinogens of concern for the future resident exposed to groundwater under the RME scenario. Dermal contact with groundwater was the primary route of concern for the construction worker, and ingestion of groundwater was the primary route of concern for the future resident.

Incremental cancer risks were less than 1×10^{-6} for the construction worker under both exposure scenarios and for the future resident (for both dermal contact and inhalation routes of exposure) under the

CTE scenario. The incremental cancer risk associated with the ingestion of groundwater for the CTE future resident (6.4×10^{-5}) was within USEPA's target risk range of 1×10^{-6} to 1×10^{-4} but exceeded the CTDEP target cancer risk of 1×10^{-5}. However, for the RME future resident, the cumulative incremental cancer risk associated with exposure to groundwater (6.4×10^{-4}) exceeded 1×10^{-4}, the upper limit of USEPA's target risk range and the CTDEP target cancer risk. Estimated carcinogenic risks for future residents are primarily a result of exposure to dibenzo(a,h)anthracene and arsenic in groundwater. The exposure route that most contributes to the elevated carcinogenic risks for the future resident is incidental ingestion of groundwater.

8.6.5 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment, in general, was presented in Section 3.4.5. Site-specific uncertainties for Site 20 are discussed below.

Elimination of Chemicals as COCs on the Basis of Background

In accordance with U.S. Navy policy, chemicals were eliminated as COPCs on the basis of comparison to background. Manganese was the only chemical in groundwater with a maximum detected concentration that exceeded the direct contact screening criteria, but it was not retained as a COPC on the basis of background. Potential risks from dermal exposures to manganese in water are insignificant (USEPA, 2000e); consequently, the elimination of manganese as a COPC on the basis of background does not affect the risk estimates for the construction worker since this receptor was only evaluated for dermal exposures to groundwater. Future adult residents were evaluated for ingestion and dermal contact with groundwater; therefore, the estimated risks would be higher for the future adult resident if exposures to manganese were evaluated in the HHRA. If exposures to manganese in groundwater by a future adult resident were evaluated in the HHRA, then the resulting HQ for manganese would be 2.5 and the total HI would be 7.6, which exceeds the USEPA and CTDEP acceptable level of 1.0.

8.7 SUMMARY AND RECOMMENDATIONS

8.7.1 Nature and Extent of Contamination

One volatile organic, TCE, was identified as a COPC for groundwater, due to two low-level detections (i.e., maximum of 5.02 µg/L). One detection was from an overburden monitoring well and the other was from a bedrock well.

For semivolatile organics, the only COPC identified for Site 20 groundwater was benzo(a)pyrene. It was detected at a concentration of 0.05 µg/L in one overburden monitoring well.

Metals identified as COPCs for Site 20 groundwater include antimony, arsenic, nickel, silver, thallium, and zinc. One or more metals were detected above background in three of the four wells sampled. The COPCs were only identified in samples taken from the overburden monitoring wells. Silver and arsenic had two detections each above screening criteria; the remaining metals had single detections each above their respective screening criteria. The metals exceedances did not follow any discernible pattern in regards to areal distribution.

8.7.2 Contaminant Fate and Transport

One halogenated aliphatic (TCE) was identified as a COPC. Halogenated aliphatic hydrocarbons such as TCE are relatively water soluble and have a low capacity for retention by soil organic carbon. The most recent groundwater data collected at the site do not indicate significant lateral transport because TCE was detected in the more upgradient wells but not in the downgradient wells, and TCE was not detected in any downgradient wells in the Phase II RI.

The only semivolatile organic identified as a COPC for Site 20 groundwater is benzo(a)pyrene, a high-molecular-weight PAH. PAHs have very low solubilities and low environmental mobilities. In soil, PAHs are much more likely to bind to soil and be transported via mass transport mechanisms than go into solution. No PAHs were found in the bedrock well. The absence of these compounds at depth may be related to the fact that downward migration of PAHs from the surface is less likely because of their tendency to adhere to soil.

At Site 20, several metals were identified as COPCs for groundwater. Metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. Factors that assist in predicting the mobility of metals are the soil/pore water pH, REDOX potential, and cation exchange capacity. The mobility of metals generally increases with decreasing soil pH and cation exchange capacity. Based on the mobility of silver in comparison to the BGOURI-detected concentrations, it is likely that the silver detected at the site is bound to particulate matter.

8.7.3 Summary of Human Health Risk Assessment

The following is a summary of the results of the HHRA for Site 20:

- The HHRA for Site 20 considered exposures to construction workers and future adult residents. No soil samples were collected at Site 20; therefore, only exposures to groundwater were evaluated. Potential exposure pathways included dermal contact with groundwater.

- The maximum detected concentrations of TCE, benzo(a)pyrene, antimony, arsenic, nickel, silver, and thallium exceeded the direct contact risk-based COC screening levels and were retained for evaluation in the HHRA.

- Maximum detected concentrations of arsenic, silver, and zinc exceeded CTDEP's screening criteria for protection of migration of groundwater to surface water.

- The maximum detected concentrations of all chemicals in groundwater were less than the CTDEP criteria for migration from groundwater to indoor air.

- ICRs and HIs for construction workers exposed to groundwater at Site 20 were within USEPA and CTDEP acceptable levels.

- The ICR for future adult residents exposed to groundwater at Site 20 under the RME scenario exceeded USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for arsenic, benzo(a)pyrene, and TCE exceeded CTDEP's target level of 1×10^{-6} for individual chemicals. It should be noted that the maximum detected concentrations of benzo(a)pyrene and arsenic were less than their respective CTDEP RSRs for residential exposures.

- The ICR for future adult residents exposed to groundwater at Site 20 under the CTE scenario was within USEPA's target risk range of 10^{-4} to 10^{-6} but exceeded CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for arsenic and benzo(a)pyrene exceeded CTDEP's target level of 1×10^{-6} for individual chemicals.

- The HI for future adult residents exposed to groundwater at Site 20 exceeded USEPA's and CTDEP's acceptable level of 1.0 under the RME scenario. Arsenic, silver, and thallium were the major contributors to the HI. It should be noted that the maximum detected concentrations of arsenic and thallium were less than their respective CTDEP RSRs for residential exposures.

- The results of the human health risk assessment indicate that cancer risks and hazard indices exceed USEPA and CTDEP acceptable risk levels for future adult residents exposed to groundwater. Even though the calculations ere not performed, cancer risks and hazard indices for future child residents would also be expected to exceed USEPA and CTDEP acceptable levels.

- The maximum detected concentration manganese exceeded its direct contact screening criteria and the maximum detected concentration of copper exceeded its migration to surface water criteria, but

were within background levels, consequently manganese and copper were not retained as COCs for groundwater in the HHRA. HIs for adult residents exposed to manganese in groundwater would exceed the acceptable level of 1 if manganese were evaluated in the HHRA.

8.7.4 Recommendations

A small soil removal action is planned for the Area A Weapons Center to address soil contaminated with PAHs and metals. The removal action is scheduled to be completed in the spring of 2001. It will address all the known soil contamination that could be affecting the groundwater at the site.

The objectives of the BGOURI at Site 20 were to further characterize the nature and extent of groundwater contamination and to quantify the risks to human receptors from the groundwater. In general, organic and inorganic contaminants were detected infrequently and at low concentrations in the groundwater at Site 20. TCE and benzo(a)pyrene were the only organic contaminants identified as groundwater COPCs. Metals identified as COPCs were antimony, arsenic, nickel, silver, thallium, and zinc. High levels of TSS and TDS in one sample may be the reason for the elevated concentrations of two metals. All the organic and inorganic COPCs were identified in samples from overburden monitoring wells.

The HHRA determined that risks posed by exposure of construction workers to groundwater at Site 20 are below USEPA and CTDEP acceptable levels, assuming that the workers are exposed to the maximum observed concentrations of site contaminants. The HHRA also evaluated future residential groundwater usage, and calculated risks were above the CTDEP acceptable levels and were marginally above the USEPA acceptable risk range based on maximum concentrations. The groundwater, however, is classified by CTDEP as GB groundwater (i.e., not suitable for direct human consumption without treatment) and it is not expected that it will be used for human consumption in the foreseeable future.

Even though contaminant concentrations were generally low and risks are acceptable under the current land use scenario, it is recommended that an FS be prepared for the groundwater operable unit associated with Site 20. The FS should evaluate, at a minimum, land use controls and monitoring for the site. This recommendation is made for the following reasons:

- The source areas are not fully understood, but the current groundwater (i.e., concentrations and extent) data do not indicate that the sources are significant and therefore they warrant further investigation to completely characterize them.

- A limited groundwater monitoring program would verify the trend in groundwater contaminant concentrations and determine the impact of any changes in site/source area conditions in the future.

- A change in land use would potentially result in unacceptable risks to potential receptors.

TABLE 8-1

SUMMARY OF THE SAMPLING AND ANALYTICAL PROGRAM FOR SITE 20 BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION NSB-NLON, GROTON, CONNECTICUT

Sample ID	VOCs	SVOCs	Metals	Misc
S202WCMW1S01	X	X	X	X
S202WCMW2S01	X	X	X	X
S202WCMW3S01	X	X	X	X
S202WCMW3S01-F			X	
S202WMW4D01	X	X	X	X

Notes:
1 Miscellaneous parameters include perchlorate, TSS, and TDS.
2 The "F" suffix indicates that the sample was filtered.

TABLE 8-2

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR SITE 20
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location sample sample_dat	2WCMW1S S202WCMW1S01 7/25/00	2WCMW2S S202WCMW2S01 7/25/00	2WCMW3S S202WCMW3S01 7/26/00	2WCMW3S S202WCMW3S01-F 7/27/00	2WCMW4D S202WMW4D01 7/24/00	2WMW6D 2WGW6D-2 7/10/94	2WMW6S 2GW6S 3/16/94
Volatile Organics (ug/L)							
4-METHYL-2-PENTANONE	5 U	1.29 J	5 U		5 U	10 U	10 U
TRICHLOROETHENE	1 U	5.02 J	1 U		3.8 J	10 U	10 U
Semivolatile Organics (ug/L)							
4-METHYLPHENOL	5 U	5 U	9		5 U	10 U	10 U
BENZO(A)ANTHRACENE	0.05 U	0.04 J	0.05 U		0.05 U	10 U	10 U
BENZO(A)PYRENE	0.05 U	0.05	0.05 U		0.05 U	10 U	10 U
BENZO(B)FLUORANTHENE	0.1 U	0.08 J	0.1 U		0.1 U	10 U	10 U
BENZO(G,H,I)PERYLENE	0.1 U	0.07 J	0.1 U		0.1 U	10 U	10 U
BENZO(K)FLUORANTHENE	0.05 U	0.03 J	0.05 U		0.05 U	10 U	10 U
CHRYSENE	0.05 U	0.05 J	0.05 U		0.05 U	10 U	10 U
FLUORANTHENE	0.1 U	0.13	0.1 U		0.1 U	10 U	10 U
INDENO(1,2,3-CD)PYRENE	0.05 U	0.07	0.05 U		0.05 U	10 U	10 U
PHENANTHRENE	0.05 U	0.04 J	0.05 U		0.05 U	10 U	10 U
PYRENE	0.05 U	0.11	0.05 U		0.05 U	10 U	10 U
Total Metals (ug/L)							
ANTIMONY	2.6 U	2.6 U	3.5 J		2.6 U	15 U	2260
ARSENIC	15.1	2.3 U	4.1 J		2.3 U	6.5 J	2 UR
BARIUM	70.1 U	38.2 U	83.5		90 U	25	17.8
CALCIUM	138000	22500	160000		38100	40,100	27400
CHROMIUM	26.9	6.2 U	29.2		6.2 U	3 U	3 U
COBALT	12 U	6.8 U	18.8		5.3 U	3 U	20.7
COPPER	66.6	6.8 U	9.1 J		6.8 U	10.2	3 J
IRON	40200	25900	14900		188 U	23,400	394
LEAD	8.9	1.8 U	1.8 U		1.8 U	3.4 U	2 UJ
MAGNESIUM	41100	2640	138000		3230	9970	5880
MANGANESE	2170	1590	887		17.2 U	819	665
NICKEL	102	9.2 U	13.7 J		9.2 U	19.2	48
POTASSIUM	45200	6770	100000		1440	6960	6530
SILVER	326 J	114 J	5.2 U		6 U	2 U	2 UJ
SODIUM	374000	42100	1220000 J		9530	69300	21300
THALLIUM	3 U	3 U	3.8 J		3 U	5 U	1 UR
VANADIUM	10.4 U	6.3 U	10.2 J		6.3 U	3 U	6 U
ZINC	245	24.6 U	22.7 U		13.5 U	47.6	183

TABLE 8-2

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR SITE 20
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location sample sample_dat	2WCMW1S S202WCMW1S01 7/25/00	2WCMW2S S202WCMW2S01 7/25/00	2WCMW3S S202WCMW3S01 7/26/00	2WCMW3S S202WCMW3S01-F 7/27/00	2WCMW4D S202WMW4D01 7/24/00	2WMW6D 2WGW6D-2 7/10/94	2WMW6S 2GW6S 3/16/94
Dissolved Metals (ug/L)							
CALCIUM				348 J			
ZINC				53.4			
Miscellaneous Parameters (mg/L)							
AMMONIUM	2.3	1.5	13.6		0.2 U		
TOTAL DISSOLVED SOLIDS	1160	211	5142 J		135		
TOTAL SUSPENDED SOLIDS	5 U	8	2788 J		5 U		

Note:

1 Results from monitoring wells 2WMW6S and 2WMW6D were not sampled during the BGOURI. The values were not used for statistical analayses. They are included here to show impacts downgradient of the Area A Weapons Center.

TABLE 8-3

CHEMICALS RETAINED AS COPCS IN GROUNDWATER FOR SITE 20
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Direct Contact	Migration Pathways	
		Surface Water	Volatilization
Volatile Organic Compounds			
Trichloroethene	X		
Semivolatile Organic Compounds			
Benzo(a)pyrene	X		
Metals			
Antimony	X		
Arsenic	X	X	
Nickel	X		
Silver	X	X	
Thallium	X		
Zinc		X	

Notes:
X - Chemical is retained as a COPC.

TABLE 8-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 20
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Weapons Center (Site 20)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(8)
Volatile Organics																
108-10-1	4-METHYL-2-PENTANONE	1.29	J	1.29	J	ug/L	S202WCMW2S01	1/4	5	1.29	NA	16 N	7 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
79-01-6	TRICHLOROETHENE	3.8	J	5.02	J	ug/L	S202WCMW2S01	2/4	1	5.02	NA	1.6 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
Semivolatile Organics																
106-44-5	4-METHYLPHENOL	9		9		ug/L	S202WCMW3S01	1/4	5	9	NA	18 N	35 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
56-55-3	BENZO(A)ANTHRACENE	0.04	J	0.04	J	ug/L	S202WCMW2S01	1/4	0.05	0.04	NA	0.092 C	0.06 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
50-32-8	BENZO(A)PYRENE	0.05		0.05		ug/L	S202WCMW2S01	1/4	0.05	0.05	NA	0.0092 C	0.2 0.2 N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
205-99-2	BENZO(B)FLUORANTHENE	0.08	J	0.08	J	ug/L	S202WCMW2S01	1/4	0.1	0.08	NA	0.092 C	0.08 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.07	J	0.07	J	ug/L	S202WCMW2S01	1/4	0.1	0.07	NA	18 (7) N	210 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.03	J	0.03	J	ug/L	S202WCMW2S01	1/4	0.05	0.03	NA	0.92 C	0.5 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
218-01-9	CHRYSENE	0.05	J	0.05	J	ug/L	S202WCMW2S01	1/4	0.05	0.05	NA	9.2 C	4.8 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
206-44-0	FLUORANTHENE	0.13		0.13		ug/L	S202WCMW2S01	1/4	0.1	0.13	NA	150 N	280 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.07		0.07		ug/L	S202WCMW2S01	1/4	0.05	0.07	NA	0.092 C	0.5 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
85-01-8	PHENANTHRENE	0.04	J	0.04	J	ug/L	S202WCMW2S01	1/4	0.05	0.04	NA	18 (7) N	200 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
129-00-0	PYRENE	0.11		0.11		ug/L	S202WCMW2S01	1/4	0.05	0.11	NA	18 N	200 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Total Metals																
7440-36-0	ANTIMONY	3.5	J	3.5	J	ug/L	S202WCMW3S01	1/4	2.6	3.5	2.90	1.5 N	6 6 6	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-38-2	ARSENIC	4.1	J	15.1		ug/L	S202WCMW1S01	2/4	2.3	15.1	1.92	0.045 C	50 50(9) 50	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-39-3	BARIUM	83.5		83.5		ug/L	S202WCMW3S01	1/4	38.2 - 90	83.5	227	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-70-2	CALCIUM	22500		160000		ug/L	S202WCMW3S01	4/4	0	160000	188000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-47-3	CHROMIUM	26.9		29.2		ug/L	S202WCMW3S01	2/4	6.2	29.2	49.9	110 (8) N	50 100 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG

TABLE 8-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 20
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Weapons Center (Site 20)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(6)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(8)
7440-48-4	COBALT	18.8		18.8		ug/L	S202WCMW3S01	1/4	5.3 - 12	18.8	48.6	220 N	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-50-8	COPPER	9.1	J	66.6		ug/L	S202WCMW1S01	2/4	6.8	66.6	107	140 N	1300 1300 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON	14900		40200		ug/L	S202WCMW1S01	3/4	188	40200	28200	1100 N	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI
7439-92-1	LEAD	8.9		8.9		ug/L	S202WCMW1S01	1/4	1.8	8.9	6.63	N/A	15 15 N/A	CTDEP RSR FED-AL CTDEP-MCL	NO	BSL
7439-95-4	MAGNESIUM	2640		138000		ug/L	S202WCMW3S01	4/4	0	138000	191000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7439-96-5	MANGANESE	887		2170		ug/L	S202WCMW1S01	3/4	17.2	2170	11700	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-02-0	NICKEL	13.7	J	102		ug/L	S202WCMW1S01	2/4	9.2	102	32.2	73 N	100 100 100	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-09-7	POTASSIUM	1440		100000		ug/L	S202WCMW3S01	4/4	0	100000	70800	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-22-4	SILVER	114	J	326	J	ug/L	S202WCMW1S01	2/4	5.2 - 6	326	ND	18 N	36 100 50	CTDEP RSR FED-SMCL CTDEP-MCL	YES	ASL
7440-23-5	SODIUM	9530		1220000	J	ug/L	S202WCMW3S01	4/4	0	1220000	1900000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-28-0	THALLIUM	3.8	J	3.8	J	ug/L	S202WCMW3S01	1/4	3	3.8	ND	2.4 N	5 2 2	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-62-2	VANADIUM	10.2	J	10.2	J	ug/L	S202WCMW3S01	1/4	6.3 - 10.4	10.2	10.2	26 N	50 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-66-6	ZINC	245		245		ug/L	S202WCMW1S01	1/4	13.5 - 24.6	245	131	1100 N	5000 5000 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
Dissolved Metals																
7440-70-2	CALCIUM, FILTERED	348	J	348	J	ug/L	S202WCMW3S01-F	1/1	0	348	152000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-66-6	ZINC, FILTERED	53.4		53.4		ug/L	S202WCMW3S01-F	1/1	0	53.4	109	1100 N	5000 5000 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL, BKG

TABLE 8-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 20
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Weapons Center (Site 20)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Miscellaneous Parameters																
000-09-0	TOTAL DISSOLVED SOLIDS	135		5142	J	mg/L	S202WCMW3S01	4/4	0	5142	6260	N/A	N/A 500 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
000-08-9	TOTAL SUSPENDED SOLIDS	8		2788	J	mg/L	S202WCMW3S01	2/4	5	2788	236	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 The risk-based COPC screening level for tap water use is presented. The value is based on a target Hazard Quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
7 Pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.
8 Value is for hexavalent chromium.
9 The US EPA has approved a new MCL for arsenic of 10 ug/L. The MCL goes into effect in 2006. The reduction of the MCL does not impact the human health risk assessment.

Associated Samples:
S202WCMW1S01
S202WCMW2S01
S202WCMW3S01
S202WCMW3S01-F
S202WMW4D01

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
N/A = Not Applicable.
FED-MCL = Federal Maximum Contaminant Level (USEPA, August 2000).
FED-SMCL = Federal Secondary Maximum Contaminant Level (USEPA, August 2000).
FED-AL = Federal Action Level (USEPA, August 2000).
CTDEP-RSR = Connecticut DEP Remediation Standard Regulations, 1996.
CTDEP-MCL = Connecticut Maximum Contaminant Level.

Rationale Codes:
For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No Toxicity Information.
EPAI = USEPA Region one does not advocate evaluation of this chemical.

TABLE 8-5

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 20
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Weapons Center (Site 20)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	CTDEP Surface Water Criteria(5)	CTDEP Vol. Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organics															
108-10-1	4-METHYL-2-PENTANONE	1.29	J	1.29	J	ug/L	S202WCMW2S01	1/4	5	1.29	N/A	N/A	N/A	NO	NTX
79-01-6	TRICHLOROETHENE	3.8	J	5.02	J	ug/L	S202WCMW2S01	2/4	1	5.02	N/A	2340	219	NO	BSL
Semivolatile Organics															
106-44-5	4-METHYLPHENOL	9		9		ug/L	S202WCMW3S01	1/4	5	9	N/A	N/A	N/A	NO	NTX
56-55-3	BENZO(A)ANTHRACENE	0.04	J	0.04	J	ug/L	S202WCMW2S01	1/4	0.05	0.04	N/A	0.3	N/A	NO	BSL
50-32-8	BENZO(A)PYRENE	0.05		0.05		ug/L	S202WCMW2S01	1/4	0.05	0.05	N/A	0.3	N/A	NO	BSL
205-99-2	BENZO(B)FLUORANTHENE	0.08	J	0.08	J	ug/L	S202WCMW2S01	1/4	0.1	0.08	N/A	0.3	N/A	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.07	J	0.07	J	ug/L	S202WCMW2S01	1/4	0.1	0.07	N/A	N/A	N/A	NO	NTX
207-08-9	BENZO(K)FLUORANTHENE	0.03	J	0.03	J	ug/L	S202WCMW2S01	1/4	0.05	0.03	N/A	0.3	N/A	NO	BSL
218-01-9	CHRYSENE	0.05	J	0.05	J	ug/L	S202WCMW2S01	1/4	0.05	0.05	N/A	N/A	N/A	NO	NTX
206-44-0	FLUORANTHENE	0.13		0.13		ug/L	S202WCMW2S01	1/4	0.1	0.13	N/A	3700	N/A	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.07		0.07		ug/L	S202WCMW2S01	1/4	0.05	0.07	N/A	N/A	N/A	NO	NTX
85-01-8	PHENANTHRENE	0.04	J	0.04	J	ug/L	S202WCMW2S01	1/4	0.05	0.04	N/A	0.3	N/A	NO	BSL
129-00-0	PYRENE	0.11		0.11		ug/L	S202WCMW2S01	1/4	0.05	0.11	N/A	110000	N/A	NO	BSL
Total Metals															
7440-36-0	ANTIMONY	3.5	J	3.5	J	ug/L	S202WCMW3S01	1/4	2.6	3.5	2.90	86000	N/A	NO	BSL
7440-38-2	ARSENIC	4.1	J	15.1		ug/L	S202WCMW1S01	2/4	2.3	15.1	1.92	4	N/A	YES	ASL
7440-39-3	BARIUM	83.5		83.5		ug/L	S202WCMW3S01	1/4	38.2 - 90	83.5	227	N/A	N/A	NO	BKG
7440-70-2	CALCIUM	22500		160000		ug/L	S202WCMW3S01	4/4	N/A	160000	188000	N/A	N/A	NO	BKG
7440-47-3	CHROMIUM	26.9		29.2		ug/L	S202WCMW3S01	2/4	6.2	29.2	49.9	N/A	N/A	NO	BKG
7440-48-4	COBALT	18.8		18.8		ug/L	S202WCMW3S01	1/4	5.3 - 12	18.8	48.6	N/A	N/A	NO	BKG
7440-50-8	COPPER	9.1	J	66.6		ug/L	S202WCMW1S01	2/4	6.8	66.6	107	48	N/A	NO	BKG
7439-89-6	IRON	14900		40200		ug/L	S202WCMW1S01	3/4	188	40200	28200	N/A	N/A	NO	NTX
7439-92-1	LEAD	8.9		8.9		ug/L	S202WCMW1S01	1/4	1.8	8.9	6.63	13	N/A	NO	BSL
7439-95-4	MAGNESIUM	2640		138000		ug/L	S202WCMW3S01	4/4	N/A	138000	191000	N/A	N/A	NO	BKG
7439-96-5	MANGANESE	887		2170		ug/L	S202WCMW1S01	3/4	17.2	2170	11700	N/A	N/A	NO	BKG
7440-02-0	NICKEL	13.7	J	102		ug/L	S202WCMW1S01	2/4	9.2	102	32.2	880	N/A	NO	BSL
7440-09-7	POTASSIUM	1440		100000		ug/L	S202WCMW3S01	4/4	N/A	100000	70800	N/A	N/A	NO	NTX
7440-22-4	SILVER	114	J	326	J	ug/L	S202WCMW1S01	2/4	5.2 - 6	326	ND	12	N/A	YES	ASL
7440-23-5	SODIUM	9530		1220000	J	ug/L	S202WCMW3S01	4/4	N/A	1220000	1900000	N/A	N/A	NO	BKG
7440-28-0	THALLIUM	3.8	J	3.8	J	ug/L	S202WCMW3S01	1/4	3	3.8	ND	63	N/A	NO	BSL
7440-62-2	VANADIUM	10.2	J	10.2	J	ug/L	S202WCMW3S01	1/4	6.3 - 10.4	10.2	10.2	N/A	N/A	NO	NTX
7440-66-6	ZINC	245		245		ug/L	S202WCMW1S01	1/4	13.5 - 24.6	245	131	123	N/A	YES	ASL
Dissolved Metals															
7440-70-2	CALCIUM, FILTERED	348	J	348	J	ug/L	S202WCMW3S01-F	1/1	N/A	348	152000	N/A	N/A	NO	BKG
7440-66-6	ZINC, FILTERED	53.4		53.4		ug/L	S202WCMW3S01-F	1/1	N/A	53.4	109	123	N/A	NO	BSL, BKG
Miscellaneous Parameters															
000-09-0	TOTAL DISSOLVED SOLIDS	135		5142	J	mg/L	S202WCMW3S01	4/4	N/A	5142	6260	N/A	N/A	NO	BKG
000-08-9	TOTAL SUSPENDED SOLIDS	8		2788	J	mg/L	S202WCMW3S01	2/4	5	2788	236	N/A	N/A	NO	NTX

TABLE 8-5

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 20
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 Connecticut DEP Surface Water Protection criteria.
6 Connecticut DEP Volatilization criteria for residential exposures.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the CTDEP surface water protection or volatilization criteria.

Associated Samples:
S202WCMW1S01
S202WCMW2S01
S202WCMW3S01
S202WCMW3S01-F
S202WMW4D01

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No Toxicity Information.

TABLE 8-6

SELECTION OF EXPOSURE PATHWAYS FOR SITE 20
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Groundwater	Overburden/Bedrock Aquifer	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	None Quant	Construction workers may have dermal contact with groundwater during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers do not have contact with groundwater.
				Residents	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Groundwater may be used as a potable water source in the future.
					Child	Ingestion Dermal	On-Site On-Site	None None	Exposures to a child resident are less than for an adult resident.
		Air	Overburden/Bedrock Aquifer	Construction Workers	Adult	Inhalation	On-site	None	Construction workers exposure via volatilization is expected to be insignificant due to dilution with outdoor air.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers do not have contact with site groundwater.
				Residents	Adult	Inhalation	On-site	Quant	Adult residents may be exposed to volatile emissions from groundwater while showering.
					Child	Inhalation	On-site	None	Exposures to a child resident are less than those for an adult resident.

TABLE 8-7

EXPOSURE POINT CONCENTRATIONS FOR SITE 20
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Groundwater	
	RME[1]	CTE[1]
	(ug/L)	(ug/L)
Volatile Organic Compounds		
Trichloroethene	5.02	2.46
Semivolatile Organic Compounds		
Benzo(a)pyrene	0.05	0.031
Inorganics		
Antimony	3.5	1.85
Arsenic	15.1	5.38
Nickel	102	31.2
Silver	326	111
Thallium	3.8	2.08

Notes:

1 - The maximum detected concentration is used for the RME scenario and the average concentration is used for the CTE scenario.

TABLE 8-8

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 20
REASONABLE MAXIMUM EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	1.1E-07	- -	- -	- -	0.0002	- -
Adult Resident	Groundwater	Ingestion	2.7E-04	Arsenic	- -	Benzo(a)pyrene	5.1	Arsenic, Silver, Thallium
		Dermal Contact	7.4E-05	- -	Benzo(a)pyrene	- -	0.003	- -
		Inhalation (1)	3.5E-04	- -	- -	- -	0.02	- -
		Total	3.5E-04	Arsenic	Benzo(a)pyrene	Trichloroethene	5.1	Arsenic, Silver, Thallium

Notes:
1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

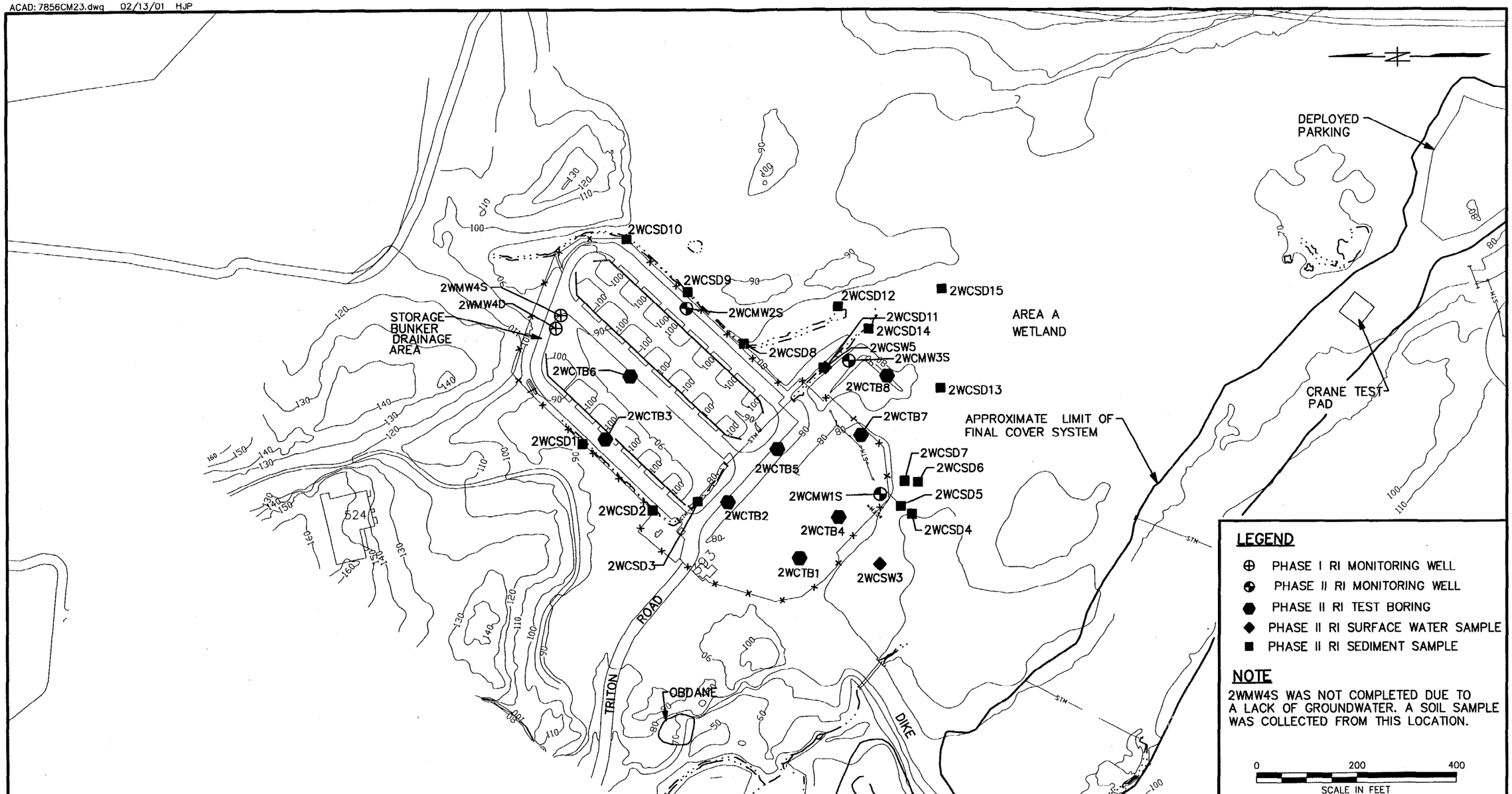
TABLE 8-9

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 20
CENTRAL TENDENCY EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	2.4E-08	- -	- -	- -	0.00008	- -
Adult Resident	Groundwater	Ingestion	1.4E-05	- -	Arsenic	- -	1.0	- -
		Dermal Contact	7.6E-06	- -	- -	Benzo(a)pyrene	0.002	- -
		Inhalation (1)	4.5E-08	- -	- -	- -	0.005	- -
		Total	2.1E-05	- -	Arsenic	Benzo(a)pyrene	1.0	- -

Notes:
1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

ACAD: 7856CM23.dwg 02/13/01 HJP



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 2/13/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

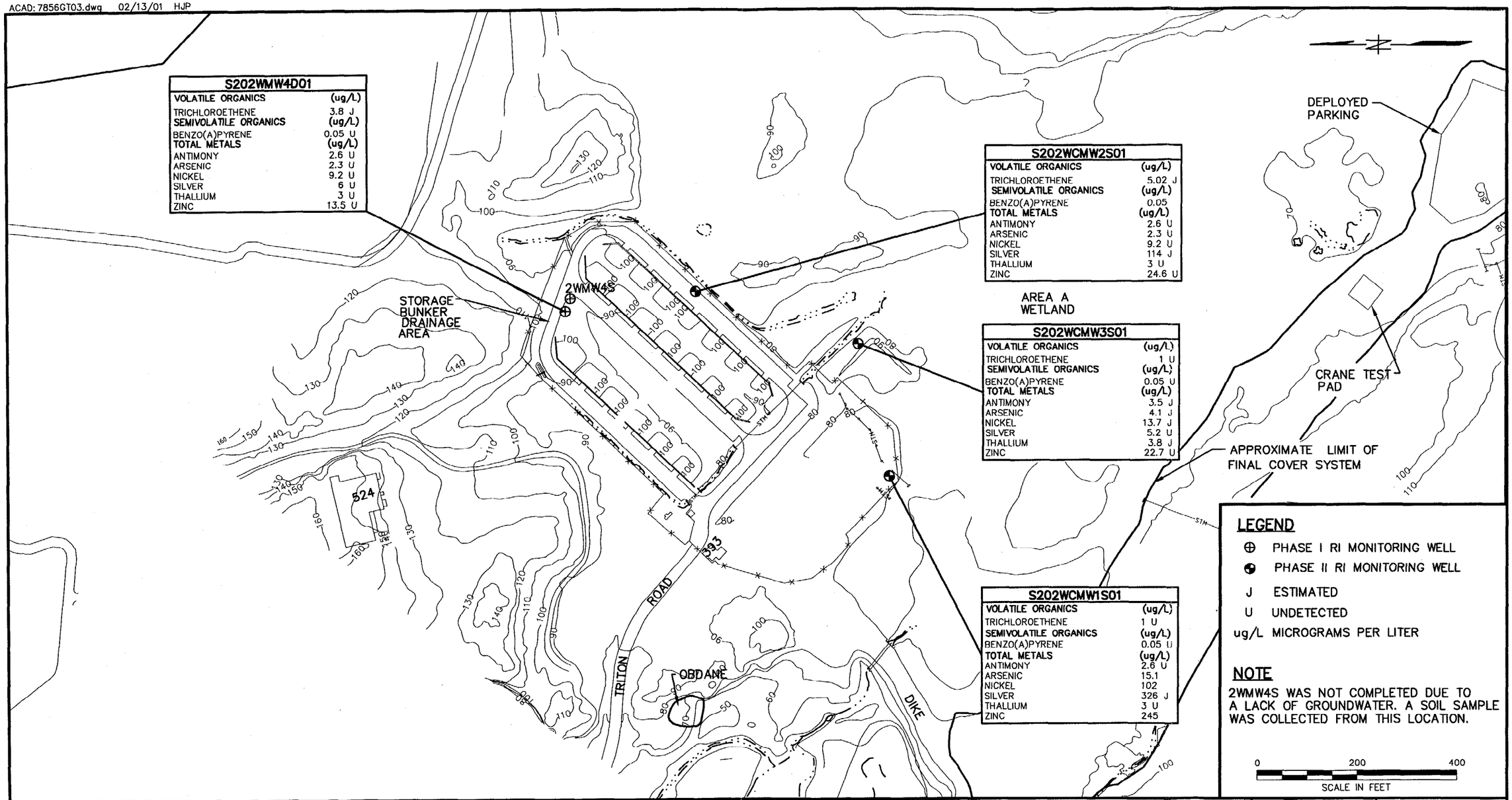
SAMPLE LOCATIONS
SITE 20-AREA A WEAPONS CENTER
NSB-NLON
GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY DPlacone DATE 2-15-01
APPROVED BY DATE
DRAWING NO. FIGURE 8-1
REV. 0

FORM CADD NO. T+NUS_BH.DGN - REV 0 - 1/20/98

10730B227

ACAD: 7856GT03.dwg 02/13/01 HJP



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/8/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

COPCs IN GROUNDWATER
SITE 20-AREA A WEAPONS CENTER
NSB-NLON, GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY D Pelcone DATE 2-15-01
APPROVED BY DATE
DRAWING NO. FIGURE 8-2
REV. 0

FORM CADD NO. T+NUS_BH.DGN - REV 0 - 1/20/98

9.0 SITE 16 – HOSPITAL INCINERATOR

9.1 SITE DESCRIPTION

Site 16 consists of the two locations where an incinerator was used at Naval Hospital Groton. In the 1980s, the Naval Hospital Groton operated a skid-mounted waste incinerator at two sites adjacent to the hospital. The two sites (i.e., 16A and 16B) are located west of Tautog Road, adjacent to Building 449 and Building 452. The sites are shown on Figure 9-1. The location of the site, relevant to other IR sites, is shown on Figure 1-2.

According to the FFA, the incinerator was used to destroy medical records and medical waste contaminated with pathological agents. Ash generated by the waste incinerator was transferred to dumpsters for disposal at the municipal landfill.

9.2 SITE INVESTIGATION

Site 16 was evaluated during the IAS that was conducted in March 1983 for NSB-NLON. No sampling activities were conducted as part of the study. The study's recommendation for this site was to not pursue further investigation of the site because, at the time of the IAS study, the site was still operational. As a result, no investigation of Site 16 was conducted during either the Phase I or Phase II RIs. The Navy has subsequently ceased operation of the incinerator at the hospital. The Navy included the site in this RI to determine the impact of the operation of the incinerator.

The field sampling and analytical program for the BGOURI at this site focused on soil. Both surface soil and subsurface soil samples were collected for analysis during test boring activities at the site. The locations of the test borings are shown on Figure 9-1. The soil samples collected during the RI and the analyses performed on the samples are summarized in Table 9-1. Seven surface soil samples (0 to 2 feet bgs) and one subsurface soil sample (2 to 10 feet bgs) were collected during the field effort. The methods used to collect the samples are described in Section 2.2. According to the final work plan, temporary groundwater monitoring wells were to be installed and sampled at this site; however, they were not installed or sampled because shallow bedrock was encountered at this site.

In addition to the sampling and analytical program, interviews were conducted during the RI to obtain historical information about the incinerator (i.e., operating parameters of the incinerator and a summary of the waste that was incinerated). Personnel at the Naval Groton Hospital (i.e., Director of Records and Regional Coordinator) and the NSB-NLON Public Works Department were contacted regarding this issue.

None of the personnel had or could locate any historical information about the incinerator or could provide any insight on the operation of the incinerator.

9.3 PHYSICAL CHARACTERISTICS

This section presents a summary of physical characteristics for the Hospital Incinerator site, based on information from the FFA, literature sources, and the preliminary field investigations and this RI. Topography and surface features, surface water, soils, geology, and hydrogeology are discussed in the following subsections.

9.3.1 Surrounding Topography and Surface Features

The skid-mounted incinerator was operated in two areas, one adjacent to Building 452 (16A) and the other adjacent to Building 452 (16B). Based on mapping provided in the FFA, it appears that these two areas are within or directly adjacent to parking lots.

The hospital complex is located on the top of the bedrock hill located in the central portion of NSB-NLON. Surface topography for this site is shown on Figure 1-3. Maximum elevations in this area exceed 200 feet above msl. The topography in this area indicates that surface water would flow toward the west and ultimately discharge into the Thames River.

9.3.2 Surface Water

Surface water runoff from the hospital parking lot is collected by a storm sewer system. The surface water is discharged to drainage swales outside the parking lot.

9.3.3 Soil Characteristics

The SCS Soils Map (SCS, 1983) classifies the soil around the hospital complex as Urban land. Bedrock exposures (Hollis-Charlton-Rock outcrop complex) are prevalent because the central bedrock high extends toward the south and west. The soils overlying the bedrock range from very stony fine sandy loam to gravelly loam.

9.3.4 Geology and Hydrogeology

Geology

The geology of the Hospital site is characterized by a very shallow (less than 10 feet thick), unsaturated weathered bedrock surface overlying a less weathered bedrock surface. The investigations conducted at

the site during this RI were conducted with direct-push technology (DPT) methods that were incapable of penetrating the more resistant bedrock. The unconsolidated material consisted of silty sand with some rock fragments. At most drilling locations, the DPT rig was unable to penetrate more than 3 feet due to bedrock refusal. This is consistent with information received from the NSB-NLON Public Works Department that indicated bedrock was excavated in order to build the hospital. The Precambrian Mamacoke Formation is the bedrock that underlies Site 16.

Hydrogeology

There have been no hydrogeologic investigations of Site 16; therefore, site-specific information is not available. The inferred bedrock groundwater potentiometric surface in the vicinity of the hospital is shown on Figure 1-6. The drawing shows that groundwater flows in a southwestward direction toward the Lower Subase and the Thames River.

9.4 NATURE AND EXTENT OF CONTAMINATION

This section presents an evaluation of the nature and extent of soil contamination at Site 16. The discussion includes only soil data collected during the BGOURI. Groundwater was not encountered during the investigation and was therefore not sampled or analyzed. Since the exposure scenarios for surface soil and subsurface soil are different, the discussion addresses each soil type separately. Soil sample locations are shown on Figure 9-1.

A summary of the BGOURI sampling and analytical program for Site 16 is presented in Table 9-1. A complete summary of the Site 16 analytical data set is provided in Appendix B. Table 9-2 presents a summary of positive soil analytical results for Site 16. Table 9-3 presents a summary of SPLP results.

As part of the HHRA, descriptive statistics (i.e., frequency of detections, minimum and maximum concentrations, range of detection limits, and the associated sample numbers) and the COPC screening criteria for each analyte detected at least once in soils at the Hospital Incinerator site were tabulated. Analytical results for surface soils are summarized and screened in Tables 9-6 through 9-8. Different exposure scenarios (i.e., direct exposure and migration) are considered in each table. Analytical results for subsurface soil samples are summarized and screened in Tables 9-9 through 9-11. Tag maps of the chemicals determined to be COPCs based on the screening assessment were created to show the horizontal extent of contamination. Figure 9-2 shows COPCs that exceeded direct exposure or migration screening criteria, and Figure 9-3 presents COPCs that exceeded CTDEP's SPLP criteria. The analytical detection limit for COPCs is presented on the tag maps if the COPC was not detected in a sample.

9.4.1 Surface Soil

For this discussion, surface soils are considered to be soil samples collected from 0 to 2 feet bgs. The nature and extent of each chemical fraction are discussed separately below.

Seven dioxin/furan congeners were detected in surface soil samples; five of which were at concentrations exceeding the CTDEP pollutant mobility criterion. None of the dioxin/furan congeners were detected at concentrations exceeding any direct exposure criteria. At least one dioxin/furan congener was detected in every Site 16 soil sample; therefore, the horizontal extent of dioxin/furan contamination was not fully defined.

1,2,3,4,6,7,8-HPCDD was detected in five of seven samples at concentrations ranging from 7 ng/kg to 120 ng/kg. The maximum concentration was detected in sample S16SB070001, which was taken from Site 16B. Surface soil sample S16SS01, taken at Site 16A near the outlet of the storm sewer outfall, had a concentration of 1,2,3,4,6,7,8-HPCDD of 31 ng/kg.

1,2,3,4,6,7,8-HPCDF was detected in five of seven surface soil samples at concentrations ranging from 0.41 to 5.4 ng/kg. The maximum concentration was detected in surface soil sample S16SS01 and it was the only concentration that exceeded the CTDEP pollutant mobility criterion of 4.7 ng/kg. In general, 1,2,3,4,6,7,8-HPCDF was detected more frequently and at higher concentrations at Site 16A than at Site 16B.

1,2,3,7,8-PECDF, 2,3,4,7,8-PECDF, and 2,3,7,8-TCDF were detected only once in sample S16SB050001. The concentrations of 2,3,4,7,8-PECDF (0.36 ng/kg) and 2,3,7,8-TCDF (1.8 ng/kg) exceeded their respective CTDEP pollutant mobility criterion (0.093 ng/kg and 0.47 ng/kg, respectively).

OCDD was detected in all surface soil samples at concentrations ranging from 110 to 29,000 ng/kg. The maximum concentration of this congener was detected in sample S16SB070001. Concentrations of OCDD in four of the seven soil samples were greater than the CTDEP pollutant mobility criterion for this compound (467 ng/kg).

OCDF was detected in three of seven soil samples at concentrations ranging from 2.9 to 12 J ng/kg. The maximum concentration of this congener was detected in surface soil sample S16SS01. None of the detected concentrations exceeded the CTDEP pollutant mobility criterion.

Three VOCs (2-butanone, acetone, and toluene) were detected at relatively low concentrations (i.e., below CTDEP pollutant mobility criterion) in Site 16 surface soil samples. 2-Butanone was detected in five of seven samples at concentrations ranging from 3 µg/kg J to 5 J µg/kg. Acetone was detected in two

of seven soil samples at a maximum concentration of 180 J µg/kg, and toluene was detected in four of seven soil samples at a maximum concentration of 4 J µg/kg.

A total of 15 SVOCs were detected in Site 16 surface soil samples. A majority of the maximum concentrations of PAHs were detected in soil sample S16SB05001. The only SVOC that was detected at a concentration that exceeded a direct contact exposure criteria was benzo(a)pyrene. None of the detected concentrations exceeded the CTDEP pollutant mobility criterion. Benzo(a)pyrene was detected in five of seven samples at concentrations ranging from 0.02 to 0.330 mg/kg. The highest concentrations of benzo(a)pyrene were detected in soil samples from Site 16A. None of the samples collected from Site 16B had concentrations in excess of the direct contact screening criteria. However, it should be noted that the two samples collected at Site 16B with nondetect concentrations had detection levels that were in excess of the screening criteria.

Five pesticides (i.e., 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, alpha chlordane, and gamma chlordane) and one PCB (i.e., aroclor 1248) were detected infrequently in Site 16 surface soil samples. The maximum concentrations of all the pesticides and the PCB were detected in sample S16SB07001. None of the pesticides were detected at concentrations in excess of any screening criteria. Aroclor 1248 was found at a concentration of 0.006 mg/kg in sample S16SB070001, which exceeds the CTDEP pollutant mobility criterion. This concentration is well below the TSCA residential cleanup criterion of 1 mg/kg; therefore, this detection does not suggest a problem.

Twenty inorganics were detected in the soil samples collected from Site 16. Arsenic, manganese, and thallium were detected at concentrations that exceeded direct contact screening criteria and background concentrations. Arsenic was detected in all seven samples at levels were above the risk-based screening level of 0.39 mg/kg. The concentrations of arsenic ranged from 1.7 to 8.5 mg/kg. Manganese was also detected in all seven surface soil samples at concentrations ranging from 100 to 400 mg/kg. Only sample S16SS01 (400 mg/kg) had a detection above the direct contact exposure criteria and site background. Thallium was detected in six of seven samples at concentrations ranging from 0.49 J (S16SB060001) to 1.2 J (S16SS01) mg/kg.

The maximum detected concentration of thallium (S16SS01) exceeded the USEPA SSL. The SPLP results for the Site 16 surface soil samples, presented in Table 9-8, indicate that chromium, copper, lead, and vanadium are a potential concern due to contaminant migration.

9.4.2 Subsurface Soil

For this discussion, subsurface soils are considered to be soil samples collected from 2 to 10 feet bgs. Only one subsurface soil sample (S16SB080405) was collected at Site 16. The chemical fractions detected in this sample are discussed below.

1,2,3,4,6,7,8-HPCDD was detected at a concentration of 24 ng/kg in sample S16SB080405. This concentration was similar to concentrations of this congener found in surface soil samples and it exceeded the CTDEP pollutant mobility criterion of 4.7 ng/kg.

OCDD was detected at a concentration of 6,400 ng/kg in the subsurface soil sample. This concentration was the second highest concentration detected in any soil sample from this site. The OCDD concentration exceeded the CTDEP mobility criterion 47 ng/kg.

Three VOCs (bromomethane, chloromethane, and toluene) were detected at relatively low concentrations (i.e., below direct exposure and CTDEP pollutant mobility criterion) in the single Site 16 subsurface soil samples. Toluene was also detected at low concentrations in four surface soil samples.

No SVOCs were detected in sample S16SB080405; however, this is probably because the detection limits for SVOCs were elevated for this sample. Several of the detection limits exceeded the screening criteria.

No pesticides or PCBs were detected in sample S16SB080405.

Fourteen inorganics were detected in the single subsurface soil sample. Antimony, beryllium, cobalt, nickel, sodium, and zinc were positively detected in surface soil samples but were not detected in the subsurface soil sample S16SB080405. Of the 14 inorganics detected, arsenic was the only compound that was detected at a concentration that exceeded any screening criteria. Arsenic was detected at a concentration of 4.4 mg/kg, which slightly exceeds background (3.6 mg/kg) and exceeds the direct contact screening criterion (0.39 mg/kg) by approximately one order of magnitude.

No detected concentrations of inorganics in subsurface soil sample S16SB080405 exceeded any USEPA SSLs. In addition, the SPLP results for the Site 16 subsurface soil sample, presented in Table 9-11, do not indicate that the inorganics pose a potential concern due to contaminant migration.

9.5 CONTAMINANT FATE AND TRANSPORT

9.5.1 Contaminant Fate and Transport Processes

Nine classes of chemicals were detected in seven surface soil samples and one subsurface soil sample at Site 16 during the BGOURI: ketones, monocyclic aromatics, halogenated aliphatics, PAHs, dioxins/furans, pesticides, PCBs, phthalate esters, and metals. No samples were collected at this site in previous investigations.

Cross contamination to Site 16 or from Site 16 is minimal. Other than the incinerator there have been no historical sources of contamination. The site is paved which reduces rainfall recharge. The data shows that the skid mounted incinerator has not impacted soils. Groundwater is not an issue since it occurs in very small quantities in a poorly developed bedrock fracture system.

Ketones

Two ketones (acetone and 2-butanone) were detected in surface soil at Site 16 at concentrations well below screening levels. No ketones were detected in the one subsurface soil sample collected at the site. Ketones are highly volatile and soluble and do not readily adsorb to soil. Therefore, they are not considered to be persistent in the environment. Hydrolysis is generally not a significant fate process for this class of chemicals, nor is bioconcentration significant. Once in the groundwater, ketones may slowly degrade. Acetone and 2-butanone are also common laboratory and field contaminants often detected in environmental samples.

Monocyclic Aromatic Compounds

One monocyclic aromatic compound, toluene, was detected in surface and subsurface soil at Site 16, with maximum concentrations well below screening levels. Monocyclic aromatic compounds are not considered to be persistent in the environment, particularly in comparison to chemicals such as PAHs and PCBs. Vapor-phase toluene will be degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 3 days. In soil, toluene is expected to have high to moderate mobility based upon K_{oc} values in the range of 37 to 178. Volatilization from moist soil surfaces is expected to be an important fate process based on published Henry's Law constants. Toluene may volatilize from dry soil surfaces based upon its vapor pressure. Biodegradation is expected to occur rapidly in soil surfaces, with half-lives in the range of several hours to 71 days. If released into water, toluene is not expected to adsorb to suspended solids and sediment based on published K_{oc} values. Biodegradation is expected to occur rapidly in water, with reported half-lives of 4 and 56 days in aerobic and anaerobic water, respectively. Volatilization from water surfaces is

expected to be an important fate process based upon this compound's Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 1 hour and 4 days, respectively. Measured BCF values in fish suggest bioconcentration in aquatic organisms is low to moderate. Hydrolysis is not expected to be an important environmental fate process for toluene due to a lack of hydrolyzable functional groups.

Halogenated Aliphatics

Two halogenated aliphatics (chloromethane and bromomethane) were detected in subsurface soil at the site. These chemicals have relatively high vapor pressures and, if released to air, will exist solely as a gas in the ambient atmosphere. The gas-phases of chloromethane and bromomethane are likely to be degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals. In soil, they are expected to have very high mobility based on their estimated K_{oc} values. Volatilization from moist soil surfaces is expected to be an important fate process based on their Henry's Law constants. Chloromethane and bromomethane may volatilize from dry soil surfaces based upon their vapor pressures. The topography of the site indicates that groundwater and surface water at the site ultimately discharges in the Thames River. If released into water, these chemicals are not expected to adsorb to suspended solids and sediment in water. Volatilization from water surfaces is expected to be an important fate process based upon these compounds' Henry's Law constants. Estimated volatilization half-lives for chloromethane in a model river and model lake are 46 minutes and 3 days, respectively. Estimated BCFs of 3.2 and 4.2 for chloromethane and bromomethane suggest that the potential for bioconcentration in aquatic organisms is low.

Polynuclear Aromatic Hydrocarbons (PAHs)

Both low-molecular-weight and high-molecular-weight PAHs were detected in surface soil samples at Site 16. No PAHs were detected in subsurface soil. The highest concentrations of PAHs were reported in Sample S16SB050001, which is located near Building 452. PAHs are generally considered to be fairly immobile in the environment. As noted in Section 3.3, PAHs have very low solubilities, vapor pressures, and Henry's Law constants and high K_{oc}s and K_{ow}s. The low-molecular-weight PAHs (e.g., acenaphthene, anthracene, fluorene, phenanthrene) are more mobile (higher solubilities, etc.) than the high-molecular-weight PAHs [e.g., benzo(a)pyrene, benzo(a)anthracene, chrysene, etc.]. PAHs in soil are much more likely to bind to soil and be transported via mass transport mechanisms than go into solution. PAHs can be degraded via aerobic bacteria but may be relatively persistent in the absence of microbial population or macronutrients such as phosphorous and nitrogen.

Dioxins/Furans

Dioxins and furans were detected in surface and subsurface soil at Site 16. Seven congeners were detected in surface soil and two in subsurface soil. Dioxins are currently released to the environment primarily through emissions from the incineration of municipal and chemical wastes, in exhaust from automobiles using leaded gasoline, and from the improper disposal of certain chlorinated chemical wastes. Their presence at Site 16 would not be unexpected since medical waste was incinerated at the site. The fact that most dioxin/furan congeners (and higher concentrations) were detected in surface soil versus subsurface soil indicates that air deposition was likely the primary release mechanism. Information is not available on the fate of all dioxin/furan congeners in the environment. However, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is expected to be fairly immobile in soil. Leaching through the soil column is possible in soils of very low organic carbon content as a result of solvation or biotic mixing by earthworms. Photodegradation on terrestrial surfaces may be an important transformation process. Volatilization from soil surfaces during warm conditions may be a major removal mechanism. The persistence half-life of TCDD on soil surfaces may vary from less than 1 year to 3 years, but half-lives in soil interiors may be as long as 12 years. Screening studies have shown that TCDD is generally resistant to biodegradation. If released to water, TCDD will predominantly be associated with sediments and suspended material. TCDD near the water's surface may experience some photodegradation. Partitioning from the water column to sediment and suspended material will occur. Volatilization from the water column may be important, but adsorption to sediment will limit the overall rate by which TCDD is removed from water. The persistence half-life of TCDD in surface water (i.e., lakes) has been estimated to be in excess of 1.5 years. Bioconcentration in aquatic organisms is expected based on K_{ow} and BCF values. If released to the atmosphere, vapor-phase TCDD may be degraded by reaction with hydroxyl radicals and direct photolysis. Particulate-phase TCDD may be physically removed from air by wet and dry deposition.

Polychlorinated Biphenyls (PCBs)

One PCB, Aroclor 1248, was detected in one surface soil sample (S16SB070001) at Site 16. No PCBs were detected in subsurface soil. PCBs are considered to be very persistent organic chemicals. In soil, Aroclor 1248 will become tightly adsorbed to the soil particles. In the presence of organic solvents, which may be possible at waste sites, Aroclor 1248 will have a greater tendency to leach through soil. Screening studies indicate that Aroclor 1248 is susceptible to biodegradation in soils. Biodegradation is the only process known to transform PCBs under environmental conditions, and only the lighter compounds are measurably biodegraded. Although the volatilization rate of Aroclor 1248 may be low from soil surfaces due to tight adsorption and low vapor pressure, the total loss by volatilization over time may be significant because of the persistence and stability of Aroclor 1248. Volatilization from water surfaces is expected to be an important fate process based upon Aroclor 1248's estimated Henry's Law

constant values ranging from $1.6x10^{-4}$ to $7.4x10^{-5}$ atm-m^3/mole. Estimated volatilization half-lives for a model river and model lake will range from 7.5 to 16 hours and 9 to 14 days, respectively. However, volatilization from water surfaces is expected to attenuate by adsorption to suspended solids and sediment in the water column. Aroclor 1248 is expected to undergo anaerobic biodegradation in sediments. Aroclor 1248 is known to bioconcentrate significantly in aquatic organisms, with measured BCFs ranging from 60,000 to 120,000.

Pesticides

Two types of pesticides were detected in surface soil at Site 16, DDT and its metabolites (DDD and DDE) and chlordanes (alpha-chlordane and gamma-chlordane). These pesticides were detected mainly in Sample S16SB070001, which is located directly south of Building 449. No pesticides were detected in subsurface soil. Whether pesticides are sprayed, dusted, or applied directly to the soil, the soil is the ultimate sink for these chemicals. Surface soil runoff may carry pesticides to adjacent surface water bodies (i.e., the Thames River). Bioconcentration of pesticides in the food chain is another important fate mechanism. Hydrolysis, oxidation, and photolysis are not generally important fate mechanisms for pesticides in soil or water. Hydrolysis half-lives for several pesticides are reported in periods of months to years. Some properties of the pesticides found at Site 16 are discussed below.

DDT and its metabolites (DDD and DDE) are considered to be persistent chemicals. They undergo extensive adsorption to soil and are not highly soluble. Biodegradation may occur under both aerobic and anaerobic conditions in the presence of certain soil microorganisms. Under aerobic conditions, DDT may be transformed to DDE and, under anaerobic conditions, DDD may result. DDD, DDE, and DDT are, however, somewhat volatile, with a reported half-life of 100 days for DDT. They are highly lipophilic and therefore readily bioaccumulate.

Chlordane has been released into the environment primarily from its application as an insecticide. Currently, there are no approved uses for chlordane in the United States. If released to soil, chlordane may persist for long periods of time; under field conditions, the mean degradation rate has been observed with a mean half-life of 3.3 years. Chlordane is expected to be generally immobile or only slightly mobile in soil based on field tests. However, it has been detected in various groundwaters in the United States, indicating that movement to groundwater can occur. Soil volatility tests have found that chlordane can volatilize significantly from soil surfaces on which it has been sprayed, particularly moist soil surfaces; however, shallow incorporation into soil will greatly restrict volatile losses. If released to water, chlordane is not expected to undergo significant hydrolysis, oxidation, or direct photolysis. Studies suggest that chlordane may be very persistent in the adsorbed state in the aquatic environment. Adsorption to sediment is expected to be a major fate process based on soil adsorption data, estimated K_{oc} values (15,500 to 24,600), and extensive sediment monitoring data. Bioconcentration is expected to be

important based on experimental BCF values that are generally above 3,200. The volatilization half-life from a river was estimated to be 7.3 to 7.9 hours in one study, and the volatilization half-lives from a representative environmental pond, river, and lake were estimated to be 18 to 26, 3.6 to 5.2 and 14.4 to 20.6 days, respectively. However, adsorption to sediment significantly attenuates the importance of volatilization. If released to the atmosphere, chlordane exists in the vapor phase.

Phthalate Esters

One phthalate, butyl benzyl phthalate, was detected in one surface soil sample at Site 16. Phthalate esters are considered to be relatively persistent chemicals in the environment. Although numerous studies have demonstrated that phthalate esters undergo biodegradation, it appears that this is a slow process in both soils and surface waters. Certain microorganisms have been shown to excrete products that increase the solubility of phthalate esters and enhance their biodegradation. Biodegradation of phthalates in water is an important fate mechanism, with a half-life of 2 to 3 weeks reported for bis(2-ethylhexyl) phthalate. Bioaccumulation is also a significant fate process. Hydrolysis of phthalate esters is very slow, with calculated half-lives of 3 years (dimethyl phthalate) to 2,000 years [bis(2-ethylhexyl) phthalate] (USEPA, 1979). Phthalates are also common laboratory and field blank contaminants, and their presence may be the result of equipment or laboratory contamination.

Metals

Twenty metals were detected in surface and subsurface soil at Site 16. The concentrations of most of the detected metals were within naturally occurring background levels. As noted in Section 3.3, metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. The major fate mechanisms for metals are adsorption to the soil matrix (as compared to being part of the soil structure) and bioaccumulation.

Under normal conditions, metals are not very mobile in the environment. Because metals frequently remain bound to particulate matter, the major transport mechanism for metals is bulk movement processes (erosion). However, metals can become mobile in the environment under certain conditions. The mobility of metals is influenced primarily by their physical or chemical properties in conjunction with the physical and chemical properties of the soil matrix. Factors that assist in predicting the mobility of metals are the soil/pore water pH, REDOX potential, and cation exchange capacity. The mobility of metals generally increases with decreasing soil pH and cation exchange capacity. The effect of REDOX potential varies for each metal.

9.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific risk assessment for the identified exposure scenarios for Site 16. The risk assessment methodology was described in Section 3.4 and detail calculations including RAGS Part D tables are presented in Appendix C.

9.6.1 Data Evaluation

COPCs were identified for Site 16 using the risk-based screening levels, as discussed in Section 3.4.1. Tables 9-4 and 9-5 summarize the COPCs retained for Site 16. A medium-specific discussion of COPCs is presented in the following subsections. Within a given medium, discussions of direct contact exposure COPCs (i.e., those chemicals detected at concentrations in excess of USEPA and CTDEP direct contact exposure criteria) and additional COPCs are provided. Additional COPCs are identified on chemical migration tendencies: migration from soil to groundwater and migration of volatiles from soil through building foundations into indoor air. These additional COPCs are not quantitatively evaluated in the HHRA because they are not considered to be significant contributors to the direct contact exposure pathways identified for potential human receptors.

Surface Soil (0 to 2 feet)

A comparison of the maximum detected concentrations in surface soil to risk-based screening criteria is presented in Table 9-6. The maximum detected concentrations of the following chemicals in surface soil exceeded the direct contact risk-based COC screening levels and were retained as COPCs for surface soil:

- SVOCs-benzo(a)pyrene
- Inorganics-arsenic, manganese, and thallium

The maximum detected concentrations of benzo(a)pyrene, arsenic, and thallium exceeded their respective USEPA PRGs but were below their respective CTDEP RSRs for residential exposures.

The maximum detected concentrations of all chemicals were less than the USEPA SSLs for soil to air; therefore, exposures through inhalation of fugitive dust and volatiles were not retained for evaluation in the risk assessment for surface soils at Site 16.

A comparison of the maximum detected concentration in surface soil to migration criteria is presented in Table 9-7. The maximum detected concentrations of the following chemicals exceeded their respective screening criteria, indicating a potential for these chemicals to migrate to groundwater:

- Dioxins-1,2,3,4,6,7,8-HPCDD, 1,2,3,4,6,7,8-HPCDF, 2,3,4,7,8-PECDF, 2,3,7,8-TCDF, and OCDD
- Pesticides/PCBs-Aroclor 1248
- Inorganics-thallium

Maximum detected concentrations of 1,2,3,4,6,7,8-HPCDD, 1,2,3,4,6,7,8-HPCDF, 2,3,4,7,8-PECDF, 2,3,7,8-TCDF, and OCDD exceeded their respective CTDEP pollutant mobility criterion but were less than their respective USEPA SSLs for migration from soil to groundwater. The maximum detected concentration of Aroclor 1248 exceeded its CTDEP mobility pollutant criterion and the maximum detected concentration of thallium exceeded its USEPA SSL, although SPLP results for Aroclor 1248 and thallium were all non-detect. The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from soil to indoor air.

Under Connecticut RSR (CTDEP, 1996), concerns regarding the mobility of inorganics in soil are addressed using SPLP data. A comparison of site-specific SPLP data and RSRs is presented in Table 9-8. The maximum detected concentrations for chromium, copper, lead, and vanadium exceeded their respective CTDEP mobility criterion and were retained as COPCs for the soil to groundwater migration pathway.

Subsurface Soil (2 to 10 feet)

A comparison of the maximum detected concentrations in subsurface soil to risk-based screening criteria is presented in Table 9-9. The maximum detected concentrations of the following chemicals in subsurface soil exceeded the direct contact risk-based COC screening levels and were retained as COPCs for subsurface soil:

- Inorganics-arsenic

The maximum detected concentrations of all chemicals were less than the USEPA SSLs for soil to air; therefore, exposures through inhalation of fugitive dust and volatiles were not retained for evaluation in the risk assessment for subsurface soil at Site 16.

A comparison of the maximum detected concentrations in subsurface soil to migration criteria is presented in Table 9-10. The maximum detected concentrations of 1,2,3,4,6,7,8-HPCDD and OCDD exceeded their respective CTDEP mobility criteria; therefore, these chemicals were retained as COPCs for the soil to groundwater migration pathway. The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from soil to indoor air.

Under Connecticut RSR (CTDEP, 1996), concerns regarding the mobility of inorganics in soil are addressed using SPLP data. A comparison of site-specific SPLP data and RSRs is presented in Table 9-11. The maximum detected concentrations of all inorganics were less than their respective CTDEP mobility criteria.

Groundwater

As discussed in Section 9.4, no groundwater samples were collected at Site 16.

9.6.2 Exposure Assessment

Only soil samples were collected during the current investigation; consequently, only exposures to soil were evaluated in the risk assessment for Site 16. Potential receptors for Site 16 included construction workers, full-time employees, older child trespassers, and future residents. Exposure assumptions for these receptors were presented in Table 3-14. Potential exposure pathways are summarized in Table 9-12.

Construction workers were assumed to be exposed to surface and subsurface soil. Potential exposure pathways included incidental ingestion and dermal contact with soil.

Full-time employees may be exposed to site media while performing site inspections or daily duties. This receptor was only evaluated for exposures to surface soil. Potential exposure pathways included incidental ingestion and dermal contact with soil.

Older child trespassers may be exposed to soil while trespassing on or near the site while exploring, playing, or performing other activities. This receptor was only evaluated for exposures to surface soil. Potential exposure pathways included incidental ingestion and dermal contact with soil.

Future child and adult residents were assumed to be exposed to surface soil and subsurface soil. Potential exposure pathways for soil included incidental ingestion and dermal contact with soil. As previously discussed, future residential receptors are not potential receptors under current land use and are included only to provide an indication of potential risks if the facility were to close and then be developed for residential use.

As discussed in Section 3.4, since fewer than 10 soil samples were collected, the maximum detected concentration and average concentration were used for the exposure point concentrations for the RME and CTE, respectively. Exposure point concentrations for Site 16 are presented in Table 9-13.

9.6.3 Risk Characterization

Potential ICRs and HIs were calculated for construction workers, full-time employees, older child trespassers, and future residents exposed to soil, using the methodology presented in Section 3.4. The results are summarized in Tables 9-14 and 9-15 and are discussed below. Sample calculations and chemical-specific risks in RAGS Part D format are provided in Appendix C.

Carcinogenic Risks

ICRs for Site 16 ranged from 5.7×10^{-8} for older child trespassers (CTE) to 7.8×10^{-6} for child residents (RME). All ICRs for exposures to soil at Site 16 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and less than CTDEP's acceptable level of 1×10^{-5} for cumulative exposures. Although all ICRs were less than CDTEP's target level for cumulative exposures, chemical-specific ICRs for arsenic (full-time workers, older child trespassers, child residents, and adult residents) and benzo(a)pyrene (child residents) exceeded CTDEP's target level of 1×10^{-6} for individual chemicals. It should be noted that the maximum detected concentrations of benzo(a)pyrene and arsenic were less than their respective CTDEP RSRs for residential exposures.

Noncarcinogenic Risks

All HIs for exposure to soil at Site 16 were less than USEPA's and CTDEPs acceptable level of 1.0. HIs for Site 16 ranged from 0.007 for full-time employees (CTE) and adult residents (CTE) to 0.3 for child residents (RME).

9.6.4 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment, in general, was presented in Section 3.4.5. Site-specific uncertainties for Site 16 are discussed below.

Migration of Dioxins from Soil to Groundwater

Maximum detected concentrations of several dioxin congeners exceeded the CTDEP pollutant mobility criterion but were less than USEPA SSLs for migration from soil to groundwater. The CTDEP pollutant mobility criterion are derived by multiplying the groundwater protection criterion by 20, which is based on the fact that the TCLP test requires a soil-to-extract ratio of 20. USEPA SSLs are derived using a simple conservative groundwater model and the chemicals' physical constants. Although both sets of criteria are conservative, the USEPA SSLs give a more realistic indication of a chemical's potential to migrate from soil to groundwater since the USEPA SSLs are based on chemical-specific parameters. In addition, as discussed in Section 3.3, dioxins are considered to be very persistent and relatively immobile in soil and are

essentially insoluble in water. Consequently, the migration of dioxins from soil to groundwater at Site 16 is not expected to be a significant migration pathway.

Exposure Point Concentrations

The maximum detected concentration was used as the exposure point concentration for the RME scenario since fewer than 10 soil samples were collected at Site 16. As a result of using the maximum detected concentration, the estimates of risk are most likely to be overstated since it is unlikely that potential receptors would be exposed to the maximum concentration over the entire exposure period.

Lack of Dermal Absorption Values for Some Chemicals

No dermal absorption value was available for thallium; consequently, dermal exposures to thallium in soil could not be evaluated. The lack of a dermal absorption value for thallium does not significantly impact the estimated risks. The highest HI for exposures to thallium in soil occurred for a child resident (HI = 0.1) under the RME scenario. The HI would still be less than the acceptable level of 1.0, even with 100 percent dermal absorption of thallium (HI = 0.3). Therefore, there is no significant uncertainty due to the lack of a dermal absorption for thallium.

Lack of Groundwater Data

According to the final work plan, temporary groundwater monitoring wells were to be installed and sampled at the site; however, they were not installed or sampled because shallow bedrock was encountered. The contaminants detected in soil samples collected from the site are typically not mobile and are not expected to migrate vertically to groundwater beneath the site. The potential source of contamination is a former skid mounted incinerator which would not introduce contamination in the subsurface such as an UST might. Based on the Navy's experience with drilling a bedrock well (i.e., 2LMW35B) at a location upgradient of the site, the depth of drilling may exceed 100 feet until a substantial fracture is encountered that would yield sufficient groundwater. Consequently, it is unlikely that contamination in surface soil at the site has impacted groundwater beneath the site. Also, there are no current potential exposure pathways from groundwater. The only potential future exposure pathway would be if groundwater at the site was developed as a potable well supply which is not likely based on the expect future site use. Therefore, the absence of groundwater data for Site 16 does not introduce any major uncertainty in the HHRA for the site.

Elevated Detection Limits Associated With Sample S16SB050001

The reported detection limits for anthracene and dibenzo(a,h)anthracene in sample S16SB05001 were elevated. The reported detection limit of 850 µg/kg for anthracene is below its USEPA Region IX

residential PRG of 22,000,000 µg/kg and CTDEP residential RSR of 1,000,000 µg/kg, consequently the elevated detection limit for anthracene does not impact the HHRA. The reported detection limit of 850 µg/kg for dibenzo(a,h)anthracene exceeds it USEPA Region IX residential PRG of 62 µg/kg but is below its CTDEP residential RSR of 1,000 µg/kg. Other PAHs were detected in this sample so it is likely that dibenzo(a,h)anthracene is also present in this sample at a concentration below the detection limit. ICRs at Site 16 were highest for a child resident (7.8×10^{-6}). Conservatively assuming that dibenzo(a,h)anthracene is present in soil at a concentration equal to the detection limit of 850 µg/kg results in an ICR of 1.2×10^{-5}, which is within USEPA's target risk range, but slightly exceeds CTDEP's acceptable risk level of 1×10^{-5} for cumulative exposures. Based on the concentrations of the other carcinogenic PAHs detected in soil samples at Site 16 it is unlikely that dibenzo(a,h)anthracene is present at a concentration of 850 µg/kg in sample S16SB050001. Therefore, although the ICRs for receptors exposed to PAHs in soil at Site 16 are likely higher than those estimated in the HHRA, they would still be with USEPA and CTDEP acceptable levels if dibenzo(a,h)anthracene was evaluated in the HHRA. Consequently, the elevated detection limits for dibenzo(a,h)anthracene do not impact the conclusions of the HHRA.

9.7 SUMMARY AND RECOMMENDATIONS

9.7.1 Nature and Extent of Contamination

Seven surface soil samples and one subsurface soil sample were collected at Site 16. At least one congener of dioxin or furan was detected in all the soil samples. The pervasive detections of these compounds are probably related to the past operation of the incinerator at Site 16. Although dioxins/furans were detected throughout Site 16, the concentrations are considered low when compared to direct exposure and EPA SSL criteria.

Three VOCs were detected in surface soil samples and three were detected in subsurface soil samples. Toluene was the only VOC detected in both surface and subsurface soil samples. The detected concentrations of toluene and the other VOCs were all below the relevant screening criteria.

SVOCs were only detected in Site 16 surface soil samples and may be related to the asphalt pavement, which covers a majority of the site. A total of 15 SVOCs were detected in Site 16 surface soil samples. The only SVOC that was detected at a concentration that exceeded a direct contact exposure criterion was benzo(a)pyrene.

Pesticides and PCBs were only detected in Site 16 surface soil samples. The maximum concentrations of all the pesticides (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, alpha chlordane, and gamma chlordane) and the PCB (Aroclor 1248) were detected in sample S16SB07001. None of the pesticides were detected at

concentrations in excess of any screening criteria. Aroclor 1248 was found at a concentration of 0.006 mg/kg in sample S16SB070001, which exceeds the CTDEP pollutant mobility criterion. This concentration is well below the TSCA residential cleanup criterion of 1 mg/kg; therefore, this detection does not suggest a problem.

Twenty inorganics were detected in the soil samples collected from Site 16. Arsenic, manganese, and thallium were detected at concentrations that exceeded direct contact screening criteria and background concentrations. Arsenic was detected in all the soil samples (surface and subsurface). All seven samples were above the risk-based screening level of 0.39 mg/kg but were very close to the background value of 3.6 mg/kg. Manganese was also detected in all soil samples, but only the concentration detected in a single surface soil sample exceeded screening criteria. Thallium was detected in six of seven samples. The maximum detected concentration of thallium (S16SS01) exceeded the USEPA SSL.

The SPLP results for the Site 16 surface soil samples indicate that chromium, copper, lead, and vanadium are a potential concern due to contaminant migration. The SPLP results for the Site 16 subsurface soil sample do not indicate that inorganics pose a potential concern due to contaminant migration.

9.7.2 Summary of Human Health Risk Assessment

The following items summarize the HHRA for Site 16.

- The HHRA for Site 16 considered exposures to construction workers, full-time employees, older child trespassers, and future residents. No groundwater samples were collected at Site 16; therefore, only exposures to soil were evaluated. Potential exposure pathways included incidental ingestion and dermal contact with soil. The maximum detected concentrations of all chemicals were less than EPA SSLs for migration from soil to air; consequently, potential exposures via inhalation of fugitive dust and volatiles were not evaluated.

- Maximum detected concentrations of 1,2,3,4,6,7,8-HPCDD, 1,2,3,4,6,7,8-HPCDF, 2,3,4,7,8-PECDF, 2,3,7,8-TCDF, OCDD, Aroclor 1248, and thallium in surface soil and 1,2,3,4,6,7,8-HPCDD and OCDD in subsurface soil exceeded the CTDEP pollutant mobility criterion for migration from soil to groundwater, indicating the potential exists for these chemicals to migrate from soil to groundwater. However, concentrations of all dioxin congeners were below USEPA SSLs for migration from soil to groundwater. SPLP results for Aroclor 1248 and thallium were all non-detect.

- The maximum detected concentrations of all chemicals in surface and subsurface soil were less than the CTDEP criteria for migration from soil to indoor air.

- All ICRs for exposure to soil at Site 16 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for arsenic (full-time workers, older child trespassers, child residents, and adult residents) and benzo(a)pyrene (child residents) exceeded CTDEP's target level of 1×10^{-6} for individual chemicals. It should be noted that the maximum detected concentrations of benzo(a)pyrene and arsenic were less than their respective CTDEP RSRs for residential exposures.

- All HIs for exposure to soil at Site 16 were less than USEPA's and CTDEP's acceptable level of 1.0.

9.7.3 Recommendations

One objective of the RI at Site 16 was to perform an initial characterization of the nature and extent of contamination at the site because no sampling or analytical programs had been completed at the site in the past. Another objective of the RI was to quantify the risks to human receptors associated with the site. Risks to ecological receptors were not evaluated during this RI, in accordance with the final work plan, because the site is paved.

The first objective of the RI was completed by conducting a field sampling and analytical program. The program for this site focused on soil. Both surface soil and subsurface soil samples were collected and analyzed. Temporary groundwater monitoring wells were proposed to be installed and sampled at this site in the final work plan; however, these wells were not installed or sampled because of the shallow depth of bedrock at this site.

The nature and extent and HHRA results from this RI indicate that the past operation of the skid-mounted incinerator at Site 16 has not significantly impacted the surrounding soil and the site soils do not pose significant risks to any potential human receptors. All ICRs for exposure to soil at Site 16 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. All HIs for exposure to soil at Site 16 were less than USEPA's and CTDEP's acceptable level of 1.0.

Even though several chemicals were detected at concentrations that exceed screening criteria for contaminant migration from soil to groundwater, it is unlikely that the groundwater beneath this site is impacted because of the following reasons:

- The CTDEP pollutant migration criterion, which were used to identify migration COPCs, are overly conservative and the COPCs at this site (i.e., dioxins/furans, PCBs, and metals) are not typically mobile in dissolved phase.

- Asphalt paving covers a majority of the site and limits infiltration through the soil and erosion of surface soil.

- Relatively competent bedrock is very shallow at this site and it is likely that it would impede vertical contaminant migration.

The results of this RI do not indicate that subsequent rounds of investigation are necessary to further characterize this site. In addition, the results do not suggest that a FS is necessary for this site. Therefore, it is recommended that a no further action decision document be prepared for this site.

TABLE 9-1

SUMMARY OF THE SAMPLING AND ANALYTICAL PROGRAM FOR SITE 16 BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION NSB-NLON, GROTON, CONNECTICUT

SAMPLE ID	VOC	SVOC	METALS	PEST/PCB	SPLPM	SPLPP	DIOXINS/FURANS
S16SB010001	X	X	X	X	X	X	X
S16SB030001	X	X	X	X	X	X	X
S16SB050001	X	X	X	X	X	X	X
S16SB060001	X	X	X	X	X	X	X
S16SB070001	X	X	X	X	X	X	X
S16SB080001	X	X	X	X	X	X	X
S16SB080405	X	X	X	X	X	X	X
S16SS01	X	X	X	X	X	X	X

SPLPM - SPLP Metals
SPLP - SPLP PCBs

TABLE 9-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 16
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	S16SB01	S16SB03	S16SB05	S16SB06	S16SB07	S16SB08	S16SB08	S16SS01
matrix	SS	SS	SS	SS	SS	SS	SB	SS
nsample	S16SB010001-SO	S16SB030001-SO	S16SB050001-SO	S16SB060001-SO	S16SB070001-SO	S16SB080001-SO	S16SB080405-SO	S16SS01-SO
sample	S16SB010001	S16SB030001	S16SB050001	S16SB060001	S16SB070001	S16SB080001	S16SB080405	S16SS01
top_depth	0	0	0	0	0	0	4	0
bottom_dep	1	1	1	1	1	1	5	0
sample_dat	6/13/00	6/13/00	6/13/00	6/13/00	6/13/00	6/13/00	6/13/00	6/25/00
Dioxins/Furans (ng/kg)								
1,2,3,4,6,7,8-HPCDD	21	1.9 U	7	3.1 U	120	20	24	31
1,2,3,4,6,7,8-HPCDF	3	0.41	3.4	0.44	0.21 U	0.33 U	0.5 U	5.4
1,2,3,7,8-PECDF	0.13 U	0.2 U	0.21	0.11 U	0.19 U	0.12 U	0.14 U	0.37 U
2,3,4,7,8-PECDF	0.13 U	0.2 U	0.36	0.11 U	0.19 U	0.12 U	0.14 U	0.38 U
2,3,7,8-TCDF	0.18 U	0.19 U	1.8	0.13 U	0.16 U	0.15 U	0.16 U	0.58 U
OCDD	740	110	240	450	29000	4300	6400	1200 J
OCDF	7.9	0.3 U	2.9	0.24 U	0.25 U	0.13 U	0.18 U	12 J
TOTAL HPCDD	120	1.9 U	20	3.1 U	220	38	43	69
TOTAL HPCDF	3	0.41	3.4	0.69	0.21 U	0.33 U	0.22 U	5.4
TOTAL HXCDF	3.1	0.1 U	2.1	0.2 U	0.14 U	0.16 U	0.14 U	1.1 UJ
TOTAL PECDF	0.13 U	0.2 U	4	0.11 U	0.19 U	0.12 U	0.14 U	2.3
TOTAL TCDD	0.22 U	0.54 J	0.17 U	0.16 U	0.17 U	0.22 U	0.2 U	0.65 UJ
TOTAL TCDF	0.9	0.19 U	2.2	0.13 U	0.16 U	0.15 U	0.16 U	0.58 U
Volatile Organics (ug/kg)								
2-BUTANONE	4 J	5 J	3 J	10 UJ	3 J	4 J	10 UR	12 U
ACETONE	37	51 U	29 U	10 U	67 U	56 U	10 UR	180 J
BROMOMETHANE	5 U	5 UJ	5 U	5 UJ	7 U	5 U	32 J	6 UJ
CHLOROMETHANE	5 U	5 UJ	5 U	5 UJ	7 U	5 U	91 J	6 UJ
TOLUENE	5 U	3 J	1 J	5 UJ	2 J	1 J	4 J	6 UJ
Semivolatile Organics (ug/kg)								
ACENAPHTHYLENE	180 U	170 U	99 J	170 U	190 U	200 U	170 U	44 J
ANTHRACENE	180 U	170 U	850 U	170 U	190 U	200 U	170 U	25 J
BENZO(A)ANTHRACENE	50 J	41 J	410 J	22 J	190 U	200 U	170 U	200
BENZO(A)PYRENE	48 J	41 J	330 J	20 J	190 U	200 U	170 U	200
BENZO(B)FLUORANTHENE	50 J	54 J	260 J	170 U	190 U	200 U	170 U	200
BENZO(G,H,I)PERYLENE	67 J	60 J	360 J	24 J	190 U	200 U	170 U	150 J
BENZO(K)FLUORANTHENE	39 J	48 J	280 J	170 U	190 U	200 U	170 U	200
BENZOIC ACID								180 J
BUTYL BENZYL PHTHALATE	180 U	170 U	850 U	20 J	200 U	200 U	180 U	190 U
CHRYSENE	67 J	63 J	520 J	26 J	190 U	200 U	170 U	260
DIBENZO(A,H)ANTHRACENE	180 UJ	170 U	850 UJ	170 U	190 U	200 U	170 U	49 J
FLUORANTHENE	99 J	100 J	630 J	41 J	190 U	200 U	170 U	360
INDENO(1,2,3-CD)PYRENE	52 J	51 J	280 J	20 J	190 U	200 U	170 U	130 J
PHENANTHRENE	44 J	46 J	230 J	35 J	190 U	200 U	170 U	120 J
PYRENE	91 J	98 J	720 J	47 J	190 U	200 U	170 U	370

TABLE 9-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 16
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	S16SB01	S16SB03	S16SB05	S16SB06	S16SB07	S16SB08	S16SB08	S16SS01
matrix	SS	SS	SS	SS	SS	SS	SB	SS
nsample	S16SB010001-SO	S16SB030001-SO	S16SB050001-SO	S16SB060001-SO	S16SB070001-SO	S16SB080001-SO	S16SB080405-SO	S16SS01-SO
sample	S16SB010001	S16SB030001	S16SB050001	S16SB060001	S16SB070001	S16SB080001	S16SB080405	S16SS01
top_depth	0	0	0	0	0	0	4	0
bottom_dep	1	1	1	1	1	1	5	0
sample_dat	6/13/00	6/13/00	6/13/00	6/13/00	6/13/00	6/13/00	6/13/00	6/25/00
Pesticides/PCBs (ug/kg)								
4,4'-DDD	1.4 U	1.4 U	1.4 U	1.4 UJ	2.4	1.6 U	1.4 U	0.76 U
4,4'-DDE	1.4 U	1.4 U	1.4 U	1.4 UJ	4.7 J	1.6 U	1.4 U	2.2 J
4,4'-DDT	2.7 J	1.4 U	1.5 J	1.4 UJ	4.1	1.6 U	1.4 U	10 R
ALPHA-CHLORDANE	0.74 U	0.74 U	0.72 U	0.73 UJ	0.51 J	0.85 U	0.74 U	0.39 U
AROCLOR-1248	7.3 U	7.3 U	7 U	7.2 UJ	6 J	8.3 U	7.3 U	7.7 U
GAMMA-CHLORDANE	0.74 U	0.74 U	0.72 U	0.73 UJ	4.2	0.85 U	0.74 U	0.39 U
Inorganics (mg/kg)								
ALUMINUM	5600	4400	4600	8900	21000	17000	8100	8900
ANTIMONY	0.48 UJ	0.57 UJ	0.56 UJ	0.54 UJ	0.71 J	0.6 UJ	0.54 UJ	1 U
ARSENIC	3.6	1.7	2.5	2.5	5.2	4.2	4.4	8.5
BARIUM	41	27	34	41	37	29	34	47
BERYLLIUM	0.23 J	0.35 U	0.27	0.59 U	0.7 U	0.74 U	0.38 U	0.36 U
CALCIUM	1300	660 J	1000	47000 J	1000 J	560 J	1500 J	2100
CHROMIUM	9.7 U	4.9	8.9 U	14	22	23	15	14
COBALT	6	4.6 U	4.9	4.8 U	8 U	9.1 U	6.2 U	7.8
COPPER	13 J	7.3	11 J	12	12	14	14	200
IRON	8400	5600 J	6700	9500 J	18000 J	16000 J	10000 J	16000
LEAD	3.9	3.5	35	5.1	12	4	3.8	16
MAGNESIUM	2200	1500	1900	3200	2800	3900	2500	2500
MANGANESE	130	120 J	200	140 J	100 J	120 J	180 J	400
NICKEL	7.1	5.1 U	6.2	8.7 U	11 U	13 U	10 U	38
POTASSIUM	1600	1100	1400	1600	670	900	1200	1700
SILVER	2 J	1.3 J	2.2	2.2 J	4.9	4.2	2.6	4.9
SODIUM	76 U	41 U	62 U	210	180 U	160 U	130 U	60 U
THALLIUM	0.65 J	0.53 J	0.44 U	0.49 J	0.54 J	0.63 J	0.44 J	1.2 J
VANADIUM	16	11	13	21	40	34	20	24 U
ZINC	24	61	26	48	43	25	18 U	1300

TABLE 9-3

SUMMARY OF SPLP SAMPLING AND ANALYTICAL PROGRAM FOR SITE 16
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	S16SB01	S16SB03	S16SB05	S16SB06	S16SB07	S16SB08	S16SB08	S16SS01
matrix	SPLP	SPLP	SPLP	SPLP	SPLP	SPLP	SPLP	SPLP
nsample	S16SB010001-SO-P	S16SB030001-SO-P	S16SB050001-SO-P	S16SB060001-SO-P	S16SB070001-SO-P	S16SB080001-SO-P	S16SB080405-SO-P	S16SS01-SO-P
sample	S16SB010001	S16SB030001	S16SB050001	S16SB060001	S16SB070001	S16SB080001	S16SB080405	S16SS01
top_depth	0	0	0	0	0	0	4	0
bottom_dep	1	1	1	1	1	1	5	0
sample_dat	6/13/00	6/13/00	6/13/00	6/13/00	6/13/00	6/13/00	6/13/00	6/25/00
PCBs (ug/L)								
AROCLOR-1016	2 U	2 U	2 U	2 U	2 U	2 U	2 U	0.8 U
AROCLOR-1221	4 U	4 U	4 U	4 U	4 U	4 U	4 U	1.6 U
AROCLOR-1232	2 U	2 U	2 U	2 U	2 U	2 U	2 U	0.8 U
AROCLOR-1242	2 U	2 U	2 U	2 U	2 U	2 U	2 U	0.8 U
AROCLOR-1248	2 U	2 U	2 U	2 U	2 U	2 U	2 U	0.8 U
AROCLOR-1254	2 U	2 U	2 U	2 U	2 U	2 U	2 U	0.8 U
AROCLOR-1260	2 U	2 U	2 U	2 U	2 U	2 U	2 U	0.8 U
Total Metals (ug/L)								
ALUMINUM	760	760	640	500	1200	66 U	66 U	370 U
ANTIMONY	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.6 U
ARSENIC	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	2.3 U
BARIUM	210 U	170 U	180 U	79 U	210 U	210 U	190 U	200 U
BERYLLIUM	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.72 U
CADMIUM	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.64 U
CALCIUM	1300 J	870 U	840 J	26000 J	1500 U	1200 U	2700 U	2500 U
CHROMIUM	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	7.1 J
COBALT	5.2 U	5.2 U	5.2 U	5.2 U	5.2 U	5.2 U	5.2 U	4.2 U
COPPER	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	34
IRON	540	510	490	84 U	800	22 U	22 U	650
LEAD	2.1 U	2.1 U	2.5 J	2.1 U	2.1 U	2.1 U	2.1 U	3.1 J
MAGNESIUM	280	210	240	270	200	210	150	530
MANGANESE	8.7	16 U	16	3.5 U	3.9 U	19	24	24 U
MERCURY	0.14 U	0.16 U	0.15 U	0.17 U	0.19 U	0.17 U	0.16 U	0.12 U
NICKEL	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	9.2 U
POTASSIUM	780 U	1100 U	610 U	2100 U	540 U	620 U	360 U	1700
SELENIUM	2.7 U	2.7 U	2.7 U	4 U	2.8 U	2.7 U	2.7 U	2.8 U
SILVER	5.7 U	5.7 U	5.7 U	5.7 U	5.7 U	5.7 U	5.7 U	5.2 U
SODIUM	3900 U	3700 U	3700 U	5700 U	6800 U	6200 U	5200 U	1500 U
THALLIUM	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	3 U
VANADIUM	4.8 J	4.4 U	4.4 U	21	4.4 U	4.4 U	4.4 U	6.3 U
ZINC	24 U	45 U	32 U	23 U	42 U	46 U	25 U	360 U

TABLE 9-4

CHEMICALS RETAINED AS COPCs AT SITE 16
DIRECT CONTACT EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Surface Soil		Subsurface Soil	
	Direct Contact	Soil to Air	Direct Contact	Soil to Air
Semivolatile Organic Compounds				
Benzo(a)pyrene	X			
Metals				
Arsenic	X		X	
Manganese	X			
Thallium	X			

Notes:
X - Chemical is retained as a COC.

TABLE 9-5

CHEMICALS RETAINED AS COPCs AT SITE 16
POTENTIAL MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Surface Soil		Subsurface Soil	
	Soil to Groundwater	Soil to Indoor Air	Soil to Groundwater	Soil to Indoor Air
Dioxins/Furans				
1,2,3,4,6,7,8-HPCDD	X		X	
1,2,3,4,6,7,8-HPCDF	X			
2,3,4,7,8-PECDF	X			
2,3,7,8-TCDF	X			
OCDD	X		X	
Total HXCDD				
Pesticides/PCBs				
Aroclor-1248	X			
Metals				
Chromium	X			
Copper	X			
Lead	X			
Thallium	X			
Vanadium	X			

Notes:
X - Chemical is retained as a COC.

TABLE 9-6

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL AT SITE 16
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Hospital Incinerator (Site 16)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COC Screening Level(5)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COC Flag	Rationale for Contaminant Deletion or Selection(6)
Dioxins/Furans																	
35822-46-9	1,2,3,4,6,7,8-HPCDD	0.000007		0.00012		mg/kg	S16SB070001	5/7	0.0000019 - 0.0000031	1.2E-04	NA	3.9E-04	C	NA	SSL-INH CTRESSOIL	NO	BSL
67562-39-4	1,2,3,4,6,7,8-HPCDF	0.00000041		0.0000054		mg/kg	S16SS01	5/7	0.00000021 - 0.00000033	5.4E-06	NA	3.9E-04	C	NA	SSL-INH CTRESSOIL	NO	BSL
57117-41-6	1,2,3,7,8-PECDF	0.00000021		0.00000021		mg/kg	S16SB050001	1/7	0.00000011 - 0.00000037	2.1E-07	NA	7.8E-05	C	NA	SSL-INH CTRESSOIL	NO	BSL
57117-31-4	2,3,4,7,8-PECDF	0.00000036		0.00000036		mg/kg	S16SB050001	1/7	0.00000011 - 0.00000038	3.6E-07	NA	7.8E-06	C	NA	SSL-INH CTRESSOIL	NO	BSL
51207-31-9	2,3,7,8-TCDF	0.0000018		0.0000018		mg/kg	S16SB050001	1/7	0.00000013 - 0.00000058	1.8E-06	NA	3.9E-05	C	NA	SSL-INH CTRESSOIL	NO	BSL
3268-87-9	OCDD	0.00011		0.029		mg/kg	S16SB070001	7/7	---	2.9E-02	NA	3.9E-02	C	NA	SSL-INH CTRESSOIL	NO	BSL
39001-02-0	OCDF	0.0000029		0.000012	J	mg/kg	S16SS01	3/7	0.00000013 - 0.0000003	1.2E-05	NA	3.9E-02	C	NA	SSL-INH CTRESSOIL	NO	BSL
37871-00-4	TOTAL HPCDD	0.00002		0.00022		mg/kg	S16SB070001	5/7	0.0000019 - 0.0000031	2.2E-04	NA	NA		NA	SSL-INH CTRESSOIL	NO	NTX
38998-75-3	TOTAL HPCDF	0.00000041		0.0000054		mg/kg	S16SS01	5/7	0.00000021 - 0.00000033	5.4E-06	NA	NA		NA	SSL-INH CTRESSOIL	NO	NTX
55684-94-1	TOTAL HXCDF	0.0000021		0.0000031		mg/kg	S16SB010001	2/7	0.0000001 - 0.0000011	3.1E-06	NA	NA		NA	SSL-INH CTRESSOIL	NO	NTX
30402-15-4	TOTAL PECDF	0.0000023		0.000004		mg/kg	S16SB050001	2/7	0.00000011 - 0.0000002	4.0E-06	NA	NA		NA	SSL-INH CTRESSOIL	NO	NTX
41903-57-5	TOTAL TCDD	0.00000054	J	0.00000054	J	mg/kg	S16SB030001	1/7	0.00000016 - 0.00000065	5.4E-07	NA	NA		NA	SSL-INH CTRESSOIL	NO	NTX
55722-27-5	TOTAL TCDF	0.0000009		0.0000022		mg/kg	S16SB050001	2/7	0.00000013 - 0.00000058	2.2E-06	NA	NA		NA	SSL-INH CTRESSOIL	NO	NTX
Volatile Organics																	
78-93-3	2-BUTANONE	0.003	J	0.005	J	mg/kg	S16SB030001	5/7	0.01 - 0.012	0.005	NA	730	N	NA 500	SSL-INH CTRESSOIL	NO	BSL
67-64-1	ACETONE	0.037		0.18	J	mg/kg	S16SS01	2/7	0.01 - 0.067	0.18	NA	160	N	100000 500	SSL-INH CTRESSOIL	NO	BSL
108-88-3	TOLUENE	0.001	J	0.003	J	mg/kg	S16SB030001	4/7	0.005 - 0.006	0.003	NA	52	N	650 500	SSL-INH CTRESSOIL	NO	BSL
Semivolatile Organics																	
208-96-8	ACENAPHTHYLENE	0.044	J	0.099	J	mg/kg	S16SB050001	2/7	0.17 - 0.2	0.099	NA	370 (7)	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
120-12-7	ANTHRACENE	0.025	J	0.025	J	mg/kg	S16SS01	1/7	0.17 - 0.85	0.025	NA	2200	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
56-55-3	BENZO(A)ANTHRACENE	0.022	J	0.41	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.41	NA	0.62	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
50-32-8	BENZO(A)PYRENE	0.02	J	0.33	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.33	NA	0.062	C	NA 1	SSL-INH CTRESSOIL	YES	ASL
205-99-2	BENZO(B)FLUORANTHENE	0.05	J	0.26	J	mg/kg	S16SB050001	4/7	0.17 - 0.2	0.26	NA	0.62	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.024	J	0.36	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.36	NA	230 (8)	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.039	J	0.28	J	mg/kg	S16SB050001	4/7	0.17 - 0.2	0.28	NA	6.2	C	NA 8.4	SSL-INH CTRESSOIL	NO	BSL

TABLE 9-6

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL AT SITE 16
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Hospital Incinerator (Site 16)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based Screening Level(5)	COC	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COC Flag	Rationale for Contaminant Deletion or Selection(6)
65-85-0	BENZOIC ACID	0.18	J	0.18	J	mg/kg	S16SS01	1/1	---	0.18	NA	10000	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
85-68-7	BUTYL BENZYL PHTHALATE	0.02	J	0.02	J	mg/kg	S16SB060001	1/7	0.17 - 0.85	0.02	NA	1200	N	930 1000	SSL-INH CTRESSOIL	NO	BSL
218-01-9	CHRYSENE	0.026	J	0.52	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.52	NA	62	C	NA 84	SSL-INH CTRESSOIL	NO	BSL
53-70-3	DIBENZO(A,H)ANTHRACENE	0.049	J	0.049	J	mg/kg	S16SS01	1/7	0.17 - 0.85	0.049	NA	0.062	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
206-44-0	FLUORANTHENE	0.041	J	0.63	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.63	NA	230	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.02	J	0.28	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.28	NA	0.62	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
85-01-8	PHENANTHRENE	0.035	J	0.23	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.23	NA	230 (8)	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
129-00-0	PYRENE	0.047	J	0.72	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.72	NA	230	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
Pesticides/PCBs																	
72-54-8	4,4'-DDD	0.0024		0.0024		mg/kg	S16SB070001	1/7	0.00076 - 0.0016	0.0024	NA	2.4	C	NA 2.6	SSL-INH CTRESSOIL	NO	BSL
72-55-9	4,4'-DDE	0.0022	J	0.0047	J	mg/kg	S16SB070001	2/7	0.0014 - 0.0016	0.0047	NA	1.7	C	NA 1.8	SSL-INH CTRESSOIL	NO	BSL
50-29-3	4,4'-DDT	0.0015	J	0.0041		mg/kg	S16SB070001	3/6	0.0014 - 0.0016	0.0041	NA	1.7	C	NA 1.8	SSL-INH CTRESSOIL	NO	BSL
5103-71-9	ALPHA-CHLORDANE	0.00051	J	0.00051	J	mg/kg	S16SB070001	1/7	0.00039 - 0.00085	0.00051	NA	1.6	C	20 0.49	SSL-INH CTRESSOIL	NO	BSL
12672-29-6	AROCLOR-1248	0.006	J	0.006	J	mg/kg	S16SB070001	1/7	0.007 - 0.0083	0.006	NA	0.22	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
12789-03-6	GAMMA-CHLORDANE	0.0042		0.0042		mg/kg	S16SB070001	1/7	0.00039 - 0.00085	0.0042	NA	1.6	C	20 0.49	SSL-INH CTRESSOIL	NO	BSL
Inorganics																	
7429-90-5	ALUMINUM	4400		21000		mg/kg	S16SB070001	7/7	---	21000	17600	7600	N	NA NA	SSL-INH CTRESSOIL	NO	EPAI
7440-36-0	ANTIMONY	0.71	J	0.71	J	mg/kg	S16SB070001	1/7	0.48 - 1	0.71	2.05	3.1	N	NA 27	SSL-INH CTRESSOIL	NO	BSL, BKG
7440-38-2	ARSENIC	1.7		8.5		mg/kg	S16SS01	7/7	---	8.5	3.6	0.39	C	750 10	SSL-INH CTRESSOIL	YES	ASL
7440-39-3	BARIUM	27		47		mg/kg	S16SS01	7/7	---	47	39	540	N	690000 4700	SSL-INH CTRESSOIL	NO	BSL
7440-41-7	BERYLLIUM	0.23	J	0.27		mg/kg	S16SB050001	2/7	0.35 - 0.74	0.27	0.72	15	N	1300 2	SSL-INH CTRESSOIL	NO	BSL,BKG
7440-70-2	CALCIUM	560	J	47000	J	mg/kg	S16SB060001	7/7	---	47000	314	NA		NA NA	SSL-INH CTRESSOIL	NO	NUT
7440-47-3	CHROMIUM	4.9		23		mg/kg	S16SB080001	5/7	8.9 - 9.7	23	19.3	30 (9)	C	270 100	SSL-INH CTRESSOIL	NO	BSL
7440-48-4	COBALT	4.9		7.8		mg/kg	S16SS01	3/7	4.6 - 9.1	7.8	7	470	N	NA NA	SSL-INH CTRESSOIL	NO	BSL
7440-50-8	COPPER	7.3		200		mg/kg	S16SS01	7/7	---	200	17.9	290	N	NA 2500	SSL-INH CTRESSOIL	NO	BSL
7439-89-6	IRON	5600	J	18000	J	mg/kg	S16SB070001	7/7	---	18000	16800	2300	N	NA NA	SSL-INH CTRESSOIL	NO	EPAI
7439-92-1	LEAD	3.5		35		mg/kg	S16SB050001	7/7	---	35	17.5	400 (10)	N	NA 500	SSL-INH CTRESSOIL	NO	BSL
7439-95-4	MAGNESIUM	1500		3900		mg/kg	S16SB080001	7/7	---	3900	2460	NA		NA NA	SSL-INH CTRESSOIL	NO	NUT

TABLE 9-6

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL AT SITE 16
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Hospital Incinerator (Site 16)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COC Screening Level(5)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COC Flag	Rationale for Contaminant Deletion or Selection(6)
7439-96-5	MANGANESE	100	J	400		mg/kg	S16SS01	7/7	---	400	172	180	N	NA NA	SSL-INH CTRESSOIL	YES	ASL
7440-02-0	NICKEL	6.2		38		mg/kg	S16SS01	3/7	5.1 - 13	38	5	160	N	13000 1400	SSL-INH CTRESSOIL	NO	BSL
7440-09-7	POTASSIUM	670		1700		mg/kg	S16SS01	7/7	---	1700	669	NA		NA NA	SSL-INH CTRESSOIL	NO	NUT
7440-22-4	SILVER	1.3	J	4.9		mg/kg	S16SB070001, S16SS01	7/7	---	4.9	0.385	39	N	NA 340	SSL-INH CTRESSOIL	NO	BSL
7440-23-5	SODIUM	210		210		mg/kg	S16SB060001	1/7	41 - 180	210	16.56	NA		NA NA	SSL-INH CTRESSOIL	NO	NUT
7440-28-0	THALLIUM	0.49	J	1.2	J	mg/kg	S16SS01	6/7	0.44	1.2	0.105	0.52	N	NA 5.4	SSL-INH CTRESSOIL	YES	ASL
7440-62-2	VANADIUM	11		40		mg/kg	S16SB070001	6/7	24	40	33.3	55	N	NA 470	SSL-INH CTRESSOIL	NO	BSL
7440-66-6	ZINC	24		1300		mg/kg	S16SS01	7/7	---	1300	25.6	2300	N	NA 20000	SSL-INH CTRESSOIL	NO	BSL

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COC .

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COC.
5 The risk-based COC screening level for residential land use is presented. The value is based on a target Hazard Quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COC if the maximum detected concentration exceeds the risk-based COC screening level and/or an ARAR/TBC(s).
7 Acenaphthene is used as a surrogate for acenaphthylene.
8 Pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.
9 Hexavalent Chromium.
10 OSWER soil screening level for residential land use (USEPA, July 1994).

Associated Samples:

S16SB010001	S16SB070001
S16SB030001	S16SB080001
S16SB050001	S16SS01
S16SB060001	

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
SSL-INH = Soil Screening Level for transfers from soil to air (Inhalation) (USEPA, May 1996).
CTRESSOIL - CTDEP direct contact criteria for residential exposures to soil.

Rationale Codes:

For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No criteria available.
EPAI = USEPA Region 1 does not advocate evaluation of this chemical.

TABLE 9-7

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL AT SITE 16
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Hospital Incinerator (Site 16)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	EPA SSL-Soil to GW(5)	CTDEP Mobility Criteria(6)	CTDEP Soil Vapor Volatilization(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Dioxins/Furans																
35822-46-9	1,2,3,4,6,7,8-HPCDD	0.000007		0.00012		mg/kg	S16SB070001	5/7	0.0000019 - 0.0000031	1.2E-04	NA	5.60E-04	4.67E-06	NA	YES	ASL
67562-39-4	1,2,3,4,6,7,8-HPCDF	0.00000041		0.0000054		mg/kg	S16SS01	5/7	0.00000021 - 0.00000033	5.4E-06	NA	5.60E-04	4.67E-06	NA	YES	ASL
57117-41-6	1,2,3,7,8-PECDF	0.00000021		0.00000021		mg/kg	S16SB050001	1/7	0.00000011 - 0.00000037	2.1E-07	NA	1.12E-04	9.34E-07 (5)	NA	NO	BSL
57117-31-4	2,3,4,7,8-PECDF	0.00000036		0.00000036		mg/kg	S16SB050001	1/7	0.00000011 - 0.00000038	3.6E-07	NA	1.12E-05	9.34E-08	NA	YES	ASL
51207-31-9	2,3,7,8-TCDF	0.0000018		0.0000018		mg/kg	S16SB050001	1/7	0.00000013 - 0.00000058	1.8E-06	NA	5.60E-05	4.67E-07	NA	YES	ASL
3268-87-9	OCDD	0.00011		0.029		mg/kg	S16SB070001	7/7	---	2.9E-02	NA	5.60E-02	4.67E-04	NA	YES	ASL
39001-02-0	OCDF	0.0000029		0.000012	J	mg/kg	S16SS01	3/7	0.00000013 - 0.0000003	1.2E-05	NA	5.60E-02	4.67E-04 (5)	NA	NO	BSL
37871-00-4	TOTAL HPCDD	0.00002		0.00022		mg/kg	S16SB070001	5/7	0.0000019 - 0.0000031	2.2E-04	NA	NA	NA	NA	NO	NTX
38998-75-3	TOTAL HPCDF	0.00000041		0.0000054		mg/kg	S16SS01	5/7	0.00000021 - 0.00000033	5.4E-06	NA	NA	NA	NA	NO	NTX
55684-94-1	TOTAL HXCDF	0.0000021		0.0000031		mg/kg	S16SB010001	2/7	0.0000001 - 0.0000011	3.1E-06	NA	NA	NA	NA	NO	NTX
30402-15-4	TOTAL PECDF	0.0000023		0.000004		mg/kg	S16SB050001	2/7	0.00000011 - 0.0000002	4.0E-06	NA	NA	NA	NA	NO	NTX
41903-57-5	TOTAL TCDD	0.00000054	J	0.00000054	J	mg/kg	S16SB030001	1/7	0.00000016 - 0.00000065	5.4E-07	NA	NA	NA	NA	NO	NTX
55722-27-5	TOTAL TCDF	0.0000009		0.0000022		mg/kg	S16SB050001	2/7	0.00000013 - 0.00000058	2.2E-06	NA	NA	NA	NA	NO	NTX
Volatile Organics																
78-93-3	2-BUTANONE	0.003	J	0.005	J	mg/kg	S16SB030001	5/7	0.01 - 0.012	0.005	NA	NA	80	2400	NO	BSL
67-64-1	ACETONE	0.037		0.18	J	mg/kg	S16SS01	2/7	0.01 - 0.067	0.18	NA	16	140	2400	NO	BSL
108-88-3	TOLUENE	0.001	J	0.003	J	mg/kg	S16SB030001	4/7	0.005 - 0.006	0.003	NA	12	67	760	NO	BSL
Semivolatile Organics																
208-96-8	ACENAPHTHYLENE	0.044	J	0.099	J	mg/kg	S16SB050001	2/7	0.17 - 0.2	0.099	NA	NA	84	NA	NO	BSL
120-12-7	ANTHRACENE	0.025	J	0.025	J	mg/kg	S16SS01	1/7	0.17 - 0.85	0.025	NA	12000	400	NA	NO	BSL
56-55-3	BENZO(A)ANTHRACENE	0.022	J	0.41	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.41	NA	2	1	NA	NO	BSL
50-32-8	BENZO(A)PYRENE	0.02	J	0.33	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.33	NA	8	1	NA	NO	BSL
205-99-2	BENZO(B)FLUORANTHENE	0.05	J	0.26	J	mg/kg	S16SB050001	4/7	0.17 - 0.2	0.26	NA	NA	1	NA	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.024	J	0.36	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.36	NA	4200(9)	42	NA	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.039	J	0.28	J	mg/kg	S16SB050001	4/7	0.17 - 0.2	0.28	NA	49	1	NA	NO	BSL
65-85-0	BENZOIC ACID	0.18	J	0.18	J	mg/kg	S16SS01	1/1	---	0.18	NA	400	10000	NA	NO	BSL
85-68-7	BUTYL BENZYL PHTHALATE	0.02	J	0.02	J	mg/kg	S16SB060001	1/7	0.17 - 0.85	0.02	NA	930	NA	NA	NO	BSL
218-01-9	CHRYSENE	0.026	J	0.52	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.52	NA	160	1	NA	NO	BSL
53-70-3	DIBENZO(A,H)ANTHRACENE	0.049	J	0.049	J	mg/kg	S16SS01	1/7	0.17 - 0.85	0.049	NA	2	1	NA	NO	BSL
206-44-0	FLUORANTHENE	0.041	J	0.63	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.63	NA	4300	56	NA	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.02	J	0.28	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.28	NA	14	1	NA	NO	BSL
85-01-8	PHENANTHRENE	0.035	J	0.23	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.23	NA	4200(9)	40	NA	NO	BSL
129-00-0	PYRENE	0.047	J	0.72	J	mg/kg	S16SB050001	5/7	0.19 - 0.2	0.72	NA	4200	40	NA	NO	BSL
Pesticides/PCBs																
72-54-8	4,4'-DDD	0.0024		0.0024		mg/kg	S16SB070001	1/7	0.00076 - 0.0016	0.0024	NA	16	NA	NA	NO	BSL
72-55-9	4,4'-DDE	0.0022	J	0.0047	J	mg/kg	S16SB070001	2/7	0.0014 - 0.0016	0.0047	NA	54	NA	NA	NO	BSL
50-29-3	4,4'-DDT	0.0015	J	0.0041		mg/kg	S16SB070001	3/6	0.0014 - 0.0016	0.0041	NA	32	NA	NA	NO	BSL
5103-71-9	ALPHA-CHLORDANE	0.00051	J	0.00051	J	mg/kg	S16SB070001	1/7	0.00039 - 0.00085	0.00051	NA	10	0.066	NA	NO	BSL
12672-29-6	AROCLOR-1248	0.006	J	0.006	J	mg/kg	S16SB070001	1/7	0.007 - 0.0083	0.006	NA	NA	0.005	NA	YES	ASL
12789-03-6	GAMMA-CHLORDANE	0.0042		0.0042		mg/kg	S16SB070001	1/7	0.00039 - 0.00085	0.0042	NA	10	0.066	NA	NO	BSL
Inorganics																
7429-90-5	ALUMINUM	4400		21000		mg/kg	S16SB070001	7/7	---	21000	17600	NA	NA(10)	NA	NO	NTX
7440-36-0	ANTIMONY	0.71	J	0.71	J	mg/kg	S16SB070001	1/7	0.48 - 1	0.71	2.05	5	NA(10)	NA	NO	BSL
7440-38-2	ARSENIC	1.7		8.5		mg/kg	S16SS01	7/7	---	8.5	3.6	29	NA(10)	NA	NO	BSL
7440-39-3	BARIUM	27		47		mg/kg	S16SS01	7/7	---	47	39	1600	NA(10)	NA	NO	BSL
7440-41-7	BERYLLIUM	0.23	J	0.27		mg/kg	S16SB050001	2/7	0.35 - 0.74	0.27	0.72	63	NA(10)	NA	NO	BSL,BKG
7440-70-2	CALCIUM	560	J	47000	J	mg/kg	S16SB060001	7/7	---	47000	314	NA	NA(10)	NA	NO	NUT
7440-47-3	CHROMIUM	4.9		23		mg/kg	S16SB080001	5/7	8.9 - 9.7	23	19.3	38	NA(10)	NA	NO	BSL
7440-48-4	COBALT	4.9		7.8		mg/kg	S16SS01	3/7	4.6 - 9.1	7.8	7	NA	NA(10)	NA	NO	NTX
7440-50-8	COPPER	7.3		200		mg/kg	S16SS01	7/7	---	200	17.9	NA	NA(10)	NA	NO	NTX
7439-89-6	IRON	5600	J	18000	J	mg/kg	S16SB070001	7/7	---	18000	16800	NA	NA(10)	NA	NO	BKG
7439-92-1	LEAD	3.5		35		mg/kg	S16SB050001	7/7	---	35	17.5	NA	NA(10)	NA	NO	NTX
7439-95-4	MAGNESIUM	1500		3900		mg/kg	S16SB080001	7/7	---	3900	2460	NA	NA(10)	NA	NO	NUT
7439-96-5	MANGANESE	100	J	400		mg/kg	S16SS01	7/7	---	400	172	NA	NA(10)	NA	NO	NTX

TABLE 9-7

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL AT SITE 16
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Hospital Incinerator (Site 16)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	EPA SSL-Soil to GW(5)	CTDEP Mobility Criteria(6)	CTDEP Soil Vapor Volatilization(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
7440-02-0	NICKEL	6.2		38		mg/kg	S16SS01	3/7	5.1 - 13	38	5	130	NA(10)	NA	NO	BSL
7440-09-7	POTASSIUM	670		1700		mg/kg	S16SS01	7/7	---	1700	669	NA	NA(10)	NA	NO	NUT
7440-22-4	SILVER	1.3	J	4.9		mg/kg	S16SB070001, S16SS01	7/7	---	4.9	0.385	34	NA(10)	NA	NO	BSL
7440-23-5	SODIUM	210		210		mg/kg	S16SB060001	1/7	41 - 180	210	16.56	NA	NA(10)	NA	NO	NUT
7440-28-0	THALLIUM	0.49	J	1.2	J	mg/kg	S16SS01	6/7	0.44	1.2	0.105	0.7	NA(10)	NA	YES	ASL
7440-62-2	VANADIUM	11		40		mg/kg	S16SB070001	6/7	24	40	33.3	6000	NA(10)	NA	NO	BSL
7440-66-6	ZINC	24		1300		mg/kg	S16SS01	7/7	---	1300	25.6	12000	NA(10)	NA	NO	BSL

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COC .

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COC.
5 USEPA Soil Screening Level Guidance, May 1996.
6 CTDEP Remediation Standard Regulations, 1996.
7 The chemical is selected as a COC if the maximum detected concentration exceeds the risk-based COC screening level and/or an ARAR/TBC(s).
8 TTNUS, April 14, 1999. Toxicity criteria not available. Toxicity criteria for 2,3,7,8-TCDD used in conjunction with toxicity equivalent factor (TEF) (EPA/625/3-89/016, March 1989) to calculate a value.
9 Pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene
10 See Table 9.6-5

Associated Samples:

S16SB010001	S16SB070001
S16SB030001	S16SB080001
S16SB050001	S16SS01
S16SB060001	

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogen
COC = Chemical of Concern
J = Estimated Value
N = Noncarcinogen
NA = Not Applicable

Rationale Codes:

For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC

For Elimination as a COC:
BKG = Within Background Levels
NTX = No criteria available.

TABLE 9-8

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL AT SITE 16
MIGRATION PATHWAYS - SPLP RESULTS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Hospital Incinerator (Site 16)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	CTDEP Mobility Criteria	COPC Flag	Rationale for Contaminant Deletion or Selection(5)
Inorganics														
7429-90-5	ALUMINUM	500		1200		ug/L	S16SB070001-SO-P	5/7	66 - 370	1200	NA	NA	NO	BSL
7440-70-2	CALCIUM	840	J	26000	J	ug/L	S16SB060001-SO-P	3/7	870 - 2500	26000	NA	NA	NO	NTX
7440-47-3	CHROMIUM	7.1	J	7.1	J	ug/L	S16SS01-SO-P	1/7	8.4	7.1	NA	0.5	YES	ASL
7440-50-8	COPPER	34		34		ug/L	S16SS01-SO-P	1/7	5.4	34	NA	13	YES	ASL
7439-89-6	IRON	490		800		ug/L	S16SB070001-SO-P	5/7	22 - 84	800	NA	NA	NO	NTX
7439-92-1	LEAD	2.5	J	3.1	J	ug/L	S16SS01-SO-P	2/7	2.1	3.1	NA	0.15	YES	ASL
7439-95-4	MAGNESIUM	200		530		ug/L	S16SS01-SO-P	7/7	---	530	NA	NA	NO	NTX
7439-96-5	MANGANESE	8.7		19		ug/L	S16SB080001-SO-P	3/7	3.5 - 24	19	NA	NA	NO	NTX
7440-09-7	POTASSIUM	1700		1700		ug/L	S16SS01-SO-P	1/7	540 - 2100	1700	NA	NA	NO	NTX
7440-62-2	VANADIUM	4.8	J	21		ug/L	S16SB060001-SO-P	2/7	4.4 - 6.3	21	NA	0.5	YES	ASL

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COC

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 SPLP analysis was not performed on background samples.
5 The chemical is selected as a COC if the maximum detected concentration exceeds the risk-based COC screening level.

Associated Samples:

S16SB010001-SO-P
S16SB030001-SO-P
S16SB050001-SO-P
S16SB060001-SO-P
S16SB070001-SO-P
S16SB080001-SO-P
S16SS01-SO-P

Definitions:

C = Carcinogen
COC = Chemical of Concern
J = Estimated Value
N = Noncarcinogen
NA = Not Applicable

Rationale Codes:

For Selection as a COC:
ASL = Above COC Screening Level

For Elimination as a COC:
NTX = No criteria available

TABLE 9-9

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SUBSURFACE SOIL AT SITE 16
DIRECT CONTACT EXPOSURE PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Hospital Incinerator (Site 16)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Dioxins/Furans																	
35822-46-9	1,2,3,4,6,7,8-HPCDD	0.000024		0.000024		mg/kg	S16SB080405-SO	1/1	---	0.000024	NA	0.00039	C	NA NA	SSL-INH CTRESSOIL	NO	BSL
3268-87-9	OCDD	0.0064		0.0064		mg/kg	S16SB080405-SO	1/1	---	0.0064	NA	0.039	C	NA NA	SSL-INH CTRESSOIL	NO	BSL
37871-00-4	TOTAL HPCDD	0.000043		0.000043		mg/kg	S16SB080405-SO	1/1	---	0.000043	NA	NA		NA NA	SSL-INH CTRESSOIL	NO	NTX
Volatile Organics																	
74-83-9	BROMOMETHANE	0.032	J	0.032	J	mg/kg	S16SB080405-SO	1/1	---	0.032	NA	3.9		10 95	SSL-INH CTRESSOIL	NO	BSL
74-87-3	CHLOROMETHANE	0.091	J	0.091	J	mg/kg	S16SB080405-SO	1/1	---	0.091	NA	1.2		NA 47	SSL-INH CTRESSOIL	NO	BSL
108-88-3	TOLUENE	0.004	J	0.004	J	mg/kg	S16SB080405-SO	1/1	---	0.004	NA	52	N	650 500	SSL-INH CTRESSOIL	NO	BSL
Inorganics																	
7429-90-5	ALUMINUM	8100		8100		mg/kg	S16SB080405-SO	1/1	---	8100	17600	7600	N	NA NA	SSL-INH CTRESSOIL	NO	BKG, EPAI
7440-38-2	ARSENIC	4.4		4.4		mg/kg	S16SB080405-SO	1/1	---	4.4	3.6	0.39	C	750 10	SSL-INH CTRESSOIL	YES	ASL
7440-39-3	BARIUM	34		34		mg/kg	S16SB080405-SO	1/1	---	34	57.2	540	N	690000 4700	SSL-INH CTRESSOIL	NO	BSL,BKG
7440-70-2	CALCIUM	1500	J	1500	J	mg/kg	S16SB080405-SO	1/1	---	1500	499	NA		NA NA	SSL-INH CTRESSOIL	NO	NUT
7440-47-3	CHROMIUM	15		15		mg/kg	S16SB080405-SO	1/1	---	15	21.5	30(7)	C	270 100	SSL-INH CTRESSOIL	NO	BSL,BKG
7440-50-8	COPPER	14		14		mg/kg	S16SB080405-SO	1/1	---	14	25.6	290	N	NA 2500	SSL-INH CTRESSOIL	NO	BSL,BKG
7439-89-6	IRON	10000	J	10000	J	mg/kg	S16SB080405-SO	1/1	---	10000	17200	2300	N	NA NA	SSL-INH CTRESSOIL	NO	BKG, EPAI
7439-92-1	LEAD	3.8		3.8		mg/kg	S16SB080405-SO	1/1	---	3.8	17.5	400(8)	N	NA 500	SSL-INH CTRESSOIL	NO	BSL,BKG
7439-95-4	MAGNESIUM	2500		2500		mg/kg	S16SB080405-SO	1/1	---	2500	3650	NA		NA NA	SSL-INH CTRESSOIL	NO	NUT
7439-96-5	MANGANESE	180	J	180	J	mg/kg	S16SB080405-SO	1/1	---	180	188	180	N	NA NA	SSL-INH CTRESSOIL	NO	BSL,BKG
7440-09-7	POTASSIUM	1200		1200		mg/kg	S16SB080405-SO	1/1	---	1200	2580	NA		NA NA	SSL-INH CTRESSOIL	NO	NUT
7440-22-4	SILVER	2.6		2.6		mg/kg	S16SB080405-SO	1/1	---	2.6	0.385	39	N	NA 340	SSL-INH CTRESSOIL	NO	BSL
7440-28-0	THALLIUM	0.44	J	0.44	J	mg/kg	S16SB080405-SO	1/1	---	0.44	0.29	0.52	N	NA 5.4	SSL-INH CTRESSOIL	NO	BSL
7440-62-2	VANADIUM	20		20		mg/kg	S16SB080405-SO	1/1	---	20	35.1	55	N	NA 470	SSL-INH CTRESSOIL	NO	BSL,BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

TABLE 9-9

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SUBSURFACE SOIL AT SITE 16
DIRECT CONTACT EXPOSURE PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COC.
5 The risk-based COPC screening level for residential land use is presented. The value is based on a target Hazard Quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COC if the maximum detected concentration exceeds the risk-based COC screening level and/or an ARAR/TBC(s).
7 Hexavalent Chromium.
8 OSWER soil screening level for residential land use (USEPA, July 1994).

Associated Samples:
S16SB080405-SO

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
SSL-INH = Soil Screening Level for transfers from soil to air (Inhalation) (USEPA, May 1996).
CTRESSOIL - CTDEP direct contact criteria for residential exposure to soil.

Rationale Codes:
For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No criteria available.

TABLE 9-10

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SUBSURFACE SOIL AT SITE 16
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Hospital Incinerator (Site 16)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	EPA SSL-Soil to GW(5)	CTDEP Mobility Criteria(6)	CTDEP Soil Vapor Volatilization(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Dioxins/Furans																
35822-46-9	1,2,3,4,6,7,8-HPCDD	0.000024		0.000024		mg/kg	S16SB080405-SO	1/1	---	2.4E-05	NA	5.60E-04	4.67E-06	NA	YES	ASL
3268-87-9	OCDD	0.0064		0.0064		mg/kg	S16SB080405-SO	1/1	---	6.4E-03	NA	5.60E-02	4.67E-05	NA	YES	ASL
37871-00-4	TOTAL HPCDD	0.000043		0.000043		mg/kg	S16SB080405-SO	1/1	---	4.3E-05	NA	NA	NA	NA	NO	NTX
Volatile Organics																
74-83-9	BROMOMETHANE	0.032	J	0.032	J	mg/kg	S16SB080405-SO	1/1	---	0.032	NA	0.2	2	NA	NO	BSL
74-87-3	CHLOROMETHANE	0.091	J	0.091	J	mg/kg	S16SB080405-SO	1/1	---	0.091	NA	NA	NA	NA	NO	NTX
108-88-3	TOLUENE	0.004	J	0.004	J	mg/kg	S16SB080405-SO	1/1	---	0.004	NA	12	67	760	NO	BSL
Inorganics																
7429-90-5	ALUMINUM	8100		8100		mg/kg	S16SB080405-SO	1/1	---	8100	17600	NA	NA(9)	NA	NO	BKG
7440-38-2	ARSENIC	4.4		4.4		mg/kg	S16SB080405-SO	1/1	---	4.4	3.6	29	NA(9)	NA	NO	BSL
7440-39-3	BARIUM	34		34		mg/kg	S16SB080405-SO	1/1	---	34	57.2	1600	NA(9)	NA	NO	BSL,BKG
7440-70-2	CALCIUM	1500	J	1500	J	mg/kg	S16SB080405-SO	1/1	---	1500	499	NA	NA(9)	NA	NO	NUT
7440-47-3	CHROMIUM	15		15		mg/kg	S16SB080405-SO	1/1	---	15	21.5	38	NA(9)	NA	NO	BSL,BKG
7440-50-8	COPPER	14		14		mg/kg	S16SB080405-SO	1/1	---	14	25.6	NA	NA(9)	NA	NO	BKG
7439-89-6	IRON	10000	J	10000	J	mg/kg	S16SB080405-SO	1/1	---	10000	17200	NA	NA(9)	NA	NO	BKG
7439-92-1	LEAD	3.8		3.8		mg/kg	S16SB080405-SO	1/1	---	3.8	17.5	NA	NA(9)	NA	NO	BKG
7439-95-4	MAGNESIUM	2500		2500		mg/kg	S16SB080405-SO	1/1	---	2500	3650	NA	NA(9)	NA	NO	NUT, BKG
7439-96-5	MANGANESE	180	J	180	J	mg/kg	S16SB080405-SO	1/1	---	180	188	NA	NA(9)	NA	NO	BKG
7440-09-7	POTASSIUM	1200		1200		mg/kg	S16SB080405-SO	1/1	---	1200	3580	NA	NA(9)	NA	NO	NUT, BKG
7440-22-4	SILVER	2.6		2.6		mg/kg	S16SB080405-SO	1/1	---	2.6	0.385	34	NA(9)	NA	NO	BSL
7440-28-0	THALLIUM	0.44	J	0.44	J	mg/kg	S16SB080405-SO	1/1	---	0.44	0.29	0.7	NA(9)	NA	NO	BSL
7440-62-2	VANADIUM	20		20		mg/kg	S16SB080405-SO	1/1	---	20	35.1	6000	NA(9)	NA	NO	BSL,BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COC.
5 USEPA Soil Screening Level Guidance, May 1996.
6 CTDEP Remediation Standard Regulations, 1996.
7 The chemical is selected as a COC if the maximum detected concentration exceeds the risk-based COC screening level and/or an ARAR/TBC(s).
8 TTNUS, April 14, 1999. Toxicity criteria not available. Toxicity criteria for 2,3,7,8-TCDD used in conjunction with toxicity equivalent factor (TEF) (EPA/625/3-89/016, March 1989) to calculate a value.
9 See Table 9.7-8

Associated Samples:
S16SB080405-SO

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
SSL-MIGR = Soil Screening Level for transfers from soil to groundwater for Dilution and Attenuation Factor of 1 (USEPA, May 1996).

For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No criteria available.

TABLE 9-11

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SUBSURFACE SOIL AT SITE 16
MIGRATION PATHWAYS - SPLP RESULTS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Hospital Incinerator (Site 16)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	CTDEP Mobility Criteria	COPC Flag	Rationale for Contaminant Deletion or Selection(5)
Inorganics														
7439-95-4	MAGNESIUM	150		150		ug/L	S16SB080405-SO-P	1/1	---	150	NA	NA	NO	NTX
7439-96-5	MANGANESE	24		24		ug/L	S16SB080405-SO-P	1/1	---	24	NA	NA	NO	NTX

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COC .

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 SPLP analysis was not performed on background samples.
5 The chemical is selected as a COC if the maximum detected concentration exceeds the risk-based COC screening level.

Associated Samples:
S16SB080405-SO-P

Definitions:
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:
For Selection as a COC:
ASL = Above COC Screening Level.

For Elimination as a COC:
NTX = No criteria available.

TABLE 9-12

SELECTION OF EXPOSURE PATHWAYS FOR SITE 16
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Soil	Surface Soil	Surface Soil	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction workers may have contact with surface soil during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Full-time employees may contact surface soil during normal work activities.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	Quant Quant	Trespassers may be exposed to surface soil while at the site.
		Air	Surface Soil	Construction Workers	Adult	Inhalation	On-site	None	No COCs were identified in surface soil for the inhalation pathway.
				Full-time Employees	Adult	Inhalation	On-site	None	No COCs were identified in surface soil for the inhalation pathway.
				Trespassers	Adolescents	Inhalation	On-Site	None	No COCs were identified in surface soil for the inhalation pathway.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction workers may have contact with subsurface soil during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employees are not exposed to subsurface soil.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers are not exposed to subsurface soil.
		Air	Subsurface Soil	Construction Workers	Adult	Inhalation	On-site	Quant	Construction workers may be exposed to fugitive dust and volatile emissions during construction activities.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to subsurface soil.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers are not exposed to subsurface soil.
Future	Surface Soil	Surface Soil	Surface Soil	Residents	Child	Ingestion Dermal	On-Site On-Site	Quant Quant	Child residents may contact surface soil.
					Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Adult residents may contact surface soil.
		Air	Surface Soil	Residents	Child	Inhalation	On-site	Quant	Child residents may be exposed to fugitive dust and volatile emissions from surface soil.
					Adult	Inhalation	On-site	Quant	Adult residents may be exposed to fugitive dust and volatile emissions from surface soil.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	Residents	Child	Ingestion Dermal	On-Site On-Site	Quant Quant	Child residents may contact subsurface soil that has been brought to the surface.
					Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Adult residents may contact subsurface soil that has been brought to the surface.
		Air	Subsurface Soil	Residents	Child	Inhalation	On-site	Quant	Child residents may be exposed to fugitive dust and volatile emissions from subsurface soil that has been brought to the surface.
					Adult	Inhalation	On-site	Quant	Adult residents may be exposed to fugitive dust and volatile emissions from subsurface soil that has been brought to the surface.

TABLE 9-12

SELECTION OF EXPOSURE PATHWAYS FOR SITE 16
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Groundwater	Overburden/Bedrock Aquifer	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	None None	Construction workers may have dermal contact with groundwater during excavation activities. Not evaluated - No groundwater samples were collected.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers do not have contact with groundwater.
				Residents	Adult	Ingestion Dermal	On-Site On-Site	None None	Groundwater may be used as a potable water source in the future. Not evaluated - No groundwater samples were collected.
					Child	Ingestion Dermal	On-Site On-Site	None None	Exposures to a child resident are less than those for an adult resident
		Air	Overburden/Bedrock Aquifer	Construction Workers	Adult	Inhalation	On-site	None	Construction workers may be exposed to chemicals that have volatilized from groundwater during excavation activities. Not evaluated - No groundwater samples collected.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to chemicals volatilizing from groundwater.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers do not have contact with site groundwater.
				Residents	Adult	Inhalation	On-site	None	On-site residents may be exposed to volatile emissions from groundwater while showering. Not evaluated - No groundwater samples collected.
					Child	Inhalation	On-site	None	Exposures to a child resident are less than those for an adult resident

TABLE 9-13

EXPOSURE POINT CONCENTRATIONS FOR SITE 16
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Surface Soil		All Soil	
	RME (mg/kg)	CTE (mg/kg)	RME (mg/kg)	CTE (mg/kg)
Semivolatile Organic Compounds				
Benzo(a)pyrene	0.33	0.12	0.33	0.11
Inorganics				
Arsenic	8.5	4.0	8.5	4.1
Manganese	400	173	400	174
Thallium	1.2	0.61	1.2	0.59

Notes:
Less than 10 soil samples were collected; therefore, the maximum detected concentration is used for RME and the average detected concentration is used for CTE.

TABLE 9-14

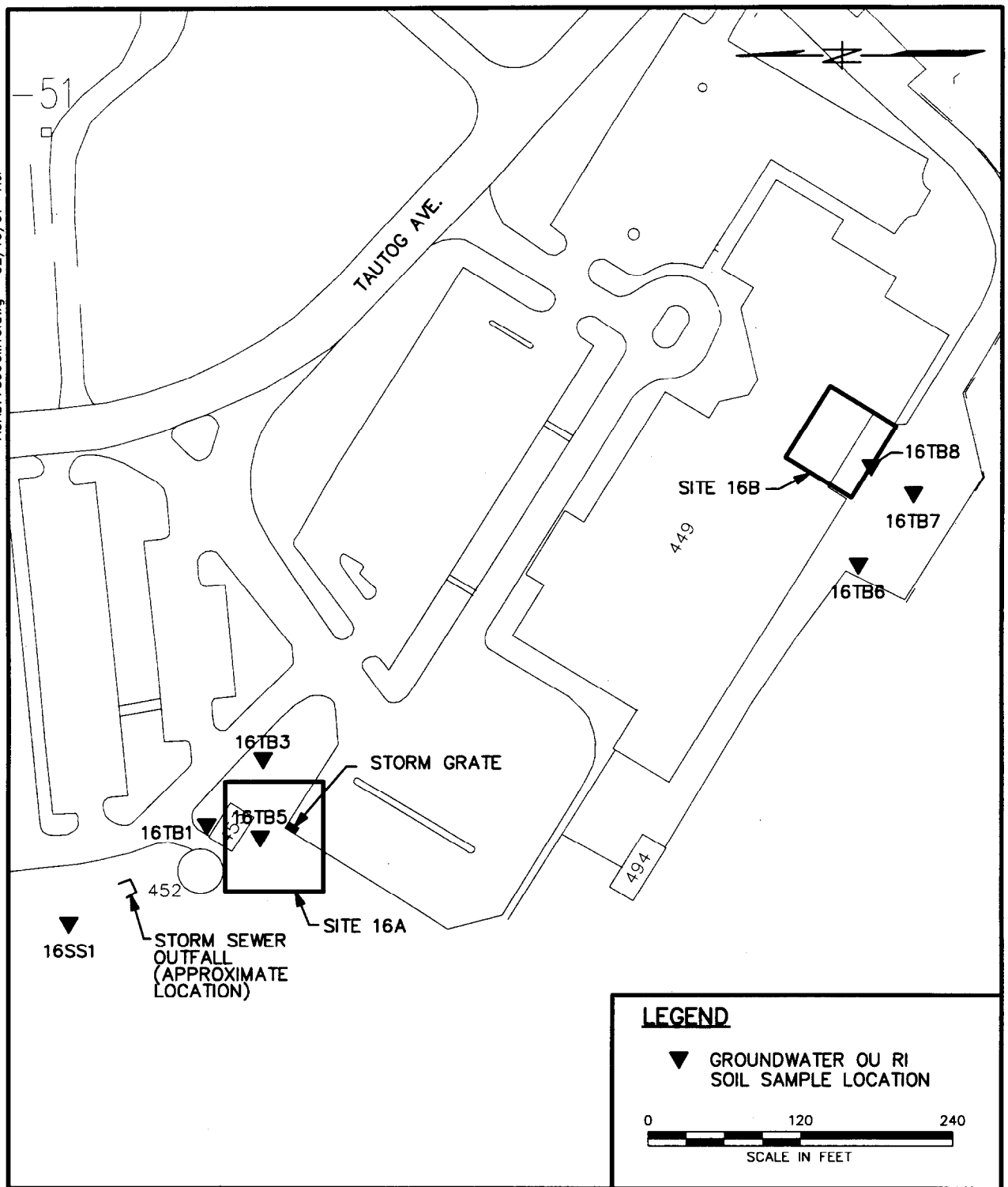
SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 16
REASONABLE MAXIMUM EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Surface/Subsurface Soil	Ingestion	4.9E-07	- -	- -	- -	0.1	- -
		Dermal Contact	3.5E-08	- -	- -	- -	0.003	- -
		Total	5.2E-07	- -	- -	- -	0.1	- -
Full-Time Workers	Surface Soil	Ingestion	3.2E-06	- -	- -	Arsenic	0.03	- -
		Dermal Contact	1.1E-06	- -	- -	- -	0.004	- -
		Total	4.3E-06	- -	- -	Arsenic	0.03	- -
Older Child Trespasser	Surface Soil	Ingestion	1.7E-06	- -	- -	Arsenic	0.04	- -
		Dermal Contact	4.8E-07	- -	- -	- -	0.004	- -
		Total	2.1E-06	- -	- -	Arsenic	0.04	- -
Child Resident	Surface/Subsurface Soil	Ingestion	7.1E-06	- -	- -	Arsenic, Benzo(a)pyrene	0.3	- -
		Dermal Contact	6.8E-07	- -	- -	- -	0.01	- -
		Total	7.8E-06	- -	- -	Arsenic, Benzo(a)pyrene	0.3	- -
Adult Resident	Surface/Subsurface Soil	Ingestion	3.1E-06	- -	- -	Arsenic	0.03	- -
		Dermal Contact	3.7E-07	- -	- -	- -	0.001	- -
		Total	3.4E-06	- -	- -	Arsenic	0.03	- -

TABLE 9-15

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 16
CENTRAL TENDENCY EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Surface/Subsurface Soil	Ingestion	7.5E-08	- -	- -	- -	0.02	- -
		Dermal Contact	9.9E-10	- -	- -	- -	0.0001	- -
		Total	7.6E-08	- -	- -	- -	0.02	- -
Full-Time Employees	Surface Soil	Ingestion	1.7E-07	- -	- -	- -	0.007	- -
		Dermal Contact	1.1E-08	- -	- -	- -	0.0002	- -
		Total	1.9E-07	- -	- -	- -	0.007	- -
Older Child Trespassers	Surface Soil	Ingestion	4.9E-08	- -	- -	- -	0.004	- -
		Dermal Contact	7.9E-09	- -	- -	- -	0.0003	- -
		Total	5.7E-08	- -	- -	- -	0.004	- -
Child Resident	Surface/Subsurface Soil	Ingestion	5.4E-07	- -	- -	- -	0.06	- -
		Dermal Contact	2.9E-08	- -	- -	- -	0.001	- -
		Total	5.7E-07	- -	- -	- -	0.07	- -
Adult Resident	Surface/Subsurface Soil	Ingestion	2.0E-07	- -	- -	- -	0.007	- -
		Dermal Contact	6.5E-09	- -	- -	- -	0.00009	- -
		Total	2.1E-07	- -	- -	- -	0.007	- -



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CHECKED BY DATE	SAMPLE LOCATIONS SITE 16–HOSPITAL INCINERATOR NSB–NLON GROTON, CONNECTICUT	APPROVED BY D Plucose DATE 2-15-01	
COST/SCHED–AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 9–1	REV. 0

FORM CADD NO. T+NUS_AV.DWG - REV 0 - 1/22/98

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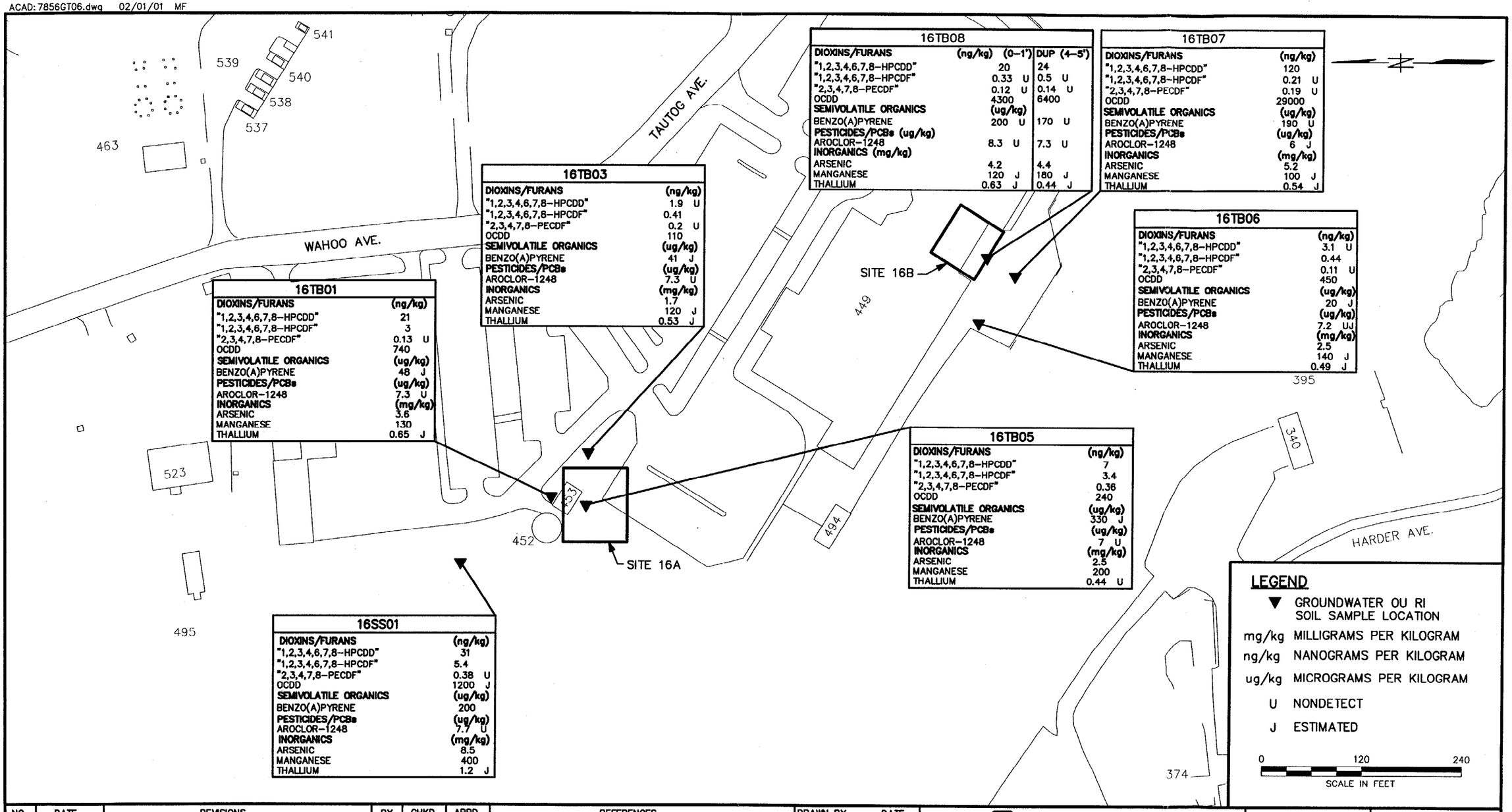

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/27/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

COPCs IN SOIL
SITE 16 – HOSPITAL INCINERATOR
NSB-NLON
GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY DPlescoe DATE 2-15-01
APPROVED BY DATE
DRAWING NO. FIGURE 9-2
REV. 0

FORM CADD NO. T+NUS_BH.DGN - REV 0 - 1/20/98

10734B333

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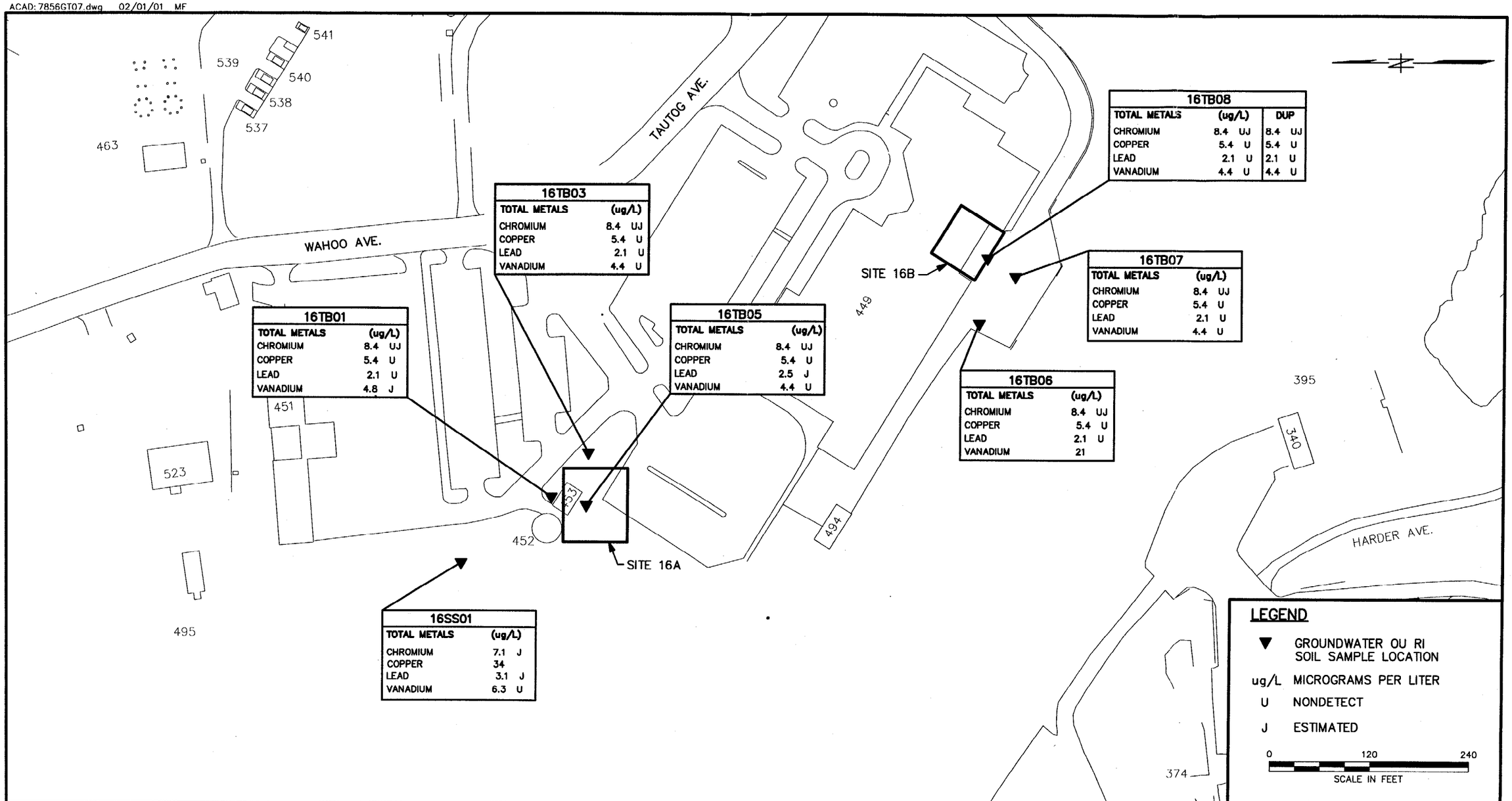

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/27/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

COPCs IN SOIL – SPLP
SITE 16 – HOSPITAL INCINERATOR
NSB-NLON
GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY D Plenone DATE 2-15-01
APPROVED BY DATE
DRAWING NO. FIGURE 9-3
REV. 0

FORM CADD NO. TtNUS_BH.DGN - REV 0 - 1/20/98

10.0 SITE 8 – GOSS COVE LANDFILL

10.1 SITE DESCRIPTION

Goss Cove Landfill (Site 8) is located in the southwestern portion of NSB-NLON, adjacent to the Thames River. It is west of Shark Boulevard and the intersection of Crystal Lake Road and Military Highway, east of the Thames River, and north of Goss Cove. The site location is depicted on Figure 1-2. Figure 10-1 displays the general site arrangement and historical sampling locations. The Nautilus Museum and a paved parking lot were constructed directly over the site of the former landfill. The Nautilus Museum is a submarine museum operated by the Navy that is open to the public. A landfill cap is currently being installed over the former landfill.

The IAS Report indicated that a landfill was operated at this site from 1946 through 1957. Incinerator ash and inert rubble were disposed at the site, in what was then the northern portion of Goss Cove. It is not known if any other materials were disposed in the former landfill. It has been reported that several large compressed-gas cylinders were uncovered during the excavation of a utility trench in the parking area north of the Nautilus Museum building. One of the cylinders was leaking propane, one was filled with ammonia, and the others were empty.

As part of Phase I, Atlantic personnel reviewed archive photographs of the Goss Cove area that were available at the Connecticut State Library (Atlantic, 1992). In a 1934 aerial photograph, the limits of Goss Cove appeared to be open water with no evidence of fill. Railroad tracks are shown at their present position between the cove and the Thames River. In 1951 aerial photographs, the fill extended southward to approximately the location of an access driveway to the museum. The 1965 aerial photographs show the landfill extending to the present limit of encroachment on Goss Cove. Aerial photographs from 1965, 1970, 1975, and 1980 show cars parked on the landfill surface. In 1986 photographs, the Nautilus Museum is present on the southern limits of the landfill and a paved parking area extends over the remaining limit of the landfill to the north. Construction of the Nautilus Museum was completed in 1985.

Atlantic personnel reviewed boring logs generated during the construction of the Nautilus Museum. The boring logs indicated the presence of fill material consisting of cinders, metal, brick, glass, and sand and gravel to a depth of 15 feet. Beneath the fill is a layer of organic silt approximately 10 to 15 feet thick. This material is presumably the sediment bottom of the former cove. The silt is underlain by fine sand to depths ranging from 25 to 100 feet below the surface. The thickness of overburden increases from east to west, toward the river.

10.2 SITE INVESTIGATIONS

The details of all investigations, including historical and current, conducted at the Goss Cove Landfill are provided in the following subsections.

10.2.1 Phase I Remedial Investigation (Atlantic, 1992)

Atlantic Environmental Services, Inc. completed an investigation of 11 sites at NSB-NLON from 1990 through 1992. Atlantic investigated seven of the 11 sites as Initial Site Inspections (ISIs) and four sites under a Phase I RI. The investigation at Goss Cove Landfill was an ISI.

The Phase I RI field investigation at this site consisted of a soil gas survey, test borings, monitoring well installation, and soil, surface water, and groundwater sampling. A soil gas survey was conducted in an attempt to locate potential sources of volatile organic contamination. Seven subsurface (3 feet deep) soil samples plus one field duplicate were collected from three test borings and four monitoring well borings to confirm the soil gas survey results. The soil borings showed the thickness of fill to range from 10 to 20 feet. Fill materials consisted of sand and gravel with small quantities of brick, glass, sandblast grit, ash, wood, and metal. All soil samples were collected from within the landfill material, generally at or below the water table. Four overburden monitoring wells were installed within the former landfill and one groundwater sample was obtained from each well. One surface water sample was collected in the Thames River downstream of the landfill. As a result of the investigation, Atlantic recommended that this site proceed to Step I of the IRP and that additional investigations be conducted at the site.

10.2.2 Phase II Remedial Investigation (B&R Environmental, 1997a)

B&R Environmental conducted a Phase II RI at 13 sites at NSB-NLON. The Goss Cove Landfill was one of the sites included in the investigation. Three rounds of investigation were completed at Goss Cove Landfill during the Phase II RI. Five surface (less than 3 feet deep) and four subsurface (greater than 3 feet deep) soil samples were collected during the installation of six monitoring wells during Round 1 of the Phase II RI. In addition, four surface and 11 subsurface soil samples plus two field duplicates were collected from 12 test borings during the Round 1 sampling event. Three supplemental surface soil samples plus a field duplicate were collected during the Round 3 sampling event. Three shallow and four deep monitoring wells were also installed during the Phase II RI. Eleven groundwater samples (plus two field duplicates) were collected from the seven new and four previously installed monitoring wells during both Rounds 1 and 2.

Surface water and sediment sampling during the Phase II RI focused on Goss Cove. Five surface water samples (plus one field duplicate) and five sediment samples (plus one field duplicate) were collected

from the perimeter of the cove. One additional sediment sample was collected from Goss Cove during the supplemental ecological sampling round of the Phase II RI.

Three rounds of air sampling were performed during the Phase II RI. Air samples were collected from three locations in or near the Nautilus Museum during Round 1; these locations included the ledge above the sump in the boiler room of the museum (8AS1), the museum floor on top of the USS Plunger showcase (8AS2), and the top of the rail on the deck outside the museum (8AS3). Samples were collected from these same three locations during Round 2. A fourth location, the pipe chase area beneath the western end of the museum that leads to the docked Nautilus submarine, was also sampled during Round 2 (8AS4). Samples collected during Rounds 1 and 2 were analyzed for TCL VOCs using USEPA methodology (Method TO-1).

A confirmatory third round of air sampling was performed using sampling and analysis methods specified by the National Institute for Occupational Safety and Health (NIOSH) since it had been determined that these methods may be more appropriate in evaluating the air at the museum. Four air samples plus one field duplicate were collected from the same four locations used for air sampling during Round 2. Three tubes were used for sample collection at each location; these included two tubes in series (T1 and T2), which were filled with coconut charcoal, and a third tube (T3) filled with Anasorb. Tubes T1 and T2 were used for the analysis of acetone, toluene, ethylbenzene, methyl chloride, methylene chloride, and 1,1,1-trichloroethane. Tube T3 was used for the analysis of 2-butanone. Most of these compounds were previously detected in sample Rounds 1 and 2, which served as the basis for selection and analysis during sample Round 3.

The Navy initiated additional sampling at the Goss Cove Landfill and Nautilus Memorial Museum (Site 8) because of public concern for the possible unacceptable risks at the site reported in the Draft Phase II RI Report. The additional sampling was conducted by B&R Environmental in July 1995 and consisted of the collection of four soil samples and two rounds of air sampling within and outside the museum. The letter report concluded that no unacceptable risks associated with exposure to the air or soil at Goss Cove exist.

The Phase II RI Report recommended that an FS of remedial alternatives be conducted at the Goss Cove Landfill site. The report indicated that a phased approach should be used to proceed to the FS. The report indicated that sufficient data had been collected for the sediment and surface water media and an FS could be completed for these media. Additional investigation of the soil and groundwater was recommended to verify the source and extent of the PCE contamination detected in the upgradient wells. It was recommended that groundwater be evaluated separately in a base-wide groundwater FS.

10.2.3 Data Gap Investigation (B&R Environmental, 1997d)

B&R Environmental conducted a data gap investigation at the Goss Cove Landfill to address the source of chlorinated VOC contamination detected in the groundwater of upgradient wells at the site. Borings and wells were installed and soil and groundwater samples were collected during the investigation. The results of the investigation concluded that chlorinated compounds are migrating onto the site from an upgradient off-site source. The upgradient off-site source appears to be Fosconi Cleaners. The DGI report states that a fracture system is aligned northwest-southeast and appears to transport contamination from the dry cleaners to the monitoring well 8MS8S/8MW8D location. This also evidenced by the DGI Figure 2-2 that shows groundwater flow in the shallow system moves from monitoring well 8MW9S at the dry cleaners site to lower potentiometric heads at monitoring wells 8MW10S and 8MS8S at the gate near the Nautilus Museum. The DGI also indicates that there are numerous utility conduits that may contribute to local groundwater flow characteristics.

The report recommended that further groundwater characterization be completed to address the contaminant source. The report also recommended that the upcoming FS for the Goss Cove Landfill should be prepared separately from the ongoing upgradient groundwater characterization activities.

10.2.4 Wetlands Function and Values Assessment (TtNUS, 1998a)

A Wetlands Function and Values Assessment was completed by Connecticut College for TtNUS in July 1998 to evaluate if the ecological stress in the Goss Cove water body was a result of natural conditions or due to contaminant migration from other NSB-NLON sites. This study evaluated the marginal cove vegetation in terms of its ecological functions and values and identified the wetland species associated with the fringing belt. A detailed vegetation inventory of the taxa, which included an inventory of all species of vascular plants present above mean high tide and an examination of the biota associated with the intertidal zone, was undertaken.

No discrete wetland plant communities were identified. A few wetland species were found. The results of this assessment concluded that the contrast between the Thames River and cove side is dramatic due to the lack of tidal flushing. Although the tidal range is reflected within the cove, it does not appear adequate to aid in supporting a rich viable intertidal algal population and invertebrate biota. This may be related to water quality since it appears that estuarine organisms can and have become established in the cove in the past but fail to thrive. Although there are tidal fluctuations, the absence of regular tidal flushing may concentrate any constituents that may be present.

10.2.5 Phase I/II Environmental Site Assessment of Fusconi Dry Cleaners (CTDEP, 1999)

CTDEP conducted a Phase I/II Environmental Site Assessment of Fusconi Dry Cleaners in July and August of 1998. The dry cleaner has operated at a location east and upgradient of the Goss Cove Landfill site on the corner of Crystal Lake Road and Military Highway for approximately 50 years. The dry cleaner uses tetrachloroethene in its cleaning process. Tetrachloroethene has been detected in the groundwater at the Goss Cove Landfill. The purpose of the investigation was to assess the dry cleaner's operation and to determine if a release of tetrachloroethene had occurred on site.

The assessment involved interviewing the operator of the dry cleaner and collecting medium-specific samples. The interview revealed that, historically, it was common practice to dump spent (i.e., used) tetrachloroethene out the back door of the facility onto the ground. The dry cleaner now retains the services of Safety Kleen to dispose of spent filters and product. A drum of liquid waste in the rear of the establishment was damaged and had rainfall overflowing the container. A PID scan of the drum showed concentrations of 349 meter units. It was also determined that the building was historically hooked up to a septic system and leachfield but currently utilizes municipal sewer.

Thirteen soil samples, two groundwater samples, and one aqueous drum sample were collected by CTDEP during the investigation. The samples were obtained and collected utilizing a Geoprobe®/microwell system and analyzed for VOCs. Tetrachloroethene was detected in each of the media sampled in nearly all the samples. Several other VOCs were also detected. Soil, groundwater, surface water and sediment data were collected as part of the Phase I and II RI investigations at Goss Cove. The CTDEP represented these data to show the distribution of chlorinated solvents in the area surrounding the Fosconi's Dry Cleaner site. Although the CTDEP does not directly indicate that the detections at the Goss Cove area are from the Fosconi site, the reporting would imply that a relationship is possible.

The results of the investigation conclusively showed that a release of tetrachloroethene occurred at the site. This suggests that the dry cleaner is the source of the tetrachloroethene that was detected in the downgradient groundwater at the Goss Cove Landfill. Fusconi Dry Cleaners has procured a consultant to help them address their environmental concerns. They also voluntarily removed a drum of spent tetrachloroethene and completed a soil removal action in the vicinity of the drum. The consultant will also perform further investigations to determine the nature and extent of the contamination and produce a remedial action plan to address site issues.

10.2.6 Evaluation of Chemical and Toxicological Data for Goss Cove (SAIC, 1999)

The purpose of this study, conducted by Science Applications International Corporation (SAIC) in 1998, was to provide the necessary information to reach conclusions regarding the degree and extent of ecological risk posed by chemical contamination for Goss Cove. The objectives of the study were to establish toxicological response relationships to contaminants in Goss Cove sediments, to describe the extent of ecological risks associated with chemical contaminants in Goss Cove sediments, and to identify risks for biological effects. Based on data needs, 10 stations were sampled for chemical, toxicological, and Toxicity Identification Evaluation (TIE). The TIE involves chemical manipulation of the sediment to separate contaminant classes. The TIE employed three manipulations: C18 column extraction, ethylenediaminetetraacetic acid (EDTA) chelation, and an aeration/ULVA treatment. Ulva is an algae. These three steps remove organic compounds, metals, and hydrogen sulfide/ammonia, respectively.

The results of the study clearly support the conclusion that a complete pathway does not exist between site-specific contaminants and observed ecological effects. The likely source of toxicity in one of two species where toxicity was observed was ammonia from natural sources. It may be possible to improve benthic habitat quality by reducing the hypoxic conditions in the cove, thereby reducing the ammonia concentrations that appear to be the cause of the depauperate aquatic community.

10.2.7 Feasibility Study for Soil Operable Unit (TtNUS, 1999d)

An FS for the soil and sediment OUs at Goss Cove Landfill (TtNUS, 1999d) was prepared in 1999. Additional investigations conducted as part of the FS (SAIC, 1999) showed that the contaminant levels detected in the sediment and surface water in Goss Cove did not pose potential adverse risks to human health or the environment. Based on these findings, no further action was recommended for these media. The two remedial alternatives evaluated in the FS were no action and installation of engineered control cap with institutional controls and monitoring. The capping alternative was selected for the Goss Cove Landfill and was presented in the Proposed Plan for the site. The Proposed Plan was presented at a public meeting in June 1999. The ROD for this site was signed by the Navy and regulators in September 1999.

10.2.8 Bidding Documents for Goss Cove Landfill (TtNUS, 2000b)

TtNUS completed the design of the landfill cap and replacement storm sewer system for the Goss Cove Landfill in 2000. The Bidding Documents version of the design was issued by TtNUS in July 2000. The package included design drawings and specifications. A total of 43 design drawings were prepared to show the necessary details regarding grading, storm drainage, construction details, etc. The specifications address pilings, culverts, replacement utilities, grading, and other earth work activities. The

document also addresses land use restrictions, site monitoring, and 5-year site reviews. The storm sewer and landfill cap are currently being constructed at Goss Cove Landfill by the Navy's Remedial Action Contractor.

10.2.9 Basewide Groundwater OU RI

During the BGOURI, only groundwater samples were collected from historical monitoring wells to further characterize this site. A summary of the sampling and analytical program is presented in Table 10-1. The nine monitoring wells (8MW01, 8MW02S, 8MW02D, 8MW03, 8MW04, 8MW5S, 8MW06S, 8MW06D, and 8MW09S) that were sampled are shown on Figure 10-1. A field duplicate was also collected from monitoring well 8MW06S. The methodology used to complete groundwater sampling was discussed in Section 2.3.

Monitoring well 8MW09S is located upgradient of the Goss Cove Landfill site. The analytical results from this well were included in the nature and extent of contamination evaluation provided in this RI but were not included in the HHRA evaluation since the contamination within the groundwater at this well location is not site related.

Monitoring wells 8MW8S, 8MW8D, and 8MW10S were sampled during this RI but were considered background wells. Their locations are shown on Figure 10-1. These wells have historically been associated with the Goss Cove Landfill. However, similar to 8MW09S, the contamination present in these upgradient wells is not considered to be site related. The positive analytical results for samples collected from these wells are presented in Table 3-2 and are discussed in the nature and extent of contamination section provided below.

10.3 PHYSICAL CHARACTERISTICS

This section presents a summary of physical characteristics for the Goss Cove Landfill based on information generated during the Phase I and Phase II RIs and the BGOURI. Topography and surface features, surface water, soils, geology, and hydrogeology are discussed in the following subsections.

10.3.1 Surrounding Topography and Surface Features

Figure 1-3 shows the topography and surface features at the Goss Cove Landfill. An exposed bedrock high is located along the northeastern edge of the landfill. In the most northern portion of the landfill, the ground surface has an approximate slope along the bedrock ridge of 50 percent. The slope of the hill is steeper in the central part of the landfill. The ground surface across the remainder of the site slopes mildly toward the Thames River.

The Nautilus Museum and a paved parking lot were constructed directly over the site of the former landfill. Railroad tracks are located between the site and the Thames River. Remaining portions of the site are grass covered.

A landfill cap is currently being constructed over the landfill wastes and will result in a final grade that is greater in elevation than the pre-construction grade.

10.3.2 Surface Water Features

The Goss Cove Landfill is located along the eastern bank of the Thames River. Goss Cove borders the site to the south. Historically, several storm sewer pipes transected the site, running east-west, and discharged to the Thames River. All drainage from the site flows west and southwest to the Thames River and Goss Cove.

The storm sewers that existed prior to 1999 have been removed or grouted shut. A 4-foot by 10-foot box culvert has been installed to replace the three 42-inch corrugated metal storm sewers that conveyed upgradient stormwater through the site to the Thames River. A shallow replacement stormwater drainage system will also be installed after the landfill cap is completed to collect and transmit stormwater runoff.

10.3.3 Soil Characteristics

The SCS Soils Map (SCS, 1983) classifies the soil at the Goss Cove Landfill as Rock Outcrop-Hollis. This soil is defined as rock outcrop covered by Hollis soil and Urban land. The bedrock outcrop occurs along the northeastern border of the site. The overlying Hollis soil is a very dark brown, fine, sandy loam. As a result of landfilling activity, Urban land exists across most of the site.

10.3.4 Geology and Hydrogeology

This section provides a discussion of the geology and hydrogeology of the Goss Cove Landfill. A discussion of the site conceptual model is provided in Section 4.0. Section 4.0 addresses larger scale issues and presents additional interpretations of the site.

Geology

The geology of the Goss Cove Landfill generally consists of alluvial deposits overlying metamorphic bedrock. Fill overlies the natural geologic materials within the landfill area. The approximate limit of fill is shown on Figure 10-1. A bedrock hill rises northeast of the site and a cove borders the site to the south. The site contains fill materials (primarily sand and gravel with miscellaneous rubble) that slightly thicken

as the bedrock surface slopes to the southwest toward the Thames River. Across most of the landfill, the overburden immediately beneath the fill consists of clayey silt that thickens toward the southwest. Beneath the clayey silt, or beneath the fill where the clayey silt is not present, the overburden consists of irregular thicknesses of fine to medium sand with intervals that contain gravel and rock fragments. The natural materials are mapped as stratified drift of glacial outwash streams (USGS, 1960) but may also be modern-day stream deposits.

The bedrock at the site has been identified as the Mamacoke Formation on the bedrock geologic map (USGS, 1967). The bedrock surface was field identified in the northern outcrop area and at monitoring well 8MW8D at an elevation of 7.8 feet. The bedrock surface dips steeply southwest toward the Thames River. Recent piling activities for the installation of the replacement storm sewer have shown the depth to the bedrock surface to be in excess of 100 feet below pre-construction grade. Figures 4-16 and 4-17 are geologic cross sections that include portions of the Goss Cove Landfill.

Hydrogeology

Two rounds of groundwater-level measurements were taken in Goss Cove Landfill monitoring wells during the BGOURI. The measurements and the associated elevations are summarized in Tables 2-2 and 2-3 in Section 2.0. The elevations were used in conjunction with water-level elevations from other Southern Region sites to create the potentiometric surface maps provided in Section 4.0. Figures 4-12 and 4-14 show overburden groundwater flow patterns, and Figures 4-13 and 4-15 show bedrock groundwater flow patterns. Drawing 1-5 shows historic shallow overburden groundwater contours for the Goss Cove Landfill.

During historical and current investigations at this site, groundwater was encountered within both the overburden and bedrock. The depth to groundwater averages about 7 feet, and the water table extends up into the landfill materials over most of the site. Groundwater flows west and southwest through the Goss Cove area toward the Thames River. Manmade (utility conduits) and natural (bedrock fractures) occur at this site to impact the direction of groundwater and contaminant flow. There is a downward component of flow from the overburden to the bedrock at the 8MW8 well cluster. There was also a downward component of flow from the shallow to the deeper overburden for two of the three comprehensive water-level measurement rounds at the 8MW2 and 8MW6 well clusters. The downward gradient at the 8MW2 cluster and the detection of chlorinated solvents in the deeper well (8MW2D) give credence to the argument that the chlorinated solvent occurrence is due to upgradient contamination. Contamination is introduced at a shallow upgradient source and a portion goes into the dissolved phase. The dissolved phase contamination gets transported deep due to the gradients and is manifested as a higher concentration of chlorinated compounds at depth (8MW2D) versus more shallow (8MW2S). Had the source of the chlorinated solvent contamination been from a landfill source the shallow well should

have a higher concentration than the deeper well. All other volatile organic compounds show concentrations greater in 8MW2S versus 8MW2D. The source of these contaminants is likely from the landfill itself.

Based on tidal studies performed at the Lower Subase, it is expected that shallow overburden groundwater levels will fluctuate with the tide over most of the area of the Goss Cove Landfill. Based on slug test results for the Goss Cove Landfill (Table 4-1), the fill materials appear to be much more permeable than the alluvium. The estimated average hydraulic conductivities based on these slug tests are 43 ft/day for the fill and 0.4 ft/day for the alluvium.

An average shallow groundwater hydraulic gradient of .0075 was calculated using the groundwater-level measurements/potentiometric surface maps for June and August 2000. Based on the average hydraulic conductivity of 43 ft/day, the flow gradient of 0.0075, and an assumed porosity of 0.30, the average shallow groundwater flow velocity across Site 8 is 1.1 ft/day.

10.4 NATURE AND EXTENT OF CONTAMINATION

This section presents an evaluation of the nature and extent of groundwater contamination at Site 8. The discussion includes historical data collected during Rounds 1 and 2 of the Phase II RI and groundwater data collected during the BGOURI. Groundwater sample locations are shown on Figure 10-1.

10.4.1 Previous Investigations

Soil, overburden groundwater, and bedrock groundwater sampling was conducted at the Goss Cove Landfill during the Phase I and Phase II RIs and the Data Gap Investigation. Based upon the results of these investigations, the nature and extent of contamination of the soil and groundwater at the Goss Cove Landfill are discussed on a matrix-specific basis in the following subsections. A summary of historical groundwater analytical data is contained in Appendix D.

10.4.1.1 Historic Soil Data

Several VOCs, including three ketones, five monocyclic aromatics, five chlorinated aliphatics, and carbon disulfide, were detected in the Goss Cove Landfill soil samples. With the exception of acetone, 2-butanone, ethylbenzene, PCE, toluene, and total xylenes, VOCs were infrequently detected (i.e., in from one to four of 39 samples) in soil samples. Acetone and 2-butanone, which are both common laboratory contaminants, were detected at concentrations ranging from 0.053 mg/kg to 23 mg/kg and from 0.028 mg/kg to 0.12 mg/kg, respectively.

Two of the five detected monocyclic aromatic compounds were present at relatively high concentrations in the soil sample collected from a depth interval of 10 to 12 feet from boring 8TB8 (ethylbenzene at 69 mg/kg, toluene at 15 mg/kg, and total xylenes at 480 mg/kg), which is located in the central portion of the site. These results indicate the presence of fuel-related contamination. The maximum detection of toluene was found in location 8MW3 at 22 mg/kg. Concentrations of ethylbenzene, toluene, and total xylenes increased with depth. PCE was the most frequently detected VOC (15 out of 39 samples). PCE was detected at a maximum concentration of 0.086 mg/kg in boring 8SB10S. Concentrations of VOCs were generally higher in soil samples collected at depths greater than 6 feet. It is important to note that the highest concentrations of PCE are associated with the Fusconi Dry Cleaner's site, which is upgradient of the Goss Cove Landfill. This dry cleaner is the contributing source of the PCE at soil boring 8SB10S. This source also impacts downgradient groundwater sampling points at Goss Cove.

Thirty-one SVOCs were detected in the Goss Cove Landfill soil samples. Sixteen of these SVOCs were PAHs. Maximum concentrations of eight SVOCs were detected in the soil sample collected from a depth interval of 0 to 2 feet bgs from boring 8MW8S (collected just outside the eastern border of the former landfill). Maximum concentrations of eight more SVOCs were detected in the soil sample collected from a depth interval of 8 to 9 feet bgs from boring 8TB6. PAHs were the most prevalent class of SVOCs and were generally detected at the highest concentrations. PAHs were detected in from 22 to 34 samples out of 34 samples collected, making PAHs the most frequently detected class of SVOCs. Maximum concentrations of PAHs ranged from 7.5 mg/kg [benzo(g,h,i)perylene] to 500 mg/kg (chrysene). 2,4-Dimethylphenol, 2-methylphenol, 3,3'-dichlorobenzidine, 4-methylphenol, benzoic acid, bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, di-n-butyl phthalate, di-n-octyl phthalate, dibenzofuran, diethyl phthalate, isophorone, and phenol were also each detected in from one to nine samples.

Seventeen pesticides and three PCBs were detected in the Goss Cove Landfill soil samples. Maximum detected concentrations of five pesticides and two PCBs were found in the soil sample collected at a depth interval of 14 to 16 feet from boring 8TB5. 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE were the most frequently detected pesticides. 4,4'-DDT and its breakdown products were also detected at higher concentrations than other pesticides. The maximum concentrations of the three detected PCBs ranged from 0.5 mg/kg (Aroclor 1260) to 33 mg/kg (Aroclor 1254), and the maximum concentrations of 4,4'-DDT and its breakdown products were 1.2 mg/kg (4,4'-DDE) and 3.4 mg/kg (4,4'-DDT). Endrin, endrin aldehyde, and heptachlor were detected in from 11 to 17 samples collected. The remaining pesticides and PCBs were detected in from one to nine soil samples.

Of the two soil samples collected, OCDD was detected in one sample (8TB5-1416) at a maximum concentration of 0.0028 mg/kg in Goss Cove soil samples.

Twenty-four metals were detected in the Goss Cove Landfill soil samples. Fourteen of these metals were detected in 34 out of 34 soil samples. Maximum concentrations of 12 metals were detected in the soil sample collected from a depth interval of 4 to 6 feet but in various different sample locations. Antimony, beryllium, cadmium, cobalt, lead, manganese, nickel, vanadium, and zinc were selected in the EDSR (TtNUS, 1999c) as COPCs. Antimony, selenium, and thallium were detected the least frequently, in from two to five soil samples.

TCLP extraction followed by analysis for metals was performed for 17 Goss Cove Landfill soil samples. Seven metals were detected in TCLP leachates of the soil samples. Barium, cadmium, chromium, and lead were detected in eight or more of the leachates (i.e., in from eight to 17 of the 17 leachates). Maximum concentrations of arsenic, selenium, and silver were detected in from three to four of the 17 leachates. Lead was detected at the highest concentration (4.8 mg/L).

10.4.1.2 Historic Groundwater Data

Groundwater samples from both overburden and bedrock wells were collected at the Goss Cove Landfill. Well 8MW8S was screened at an interval that spans both the overburden and bedrock aquifers. Groundwater samples collected from this well are considered to be representative of the overburden aquifer for purposes of data evaluation. It is important to note that monitoring wells 8MW8S, 8MW8D, 8MW9S, and 8MW10S are upgradient of the Goss Cove Landfill site and are being impacted by a release of PCE from the Fusconi Dry Cleaner's site. Appendix D presents descriptive statistics (i.e., frequency of detection, minimum and maximum concentrations, range of detection limits for nondetects, 95% UCL, and sample number and location associated with maximum concentration) and associated COPC screening criteria for each analyte detected at least once in groundwater samples collected from overburden wells at the Goss Cove Landfill.

Overburden Groundwater Data

Fifteen VOCs, including four monocyclic aromatics, seven chlorinated aliphatics, three ketones, and carbon disulfide, were detected in the groundwater samples collected from overburden wells. The reported concentrations of most of these VOCs were relatively low, ranging from 1 µg/L to 12 µg/L. However, reported maximum concentrations of the fuel-related monocyclic aromatics (ethylbenzene, toluene, and total xylenes) ranged from 120 µg/L (ethylbenzene) to 610 µg/L (total xylenes). Benzene, ethylbenzene, and total xylenes were the most frequently detected VOCs (detected in from eight to 16 out of 27 groundwater samples). Additionally, the maximum reported concentrations for acetone and 4-methyl-2-pentanone were also relatively high (700 and 200 µg/L, respectively) but these VOCs were only detected in from one to three of 27 samples. PCE was detected in 11 of 27 samples at a maximum concentration of 120 µg/L in well 8MW8S (which is located northwest and downgradient of the dry

cleaners). The maximum concentrations of 1,2-dichloroethene (total), 4-methyl-2-pentanone, acetone, benzene, ethylbenzene, toluene, and total xylenes were associated with groundwater samples collected from this well.

As shown in Appendix D, 30 SVOCs were detected in the groundwater samples collected from Goss Cove Landfill overburden wells. Various classes of SVOCs, including substituted phenols, PAHs, and phthalates, as well as benzoic acid, carbazole, dibenzofuran, 4-bromophenyl ether, and n-nitrosodiphenylamine, were detected. In general, SVOCs were infrequently detected at relatively low concentrations. With the exception of PAHs, 2,4-dimethylphenol, and 2-methylnaphthalene, the remaining SVOCs were detected in from one to eight samples. Concentrations of all but five SVOCs [2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, bis(2-ethylhexyl) phthalate, and naphthalene] ranged from 0.5 µg/L to 26 µg/L. The concentrations of the other five SVOCs ranged from 0.6 µg/L to 500 µg/L. Maximum concentrations of 19 of the 25 SVOCs were associated with groundwater samples collected from well 8MW3.

Twenty-four metals were detected in the unfiltered groundwater samples collected from the Goss Cove Landfill overburden wells, and 20 metals were detected in the associated filtered groundwater samples. In general, reported concentrations of metals in filtered and unfiltered samples were relatively similar (i.e., at the same order of magnitude). Exceptions to this statement include reported results for copper; the maximum concentration reported for this metal in unfiltered groundwater samples was approximately 80 times larger than the maximum concentration reported for the filtered groundwater samples. A majority of the maximum concentrations were associated with samples collected from well 8MW7S.

Radionuclide analyses (gross alpha and gross beta) were performed for groundwater samples collected from six overburden wells during the Phase I RI. Complete gamma spectrum analysis was performed on three samples and gross alpha and gross beta analyses were performed on seven groundwater samples collected from overburden wells during the Phase II RI. Based on the levels of uncertainty reported with the results (i.e., uncertainty levels are greater than results themselves), gross alpha levels in groundwater samples collected from all overburden wells except 8MW1 (Phase I result) and 8MW4 (Phase II Round 2 results) are considered to be not detected. Gross alpha was positively detected at concentrations of 28.9 pCi/L, (Phase I) and 21 pCi/L (Phase II Round 2) in samples from overburden wells 8MW1 and 8MW4, respectively. Gross beta was detected in groundwater samples from Goss Cove Landfill overburden wells at concentrations ranging from 21.7 pCi/L to 170 pCi/L.

The only radionuclide identified by complete gamma spectrum analysis was naturally occurring potassium-40. Based on the levels of uncertainty reported with the results, potassium-40 is considered to be not detected in the groundwater samples collected from well 8MW4 during Rounds 1 and 2 of the

Phase II RI. Potassium-40 was positively detected at concentrations of 130 pCi/L and 160 pCi/L in the field duplicate pair collected from well 8MW1 during Round 2 of the Phase II RI.

Bedrock Groundwater Data

All bedrock monitoring wells were completed upgradient of the limits of the Goss Cove Landfill. Therefore, the source of detected compounds in bedrock monitoring wells is not attributable to the landfill materials. Seven VOCs, including one monocyclic aromatic, three chlorinated aliphatics, two ketones, and carbon disulfide, were detected in from one to two of the eight groundwater samples collected from Goss Cove Landfill bedrock wells. The only exception was PCE, which was detected in all eight samples that were collected. Total xylenes was detected at a concentration of 58 µg/L. 1,2-Dichloroethene (total) and TCE were detected at maximum concentrations of 1 and 25 µg/L, respectively. Maximum concentrations of acetone and 2-hexanone were 220 and 49 µg/L, respectively. Concentrations of PCE ranged from 120 to 5,600 µg/L. Maximum concentrations of all the VOCs were found in groundwater samples collected from well 8MW8D. Unlike the groundwater samples collected from the Goss Cove overburden wells, monocyclic aromatics were not detected at significant concentrations in groundwater samples from the Goss Cove Landfill bedrock wells.

Only three SVOCs [benzoic acid, bis(2-ethylhexyl) phthalate, and phenol] were detected in groundwater samples from Goss Cove Landfill bedrock. These compounds were only detected each in one out of two samples collected, with the maxima all occurring in well 8MW8D. The maximum detected concentrations for these SVOCs ranged from 0.8 to 17 µg/L.

Eighteen metals were detected in the unfiltered groundwater samples collected from the Goss Cove Landfill bedrock wells, and 10 metals were detected in the associated filtered groundwater samples. Reported concentrations of metals in filtered and unfiltered samples were relatively similar (i.e., at the same order of magnitude). Exceptions to this statement include reported results for copper and iron; maximum concentrations reported for each of these metals in unfiltered groundwater samples from bedrock wells were from approximately 17 to 190 times the maximum concentrations reported for the respective filtered groundwater samples. Unlike the overburden groundwater samples, the majority of maximum concentrations of the detected metals were below respective concentrations of these metals detected in unfiltered samples collected from off-site residential wells. The only exceptions were aluminum in unfiltered samples, arsenic in unfiltered samples, chromium in unfiltered samples, cobalt in unfiltered samples, magnesium in unfiltered and filtered samples, and vanadium in unfiltered samples. Maximum concentrations of metals detected in groundwater samples from bedrock wells were less than maximum concentrations of respective metals detected in groundwater samples from overburden wells.

10.4.2 Basewide Groundwater OU RI

A summary of the BGOURI sampling and analytical program for Site 8 is presented in Table 10-1. A complete summary of the Site 8 analytical data set is provided in Appendix B. Table 10-2 presents a summary of positive groundwater analytical results for Site 8.

As part of the HHRA, descriptive statistics (i.e., frequency of detections, minimum and maximum concentrations, range of detection limits, and the associated sample numbers) and the COPC screening criteria for each analyte detected at least once in groundwater at the Goss Cove Landfill were tabulated. Analytical results for groundwater are summarized and screened in Tables 10-4 and 10-5. Different exposure scenarios (i.e., direct exposure and migration) are considered in each table. Tag maps of the chemicals determined to be COPCs based on the screening assessment were created to show the horizontal extent of contamination. Figure 10-2 shows COPCs that exceeded direct exposure or migration screening criteria. The analytical detection limit for a COPC is presented on the tag maps if the COPC was not detected in a sample.

Nine VOCs were detected in the eight groundwater samples collected from the overburden aquifer. The following VOCs were detected at concentrations in excess of their respective screening criteria: benzene, cis-1,2-dichloroethene, m- and p-xylenes, PCE, TCE, vinyl chloride, total xylenes. The source of the PCE and its degradation compounds (TCE, cis-1,2-dichloroethene, vinyl chloride) is the Fusconi Dry Cleaners site, located upgradient of the Goss Cove Landfill. Soil data from the Goss Cove Landfill suggest that the source of the fuel hydrocarbons (benzene, toluene, xylenes) is the Goss Cove Landfill.

Benzene was detected in one sample (8MW2S) at a concentration of 2 µg/L, which exceeded the risk-based screening criterion of 0.35 µg/L. During previous investigations, benzene was also detected at a concentration of 2 J µg/L at 8MW2S. M- and p-xylenes were detected in five of eight samples at concentrations ranging from 1 to 284 µg/L (8MW3). Total xylenes were also detected in five of eight samples at concentrations ranging from 5 to 454 µg/L (8MW3). During previous investigations, total xylenes were detected at concentrations ranging from 2 J to 610 µg/L (8MW3). Only the sample from 8MW03 had m- and p-xylenes (284 µg/L) and total xylenes (454 µg/L) in excess of the screening criterion for total xylenes (140 µg/L). Monitoring well 8MW3 is located on the downgradient side of the site. This well is bounded by wells cross-gradient, upgradient, and vertically with lower xylene concentrations. The distribution of soil and groundwater data implies that the source of the xylene is a source within the landfill.

PCE was detected in monitoring well 8MW2D at a concentration of 31 µg/L. During previous investigations, PCE was detected at a concentration of 5 J µg/L in monitoring well 8MW2D. Well 8MW2D is screened beneath an organic silt layer and is the downgradient well for this zone in the central portion

of Goss Cove. PCE was also detected in all four upgradient bedrock wells at concentrations ranging from 619 µg/L to 1,900 µg/L. TCE was also detected in monitoring well 8MW2D at a concentration of 25 µg/L. During previous investigations, TCE was detected at a concentration of 8 J µg/L at monitoring well 8MW2D. TCE was detected in three of four upgradient bedrock wells at concentrations ranging from 1 µg/L to 25 µg/L. It is likely that the origin and extent of this compound are the same as PCE since TCE is a degradation product of PCE. cis-1,2-Dichloroethene, which is a degradation product of TCE, was also detected in monitoring well 8MW2D at a concentration of 25 µg/L. Vinyl chloride was detected in monitoring well 8MW2D at a concentration of 1 µg/L. During previous investigations, vinyl chloride was not detected at 8MW2D. The detection of vinyl chloride in this well is likely the result that cis-1,2-dichloroethene is biodegrading at this location.

The VOC data for the Goss Cove Landfill site indicate that the groundwater contamination issues are originating from two distinct sources: the chlorinated solvents from an upgradient source and the fuel hydrocarbons from the landfill. The fuel hydrocarbons are restricted to a fairly small area in the proximity of well cluster 8MW2S/D and monitoring well 8MW3. The downgradient limits of all COPCs were not determined during this RI. The tidal influence could be acting to disperse and dilute contaminant concentrations in the groundwater in proximity to the Thames River.

Numerous SVOCs were detected in groundwater at the Goss Cove Landfill site during the BGOURI at concentrations in excess of their respective screening criteria: 1-methylnaphthalene, 2,4-dimethylphenol, 2-methylnaphthalene, 4-methylphenol, acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, naphthalene, and phenanthrene. The highest concentration of any SVOC in groundwater samples was 2,4-dimethylphenol at a concentration of 240 µg/L in monitoring well 8MW3. No other compound had a concentration in excess of 100 µg/L, and the majority of SVOC compounds had concentrations below 2 µg/L.

1-Methylnaphthalene was detected in three of eight samples at concentrations ranging from 1.3 µg/L (8MW4) to 19 µg/L (8MW3). All these detections were from monitoring wells located near the center of the landfill. 1-Methylnaphthalene was not detected in groundwater samples collected during the previous investigations.

2-Methylnaphthalene was detected in three of eight samples at concentrations ranging from 0.82 µg/L (8MW4) to 15 J µg/L (8MW3). The detections are limited to the southern portion of the museum parking lot in the shallow groundwater zone. 2-Methylnaphthalene was detected at concentrations ranging from 1 J µg/L (8MW4) to 12 J µg/L (8MW3) during the previous investigations.

2,4-Dimethylphenol was detected at concentrations of 14 µg/L (8MW2S) and 240 µg/L (8MW3). 4-Methylphenol was detected at 6 µg/L and 27 µg/L in the same wells. During previous investigations, 2,4-dimethylphenol was detected at concentrations of 200 µg/L and 320 µg/L at wells 8MW2S and 8MW3, respectively. 4-Methylphenol was detected at 500 µg/L and 340 µg/L in the same wells during previous investigations.

Acenaphthene was detected in four of eight samples at concentrations ranging from 0.85 µg/L (8MW6S) to 7.9 µg/L (8MW3). During the previous investigations, acenaphthene was detected at a concentration of 2 J µg/L at 8MW6S and was not detected at 8MW3. These concentrations were detected in shallow monitoring wells in the central portion of the landfill. The northern limit of this compound is well 8MW1 (i.e., acenaphthene was not detected). The southern limit was not defined during this RI.

Benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene had similar distributions across the site. In general, these compounds were detected in all shallow monitoring wells and in deep well 8MW6D. In monitoring well 8MW6S, benzo(a) anthracene was the only one of these three compounds to be detected. Only benzo(b)fluoranthene was detected above 1 µg/L, and all other detections were below 1 µg/L. During previous investigations, these compounds were detected sporadically at low concentrations (less than 4 µg/L) in the shallow wells and were not detected in the deep wells.

Benzo(k)fluoranthene was detected in five of eight samples at concentrations ranging from 0.05 µg/L (8MW4) to 1.1 µg/L (8MW3). During previous investigations, benzo(k)fluoranthene was not detected at 8MW4 and was detected at a concentration of 5 J µg/L at 8MW3. The positive detections of this compound were sporadic across the site, with no trend or pattern.

Dibenzo(a,h)anthracene was detected in three of eight samples at concentrations ranging from 0.06 µg/L (8MW6) to 0.46 µg/L (8MW3). During previous investigations, dibenzo(a,h)anthracene was not detected at wells 8MW6 and 8MW3. The occurrences of this compound were limited to the central area of the landfill.

Indeno(1,2,3-cd)pyrene was detected in six of eight samples at concentrations ranging from 0.02 µg/L (8MW1) to 1.4 µg/L (8MW3). Indeno(1,2,3,-cd)pyrene was detected throughout the site within the shallow and deep wells. During previous investigations, indeno(1,2,3-cd)pyrene was not detected at 8MW1 and was detected at a concentration of 4 J µg/L at 8MW3.

Naphthalene was detected in four of eight samples at concentrations ranging from 1.5 to 56 µg/L (8MW3). Similar to many of the SVOCs, naphthalene was detected in the central portion of the landfill. During the

previous investigations, naphthalene was detected at concentrations ranging from 2 J µg/L to 62 µg/L (8MW3).

Phenanthrene was detected in all eight samples at concentrations ranging from 0.03 µg/L (8MW1) to 11 (8MW3) µg/L. The detections indicate that the highest concentrations of phenanthrene are found in proximity to the new storm sewer. During previous investigations, phenanthrene was detected at concentrations of 3 J µg/L and 14 J µg/L at wells 8MW1 and 8MW3, respectively.

The SVOC data indicate that low levels of these compounds have impacted the groundwater. The low concentrations suggest sources in the landfill waste are contributing low mass fluxes of contaminants to the groundwater. The central portion of the landfill shows the greatest concentration of groundwater SVOC COPCs.

Antimony, arsenic, barium, chromium, lead, and zinc concentrations were detected above background concentrations and exceeded either the direct contact screening criteria or the migration pathway criteria. Antimony was only detected in the sample from well 8MW2S at a concentration of 10.4 µg/L. This detection is likely from a source within the landfill because upgradient background concentrations were lower. Since this well is a downgradient well, no other wells bound the antimony detection.

Arsenic was detected in six of eight samples, with concentrations ranging from 2.3 µg/L to 14.5 µg/L. Arsenic was not detected in monitoring wells 8MW1S and 8MW5S, which are located at the northern end of the site, and in monitoring well 8MW9S, which is located upgradient of the landfill. The highest concentration of 14.5 µg/L was detected in well 8MW2D. This well is screened in a deeper sand unit. During previous investigations, arsenic was also not detected at monitoring wells 8MW1S and 8MW5S, and the highest concentration of 29.8 J µg/L was detected in well 8MW2D.

Barium was detected in seven of eight samples at concentrations ranging from 43.9 to 1,180 µg/L (8MW4). Barium was not detected in well 8MW5S, which is the northernmost monitoring well at the site, and well 8MW9S, which is upgradient of the site. Concentrations of barium are highest in the shallow fill zone and decrease toward the north with depth (i.e., below the organic silt), suggesting the barium is from fill material at the landfill. During previous investigations, barium was detected at concentrations ranging from 38 J µg/L to 1,340 J µg/L (8MW4). Barium was not detected in well 8MW5S during the previous investigations.

Chromium was detected in four of eight samples at concentrations ranging from 7.6 to 50.5 µg/L. Chromium was detected in monitoring wells 8MW2S, 8MW2D, 8MW4, and 8MW6. Monitoring well 8MW2S had the highest chromium concentration, 50.5 µg/L. This concentration is essentially equal to

the direct contact exposure criterion of 50 µg/L. No other samples exceeded the criterion. During previous investigations, chromium concentrations ranged from 1.1 to 221 µg/L (8MW7S), and chromium was detected at a concentration of 8.9 µg/L in 8MW2S. Concentrations of chromium are highest in the shallow fill zone and decrease toward the northern portion and with depth (i.e., below the organic silt), suggesting that the chromium contamination is from fill materials in the landfill.

Lead was detected in three of eight samples at concentrations ranging from 2.5 to 53.1 µg/L. The detected concentrations of lead in monitoring wells 8MW4 and 8MW2S exceeded the screening criteria. During previous investigations, lead was detected at concentrations of 3.6 J and 98 µg/L in wells 8MW4 and 8MW2S, respectively. Detected lead concentrations for all monitoring wells ranged from 1.1 to 1,600 J µg/L (8MW7S) during the previous investigations. Concentrations of lead are highest in the shallow fill and decrease toward the north and with depth (i.e., below the organic silt), suggesting that the lead contamination is from fill materials in the landfill.

Zinc was detected in two of eight samples at concentrations ranging from 63.5 µg/L (8MW4) to 170 µg/L (8MW2S). These wells are located in the shallow fill. Concentrations of zinc decrease with depth, suggesting a source of zinc within the landfill. During previous investigations, zinc was detected at concentrations of 61.2 and 179 µg/L in wells 8MW4 and 8MW2S, respectively.

10.5 CONTAMINANT FATE AND TRANSPORT

10.5.1 Contaminant Fate and Transport Processes

Five classes of chemicals were detected in Site 8 groundwater during the BGOURI: monocyclic aromatics, halogenated aliphatics, phenols, PAHs, and metals. These classes, in general, correspond with those detected in the Phase II RI (B&R Environmental, 1997a) except that phthalate esters were detected in the Phase II RI but were not detected during the BGOURI.

Monocyclic Aromatic Compounds

Fuel-related monocyclic aromatic compounds (i.e., benzene, ethylbenzene, toluene, and xylenes) were detected in shallow and deep groundwater samples in the Phase II RI and the BGOURI at similar concentrations. The maximum concentrations of these compounds occurred at the same location (8MW03) in both investigations. Monocyclic aromatic compounds are not considered to be persistent in the environment, particularly in comparison to chemicals such as PCBs and pesticides. They may migrate through the soil column when solubilized by infiltrating precipitation. Some portion of these chemicals is retained by the soil, but most of them will continue migrating downward until they reach the

water table. Bioconcentration in aquatic animals is not expected to be significant for monocyclic aromatics. They are subject to degradation via the action of both soil and aquatic microorganisms.

In the event that these compounds discharge to surface water bodies, volatilization and biodegradation may occur relatively rapidly. This fact is important at Site 8 because the Thames River is the eventual discharge point for groundwater at the site. Additional environmental degradation processes, such as hydrolysis and photolysis, are considered to be insignificant fate mechanisms for monocyclic aromatics in aquatic systems.

Halogenated Aliphatics

Several halogenated aliphatics (tran-1,2-DCE, cis-1,2-DCE, PCE, TCE, and vinyl chloride) have been detected in groundwater samples from Site 8. The concentrations of PCE were much greater than the other halogenated aliphatics both in the Phase II RI (3,700 µg/L) and BGOURI of 2000 (1,440 µg/L) at the same location (i.e., monitoring well 8MW09, which is located adjacent to Fusconi Dry Cleaners). PCE was also detected in surface and subsurface soil in the Phase II RI at relatively low concentrations (1 to 28 µg/kg), with the highest concentration occurring in subsurface soil. An investigation conducted by the CTDEP (1999) showed that Fusconi Dry Cleaners has had a considerable release of PCE. A northwest-southeast fracture in the bedrock was mapped in the Mamacoke Formation outcrop near Fusconi's Dry Cleaners (TtNUS, 1997d). Also near Fusconi's Dry Cleaners, bedrock monitoring well 8MW9S and several soil borings have been shown to contain significant source area concentrations of PCE (CTDEP, 1999). The groundwater flow direction is toward the Thames River from Fusconi's Dry Cleaners. PCE-contaminated groundwater would likely be transported along the bedrock fracture zone toward the entrance to the Goss Cove landfill. PCE-contaminated bedrock monitoring well cluster 8MW8S/D and PCE-contaminated bedrock monitoring well 8MW10S are northwest of the Fusconi facility. As PCE-contaminated groundwater flows along the bedrock fracture and with gradient, a trench in the bedrock is encountered in association with NSB-NLON stormwater system. The trench for the stormwater system was blasted through the saturated Mamacoke Formation bedrock and through the associated fractures. The intersection of the bedrock fractures and the stormwater system create a preferential pathway for the flow of PCE-contaminated groundwater. The flow of PCE along this pathway is manifested in PCE-contaminated downgradient monitoring well 8MW2D.

Halogenated aliphatic hydrocarbons such as PCE are relatively water soluble and have a low capacity for retention by soil organic carbon. Therefore, PCE is frequently detected in groundwater. Halogenated aliphatics may migrate through the soil column after being released by a spill event or by a subsurface release when solubilized by infiltrating precipitation. Some portion of halogenated aliphatics may be retained by the soil, but most of the chemical will continue migrating downward until it reaches the water table. The Nautilus Museum and a paved parking lot have been constructed over the site of the former

landfill. These would serve to retard vertical contamination of environmentally mobile compounds by preventing infiltration of rainwater. After reaching the water table, migration is primarily lateral with the hydraulic gradient. The analytical data from the historic investigations show that Fusconi Dry Cleaners acts as the upgradient source of contamination. Halogenated aliphatics were found in the deep and shallow soil samples collected during the Phase II RI field investigation and also in the overburden and bedrock groundwater, confirming the occurrence of contaminant transport from the site. Halogenated aliphatics can migrate to surface water and sediment, but attenuation and dilution factors, such as volatilization, generally result in its rapid decrease in concentration.

PCE and TCE are susceptible to degradation and the intermediate biodegradation products are cis-1,2-DCE and vinyl chloride. It appears that degradation is occurring in the groundwater at Site 8 since typical degradation products of PCE (i.e., TCE, 1,2-DCE, and vinyl chloride) have been detected in the groundwater. The data indicate that degradation is occurring over time because two potential degradation products (TCE, 1,2-DCE) were detected in the Phase II RI and three products (TCE, 1,2-DCE, and vinyl chloride) were found in groundwater samples collected in the BGOURI.

Phenols

Several phenols (2-methylphenol, 4-methylphenol, and 2,4-dimetnylphenol) were detected in groundwater at the site, mainly in the sample from well 8MW03. These compounds were also detected in the same well in the Phase II RI at similar concentrations. Based on their water solubility and K_{oc} values, methylphenols are expected to have moderate to high mobility in the environment. In water, methylphenols may adsorb to suspended solids and sediment in the water column based upon the K_{oc} values, but not to the extent of chemicals such as PAHs and phthalates. In surface water, methylphenols are expected to biodegrade rapidly. Volatilization from water surfaces is expected to occur based upon these compounds' Henry's Law constants. Estimated volatilization half-lives for 4-methylphenol in a model river and model lake are 38 and 281 days, respectively. Photolysis in surface water may be an important fate process for methylphenols based on reported photolysis half-lives. Methylphenols are not expected to undergo hydrolysis. Estimated BCFs of these phenols range from 16 to 75, suggesting that the potential for bioconcentration in aquatic organisms is low.

Polynuclear Aromatic Hydrocarbons (PAHs)

Both low-molecular-weight and high-molecular-weight PAHs were detected in groundwater samples collected at Site 8 during the Phase II RI and BGOURI. The PAHs were detected at greater frequencies in the BGOURI, but this is likely because lower detection limits were used in the more recent investigation. PAHs are generally considered to be fairly immobile in the environment. As noted in Section 3.3, PAHs have very low solubilities, vapor pressures, and Henry's Law constants and high K_{ocs}

and K_{ows}. The low-molecular-weight PAHs (e.g., acenaphthene, anthracene, fluorene, phenanthrene) are more mobile (higher solubilities, etc.) than the high-molecular-weight PAHs [e.g., benzo(a)pyrene, benzo(a)anthracene, chrysene, etc.]. PAHs in soil are much more likely to bind to soil and be transported via mass transport mechanisms than go into solution. PAHs can be degraded via aerobic bacteria but may be relatively persistent in the absence of microbial population or macronutrients such as phosphorous and nitrogen.

PAHs have very low water solubilities and generally do not enter into solution. However, the concentrations of the high-molecular-weight PAHs detected in groundwater exceed the published solubilities for these compounds (see Table 3-5). Although it would seem likely that these PAH concentrations are the result of the adherence of PAHs to the soil particles present in the groundwater (i.e., samples with high turbidity), the comparison of TSS and TDS data to PAH concentrations does not support this conclusion.

Metals

Sixteen metals were detected in shallow and deep groundwater samples at the site. As noted in Section 3.3, metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. The major fate mechanisms for metals are adsorption to the soil matrix (as compared to being part of the soil structure) and bioaccumulation. In addition, under normal conditions, metals are not very mobile in the environment. Because metals frequently remain bound to particulate matter, the major transport mechanism for metals is bulk movement processes (erosion). However, metals can become mobile in the environment under certain conditions. The mobility of metals is influenced primarily by their physical or chemical properties in conjunction with the physical and chemical properties of the soil matrix. Factors that assist in predicting the mobility of metals are the soil/pore water pH, REDOX potential, and cation exchange capacity. The mobility of metals generally increases with decreasing soil pH and cation exchange capacity. The effect of REDOX potential varies for each metal. Groundwater samples collected from 8MW5S were analyzed for total metals and dissolved metals. A comparison of the total and dissolved concentrations indicates that there was little difference in the total and dissolved concentrations for these metals, with the possible exception of sodium (unfiltered = 9,290 mg/L; filtered = 4,770 mg/L). These data indicate the metals detected at this sampling location are more likely to be in the dissolved phase rather than bound to particulate matter.

The specific metals of concern in Site 8 groundwater include arsenic, lead and zinc. Groundwater pH values at Site 8 range from mildly acidic (5.37) in a shallow well on the eat side to mildly basic (8.72) on the western edge of the landfill. Groundwater REDOX conditions, measured by platinum electrode potentials, range from slightly oxidizing (+140 mV) on the east side to strongly reducing (-430 mV) in a deep well on the western edge of the landfill. It is apparent that the presence of the landfill impacts the

REDOX environment in the groundwater. In addition, the landfill and proximity to the Thames River probably influence groundwater pH.

Lead and zinc transport in this groundwater environment is dominated by the cationic nature of the metals. Transport is retarded by exchange reactions with aquifer solids. Although the reducing groundwater environment beneath the landfill does not impact the charge on the dissolved lead and zinc, their transport is indirectly impacted as iron and manganese oxyhydroxide coatings dissolve and surface exchange and sorption sites disappear. Transport retardation by exchange will be limited to reactions with fixed charge exchangers (e.g., certain clay minerals). Alternatively, lead and zinc transport may be retarded as they are precipitated as insoluble sulfide minerals.

Arsenic speciation is directly impacted by the REDOX conditions with arsenic (V) reduced to arsenic (III). Arsenic (III) will be mobile in the ambient environment because the predominant species is a neutral molecule and because potential sorption sites (e.g., iron oxyhydroxides) are dissolving.

Capping the Site 8 Landfill will limit infiltration and generation of additional reduced leachate to the groundwater. Subsequent influx of more oxidizing groundwater from upgradient may slowly raise the ambient REDOX conditions in the aquifer beneath the landfill. More oxidizing conditions may mobilize lead and zinc from sulfide minerals but would also precipitate iron oxyhydroxides thereby increasing retardation by exchange and sorption mechanisms. Additional iron oxyhydroxide precipitates would also tend to retard arsenic transport.

10.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific risk assessment for the identified exposure scenarios for Site 8. The risk assessment methodology was described in Section 3.4, and detailed calculations including RAGS Part D tables are presented in Appendix C. A summary of previous risk assessments for the site is also presented.

As part of the remediation of the soil OU at Goss Cove Landfill, an engineered cap is currently being constructed over the former landfill. The cap is designed to reduce infiltration through the waste and to eliminate direct exposure to soil. Land use restrictions have also been put into place to limit future use of the site.

10.6.1 Data Evaluation

COPCs were identified for Site 8 using the risk-based screening levels, as discussed in Section 3.4.1. Table 10-3 summarizes the COPCs retained for Site 8. A discussion of direct contact exposure COPCs

(i.e., those chemicals detected at concentrations in excess of USEPA and CTDEP direct contact exposure criteria) and additional COPCs is provided below. Additional COPCs are identified on chemical migration tendencies: migration of groundwater to surface water and migration of volatiles from groundwater through building foundations into indoor air. These additional COPCs are not quantitatively evaluated in the HHRA because they are not considered to be significant contributors to the direct contact exposure pathways identified for potential human receptors.

A comparison of the maximum detected concentrations in groundwater to direct contact risk-based screening criteria is presented in Table 10-4. The maximum detected concentrations of the following chemicals in groundwater exceeded the direct contact risk-based COPC screening levels and were retained as COPCs for groundwater:

- VOCs-benzene, cis-1,2-dichloroethene, tetrachloroethene, TCE, vinyl chloride, and total xylenes.

- SVOCs-1-methylnaphthalene, 2-methylnaphthalene, 2,4-dimethylphenol, 4-methylphenol, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene.

- Metals-antimony, arsenic, barium, chromium, and lead.

The maximum detected concentration of manganese exceeded its USEPA Region IX PRG but was within background levels; consequently, manganese was not retained as a COPC.

A comparison of the maximum detected concentrations in groundwater to migration criteria is presented in Table 10-5. The maximum detected concentrations of the following chemicals exceeded their respective screening criteria for protection of migration to surface water:

- VOCs-tetrachloroethene.
- SVOCs-acenaphthene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and phenanthrene.
- Metals-arsenic, lead, and zinc.

The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from groundwater to indoor air.

10.6.2 Exposure Assessment

Only groundwater samples were collected during the current investigation; consequently, only exposures to groundwater were evaluated in the HHRA for Site 8. Construction workers were the only receptors identified for exposure to groundwater. Construction workers could come into contact with groundwater while excavating building foundations. In such an instance, construction workers could be exposed to the groundwater via dermal contact. Exposure assumptions for construction workers were presented in Table 3-14. Potential exposure pathways are summarized in Table 10-6.

A remedial action is currently being conducted for the soil OU at Site 8. The main components of the remedial action are the installation of an engineered landfill cup and institutional controls which will prohibit residential usage of the site.

As discussed in Section 3.4, the maximum detected concentration and average concentration were used for the exposure point concentrations for the RME and CTE, respectively. Exposure point concentrations for Site 8 are presented in Table 10-7.

10.6.3 Risk Characterization

Potential ICRs and HIs were calculated for construction workers exposed to groundwater using the methodology presented in Section 3.4. The results are summarized in Table 10-8 and are discussed below. Sample calculations and chemical-specific risks in RAGS Part D format are provided in Appendix C.

Carcinogenic Risks

ICRs for a construction worker exposed to groundwater were 9.5×10^{-6} and 7.5×10^{-7} for the RME and CTE scenarios, respectively, which were within or less than USEPA's target risk range of 10^{-4} to 10^{-6} and less than CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene exceeded CTDEP's target level of 1×10^{-6} for individual chemicals. It should be noted that the maximum detected concentration of dibenz (a,h)anthracene was less than its CTDEP RSR.

Noncarcinogenic Risks

HIs for a construction worker exposed to groundwater were 0.03 and 0.01 for the RME and CTE scenarios, respectively, which were less than EPA's and CTDEP's acceptable level of 1.0.

Lead

Lead was identified as a COPC in groundwater at Site 8. Lead was detected at a maximum concentration of 53.1 µg/L, which exceeds the Safe Drinking Water Act action level and CTDEP RSR of 15 µg/L. However, the average concentration of lead in groundwater, 10.2 µg/L (Table 10-7), is less than 15 µg/L. Quantitative risks resulting from exposures to lead in groundwater were not evaluated since groundwater will not be used as a potable water supply in the future.

10.6.4 Summary of Previous Risk Assessments

The baseline HHRA conducted during the Phase II RI focused on CTE and RME exposure scenarios for multiple receptor groups: full-time employees, older child trespassers, future residents, and construction workers. Future potential residents are not expected to come in contact with groundwater at the site because the saline conditions that exist near the Thames River would prevent domestic use of groundwater. Therefore, groundwater was not considered to be a potential medium of exposure for the future resident. In addition, groundwater was not considered to be a potential medium of exposure for the full-time employee or the older child trespasser. Dermal contact with groundwater during intrusive activities was evaluated as a potential route of exposure for the construction worker.

The noncarcinogenic risk associated with dermal contact with groundwater for the construction worker was less than 1 for the CTE scenario but exceeded 1 (4.8) for the RME scenario. Elevated hazards for this receptor were primarily attributed to PCE in groundwater. The chemical-specific HQ for PCE via dermal contact with groundwater exceeded 1 (3.6). This assessment included the PCE concentrations detected in upgradient bedrock wells that were later determined to be impacted by an upgradient source. Therefore, the risks estimated during this assessment were overestimated for the site.

Carcinogenic risks associated with dermal contact with groundwater were within USEPA's acceptable target risk range of 1×10^{-4} to 1×10^{-6} for the construction worker under CTE and RME. However, the carcinogenic risk associated with this exposure route under RME (2.8×10^{-5}) exceeded the CTDEP target cancer risk level (1×10^{-5}). The primary contributor to this risk was PCE, with a chemical-specific risk of 2.7×10^{-5}. As discussed above, the site-specific risks associated with PCE for the site were overestimated since concentrations of PCE from upgradient bedrock wells were included in the assessment.

10.6.5 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment, in general, was presented in Section 3.4.5. Site-specific uncertainties for Site 8 are discussed below.

Elimination of Chemicals as COPCs on the Basis of Background

In accordance with U.S. Navy policy, chemicals were eliminated as COPCs on the basis of comparison to background. Manganese was the only chemical in groundwater with a maximum detected concentration that exceeded the direct contact screening criteria but was not retained as a COPC on the basis of background. Dermal exposure to groundwater by construction workers was the only exposure pathway evaluated at Site 8. Potential risks from exposures to manganese in water are negligible (USEPA, 2000e); consequently, the elimination of manganese as a COPC on the basis of background does not affect the risk estimates for construction workers at Site 8.

10.7 SUMMARY AND RECOMMENDATIONS

10.7.1 Nature and Extent of Contamination

VOCs, SVOCs, and metals were detected at concentrations in excess of regulatory screening criteria. Metals were also detected at concentrations that exceeded background concentrations. PCE is known to originate from an upgradient source (i.e., Fusconi Dry Cleaners). This source is significant and contributes to the occurrence of chlorinated solvents (i.e., PCE, TCE, cis-1,2-DCE, and vinyl chloride) in the groundwater at the Goss Cove Landfill site. Aromatic hydrocarbons, PAHs, and inorganics have been found in historical soil samples taken at Goss Cove Landfill and are likely related to historical disposal operations at this site. Based on the results of this groundwater RI, these sources are continuing to contribute contamination to the overburden groundwater at the Goss Cove Landfill. The aromatic hydrocarbon, PAH, and metal COPCs were typically detected most frequently in the shallow groundwater in the central portion of the landfill.

The horizontal and vertical extents of most chemicals in the groundwater were not able to be defined during this RI because of the closeness of the site to the Thames River. The Thames River is tidally influenced and impacts the groundwater at the Goss Cove Landfill twice daily. The tidal influence is likely acting to disperse and dilute contaminant concentrations in the groundwater in proximity to the Thames River.

10.7.2 Contaminant Fate and Transport

Fuel-related monocyclic aromatic compounds (i.e., benzene, ethylbenzene, toluene, and xylenes) were detected in shallow and deep groundwater samples. It is likely that these compounds were solubilized from the soil by infiltrating precipitation and eventually reached the water table. It is likely that these compounds are reaching the Thames River, but once they reach the river their concentrations will

decrease significantly due to dilution, dispersion, volatilization, and biodegradation. It is unlikely that they will bioconcentrate in aquatic animals.

Several halogenated aliphatics (tran-1,2-DCE, cis-1,2-DCE, PCE, TCE, and vinyl chloride) have been detected in groundwater samples from Site 8. Previous investigations have shown that the source of the PCE is not site related and is located upgradient of the Goss Cove Landfill. Halogenated aliphatic hydrocarbons such as PCE are relatively water soluble and have a low capacity for retention by soil organic carbon. Because the source is located upgradient of the site, it is likely that these compounds are migrating laterally with the hydraulic gradient when they reach the site. Similar to aromatic compounds, it is likely that, when these compounds reach the Thames River, their concentrations will decrease significantly due to dilution, dispersion, volatilization, and biodegradation. It appears that biodegradation is occurring in the groundwater at Site 8 since typical degradation products of PCE, such as TCE, cis-1,2-DCE, and vinyl chloride, have been detected in the groundwater.

The SVOCs detected in the Site 8 groundwater during the BGOURI included phenols and PAHs. It is likely that a source within the soil is contributing to the detection of these compounds in the groundwater. Methylphenols are expected to have moderate to high mobility in the environment. In water, methylphenols may adsorb to suspended solids and sediment in the water column. Once methylphenols reach the Thames River, it is expected that they will biodegrade rapidly. PAHs are generally considered to be fairly immobile in the environment. However, the concentrations of the high-molecular weight PAHs detected in groundwater exceed the published solubilities for these compounds. TSS and TDS data do not indicate that the high concentrations are the result of the adherence of PAHs to the soil particles present in the groundwater. Therefore, it appears that the PAHs are migrating to the Thames River. Once in the river, it is likely that the PAHs adsorb to suspended sediment and either settle out or are transported via the surface water.

Metals were detected in shallow and deep groundwater samples at the site. Generally, the most significant concentrations of metals were detected in the shallow groundwater and the source of these metals appears to be the landfill material. A comparison of the total and dissolved metals concentrations indicates that there was little difference between the concentrations, which indicates that the detected metals are likely to be in the dissolved phase rather than bound to particulate matter. This information indicates that the metals are being transported to the Thames River. The geochemical environment near the Thames River is transitional between freshwater and more saline water and includes increasing chloride and sulfate concentrations as the influence of seawater increases and produces strongly reducing conditions. Both factors suggest an increasing likelihood that metals will precipitate as an insoluble sulfate or sulfide mineral and thereby limit further transport.

10.7.3 Summary of Human Health Risk Assessment

The following items summarize the HHRA for Site 8:

- The HHRA for Site 8 considered exposures to construction workers. No soil samples were collected at Site 8; therefore, only exposures to groundwater were evaluated. The potential exposure pathway was dermal contact with groundwater.

- Maximum detected concentrations of several VOCs, SVOCs, and metals exceeded the direct contact risk-based COPC screening levels and were retained for quantitative evaluation in the HHRA.

- Maximum detected concentrations of several VOCs, SVOCs, and metals exceeded the CTDEP screening criteria for protection of migration of groundwater to surface water.

- The maximum detected concentrations of all chemicals in groundwater were less than the CTDEP criteria for migration from groundwater to indoor air.

- All ICRs for construction workers exposed to groundwater at Site 8 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene exceeded CTDEP's target level of 1×10^{-6} for individual chemicals. It should be noted that the maximum detected concentration of dibenzo(a,h)anthracene was less than its CTDEP RSR.

- All HIs for construction worker exposure to groundwater at Site 8 were less than USEPA's and CTDEP's acceptable level of 1.0.

- The maximum detected concentration of manganese in groundwater exceeded its screening criteria but was within background levels, consequently manganese was retained as COCs in the HHRA. ICRs and HIs would still have been within USEPA and CTDEP target levels if manganese had been evaluated in the HHRA.

10.7.4 Summary and Recommendations

A remedial action is currently being conducted for the soil OU at Site 8. The main components of the remedial action are the installation of an engineered landfill cap and implementation of institutional controls. A secondary component of the remedial action is the decommissioning of the existing storm sewer and the installation of a replacement storm sewer system. The Navy plans to implement a

Groundwater Monitoring Program when the remedial action for the soil is complete. A draft Groundwater Monitoring Plan (TtNUS, 2000) was prepared and is currently under regulatory review.

It is expected that chlorinated solvent concentrations within the Site 8 groundwater will decrease when the upgradient source from the Fusconi Dry Cleaners is addressed. The CTDEP and Fusconi's consultant are currently working to address this problem.

The objectives of the BGOURI at Site 8 were to further characterize the nature and extent of groundwater contamination and to quantify the risks to human receptors from the groundwater at the site. The analytical data from this RI indicate that sources of VOCs, SVOCs, and metals within the fill material are continuing to impact the shallow groundwater at the site. Based on contaminant fate and transport information, it is likely that these chemicals are mobile and are being transported in the groundwater to the Thames River. However, the results of the human health risk assessment showed that all ICRs for construction workers exposed to groundwater at Site 8 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. All HIs for construction worker exposure to groundwater at Site 8 were less than USEPA's and CTDEP's acceptable level of 1.0.

The results of this investigation confirmed the conceptual site model developed during the previous investigations. Based on this RI's findings, it is recommended that the Navy complete the soil OU remedial action, implement land use controls, and begin the Groundwater Monitoring Plan as soon as the action is finalized. Installation of the engineered cap should significantly reduce vertical contaminant migration from the unsaturated soil to the groundwater, which in turn will reduce any lateral contaminant migration from the groundwater to the Thames River. This theory will be confirmed by execution of the Groundwater Monitoring Plan. It is recommended that the decision for preparation of an FS for the groundwater OU at Goss Cove Landfill be postponed until site conditions stabilize and the groundwater monitoring program determines the trends in groundwater contaminant concentrations. If the results of the monitoring program support that there are no unacceptable risks to human health or the environment, then an FS will not be prepared, and the Navy will pursue a no-further-action ROD for the groundwater OU. If the results suggest that further actions are required, then the Navy will prepare an FS for the groundwater OU to develop appropriate remedial alternatives.

TABLE 10-1

SUMMARY OF THE SAMPLING AND ANALYTICAL PROGRAM FOR SITE 8 BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION NSB-NLON, GROTON, CONNECTICUT

Sample ID	VOCs	SVOCs	Metals	Misc (1)	Pesticide/ PCBs
GROUNDWATER					
S8MW0101	X	X	X	X	X
S8MW02D01	X	X	X	X	X
S8MW02S01	X	X	X	X	X
S8MW0301	X	X	X	X	X
S8MW0401	X	X	X	X	X
S8MW05S01	X	X	X	X	X
S8MW05S01-F			X		
S8MW06D01	X	X	X	X	X
S8MW06S01	X	X	X	X	X
FD0808001 (2)	X	X	X	X	X
S8MW09S01 (3)	X	X	X	X	X

Notes:
1 Miscellaneous Parameters include TDS, TSS, and chloride.
2 Duplicate to S8MW06S 01.
3 Upgradient well.

TABLE 10-2

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS FOR SITE 8
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	8MW01	8MW02D	8WM02S	8MW03	8MW04	8MW05S	8MW05S	8MW06D	8MW06S	8MW06S	8MW09S 1
nsample	S8MW0101	S8MW02D01	S8MW02S01	S8MW0301	S8MW0401	S8MW05S01	S8MW05S01-F	S8MW06D01	S8MW06S01	S8MW06S01-D	S8MW09S01
sample	S8MW0101	S8MW02D01	S8MW02S01	S8MW0301	S8MW0401	S8MW05S01	S8MW05S01-F	S8MW06D01	S8MW06S01	FD0808001	S8MW09S01
sample_dat	8/8/00	8/7/00	8/7/00	8/8/00	8/8/00	8/7/00	8/7/00	8/8/00	8/8/00	8/8/00	8/18/00
Volatile Organics (ug/L)											
BENZENE	1 U	1 U	2	25 U	1 U	1 U		1 U	1 U	1 U	1 U
CIS-1,2-DICHLOROETHENE	1 U	33	1 U	25 U	1 U	1 U		1 U	1 U	1 U	1.03
ETHYLBENZENE	1 U	1 U	18	108	2	1 U		27	2	2	1 U
M+P-XYLENES	2 U	2 U	54 E	284	6	2 U		1 J	1 J	2 J	2 U
O-XYLENE	1 U	1 U	31 E	136	2	1 U		33 E	3	3	1 U
TETRACHLOROETHENE	1 U	31	1 U	25 U	1 U	1 U		1 U	1 U	1 U	1440
TOLUENE	1 U	1 U	2	31	1 U	1 U		1 U	1 U	1 U	1 U
TRANS-1,2-DICHLOROETHENE	1 U	7	1 U	25 U	1 U	1 U		1 U	1 U	1 U	1 U
TRICHLOROETHENE	1 U	25	1 U	25 U	1 U	1 U		1 U	1 U	1 U	1.52
VINYL CHLORIDE	1 U	1	1 U	25 U	1 U	1 U		1 U	1 U	1 U	1 U
XYLENES, TOTAL	1 U	1 U	44	454	8	1 U		34	5	5	1 U
Semivolatile Organics (ug/L)											
1-METHYLNAPHTHALENE	0.5 U	0.5 U	6 J	19 J	1.3	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U
2,4-DIMETHYLPHENOL	5 U	5 U	14	240	5 U	5 U		5 U	5 U	5 U	5 U
2-METHYLNAPHTHALENE	0.5 U	0.5 U	4.2 J	15 J	0.82	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U
2-METHYLPHENOL	5 U	5 U	5 U	99	5 U	5 U		5 U	5 U	5 U	5 U
4-METHYLPHENOL	5 U	5 U	6	27	5 U	5 U		5 U	5 U	5 U	5 U
ACENAPHTHENE	0.5 U	0.5 U	5.2 J	7.9 J	1.1	0.5 U		0.5 U	0.85 J	0.9 J	0.5 U
ANTHRACENE	0.11	0.11	1.4 J	1.4 J	0.24	0.05 U		0.22 J	0.12 J	0.13 J	0.041 J
BENZO(A)ANTHRACENE	0.02 J	0.05 U	0.73 J	1.4 J	0.2	0.13		0.67 J	0.04 J	0.04 J	0.05 U
BENZO(A)PYRENE	0.02 J	0.05 U	0.86 J	2.1 J	0.15	0.1		0.83 J	0.05 U	0.05 U	0.05 U
BENZO(B)FLUORANTHENE	0.05 J	0.1 U	0.88 J	2.4 J	0.2	0.27		1.2 J	0.1 U	0.1 U	0.1 U
BENZO(G,H,I)PERYLENE	0.1 U	0.1 U	0.72 J	2.4 J	0.12	0.14		1 J	0.1 U	0.1 U	0.1 U
BENZO(K)FLUORANTHENE	0.05 U	0.05 U	0.34 J	1.1 J	0.05	0.06		0.48 J	0.05 U	0.05 U	0.05 U
CHRYSENE	0.05 U	0.03 J	0.85 J	1.9 J	0.2	0.1		1.1 J	0.03 J	0.03 J	0.05 U
DIBENZO(A,H)ANTHRACENE	0.1 U	0.1 U	0.09 J	0.46 J	0.1 U	0.1 U		0.06 J	0.1 U	0.1 U	0.1 U
FLUORANTHENE	0.3	0.9	4.6 J	5.2 J	1.1	0.19		4.2 J	0.57 J	0.53 J	0.34
FLUORENE	0.1 U	0.11	2.9 J	5.8 J	0.58	0.1 U		0.22 J	0.31 J	0.27 J	0.21
INDENO(1,2,3-CD)PYRENE	0.02 J	0.05 U	0.48 J	1.4 J	0.13	0.09		0.72 J	0.05 U	0.05 U	0.05 U
NAPHTHALENE	0.5 U	0.5 U	19 J	56 J	4.5	0.5 U		0.5 U	1.5 J	2 J	0.5 U
PHENANTHRENE	0.03 J	0.41	5.9 J	11 J	0.99	0.07		2 J	0.17 J	0.16 J	0.61
PHENOL	5 U	5 U	5 J	6	5 U	5 U		5 U	5 U	5 U	5 U
PYRENE	0.29	0.57	4.1 J	5.4 J	0.75	0.3		3.2 J	0.4 J	0.4 J	0.16
Total Metals (ug/L)											
ANTIMONY	2.6 U	2.6 U	10.4	2.6 U	2.6 U	2.6 U		2.6 U	2.6 U	2.6 U	2.6 UJ
ARSENIC	2.3 U	14.5 J	5.6	3.8 J	2.3 J	2.3 U		8.4 J	5.1	5 J	2.3 U
BARIUM	154	50.8	376	393	1180	41.4 U		43.9 J	801	941	14.1 U
CALCIUM	133000	80200	77000	32800	45200	138000		265000	48300	56200	5930 J
CHROMIUM	6.2 U	23.5	50.5	6.2 U	18	6.2 U		7.6 J	6.2 U	6.2 U	6.2 U

TABLE 10-2

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS FOR SITE 8
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location nsample sample sample_dat	8MW01 S8MW0101 S8MW0101 8/8/00	8MW02D S8MW02D01 S8MW02D01 8/7/00	8WM02S S8MW02S01 S8MW02S01 8/7/00	8MW03 S8MW0301 S8MW0301 8/8/00	8MW04 S8MW0401 S8MW0401 8/8/00	8MW05S S8MW05S01 S8MW05S01 8/7/00	8MW05S S8MW05S01-F S8MW05S01-F 8/7/00	8MW06D S8MW06D01 S8MW06D01 8/8/00	8MW06S S8MW06S01 S8MW06S01 8/8/00	8MW06S S8MW06S01-D FD0808001 8/8/00	8MW09S 1 S8MW09S01 S8MW09S01 8/18/00
COBALT	4.2 UJ	4.2 UJ	4.2 U	4.2 U	4.2 U	4.2 UJ		10.1 J	4.2 U	4.2 U	4.2 U
COPPER	6.8 UJ	6.8 UJ	35.4	6.8 U	22.2	6.8 UJ		6.8 UJ	6.8 U	6.8 U	6.8 U
IRON	2260	14500	4810	378	6050	338		2290	4330	5050	1250 J
LEAD	1.8 U	1.8 U	53.1	1.8 U	27.3	1.8 U		1.8 U	9.2	2.5 J	1.8 UJ
MAGNESIUM	417000	331000	38400	25400	24100	433000		1210000	42400	49700	1350
MANGANESE	214	851	468	30.9 J	83.4	76.9 J		4210	184	217	82
NICKEL	9.2 UJ	13.5 J	28.7	9.2 U	11.7 J	9.2 UJ		9.2 UJ	9.2 U	9.2 U	9.2 U
POTASSIUM	129000	128000	37900	28800	20000	136000		250000	29800	35400	1130
SODIUM	3450000	3470000	231000	350000	189000	9290000		8330000	286000	346000	9770
VANADIUM	6.3 U	6.3 U	6.3 U	6.3 U	6.3 U	6.3 U		6.6 J	6.3 U	6.3 U	6.3 U
ZINC	23.6 U	36.7 U	170	14.6 U	63.5	25.7 U		40 U	18.8 U	10.4 U	32.5 U
Dissolved Metals (ug/L)											
ANTIMONY							2.6 J				
ARSENIC							2.8 J				
BARIUM							46.9				
CALCIUM							144000				
MAGNESIUM							464000				
MANGANESE							90.2 J				
POTASSIUM							154000				
SODIUM							4770000				
VANADIUM							9.2 J				
Miscellanoeus Parameters (mg/L)											
TOTAL DISSOLVED SOLIDS	13200	10744 J	755 J	1126	798	139 J		27042	1460	1456	97.5 J
TOTAL SUSPENDED SOLIDS	8	15 J	23	5 U	10	5 UJ		38	5 U	5 U	5 UJ

Note:
1 Monitoring well 8MW9S was not included in the COPC selection process or in the HHRA calculations.

TABLE 10-3

CHEMICALS RETAINED AS COPCs IN GROUNDWATER AT SITE 18
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Direct Contact	Migration Pathways	
		Surface Water	Volatilization
Volatile Organic Compounds			
Benzene	X		
cis-1,2-Dichloroethene	X		
Tetrachloroethene	X	X	
Trichloroethene	X		
Vinyl Chloride	X		
Xylenes, Total	X		
Semivolatile Organic Compounds			
1-Methylnaphthalene	X		
2,4-Dimethylphenol	X		
2-Methylnaphthalene	X		
4-Methylphenol	X		
Acenaphthene		X	
Benzo(a)anthracene	X	X	
Benzo(a)pyrene	X	X	
Benzo(b)fluoranthene	X	X	
Benzo(k)fluoranthene	X	X	
Dibenzo(a,h)anthracene	X		
Indeno(1,2,3-cd)pyrene	X		
Naphthalene	X		
Phenanthrene		X	
Metals			
Antimony	X		
Arsenic	X	X	
Barium	X		
Chromium	X		
Lead	X	X	
Zinc		X	

Notes:
X - Chemical is retained as a COC.

TABLE 10-4

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 8
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Goss Cove Landfill (Site 8)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																
71-43-2	BENZENE	2		2		ug/L	S8MW02S01	1/8	1 - 25	2	N/A	0.35 C	1 5 5	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
156-59-2	CIS-1,2-DICHLOROETHENE	33		33		ug/L	S8MW02D01	1/8	1 - 25	33	N/A	6.1 N	70 70 70	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
100-41-4	ETHYLBENZENE	2		108		ug/L	S8MW0301	5/8	1	108	N/A	130 N	700 700 700	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
	M+P-XYLENES	1	J	284		ug/L	S8MW0301	5/8	2	284	N/A	140 (7) N	530 10000 N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
95-47-6	O-XYLENE	2		136		ug/L	S8MW0301	5/8	1	136	N/A	140 (7) N	530 10000 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
127-18-4	TETRACHLOROETHENE	31		31		ug/L	S8MW02D01	1/8	1 - 25	1440	N/A	1.1 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
108-88-3	TOLUENE	2		31		ug/L	S8MW0301	2/8	1	31	N/A	72 N	1000 1000 1000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
156-60-5	TRANS-1,2-DICHLOROETHENE	7		7		ug/L	S8MW02D01	1/8	1 - 25	7	N/A	12 N	100 100 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
79-01-6	TRICHLOROETHENE	25		25		ug/L	S8MW02D01	1/8	1 - 25	25	N/A	1.6 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
75-01-4	VINYL CHLORIDE	1		1		ug/L	S8MW02D01	1/8	1 - 25	1	N/A	0.041 C	2 2 2	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
1330-20-7	XYLENES, TOTAL	5		454		ug/L	S8MW0301	5/8	1	454	N/A	140 N	530 10000 10000	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
Semivolatile Organics																
90-12-0	1-METHYLNAPHTHALENE	1.3		19	J	ug/L	S8MW0301	3/8	0.5	19	N/A	0.62 (8) N	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
105-67-9	2,4-DIMETHYLPHENOL	14		240		ug/L	S8MW0301	2/8	5	240	N/A	73 N	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
91-57-6	2-METHYLNAPHTHALENE	0.82		15	J	ug/L	S8MW0301	3/8	0.5	15	N/A	0.62 (8) N	49 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
95-48-7	2-METHYLPHENOL	99		99		ug/L	S8MW0301	1/8	5	99	N/A	180 N	350 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
106-44-5	4-METHYLPHENOL	6		27		ug/L	S8MW0301	2/8	5	27	N/A	18 N	35 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
83-32-9	ACENAPHTHENE	0.85	J	7.9	J	ug/L	S8MW0301	4/8	0.5	7.9	N/A	37 N	420 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL

TABLE 10-4

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 8
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Goss Cove Landfill (Site 8)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
120-12-7	ANTHRACENE	0.11		1.4	J	ug/L	S8MW02S01,	7/8	0.05	1.4	N/A	180 N	2000 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
56-55-3	BENZO(A)ANTHRACENE	0.02	J	1.4	J	ug/L	S8MW0301	7/8	0.05	1.4	N/A	0.092 C	0.06 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
50-32-8	BENZO(A)PYRENE	0.02	J	2.1	J	ug/L	S8MW0301	6/8	0.05	2.1	N/A	0.0092 C	0.2 0.2 N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
205-99-2	BENZO(B)FLUORANTHENE	0.05	J	2.4	J	ug/L	S8MW0301	6/8	0.1	2.4	N/A	0.092 C	0.08 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
191-24-2	BENZO(G,H,I)PERYLENE	0.12		2.4	J	ug/L	S8MW0301	5/8	0.1	2.4	N/A	18 (9) N	210 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.05		1.1	J	ug/L	S8MW0301	5/8	0.05	1.1	N/A	0.92 C	0.5 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
218-01-9	CHRYSENE	0.03	J	1.9	J	ug/L	S8MW0301	7/8	0.05	1.9	N/A	9.2 C	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
53-70-3	DIBENZO(A,H)ANTHRACENE	0.06	J	0.46	J	ug/L	S8MW0301	3/8	0.1	0.46	N/A	0.0092 C	0.5 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
206-44-0	FLUORANTHENE	0.19		5.2	J	ug/L	S8MW0301	8/8	N/A	5.2	N/A	150 N	280 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
86-73-7	FLUORENE	0.11		5.8	J	ug/L	S8MW0301	7/8	0.1	5.8	N/A	24 N	280 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.02	J	1.4	J	ug/L	S8MW0301	6/8	0.05	1.4	N/A	0.092 C	0.5 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
91-20-3	NAPHTHALENE	1.5	J	56	J	ug/L	S8MW0301	4/8	0.5	56	N/A	0.62 N	280 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
85-01-8	PHENANTHRENE	0.03	J	11	J	ug/L	S8MW0301	8/8	N/A	11	N/A	18 (9) N	200 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
108-95-2	PHENOL	5	J	6		ug/L	S8MW0301	2/8	5	6	N/A	2200 N	4000 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
129-00-0	PYRENE	0.29		5.4	J	ug/L	S8MW0301	8/8	N/A	5.4	N/A	18 N	200 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Total Metals																
7440-36-0	ANTIMONY	10.4		10.4		ug/L	S8MW02S01	1/8	2.6	10.4	2.90	1.5 N	6 6 6	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-38-2	ARSENIC	2.3	J	14.5	J	ug/L	S8MW02D01	6/8	2.3	14.5	1.92	0.045 C	50 50(11) 50	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL

TABLE 10-4

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 8
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Goss Cove Landfill (Site 8)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7440-39-3	BARIUM	43.9	J	1180		ug/L	S8MW0401	7/8	14.1 - 41.4	1180	227	260	N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-70-2	CALCIUM	32800	J	265000		ug/L	S8MW06D01	8/8	N/A	265000	188000	N/A		N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-47-3	CHROMIUM	7.6	J	50.5		ug/L	S8MW02S01	4/8	6.2	50.5	49.9	110 (10)	N	50 100 N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-48-4	COBALT	10.1	J	10.1	J	ug/L	S8MW06D01	1/8	4.2	10.1	48.6	220	N	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-50-8	COPPER	22.2		35.4		ug/L	S8MW02S01	2/8	6.8	35.4	107	140	N	1300 1300 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON	338		14500		ug/L	S8MW02D01	8/8	N/A	14500	28200	1100	N	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI, BKG
7439-92-1	LEAD	2.5	J	53.1		ug/L	S8MW02S01	3/8	1.8	53.1	6.63	NA		15 15 N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7439-95-4	MAGNESIUM	25400		1210000		ug/L	S8MW06D01	8/8	N/A	1210000	191000	N/A		N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7439-96-5	MANGANESE	30.9	J	4210		ug/L	S8MW06D01	8/8	N/A	4210	11700	88	N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-02-0	NICKEL	11.7	J	28.7		ug/L	S8MW02S01	3/8	9.2	28.7	32.2	73	N	100 N/A 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-09-7	POTASSIUM	20000		250000		ug/L	S8MW06D01	8/8	N/A	250000	70800	N/A		N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-23-5	SODIUM	189000		9290000		ug/L	S8MW05S01	8/8	N/A	9290000	1900000	N/A		N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-62-2	VANADIUM	6.6	J	6.6	J	ug/L	S8MW06D01	1/8	6.3	6.6	10.2	26	N	50 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-66-6	ZINC	63.5		170		ug/L	S8MW02S01	2/8	10.4 - 40	170	131	1100	N	5000 5000 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
Dissolved Metals																	
7440-36-0	ANTIMONY, FILTERED	2.6	J	2.6	J	ug/L	S8MW05S01-F	1/1	N/A	2.6	2.01	1.5	N	6 6 6	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-38-2	ARSENIC, FILTERED	2.8	J	2.8	J	ug/L	S8MW05S01-F	1/1	N/A	2.8	2.55	0.045	C	50 50 50	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-39-3	BARIUM, FILTERED	46.9		46.9		ug/L	S8MW05S01-F	1/1	N/A	46.9	124	260	N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG

TABLE 10-4

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 8
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Goss Cove Landfill (Site 8)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7440-70-2	CALCIUM, FILTERED	144000		144000		ug/L	S8MW05S01-F	1/1	N/A	144000	152000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7439-95-4	MAGNESIUM, FILTERED	464000		464000		ug/L	S8MW05S01-F	1/1	N/A	464000	150000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7439-96-5	MANGANESE, FILTERED	90.2	J	90.2	J	ug/L	S8MW05S01-F	1/1	N/A	90.2	9400	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-09-7	POTASSIUM, FILTERED	154000		154000		ug/L	S8MW05S01-F	1/1	N/A	154000	60000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-23-5	SODIUM, FILTERED	4770000		4770000		ug/L	S8MW05S01-F	1/1	N/A	4770000	1580000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-62-2	VANADIUM, FILTERED	9.2	J	9.2	J	ug/L	S8MW05S01-F	1/1	N/A	9.2	9.90	26 N	50 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
Miscellaneous Parameters																
000-09-0	TOTAL DISSOLVED SOLIDS	97.5	J	27042		mg/L	S8MW06D01	9/9	N/A	27042	6260	N/A	N/A 500 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	NV
000-08-9	TOTAL SUSPENDED SOLIDS	8		38		mg/L	S8MW06D01	5/9	5,000	38	236	N/A	N/A N/A N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.
S8MW09S01 is located upgradient of the site and therefore was not used in COC selection or the human health risk assessment.

Footnotes:
1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 The risk-based COPC screening level for tap water use is presented. The value is based on a target Hazard Quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
7 Value is for total xylenes.
8 Naphthalene is used as a surrogate for 1-methylnaphthalene and 2-methylnaphthalene.
9 Pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.
10 Value is for hexavalent chromium.
11 The US EPA has approved a new MCL for arsenic of 10 ug/L. The MCL goes into effect in 2006. The reduction of the MCL does not impact the human health risk assessment.

Associated Samples:

S8MW0101	S8MW05S01
S8MW02D01	S8MW05S01-F
S8MW02S01	S8MW06D01
S8MW0301	S8MW06S01
S8MW0401	S8MW06S01-D

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
N/A = Not Applicable.
FED-MCL = Federal Maximum Contaminant Level (USEPA, August 2000).
FED-SMCL = Federal Secondary Maximum Contaminant Level (USEPA, August 2000).
FED-AL = Federal Action Level (USEPA, August 2000).
CTDEP-RSR = Connecticut DEP Remediation Standard Regulations, 1996.
CTDEP-MCL = Connecticut Maximum Contaminant Level.

Rationale Codes:
For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No Toxicity Information.
EPAI = USEPA Region 1 does not advocate evaluation of this chemical.
NV = Miscellaneous parameters are not evaluated in human health risk assessments.

TABLE 10-5

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 8
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Goss Cove Landfill (Site 8)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Surface Water Protection Criteria (5)	Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organics															
71-43-2	BENZENE	2		2		ug/L	S8MW02S01	1/8	1 - 25	2	N/A	710	215	NO	BSL
156-59-2	CIS-1,2-DICHLOROETHENE	33		33		ug/L	S8MW02D01	1/8	1 - 25	33	N/A	N/A	N/A	NO	NTX
100-41-4	ETHYLBENZENE	2		108		ug/L	S8MW0301	5/8	1	108	N/A	580000	50000	NO	BSL
	M+P-XYLENES	1	J	284		ug/L	S8MW0301	5/8	2	284	N/A	N/A	21300	NO	BSL
95-47-6	O-XYLENE	2		136		ug/L	S8MW0301	5/8	1	136	N/A	N/A	21300	NO	NTX
127-18-4	TETRACHLOROETHENE	31		31		ug/L	S8MW02D01	1/8	1 - 25	1440	N/A	88	1500	YES	ASL
108-88-3	TOLUENE	2		31		ug/L	S8MW0301	2/8	1	31	N/A	4000000	23500	NO	BSL
156-60-5	TRANS-1,2-DICHLOROETHENE	7		7		ug/L	S8MW02D01	1/8	1 - 25	7	N/A	N/A	N/A	NO	NTX
79-01-6	TRICHLOROETHENE	25		25		ug/L	S8MW02D01	1/8	1 - 25	25	N/A	2340	219	NO	BSL
75-01-4	VINYL CHLORIDE	1		1		ug/L	S8MW02D01	1/8	1 - 25	1	N/A	15750	2	NO	BSL
1330-20-7	XYLENES, TOTAL	5		454		ug/L	S8MW0301	5/8	1	454	N/A	N/A	21300	NO	BSL
Semivolatile Organics															
90-12-0	1-METHYLNAPHTHALENE	1.3		19	J	ug/L	S8MW0301	3/8	0.5	19	N/A	N/A	N/A	NO	NTX
105-67-9	2,4-DIMETHYLPHENOL	14		240		ug/L	S8MW0301	2/8	5	240	N/A	N/A	N/A	NO	NTX
91-57-6	2-METHYLNAPHTHALENE	0.82		15	J	ug/L	S8MW0301	3/8	0.5	15	N/A	N/A	N/A	NO	NTX
95-48-7	2-METHYLPHENOL	99		99		ug/L	S8MW0301	1/8	5	99	N/A	N/A	N/A	NO	NTX
106-44-5	4-METHYLPHENOL	6		27		ug/L	S8MW0301	2/8	5	27	N/A	N/A	N/A	NO	NTX
83-32-9	ACENAPHTHENE	0.85	J	7.9	J	ug/L	S8MW0301	4/8	0.5	7.9	N/A	0.3	N/A	YES	ASL
120-12-7	ANTHRACENE	0.11		1.4	J	ug/L	S8MW02S01,	7/8	0.05	1.4	N/A	1100000	N/A	NO	BSL
56-55-3	BENZO(A)ANTHRACENE	0.02	J	1.4	J	ug/L	S8MW0301	7/8	0.05	1.4	N/A	0.3	N/A	YES	ASL
50-32-8	BENZO(A)PYRENE	0.02	J	2.1	J	ug/L	S8MW0301	6/8	0.05	2.1	N/A	0.3	N/A	YES	ASL
205-99-2	BENZO(B)FLUORANTHENE	0.05	J	2.4	J	ug/L	S8MW0301	6/8	0.1	2.4	N/A	0.3	N/A	YES	ASL
191-24-2	BENZO(G,H,I)PERYLENE	0.12		2.4	J	ug/L	S8MW0301	5/8	0.1	2.4	N/A	N/A	N/A	NO	NTX
207-08-9	BENZO(K)FLUORANTHENE	0.05		1.1	J	ug/L	S8MW0301	5/8	0.05	1.1	N/A	0.3	N/A	YES	ASL
218-01-9	CHRYSENE	0.03	J	1.9	J	ug/L	S8MW0301	7/8	0.05	1.9	N/A	N/A	N/A	NO	NTX
53-70-3	DIBENZO(A,H)ANTHRACENE	0.06	J	0.46	J	ug/L	S8MW0301	3/8	0.1	0.46	N/A	N/A	N/A	NO	NTX
206-44-0	FLUORANTHENE	0.19		5.2	J	ug/L	S8MW0301	8/8	N/A	5.2	N/A	3700	N/A	NO	BSL
86-73-7	FLUORENE	0.11		5.8	J	ug/L	S8MW0301	7/8	0.1	5.8	N/A	140000	N/A	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.02	J	1.4	J	ug/L	S8MW0301	6/8	0.05	1.4	N/A	N/A	N/A	NO	NTX
91-20-3	NAPHTHALENE	1.5	J	56	J	ug/L	S8MW0301	4/8	0.5	56	N/A	N/A	N/A	NO	NTX
85-01-8	PHENANTHRENE	0.03	J	11	J	ug/L	S8MW0301	8/8	N/A	11	N/A	0.3	N/A	YES	ASL
108-95-2	PHENOL	5	J	6		ug/L	S8MW0301	2/8	5	6	N/A	92000000	N/A	NO	BSL
129-00-0	PYRENE	0.29		5.4	J	ug/L	S8MW0301	8/8	N/A	5.4	N/A	110000	N/A	NO	BSL
Total Metals															
7440-36-0	ANTIMONY	10.4		10.4		ug/L	S8MW02S01	1/8	2.6	10.4	2.9	86000	N/A	NO	BSL
7440-38-2	ARSENIC	2.3	J	14.5	J	ug/L	S8MW02D01	6/8	2.3	14.5	1.92	4	N/A	YES	ASL
7440-39-3	BARIUM	43.9	J	1180		ug/L	S8MW0401	7/8	14.1 - 41.4	1180	227	N/A	N/A	NO	NTX
7440-70-2	CALCIUM	32800	J	265000		ug/L	S8MW06D01	8/8	N/A	265000	188000	N/A	N/A	NO	NTX
7440-47-3	CHROMIUM	7.6	J	50.5		ug/L	S8MW02S01	4/8	6.2	50.5	49.9	N/A	N/A	NO	NTX
7440-48-4	COBALT	10.1	J	10.1	J	ug/L	S8MW06D01	1/8	4.2	10.1	48.6	N/A	N/A	NO	BKG
7440-50-8	COPPER	22.2		35.4		ug/L	S8MW02S01	2/8	6.8	35.4	107	48	N/A	NO	BSL, BKG
7439-89-6	IRON	338		14500		ug/L	S8MW02D01	8/8	N/A	14500	28200	N/A	N/A	NO	BKG
7439-92-1	LEAD	2.5	J	53.1		ug/L	S8MW02S01	3/8	1.8	53.1	6.63	13	N/A	YES	ASL
7439-95-4	MAGNESIUM	25400		1210000		ug/L	S8MW06D01	8/8	N/A	1210000	191000	N/A	N/A	NO	NTX
7439-96-5	MANGANESE	30.9	J	4210		ug/L	S8MW06D01	8/8	N/A	4210	11700	N/A	N/A	NO	BKG
7440-02-0	NICKEL	11.7	J	28.7		ug/L	S8MW02S01	3/8	9.2	28.7	32.2	880	N/A	NO	BSL, BKG
7440-09-7	POTASSIUM	20000		250000		ug/L	S8MW06D01	8/8	N/A	250000	70800	N/A	N/A	NO	NTX
7440-23-5	SODIUM	189000		9290000		ug/L	S8MW05S01	8/8	N/A	9290000	1900000	N/A	N/A	NO	NTX
7440-62-2	VANADIUM	6.6	J	6.6	J	ug/L	S8MW06D01	1/8	6.3	6.6	10.2	N/A	N/A	NO	BKG
7440-66-6	ZINC	63.5		170		ug/L	S8MW02S01	2/8	10.4 - 40	170	131	123	N/A	YES	ASL

TABLE 10-5

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 8
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Goss Cove Landfill (Site 8)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Surface Water Protection Criteria (5)	Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Dissolved Metals															
7440-36-0	ANTIMONY, FILTERED	2.6	J	2.6	J	ug/L	S8MW05S01-F	1/1	N/A	2.6	2.01	86000	N/A	NO	BSL
7440-38-2	ARSENIC, FILTERED	2.8	J	2.8	J	ug/L	S8MW05S01-F	1/1	N/A	2.8	2.55	4	N/A	NO	BSL
7440-39-3	BARIUM, FILTERED	46.9		46.9		ug/L	S8MW05S01-F	1/1	N/A	46.9	124	N/A	N/A	NO	BKG
7440-70-2	CALCIUM, FILTERED	144000		144000		ug/L	S8MW05S01-F	1/1	N/A	144000	152000	N/A	N/A	NO	BKG
7439-95-4	MAGNESIUM, FILTERED	464000		464000		ug/L	S8MW05S01-F	1/1	N/A	464000	150000	N/A	N/A	NO	NTX
7439-96-5	MANGANESE, FILTERED	90.2	J	90.2	J	ug/L	S8MW05S01-F	1/1	N/A	90.2	9400	N/A	N/A	NO	BKG
7440-09-7	POTASSIUM, FILTERED	154000		154000		ug/L	S8MW05S01-F	1/1	N/A	154000	60000	N/A	N/A	NO	NTX
7440-23-5	SODIUM, FILTERED	4770000		4770000		ug/L	S8MW05S01-F	1/1	N/A	4770000	1580000	N/A	N/A	NO	NTX
7440-62-2	VANADIUM, FILTERED	9.2	J	9.2	J	ug/L	S8MW05S01-F	1/1	N/A	9.2	9.9	N/A	N/A	NO	BKG
Miscellaneous Parameters															
000-09-0	TOTAL DISSOLVED SOLIDS	97.5	J	27042		mg/L	S8MW06D01	9/9	N/A	27042	6260	N/A	N/A	NO	NTX
000-08-9	TOTAL SUSPENDED SOLIDS	8		38		mg/L	S8MW06D01	5/9	5000	38	236	N/A	N/A	NO	BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Footnotes:
1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 Connecticut DEP Surface Water Protection criteria.
6 Connecticut DEP Volatilization criteria for residential exposures.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the CTDEP surface water protection or volatilization criteria.

Associated Samples:

S8MW0101	S8MW05S01-F
S8MW02D01	S8MW06D01
S8MW02S01	S8MW06S01
S8MW0301	S8MW06S01-D
S8MW0401	S8MW09S01
S8MW05S01	

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No Toxicity Information.

TABLE 10-6

SELECTION OF EXPOSURE PATHWAYS FOR SITE 8
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Groundwater	Overburden/Bedrock Aquifer	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	None Quant.	Construction workers may have dermal contact with groundwater during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers do not have contact with groundwater.
				Residents	Adult	Ingestion Dermal	On-Site On-Site	None None	Institutional controls prohibit residential usage at Site 8.
					Child	Ingestion Dermal	On-Site On-Site	None None	Institutional controls prohibit residential usage at Site 8.
		Air	Overburden/Bedrock Aquifer	Construction Workers	Adult	Inhalation	On-site	None	Construction workers exposure via volatilization is expected to be insignificant due to dilution with outdoor air.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers do not have contact with site groundwater.
				Residents	Adult	Inhalation	On-site	None	On-site residents may be exposed to volatile emissions from groundwater while showering. Institutional controls prohibit residential usage of Site 8.
					Child	Inhalation	On-site	None	Exposures to a child resident are less than those for an adult resident.

TABLE 10-7

EXPOSURE POINT CONCENTRATIONS FOR SITE 8
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Groundwater	
	RME [1]	CTE [1]
	(ug/L)	(ug/L)
Volatile Organic Compounds		
Benzene	2	2.00
cis-1,2-Dichloroethene	33	5.50
Tetrachloroethene	1440	165
Trichloroethene	25	4.67
Vinyl Chloride	1	1.89
Xylenes, Total	454	60.8
Semivolatile Organic Compounds		
1-Methylnaphthalene	19	3.09
2,4-Dimethylphenol	240	30.2
2-Methylnaphthalene	15	2.39
4-Methylphenol	27	5.61
Benzo(a)anthracene	1.4	0.360
Benzo(a)pyrene	2.1	0.459
Benzo(b)fluoranthene	2.4	0.572
Benzo(k)fluoranthene	1.1	0.237
Dibenzo(a,h)anthracene	0.46	0.101
Indeno(1,2,3-cd)pyrene	1.4	0.324
Naphthalene	56	9.17
Inorganics		
Antimony	10.4	2.31
Arsenic	14.5	4.79
Barium	1180	344
Chromium	50.5	12.8
Lead [2]	10.2	10.2

Notes:

1 The maximum detected concentration is used for the RME scenario and the average concentration is used for the CTE scenario.

2 The average concentration is used for lead (USEPA, 1994).

TABLE 10-8

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 8
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
REASONABLE MAXIMUM EXPOSURES								
Construction Worker	Groundwater	Dermal Contact	9.5E-06	- -	- -	Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene	0.03	- -
CENTRAL TENDENCY EXPOSURES								
Construction Worker	Groundwater	Dermal Contact	7.5E-07	- -	- -	- -	0.01	- -

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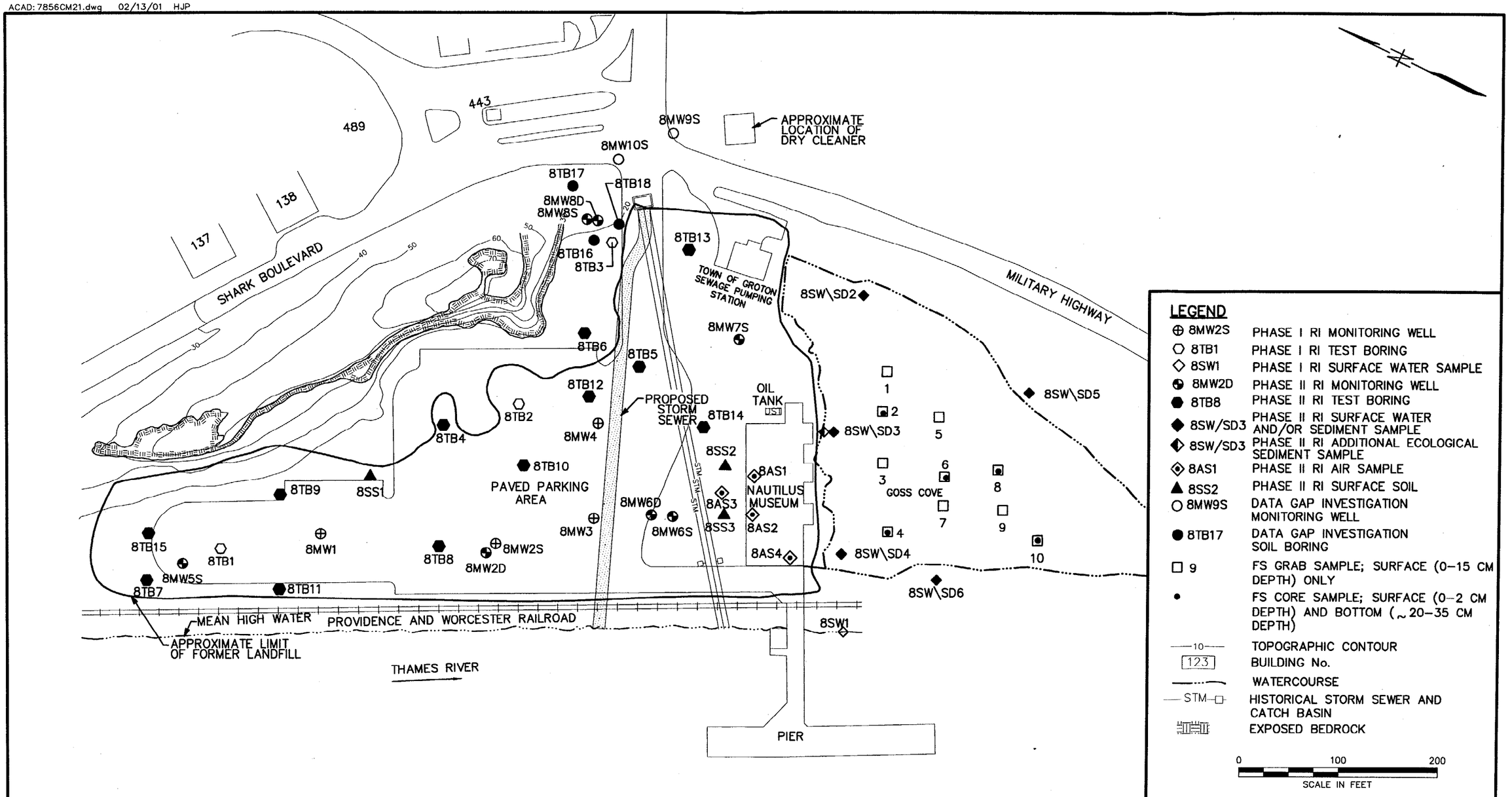


NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/19/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

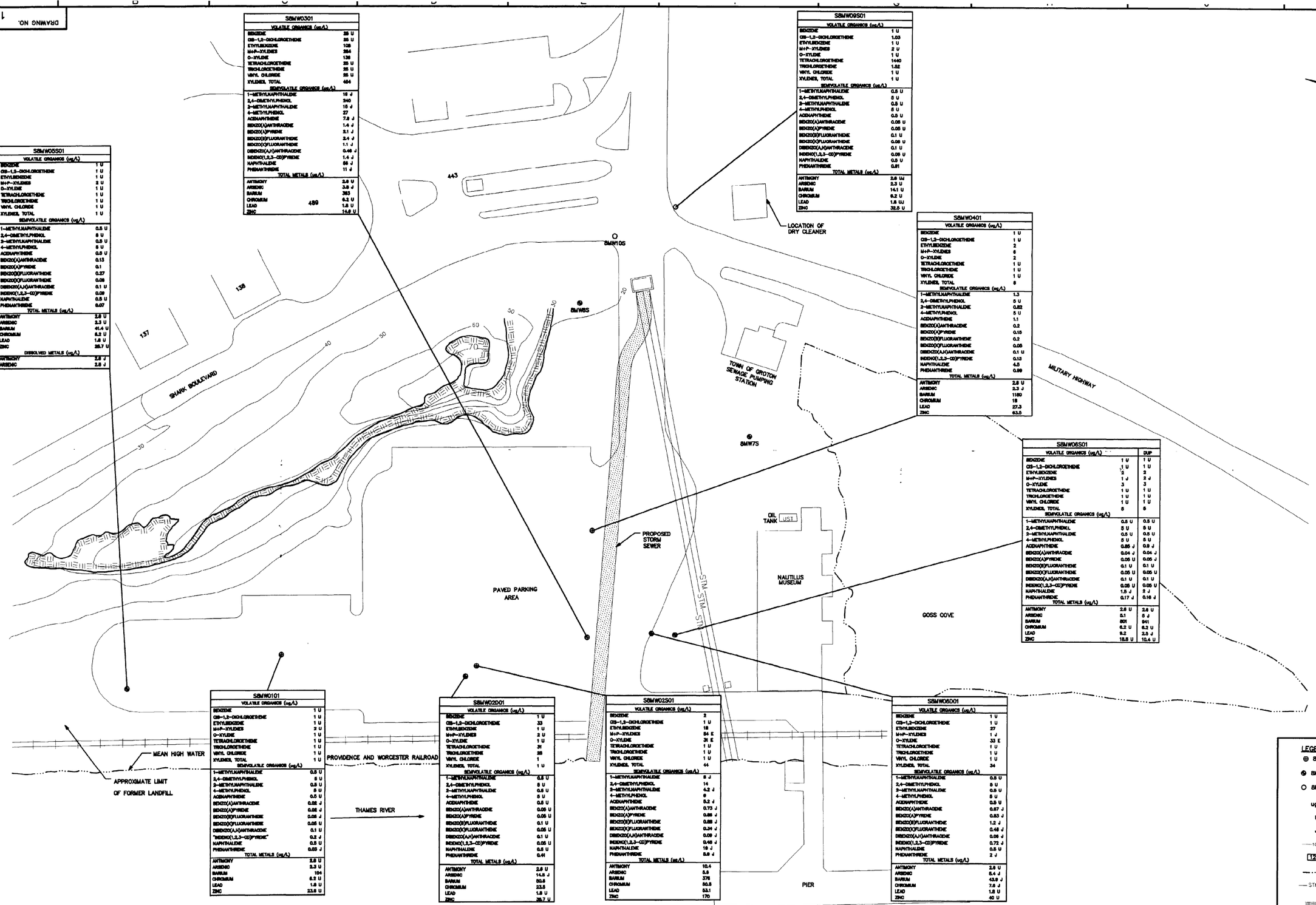
SAMPLE LOCATIONS
SITE 8-GOSS COVE LANDFILL
NSB-NLON
GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY DPCarlone DATE 2-15-01
APPROVED BY DATE
DRAWING NO. FIGURE 10-1
REV. 0

FORM CADD NO. TtNUS_BH.DGN - REV 0 - 1/20/98

10230247

DRAWING NO. 10-2 REV. 0



S8MW03S01	
VOLATILE ORGANICS (ug/L)	
BENZENE	1 U
CIS-1,2-DICHLOROETHENE	1 U
ETHYLBENZENE	1 U
M+P-XYLENES	2 U
O-XYLENE	1 U
TETRACHLOROETHENE	1 U
TRICHLOROETHENE	1 U
VINYL CHLORIDE	1 U
XYLENES, TOTAL	1 U
SEMIVOLATILE ORGANICS (ug/L)	
1-METHYLNAPHTHALENE	0.5 U
2,4-DIMETHYLPHENOL	5 U
2-METHYLNAPHTHALENE	0.5 U
4-METHYLPHENOL	5 U
ACENAPHTHENE	0.5 U
BENZO(A)ANTHRACENE	0.13
BENZO(A)PYRENE	0.1
BENZO(B)FLUORANTHENE	0.27
BENZO(K)FLUORANTHENE	0.09
DIBENZO(A,H)ANTHRACENE	0.1 U
INDENO(1,2,3-CD)PYRENE	0.09
NAPHTHALENE	0.5 U
PHENANTHRENE	0.07
TOTAL METALS (ug/L)	
ANTIMONY	2.6 U
ARSENIC	3.3 U
BARIUM	41.4 U
CHROMIUM	6.2 U
LEAD	1.8 U
ZINC	26.7 U
DISSOLVED METALS (ug/L)	
ANTIMONY	2.6 J
ARSENIC	2.6 J

S8MW0301	
VOLATILE ORGANICS (ug/L)	
BENZENE	25 U
CIS-1,2-DICHLOROETHENE	25 U
ETHYLBENZENE	108
M+P-XYLENES	354
O-XYLENE	138
TETRACHLOROETHENE	25 U
TRICHLOROETHENE	25 U
VINYL CHLORIDE	25 U
XYLENES, TOTAL	454
SEMIVOLATILE ORGANICS (ug/L)	
1-METHYLNAPHTHALENE	18 J
2,4-DIMETHYLPHENOL	340
2-METHYLNAPHTHALENE	15 J
4-METHYLPHENOL	27
ACENAPHTHENE	7.8 J
BENZO(A)ANTHRACENE	1.4 J
BENZO(A)PYRENE	2.1 J
BENZO(B)FLUORANTHENE	2.4 J
BENZO(K)FLUORANTHENE	1.1 J
DIBENZO(A,H)ANTHRACENE	0.48 J
INDENO(1,2,3-CD)PYRENE	1.4 J
NAPHTHALENE	56 J
PHENANTHRENE	11 J
TOTAL METALS (ug/L)	
ANTIMONY	2.6 U
ARSENIC	3.8 J
BARIUM	263
CHROMIUM	6.2 U
LEAD	1.8 U
ZINC	14.6 U

S8MW09S01	
VOLATILE ORGANICS (ug/L)	
BENZENE	1 U
CIS-1,2-DICHLOROETHENE	1.03
ETHYLBENZENE	1 U
M+P-XYLENES	2 U
O-XYLENE	1 U
TETRACHLOROETHENE	1440
TRICHLOROETHENE	1.52
VINYL CHLORIDE	1 U
XYLENES, TOTAL	1 U
SEMIVOLATILE ORGANICS (ug/L)	
1-METHYLNAPHTHALENE	0.5 U
2,4-DIMETHYLPHENOL	5 U
2-METHYLNAPHTHALENE	0.5 U
4-METHYLPHENOL	5 U
ACENAPHTHENE	0.5 U
BENZO(A)ANTHRACENE	0.05 U
BENZO(A)PYRENE	0.05 U
BENZO(B)FLUORANTHENE	0.1 U
BENZO(K)FLUORANTHENE	0.05 U
DIBENZO(A,H)ANTHRACENE	0.1 U
INDENO(1,2,3-CD)PYRENE	0.05 U
NAPHTHALENE	0.5 U
PHENANTHRENE	0.91
TOTAL METALS (ug/L)	
ANTIMONY	2.6 UJ
ARSENIC	2.3 U
BARIUM	14.1 U
CHROMIUM	6.2 U
LEAD	1.8 UJ
ZINC	32.5 U

S8MW0401	
VOLATILE ORGANICS (ug/L)	
BENZENE	1 U
CIS-1,2-DICHLOROETHENE	1 U
ETHYLBENZENE	2
M+P-XYLENES	6
O-XYLENE	2
TETRACHLOROETHENE	1 U
TRICHLOROETHENE	1 U
VINYL CHLORIDE	1 U
XYLENES, TOTAL	8
SEMIVOLATILE ORGANICS (ug/L)	
1-METHYLNAPHTHALENE	1.3
2,4-DIMETHYLPHENOL	5 U
2-METHYLNAPHTHALENE	0.82
4-METHYLPHENOL	5 U
ACENAPHTHENE	1.1
BENZO(A)ANTHRACENE	0.2
BENZO(A)PYRENE	0.15
BENZO(B)FLUORANTHENE	0.2
BENZO(K)FLUORANTHENE	0.05
DIBENZO(A,H)ANTHRACENE	0.1 U
INDENO(1,2,3-CD)PYRENE	0.13
NAPHTHALENE	4.5
PHENANTHRENE	0.99
TOTAL METALS (ug/L)	
ANTIMONY	2.6 U
ARSENIC	2.3 J
BARIUM	1180
CHROMIUM	18
LEAD	27.3
ZINC	63.5

S8MW06S01		DUP
VOLATILE ORGANICS (ug/L)		
BENZENE	1 U	1 U
CIS-1,2-DICHLOROETHENE	1 U	1 U
ETHYLBENZENE	2	2
M+P-XYLENES	1 J	2 J
O-XYLENE	3	3
TETRACHLOROETHENE	1 U	1 U
TRICHLOROETHENE	1 U	1 U
VINYL CHLORIDE	1 U	1 U
XYLENES, TOTAL	5	5
SEMIVOLATILE ORGANICS (ug/L)		
1-METHYLNAPHTHALENE	0.5 U	0.5 U
2,4-DIMETHYLPHENOL	5 U	5 U
2-METHYLNAPHTHALENE	0.5 U	0.5 U
4-METHYLPHENOL	5 U	5 U
ACENAPHTHENE	0.05 J	0.9 J
BENZO(A)ANTHRACENE	0.04 J	0.04 J
BENZO(A)PYRENE	0.05 U	0.05 J
BENZO(B)FLUORANTHENE	0.1 U	0.1 U
BENZO(K)FLUORANTHENE	0.05 U	0.05 U
DIBENZO(A,H)ANTHRACENE	0.1 U	0.1 U
INDENO(1,2,3-CD)PYRENE	0.05 U	0.05 U
NAPHTHALENE	1.5 J	2 J
PHENANTHRENE	0.17 J	0.16 J
TOTAL METALS (ug/L)		
ANTIMONY	2.6 U	2.6 U
ARSENIC	3.1	3 J
BARIUM	801	941
CHROMIUM	6.2 U	6.2 U
LEAD	9.2	2.5 J
ZINC	18.5 U	15.4 U

S8MW0101	
VOLATILE ORGANICS (ug/L)	
BENZENE	1 U
CIS-1,2-DICHLOROETHENE	1 U
ETHYLBENZENE	1 U
M+P-XYLENES	2 U
O-XYLENE	1 U
TETRACHLOROETHENE	1 U
TRICHLOROETHENE	1 U
VINYL CHLORIDE	1 U
XYLENES, TOTAL	1 U
SEMIVOLATILE ORGANICS (ug/L)	
1-METHYLNAPHTHALENE	0.5 U
2,4-DIMETHYLPHENOL	5 U
2-METHYLNAPHTHALENE	0.5 U
4-METHYLPHENOL	5 U
ACENAPHTHENE	0.5 U
BENZO(A)ANTHRACENE	0.02 J
BENZO(A)PYRENE	0.02 J
BENZO(B)FLUORANTHENE	0.05 J
BENZO(K)FLUORANTHENE	0.05 U
DIBENZO(A,H)ANTHRACENE	0.1 U
"INDENO(1,2,3-CD)PYRENE"	0.2 J
NAPHTHALENE	0.5 U
PHENANTHRENE	0.03 J
TOTAL METALS (ug/L)	
ANTIMONY	2.6 U
ARSENIC	2.3 U
BARIUM	194
CHROMIUM	6.2 U
LEAD	1.8 U
ZINC	23.6 U

S8MW02D01	
VOLATILE ORGANICS (ug/L)	
BENZENE	1 U
CIS-1,2-DICHLOROETHENE	33
ETHYLBENZENE	1 U
M+P-XYLENES	2 U
O-XYLENE	1 U
TETRACHLOROETHENE	31
TRICHLOROETHENE	35
VINYL CHLORIDE	1
XYLENES, TOTAL	1 U
SEMIVOLATILE ORGANICS (ug/L)	
1-METHYLNAPHTHALENE	0.5 U
2,4-DIMETHYLPHENOL	5 U
2-METHYLNAPHTHALENE	0.5 U
4-METHYLPHENOL	5 U
ACENAPHTHENE	0.5 U
BENZO(A)ANTHRACENE	0.05 U
BENZO(A)PYRENE	0.05 U
BENZO(B)FLUORANTHENE	0.1 U
BENZO(K)FLUORANTHENE	0.05 U
DIBENZO(A,H)ANTHRACENE	0.1 U
INDENO(1,2,3-CD)PYRENE	0.05 U
NAPHTHALENE	0.5 U
PHENANTHRENE	0.41
TOTAL METALS (ug/L)	
ANTIMONY	2.6 U
ARSENIC	14.5 J
BARIUM	80.8
CHROMIUM	23.5
LEAD	1.8 U
ZINC	35.7 U

S8MW02S01	
VOLATILE ORGANICS (ug/L)	
BENZENE	2
CIS-1,2-DICHLOROETHENE	1 U
ETHYLBENZENE	18
M+P-XYLENES	54 E
O-XYLENE	31 E
TETRACHLOROETHENE	1 U
TRICHLOROETHENE	1 U
VINYL CHLORIDE	1 U
XYLENES, TOTAL	44
SEMIVOLATILE ORGANICS (ug/L)	
1-METHYLNAPHTHALENE	5 J
2,4-DIMETHYLPHENOL	14
2-METHYLNAPHTHALENE	4.2 J
4-METHYLPHENOL	6
ACENAPHTHENE	5.2 J
BENZO(A)ANTHRACENE	0.73 J
BENZO(A)PYRENE	0.85 J
BENZO(B)FLUORANTHENE	0.88 J
BENZO(K)FLUORANTHENE	0.34 J
DIBENZO(A,H)ANTHRACENE	0.09 J
INDENO(1,2,3-CD)PYRENE	0.46 J
NAPHTHALENE	19 J
PHENANTHRENE	5.9 J
TOTAL METALS (ug/L)	
ANTIMONY	10.4
ARSENIC	5.5
BARIUM	376
CHROMIUM	50.5
LEAD	53.1
ZINC	170

S8MW06D01	
VOLATILE ORGANICS (ug/L)	
BENZENE	1 U
CIS-1,2-DICHLOROETHENE	1 U
ETHYLBENZENE	27
M+P-XYLENES	1 J
O-XYLENE	33 E
TETRACHLOROETHENE	1 U
TRICHLOROETHENE	1 U
VINYL CHLORIDE	1 U
XYLENES, TOTAL	34
SEMIVOLATILE ORGANICS (ug/L)	
1-METHYLNAPHTHALENE	0.5 U
2,4-DIMETHYLPHENOL	5 U
2-METHYLNAPHTHALENE	0.5 U
4-METHYLPHENOL	5 U
ACENAPHTHENE	0.5 U
BENZO(A)ANTHRACENE	0.67 J
BENZO(A)PYRENE	0.83 J
BENZO(B)FLUORANTHENE	1.2 J
BENZO(K)FLUORANTHENE	0.46 J
DIBENZO(A,H)ANTHRACENE	0.06 J
INDENO(1,2,3-CD)PYRENE	0.72 J
NAPHTHALENE	0.5 U
PHENANTHRENE	2 J
TOTAL METALS (ug/L)	
ANTIMONY	2.6 U
ARSENIC	5.4 J
BARIUM	43.9 J
CHROMIUM	7.5 J
LEAD	1.8 U
ZINC	40 U

LEGEND

⊕ 8MW2S	PHASE I RI MONITORING WELL
⊕ 8MW2D	PHASE II RI MONITORING WELL
○ 8MW9S	DATA GAP INVESTIGATION MONITORING WELL
ug/L	MICROGRAMS PER LITER
U	UNDETECTED
J	ESTIMATED
10	EXISTING CONTOUR
123	BUILDING No.
	WATERCOURSE
STM	HISTORIC STORM SEWER AND CATCH BASIN
	EXPOSED BEDROCK

0 40 80
SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES	NO.	RELEASED FOR	BY	DATE

DRAWN BY HJP DATE 12/11/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

COPCs IN GROUNDWATER
SITE 8 – GOSS COVE LANDFILL
NSB – NLON, GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY SPCrowe DATE 2-15-01
APPROVED BY DATE
DRAWING NO. FIGURE 10-2
REV. 0

ACAD: 7856GT01.dwg 02/07/01 HJP

1073C.75X

11.0 SITE 15 – SPENT ACID STORAGE AND DISPOSAL AREA

11.1 SITE DESCRIPTION

The SASDA was located in the Southern Region of NSB-NLON. It was centrally located between the southern sides of Buildings 409 and 410. The former site location and historical sampling locations are shown on Figure 11-1. The site's location relative to other IRP sites is depicted on Figure 1-2. The site is a relatively flat area completely covered with concrete or bituminous pavement.

The IAS Report indicated that this area was used before and after World War II for the temporary storage of waste battery acid in a rubber-lined underground tank. The tank was reportedly 12 feet long by 4 feet wide by 4 feet high. The batteries were placed on a concrete pad next to the tank, where some acids occasionally leaked. No major spills were ever recorded. A 1951 aerial photograph shows that the area around the tank was not paved. Acid from the batteries was stored in the tank and was subsequently pumped into a tank truck and disposed in the Area A Landfill (Site 2).

Atlantic personnel inspected the site and found the outline of the top of the tank. The area was completely covered with concrete and only the top of the tank was visible. The tank had been filled in place with soil and capped with bituminous pavement.

A time-critical removal action was completed at the SASDA during the course of the Phase II RI. The removal action, completed in January 1995, included removal of the tank, tank contents, contaminated pavement, and approximately 318 tons of lead-contaminated soil. Soil with lead concentrations in excess of 500 mg/kg or TCLP leachate results for lead in excess of 5.0 mg/L were removed by OHM Remediation Services Corporation. The excavated materials were transported off site and disposed in a RCRA landfill (Environmental Quality Company) in Bellville, Michigan. The excavation was backfilled with clean borrow material from an off-site location. The excavated area was covered with bituminous pavement.

The Navy, USEPA, and CTDEP signed a No-Further-Action Source Control ROD for this site in 1997.

11.2 SITE INVESTIGATIONS

The details of all investigations, including historical and current, conducted at the SASDA are provided in the following subsections.

11.2.1 Phase I Remedial Investigation (Atlantic, 1992)

An investigation of 11 sites was completed at NSB-NLON by Atlantic Environmental Services, Inc. from 1990 through 1992. The SASDA was one of the sites investigated during the Phase I RI. Four surface (less than 4 feet deep) and three subsurface (greater than 4 feet deep) soil samples were collected during the Phase I RI. One surface sample (15SS1) was collected from gravel inside the tank. The remaining six samples were collected from two test borings adjacent to the underground tank and a third test boring was located approximately 15 feet south of the SASDA. One surface and one subsurface soil sample were collected from each test boring. The Phase I RI recommended that this site proceed to Step II of the IRP.

11.2.2 Focused Feasibility Study (Atlantic, 1994a)

Atlantic also conducted supplemental sampling and analysis at the site in support of an FFS. Six surface soil samples (plus one field duplicate) were collected from six test borings. The report concluded that off-site landfilling was the alternative that provided superior protection of the environment, was easiest to implement, and was most cost effective.

11.2.3 Phase II Remedial Investigation (B&R Environmental, 1997a)

B&R Environmental conducted a Phase II RI at 13 sites at NSB-NLON. The SASDA was included in the investigation. Four shallow and one deep groundwater monitoring wells were installed during the Phase II RI. Two rounds of groundwater sampling were completed, and five samples (plus one field duplicate sample during Round 2 only) were collected during each sampling round. Two surface and two subsurface soil samples were collected from the four shallow monitoring well borings. Additionally, one sediment sample was collected from a stormwater drainage ditch downstream of the site.

11.2.4 Time-Critical Removal Action (Atlantic, 1995a and OHM, 1995)

OHM completed a time-critical removal action at SASDA in January 1995. The remedial action was documented in the Action Memorandum for the Spent Acid Storage and Disposal Area (Atlantic, 1995a) and the Final Report for Soil Remediation, Spent Acid Storage and Disposal Area (OHM, 1995). The maximum depth of excavation was 4 feet. OHM collected and analyzed five composite soil samples (plus one field duplicate) to confirm that all contaminated soils had been removed during the time-critical removal action. Composite samples were collected from the bottom (16600-BC) and the north, east, south, and west sidewalls (16600-NC, -EC, -SC, and -WC, respectively) of the excavation pit. A field duplicate of 16600-WC was also collected. The remedial contractor did not specify the depths of these samples.

11.2.5 CTDEP Supplemental Sampling Event

CTDEP completed additional sampling of the soil at this site in June 1997 and analyzed the samples for lead by the SPLP. CTDEP did not provide the Navy with a map showing the locations of the samples that they collected or the analytical results. The sampling and analysis were conducted to determine if remaining soils could act as a potential source of contamination to the groundwater. The results indicated that the remaining soils did not pose a potential contaminant migration problem. CTDEP issued a letter on September 15, 1997 in which they provided concurrence with the no-further-action remedy for the SASDA.

11.2.6 Basewide Groundwater OU RI

During the BGOURI, only groundwater samples were collected from historical monitoring wells to further characterize this site. A summary of the sampling and analytical program is presented in Table 11-1. The four monitoring wells (i.e., 15MW1S, 15MW1D, 15MW2S, and 15MW3S) that were sampled are shown on Figure 11-1. A representative downgradient monitoring well was also to be sampled during the BGOURI; however, the original downgradient well (15MW4S) and the proposed downgradient monitoring well (HNUS-6) were both determined to be destroyed and could not be sampled. Groundwater samples were collected from the four existing wells, and a field duplicate was also collected from monitoring well 15MW02S. The methodology used to complete groundwater sampling was discussed in Section 2.3.

11.3 PHYSICAL CHARACTERISTICS

This section presents a summary of physical characteristics for the SASDA site based on information generated during the Phase I and Phase II RIs and the BGOURI. Topography and surface features, surface water, soils, geology, and hydrogeology are discussed in the following subsections.

11.3.1 Topography and Surface Features

Figure 1-3 shows the topography and surface features of the SASDA. The entire area is covered with concrete or bituminous pavement. The site is located southwest of the central bedrock high, which narrowly extends to the south. The ground surface slopes downward from the bedrock high to the southwest. Based on the topographic contours on Figure 1-3, the ground surface slope in the vicinity of the site is relatively flat but ranges up to approximately 20 percent in areas north and east of the site. Ground elevations of the site monitoring wells are between 25 and 30 feet msl. The ground surface is also relatively flat southwest of the site.

11.3.2 Surface Water

Surface water runoff from this site is collected by a storm sewer system. The storm sewer system passes through the Tank Farm and Goss Cove Landfill sites and eventually discharges to the Thames River.

11.3.3 Soil Characteristics

The SCS Soils Map (SCS, 1983) classifies the soil at the SASDA as Urban land. Upgradient of the site (east), bedrock exposures are prevalent as the central bedrock high extends toward the south. Overlying soils are classified as the Hollis-Charlton-Rock complex. Stones and boulders are intermingled with a dark, fine, sandy loam.

11.3.4 Geology and Hydrogeology

Geology

Geologic conditions at the SASDA consist of variable thicknesses of fill and natural alluvial deposits overlying metamorphic bedrock. The overburden at the SASDA consists primarily of silty sand alluvium. Boring logs indicate that, in some intervals, there are traces of clay and, in others, there are traces of gravel and rock fragments. The SASDA has been mapped as stratified drift that was deposited by glacial meltwater streams (USGS, 1960). Minor thicknesses of fill may be present overlying the silty sand in some places. The borings for wells 15MW1D and 15MW4S encountered silt layers of 26- and 24-foot thicknesses, respectively, beneath the silty sand interval. These deposits are also most likely stratified drift.

The bedrock surface slopes to the southwest across the site, as shown on Figure 1-4. Monitoring well 15MW1D was drilled to a depth of 46.5 feet, where gneiss fragments of the Mamacoke Formation were encountered. The bedrock elevation at well 15MW1D is 17.5 feet below msl (-17.5 feet). Monitoring well 15MW4S was drilled to an elevation of 17 feet below msl (a total depth of 43 feet). Bedrock was not positively identified in this boring; however, auger refusal was reached, suggesting that the bedrock surface may have been encountered. Northeast of the site, along Rasher Avenue, bedrock crops out at ground surface. Figure 4-16 is a geologic cross section that includes a portion of Site 15.

Hydrogeology

Two rounds of water-level measurements were taken in the Site 15 monitoring wells during the BGOURI. The measurements and associated elevations are summarized in Tables 2-2 and 2-3. The elevations were used in conjunction with water-level elevations from other southern region sites to create the potentiometric surface maps provided in Section 4.0 (Figures 4-12 through 4-15). Figures 1-5 and 1-6

show historical basewide groundwater overburden and bedrock potentiometric surface maps. The SASDA is included on these figures. No bedrock monitoring wells were installed at the site.

During historical and current investigations at this site, groundwater was encountered in the alluvium at depths of less than 10 feet. Most overburden groundwater flow is expected to be through the silty sand layer, with the underlying silt deposit acting as a semi-confining unit to groundwater flow. The groundwater generally flows to the south-southwest. There is a downward vertical gradient at the 15MW1 well cluster.

Based on Figures 4-12 and 4-14, the shallow overburden flow gradient across the site is approximately 0.024. Downgradient of the site, toward the Goss Cove Landfill, the hydraulic gradient flattens out. During the Phase II RI field work, slug tests were performed at wells 15MW1S and 15MW3S. The geometric mean of the calculated hydraulic conductivities is 0.76 ft/day. This value is lower than the average alluvium hydraulic conductivity across the base but is typical of literature values for silty sand that was the identified material in the overburden. Assuming a porosity of 0.30, the estimated groundwater seepage velocity is 0.06 ft/day.

11.4 NATURE AND EXTENT OF CONTAMINATION

This section presents an evaluation of the nature and extent of groundwater contamination at Site 15. The discussion includes historical groundwater data collected during Rounds 1 and 2 of the Phase II RI and groundwater data collected during the BGOURI. Groundwater sample locations are shown on Figure 11-1.

11.4.1 Historic Site Investigations

Soil, groundwater, and sediment sampling were conducted at the SASDA during the Phase I RI, FFS, Phase II RI, and time-critical removal action. The nature and extent of contamination in groundwater at the SASDA, as determined during the Phase II RI, are summarized in the following subsection. Analytical results for soil samples are not discussed because contaminated soils from the area of the former UST and former concrete storage pad have been removed and are therefore no longer a potential source of contamination for the groundwater at this site. Analytical testing conducted by the CTDEP (SPLP, followed by analysis for lead) of the soil remaining after the time-critical removal action indicated that the lead present in the remaining soils was not mobile and, therefore, does not pose a threat to groundwater. Thus, a ROD was signed for this site that documented the selected remedy for the soil OU as no further action. Analytical results for the single sediment sample collected from the stormwater drainage ditch downstream of the site are not discussed either because contamination in this medium is not expected to impact the groundwater at this site.

Historic Groundwater Data

A total of 10 groundwater samples were collected from five overburden wells at the SASDA during Rounds 1 and 2 of the Phase II RI. Carbon disulfide was detected at a concentration of 3 µg/L in the groundwater sample collected from well 15MW1D during Round 1 of the Phase II RI. No other VOCs were detected. Five SVOCs [1,4-dichlorobenzene, bis(2-ethylhexyl) phthalate, di-n-butyl phthalate, naphthalene, and phenanthrene] were detected in the groundwater samples. The two phthalates, plasticizers that are common field and laboratory contaminants, were each detected in four of the 10 samples. The remaining SVOCs were each detected in one or two of the 10 samples. Concentrations of bis(2-ethylhexyl) phthalate ranged from 0.6 µg/L to 45 µg/L. Bis(2-ethylhexyl) phthalate (3 µg/L) was also detected in one of the groundwater samples collected from the off-site residential wells. Concentrations of the remaining SVOCs detected in the SASDA groundwater samples ranged from only 0.5 µg/L to 1 µg/L. A single pesticide, heptachlor, was also detected in a groundwater sample at a concentration of 0.54 µg/L.

Twenty-one metals were detected in the unfiltered groundwater samples collected from the SASDA wells, and 17 metals were detected in the corresponding filtered groundwater samples. A majority of the maximum concentrations were associated with samples collected from wells 15MW3S and 15MW2S, located downgradient and upgradient, respectively, of the SASDA. Maximum concentrations of aluminum (unfiltered samples only), antimony, arsenic, beryllium, cobalt, magnesium, manganese, and zinc exceeded concentrations of respective metals detected in unfiltered groundwater samples from the off-site residential wells. Notable results reported for SASDA groundwater samples include maximum concentrations of manganese in both filtered and unfiltered groundwater samples at 3080 µg/L and maximum concentrations of zinc in filtered and unfiltered groundwater samples at 450 µg/L and 453 µg/L, respectively. The maximum lead concentration in one unfiltered groundwater sample from 15MW3S (21.2 µg/L) was significantly higher than subsequent filtered (2 µg/L) and unfiltered (4.4 µg/L) samples collected from the same well.

Analyses for oil and grease, COD, hardness, and TSS were also performed for selected SASDA groundwater samples during previous investigations. A summary of historical analytical results is presented in Appendix D.

11.4.2 Basewide Groundwater OU RI

A summary of the BGOURI sampling and analytical program for Site 15 is presented in Table 11-1. A complete summary of the Site 15 analytical data set is provided in Appendix B. Table 11-2 presents a summary of positive groundwater analytical results for Site 15.

As part of the HHRA, descriptive statistics (i.e., frequency of detections, minimum and maximum concentrations, range of detection limits, and the associated sample numbers) and the COPC screening criteria for each analyte detected at least once in soils at the SASDA were tabulated. Analytical results for groundwater are summarized and screened in Tables 11-4 and 11-5. Different exposure scenarios (i.e., direct exposure and migration) are considered in each table. Tag maps of the chemicals determined to be COPCs based on the screening assessment were created to show the horizontal extent of contamination. Figure 11-2 shows COPCs that exceeded direct exposure or migration screening criteria. The analytical detection limit for a COPC is presented on the tag maps if the COPC was not detected in a sample.

The only VOC that was detected was TCE. TCE was not detected in groundwater at this site during historical sampling events. The source of the TCE is unknown. TCE was detected in three of four groundwater samples at concentrations ranging from 2.32 J µg/L (15MW2S) to 16 µg/L (15MW3S). All positively detected concentrations of TCE were in excess of the direct contact exposure criteria. Concentrations of TCE were not in excess of CTDEP pollutant mobility criteria. TCE was not detected in any Site 23 groundwater sample; therefore, it does not appear that the TCE is migrating to downgradient locations at significant concentrations.

Anthracene, fluoranthene, and pyrene were detected in Site 15 groundwater samples. None of these SVOCs were detected in groundwater samples collected during the Phase II RI. The PAHs were only detected in sample S15MW3S01. Concentrations of these PAHs were all under 100 µg/L, and none were in excess of direct contact exposure criteria or the CTDEP pollutant mobility criteria.

Fifteen inorganics were detected in the groundwater samples collected from Site 15. Seven of the 15 detected metals were present in all four samples. Significant concentrations of metals were detected most frequently in samples S15MW1S01 and S15MW2S01. Cadmium, chromium, lead, nickel, and silver were detected at concentrations that exceeded direct contact screening criteria and background concentrations. Lead is the only common inorganic detected at significant levels during both the Phase II RI and BGOURI. Chromium and lead were detected in all four BGOURI samples.

Concentrations of chromium ranged from 7.9 µg/L to 121 µg/L. Only the concentration of chromium (121 µg/L) in sample 15MW1S01 was in excess of both background and the direct contact screening criteria. The chromium concentration detected in the deep overburden monitoring well 15MW1D was below background and the direct exposure criteria.

Lead was detected at concentrations below direct contact screening criteria in all samples, except in 15MW1S01 (24.7 µg/L). Lead concentrations exceeded background and CTDEP pollutant mobility criteria in samples 15MW1S01 and 15MW2S01. The pH of the groundwater in 15MW2S was acidic (4.44), the pH of the groundwater in 15MW1S and 15MW3S was slightly acidic (5.75 and 5.91, respectively), and the pH of the groundwater in 15MW1D was near neutral (6.9). Lead was detected at 2.8 J µg/L in the deep overburden aquifer well 15MW1D. Collectively, the pH data and the detected concentrations of lead indicate that residual contamination from the former SASDA is impacting the shallow overburden groundwater.

Cadmium was detected in sample 15MW1S01 at a concentration of 0.99 µg/L and in sample 15MW2S01 at a concentration of 3.4 µg/L. However, only the concentration of cadmium in sample 15MW2S01 was in excess of the direct contact screening criteria.

Nickel was detected only in sample 15MW1S01 at a concentration of 77.6 µg/L. The high nickel concentration was not found in the adjacent, deep overburden well 15MW1D.

Silver was detected in 3 of 3 samples at concentrations ranging from 79.1 µg/L (15MW1D) to 615 µg/L (15MW2S). These concentrations are all in excess of both background and direct contact screening criteria. The maximum silver concentration was found in well 15MW2S, which also had the lowest pH (4.44). Concentrations of silver decline in the downgradient direction but the existing monitoring well network at Site 15 does not extend far enough downgradient to fully define the most downgradient extent of silver in groundwater. Even though the monitoring well network is limited at Site 15, silver was not detected in any downgradient groundwater samples at Site 23. Therefore it does not appear that silver is migrating to downgradient locations at significant concentrations.

Of the 10 remaining detected metals, concentrations of aluminum, beryllium, and zinc were in excess of background. However, concentrations of aluminum, beryllium, and zinc were below the respective direct contact screening criteria. Additionally, concentrations of lead, silver, and zinc were in excess of CTDEP pollutant mobility criteria.

11.5 CONTAMINANT FATE AND TRANSPORT

11.5.1 Contaminant Fate and Transport Processes

Three classes of chemicals were detected in groundwater at Site 15 during the BGOURI: halogenated aliphatics, PAHs, and metals. These classes were also detected in groundwater during the Phase II RI conducted in 1996. However, dichlorobenzenes, phthalates, and carbon disulfide were detected in the Phase II RI but not in the BGOURI. Pesticides were detected in groundwater during the Phase II RI but

were not analyzed for during the BGOURI. Only one pesticide was detected infrequently in groundwater during the Phase II RI, therefore pesticides were not analyzed for during the BGOURI. The potential of the three classes of chemicals cross contaminating adjacent sites is discussed later in this section.

Halogenated Aliphatics

One halogenated aliphatic (TCE) was detected in the three shallow groundwater samples collected in the BGOURI at concentrations ranging from 2.32 µg/L to 16 µg/L. The highest concentration of TCE was detected in sample S15MW3S01 which is downgradient of the former SASDA. However, TCE was not detected in any groundwater samples in the Phase II RI. TCE was detected in one surface soil sample (0 to 4 feet in depth) at a concentration of 2 µg/kg in the Phase II RI at location 15MW2S. The sample from this monitoring well S15MW2S01, had the lowest detected groundwater concentration of TCE (2.32 µg/L). Halogenated aliphatic hydrocarbons such as TCE are relatively water soluble and have a low capacity for retention by soil organic carbon and, therefore, TCE is frequently detected in groundwater. Leaching from soil may account for the presence of TCE in groundwater at the site, although the site is completely covered with concrete or pavement, which would limit the potential for leaching by rainwater. TCE may migrate through the soil column after being released by a spill event or by a subsurface release when solubilized by infiltrating precipitation. Some portion of TCE may be retained by the soil, but most of the chemical will continue migrating downward until it reaches the water table. At that time, migration is primarily lateral with the hydraulic gradient. The most recent groundwater data collected at the site may indicate that lateral transport as TCE is occurring since higher concentrations were found in downgradient wells. However, TCE was not detected in any Site 23 groundwater sample; therefore, it does not appear that the TCE is migrating to downgradient locations at significant concentrations. Based on the analytical results from the single deep monitoring well at Site 15, it does not appear that vertical migration of organic contaminants is occurring because neither TCE nor other volatile organic contaminants were detected in the well during the phase II RI or the BGOURI. Although TCE is susceptible to degradation, there is no evidence that biodegradation is occurring in the groundwater at Site 15 because no degradation products have been detected in on-site groundwater samples in either the BGOURI or the Phase II RI.

Polynuclear Aromatic Hydrocarbons (PAHs)

Low-molecular-weight PAHs (anthracene, fluoranthene, and pyrene) were detected in one shallow groundwater sample (S15MW3S01) at Site 15. Only one low-molecular-weight PAH (phenanthrene) was detected in one overburden sample (15GW3S) in the Phase II RI. No high-molecular weight PAHs were detected in groundwater at the site. Both low-and high-molecular-weight PAHs were detected in surface and subsurface soil in the Phase II RI. PAHs are generally considered to be fairly immobile in the environment. As noted in Section 3.3, PAHs have very low solubilities, vapor pressures, and Henry's Law constants and high K_{oc}s and K_{ow}s. The low-molecular-weight PAHs (e.g., acenaphthene, anthracene,

fluorene, phenanthrene) are more mobile (higher solubilities, etc.) than the high-molecular-weight PAHs [e.g., benzo(a)pyrene, benzo(a)anthracene, chrysene, etc.]. PAHs in soil are much more likely to bind to soil and be transported via mass transport mechanisms than go into solution. PAHs can be degraded via aerobic bacteria but may be relatively persistent in the absence of microbial population or macronutrients such as phosphorous and nitrogen.

No PAHs were found in the deeper overburden well. The absence of these compounds at depth may be related to the fact that downward migration of PAHs from the surface is less likely because of their tendency to adhere to soil.

Metals

At Site 15, 15 metals were detected in shallow and deep groundwater samples. As noted in Section 3.3, metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. The major fate mechanisms for metals are adsorption to the soil matrix (as compared to being part of the soil structure) and bioaccumulation.

In addition, under normal conditions, metals are not very mobile in the environment. Because metals frequently remain bound to particulate matter, the major transport mechanism for metals is bulk movement processes (erosion). However, metals can become mobile in the environment under certain conditions. The mobility of metals is influenced primarily by their physical or chemical properties in conjunction with the physical and chemical properties of the soil matrix. Factors that assist in predicting the mobility of metals are the soil/pore water pH, REDOX potential, and cation exchange capacity. The mobility of metals generally increases with decreasing soil pH and cation exchange capacity. The effect of REDOX potential varies for each metal. The highest concentrations of the metals tend to be in the shallow groundwater wells closest to the location of the former SASDA (wells 15MW1S and 15MW2S). The low pH (4.44) in the most upgradient well (15MW2S) and the generally acidic pH in two other shallow wells suggest that the metals cadmium, nickel, silver, and zinc will be present as cations and will be mobile. Any retardation of these metals will be through cation exchange reactions with the aquifer mineral surfaces.

The combination of slightly acidic and generally oxidizing groundwater at Site 15 suggests chromium will be present as the Cr(VI) chromate anion and thus more mobile than the metal cations. However, as the chromate migrates from Site 15 toward and through the more reducing and more basic pH environment of Site 23 (Tank Farm), its mobility should decrease due to reduction from Cr (VI) to Cr (III). In this environment, the likelihood of precipitation of an insoluble hydroxide is increased.

The list of metals detected in the BGOURI is similar to that of the Phase II RI. A notable exception is silver, which was detected in one deep groundwater sample in the Phase II RI at a concentration of 1.2 µg/L but was detected in the three shallow wells sampled during the BGOURI at concentrations ranging from 79.1 to 615 µg/L. The published distribution coefficients (Kds) for silver range from 10 to 1000 mL/g (Table 3-2), and it is possible that the silver detected at the site is bound to particulate matter. Silver was detected in 1 of 9 soil samples in the Phase II RI at a concentration of 460 µg/kg. Based on these data it does not appear that soil contamination is the main source of the silver in groundwater.

Lead was detected in groundwater at the site; the maximum concentration slightly exceeded screening levels. The concentrations of lead detected in the BGOURI (2.8 µg/L to 24.7 µg/L) are similar to those found in the Phase II RI (2.1 µg/L to 21.2 µg/L). The maximum concentrations in both investigations occurred in samples downgradient of the former SASDA but not at the same location. Although lead strongly adsorbs to organic matter in soil and is typically considered to be immobile, the presence of acidic conditions (battery acid) can result in the mobilization of lead. Under acidic conditions (i.e., a soil pH lower than 6), lead complexes can become soluble and subject to migration. However, soil containing elevated lead concentrations was removed during the time-critical removal action conducted by OHM in January 1995. The Phase II RI concluded that the detection of lead at 21.2 µg/L was most likely the result of suspended solids in the unfiltered sample and that, since lead was not detected in the groundwater in the dissolved phase (i.e., filtered samples), it was unlikely that lead was migrating via the groundwater. Filtered samples were not collected or analyzed during the BGOURI; therefore, this assumption could not be directly verified. However, the turbidity and TSS measurements taken during the BGOURI in monitoring well 15MW1S (i.e., 3 NTU and 5 J mg/L), which had the highest concentration of lead, do not indicate that the high concentrations of lead are related to suspended solids. Lead mobility is likely since the predominant dissolved species is a neutral molecule ($PbCO_3$).

11.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific HHRA for the identified exposure scenarios for Site 15. The risk assessment methodology was described in Section 3.4, and detail calculations including RAGS Part D tables are presented in Appendix C. A summary of previous HHRAs for the site is also presented.

11.6.1 Data Evaluation

COPCs were identified for Site 15 using the risk-based screening levels, as discussed in Section 3.4.1. Table 11-3 summarizes the COPCs retained for Site 15. A discussion of direct contact exposure COPCs (i.e., those chemicals detected at concentrations in excess of USEPA and CTDEP direct contact exposure criteria) and additional COPCs is provided below. Additional COPCs are identified on chemical migration tendencies: migration of groundwater to surface water and migration of volatiles from

groundwater through building foundations into indoor air. These additional COPCs are not quantitatively evaluated in the HHRA because they are not considered to be significant contributors to the direct contact exposure pathways identified for potential human receptors.

A comparison of the maximum detected concentrations in groundwater to direct contact risk-based screening criteria is presented in Table 11-4. The maximum detected concentrations of the following chemicals in groundwater exceeded the direct contact risk-based COPC screening levels and were retained as COPCs for groundwater:

- VOCs-trichloroethene
- Metals-cadmium, chromium, lead, nickel, and silver

The maximum detected concentration of manganese exceeded its USEPA Region IX PRG but was within background levels; consequently, manganese was not retained as a COPC.

A comparison of the maximum detected concentration in groundwater to migration criteria is presented in Table 11-5. The maximum detected concentrations of the following chemicals exceeded their respective screening criteria for protection of migration to surface water:

- Metals-lead, silver, and zinc

The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from groundwater to indoor air.

11.6.2 Exposure Assessment

Only groundwater samples were collected during the current investigation; consequently, only exposures to groundwater were evaluated in the risk assessment for Site 15. Potential receptors included construction workers and future adult residents. Exposure assumptions for these receptors were presented in Table 3-14. Potential exposure pathways are summarized in Table 11-6.

Construction workers could come into contact with groundwater while excavating building foundations. In such an instance, construction workers could be exposed to the groundwater via dermal contact.

Potential exposure pathways for future adult residents exposed to groundwater included ingestion, dermal contact, and inhalation of volatile emissions. As previously discussed, future adult residential receptors are not potential receptors under current land use and are included only to provide an indication of potential risks if the facility were to close and then be developed for residential use.

As discussed in Section 3.4, the maximum detected concentration and average concentration were used for the exposure point concentrations for the RME and CTE, respectively. Exposure point concentrations for Site 15 are presented in Table 11-7.

11.6.3 Risk Characterization

Potential ICRs and HIs were calculated for construction workers and future adult residents exposed to groundwater using the methodology presented in Section 3.4. The results are summarized in Tables 11-8 and 11-9 and are discussed below. Sample calculations and chemical-specific risks in RAGS Part D format are provided in Appendix C.

The result of the human health risk assessment indicate that cancer risks for future adult residents exposed to groundwater were within EPA's acceptable cancer risk range, but exceeded CTDEP's acceptable risk levels. Hazard indices for future adult residents exposed to groundwater exceeded EPA's and CTDEP's acceptable levels. Even though the calculations were not performed, cancer risks for future child residents would also be expected to be within EPA' acceptable cancer risk range but exceed CTDEP's acceptable risk levels and hazard indices would be expected to exceed EPA's and CTDEP's acceptable levels.

The results of the human health risk assessment indicated that cancer risks and hazard indices exceeded USEPA and CTDEP acceptable levels for future adult residents exposed to groundwater. Even though the calculations were not per performed, cancer risks and hazard indices for future child residents would also be expected to exceed USEPA and CTDEP acceptable levels.

Carcinogenic Risks

ICRs for construction workers exposed to groundwater were 4.6×10^{-10} and 4.9×10^{-11} for the RME and CTE scenarios, respectively, which were less than USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures.

The ICRs for adult residents exposed to groundwater were 4.4×10^{-6} and 2.1×10^{-7} for the RME and CTE scenarios, respectively, which were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. The chemical-specific ICR for TCE under the RME scenario exceeded CTDEP's target level of 1×10^{-6} for individual chemicals.

Noncarcinogenic Risks

HIs for construction workers exposed to groundwater were 0.04 and 0.02 for the RME and CTE scenarios, respectively, which were less than USEPA's and CTDEP's acceptable level of 1.0.

HIs for adult residents exposed to groundwater were 5.1 and 1.2 for the RME and CTE scenarios, respectively, which exceeded USEPA's and CTDEP's acceptable level of 1.0. Chromium (HQ = 1.3) and silver (HQ = 3.4) were the major contributors to the HI under the RME scenario. Chemical-specific HQs for chemicals and target organs were less than 1.0 under the CTE scenario.

Lead

Lead was identified as a COPC in groundwater at Site 15. Lead was detected at a maximum concentration of 24.7 µg/L, which exceeds the Safe Drinking Water Act action level and CTDEP RSR of 15 µg/L.

USEPA's IEUBK model was used to evaluate exposure to lead in groundwater by a future child resident. As recommended by the model, the average concentration of lead in groundwater of 11.6 µg/L was used for the exposure point concentration. Default parameters were used for the rest of the model input parameters. IEUBK model outputs are included in Appendix C. The estimated geometric mean blood-lead level for children exposed to lead in groundwater was 4.2 µg/dL, which is less than the level of concern of 10 µg/dL. The IEUBK Model estimates that 3.2 percent of children are expected to have blood-lead levels greater than 10 µg/dL. These results indicate that no adverse effects are anticipated for hypothetical future child residents exposed to lead in groundwater at Site 15.

11.6.4 Summary of Previous Risk Assessments

The baseline human health risk assessment conducted during the Phase II RI evaluated construction workers and future residents as potential receptors at Site 15. CTE and RME scenarios were evaluated for both of these receptors. Dermal contact was considered to be a potential route of exposure for the construction worker. Dermal contact with, ingestion of, and inhalation of volatiles in groundwater were considered to be potential routes of exposure for the future resident.

Noncarcinogenic risks associated with exposure to groundwater for the construction worker under the CTE and RME scenarios and for the future resident under the CTE scenario were less than one. However, noncarcinogenic risk associated with exposure to groundwater for the RME future resident exceeded one. Elevated noncarcinogenic hazards for this receptor were attributed to exposure to manganese in groundwater via ingestion. The chemical-specific HI for manganese exceeded one for

direct ingestion (2.2) under the RME scenario. Calculated risks for dermal contact with groundwater and inhalation of volatiles in groundwater while showering/bathing were relatively insignificant. This conclusion was similar to that determined for many other sites at NSB-NLON (i.e., manganese is a commonly found naturally occurring metal and the primary contributor to site noncarcinogenic risks).

The incremental cancer risk associated with exposure to groundwater for the construction worker under both RME and CTE scenarios was less than the USEPA and CTDEP target cancer risks. The cumulative incremental cancer risk associated with exposure to groundwater for the future resident under CTE conditions (9.3×10^{-6}) was within USEPA's target risk range (1×10^{-4} to 1×10^{-6}) and was less than the CTDEP target cancer risk (1×10^{-5}). However, the cumulative carcinogenic risk associated with exposure to groundwater for the future resident under the RME scenario (1.6×10^{-4}) exceeded 1×10^{-5} and 1×10^{-4}. Direct ingestion of groundwater was the primary exposure route of concern for the potential future resident; the associated incremental cancer risk for this exposure route alone exceeded 1×10^{-4}. Carcinogenic chemicals selected as COPCs for groundwater included bis(2-ethylhexyl) phthalate, 1,4-dichlorobenzene, heptachlor, arsenic, and beryllium. Although risks for these chemicals were similar (i.e., within an order of magnitude), the largest contributor to the risks associated with direct ingestion of groundwater was beryllium, with an incremental cancer risk of 8.0×10^{-5}.

11.6.5 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment, in general, was presented in Section 3.4.5. Site-specific uncertainties for Site 15 are discussed below.

Elimination of Chemicals as COPCs on the Basis of Background

In accordance with Navy policy, chemicals were eliminated as COPCs on the basis of comparison to background. Manganese was the only chemical in groundwater with a maximum detected concentration that exceeded the direct contact screening criteria but was not retained as a COPC on the basis of background. Potential risks from dermal exposures to manganese in water are insignificant (USEPA, 2000d); consequently, the elimination of manganese as a COPC on the basis of background does not affect the risk estimates for the construction worker since this receptor was only evaluated for dermal exposures to groundwater. Future adult residents were evaluated for ingestion and dermal contact with groundwater; therefore, the estimated risks would be higher for the future adult resident if exposures to manganese were evaluated in the HHRA. If exposures to manganese in groundwater by a future adult resident were evaluated in the HHRA, then the resulting HQ for manganese would be 1.0 and the total HI would be 6.1, which exceeds the USEPA and CTDEP acceptable level of 1.0.

11.7 SUMMARY AND RECOMMENDATIONS

11.7.1 Nature and Extent of Contamination

TCE was the only VOC detected in the groundwater at Site 15. TCE was detected in 3 of 4 samples at concentrations ranging from 2.32 (15MW2S) to 16 µg/L (15MW3S). The MCL for TCE is 5 µg/L and the direct contact screening criterion is 1.6 µg/L. TCE was not detected in groundwater at this site during historical sampling events, and the source of the TCE is unknown. TCE was not detected in any Site 23 (Tank Farm) groundwater sample; therefore, it does not appear that the TCE is migrating to downgradient locations at significant concentrations.

Three SVOCs (anthracene, fluoranthene, and pyrene) were detected in Site 15 groundwater samples. None of these SVOCs were detected in groundwater samples collected during the Phase II RI. The PAHs were only detected in sample S15MW3S01. Concentrations of these PAHs were all under the applicable screening criteria.

Fifteen inorganics were detected in the groundwater samples collected from Site 15. Seven of the 15 detected metals were present in all four samples. Significant concentrations of metals were detected most frequently in samples S15MW1S01 and S15MW2S01. Cadmium, chromium, lead, nickel, silver, and zinc were detected at concentrations that exceeded screening criteria. Lead is the only common inorganic detected at significant levels during both the Phase II RI and BGOURI. Chromium and lead were detected in all four BGOURI samples. It is likely that residual contamination from the former SASDA is the source of several of the inorganics detected in groundwater.

11.7.2 Contaminant Fate and Transport

The TCE detected in the groundwater at Site 15 may be the result of a spill event or a subsurface release that was solubilized by infiltrating precipitation. The most recent groundwater data collected at the site suggest that lateral transport of TCE is occurring since higher concentrations were found in downgradient wells; however, it is unclear if the former SASDA is the source of the contamination. In addition, TCE was not detected in any Site 23 (Tank Farm) groundwater sample; therefore, it does not appear that the TCE is migrating to downgradient locations at significant concentrations. The analytical results do not indicate that vertical migration of TCE in groundwater has occurred since neither TCE nor other volatile organics were detected in the deep well in the Phase II RI or the BGOURI. It does not appear that appreciable biodegradation of TCE is occurring in the groundwater at Site 15 because no degradation products have been detected in on-site groundwater samples either in the BGOURI or the Phase II RI.

The BGOURI results show that the highest concentrations of metals tended to be in the shallow groundwater wells closest to the location of the former SASDA (wells 15MW1S and 15MW2S). The low pH (4.44) in the most upgradient well (15MW2S) and the generally acidic pH in two other shallow wells suggest that the metals cadmium, nickel, silver, and zinc will be present as cations and mobile. The combination of slightly acidic and generally oxidizing groundwater at Site 15 suggests chromium will be present as the Cr(VI) chromate anion and thus more mobile than the metal cations. Silver was detected in one deep groundwater sample in the Phase II RI at a concentration of 1.2 µg/L, but it was detected in the three shallow wells sampled during the BGOURI at concentrations ranging from 79.1 to 615 µg/L. Even though the monitoring well network is limited at Site 15, silver was not detected in any downgradient groundwater samples at Site 23. Therefore it does not appear that silver is migrating to downgradient locations at significant concentrations. Based on the available data, it does not appear that soil contamination is the main source of the silver in groundwater. Lead was detected in groundwater at the site; the maximum concentration slightly exceeded screening levels. The concentrations of lead detected in the BGOURI (2.8 µg/L to 24.7 µg/L) are similar to those found in the Phase II RI (2.1 µg/L to 21.2 µg/L). Although lead is typically considered to be immobile, the presence of acidic conditions (low pH) suggests that the lead is mobile. It is likely that, as these metals migrate from Site 15 toward and through the more reducing and more basic pH environment of Site 23 (Tank Farm), their mobility should decrease and they would precipitate out.

11.7.3 Human Health Risk Assessment

The following items summarize the HHRA for Site 15:

- The HHRA for Site 15 considered exposures to construction workers and future adult residents. No soil samples were collected at Site 15; therefore, only exposures to groundwater were evaluated. Potential exposure pathways for groundwater included dermal contact for construction workers and incidental ingestion, dermal contact, and inhalation of volatile emissions for future adult residents.

- The maximum detected concentrations of TCE, cadmium, chromium, lead, nickel, and silver exceeded the direct contact risk-based COPC screening levels and were retained as COPCs for groundwater.

- Maximum detected concentrations of lead, silver, and zinc exceeded CTDEP's screening criteria for protection of migration of groundwater to surface water.

- The maximum detected concentrations of all chemicals in groundwater were less than the CTDEP criteria for migration from groundwater to indoor air.

- ICRs and HIs for construction workers exposed to groundwater at Site 15 were within USEPA and CTDEP acceptable levels.

- ICRs for future adult residents exposed to groundwater at Site 15 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. The chemical-specific ICR for TCE exceeded CTDEP's target level of 1×10^{-6} for individual chemicals.

- HIs for future adult residents exposed to groundwater at Site 15 exceeded USEPA's and CTDEP's acceptable level of 1.0 under the RME scenario. Chromium and silver were the major contributors to the HI.

- The result of the human health risk assessment indicate that cancer risks for future adult residents exposed to groundwater were within EPA's acceptable cancer risk range, but exceeded CTDEP's acceptable risk levels. Hazard indices for future adult residents exposed to groundwater exceeded EPA's and CTDEP's acceptable levels. Even though the calculations were not performed, cancer risks for future child residents would also be expected to be within EPA's acceptable cancer risk range but exceed CTDEP's acceptable risk levels and hazard indices would be expected to exceed EPA's and CTDEP's acceptable levels.

- The maximum detected concentration of lead in groundwater exceeded the Safe Drinking Water Act action level and CTDEP RSR of 15 µg/L. The IEUBK model was used to evaluate exposures of lead in groundwater by hypothetical residential children. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in groundwater at Site 15.

- The maximum detected concentration of manganese in groundwater exceeded its screening criteria but was within background levels, consequently manganese was not retained as COCs in the HHRA. HIs for adult residents exposed to manganese in groundwater would be equal to the acceptable level of 1 if manganese were evaluated in the HHRA.

11.7.4 Recommendations

A removal action was previously conducted at this site to remove an UST and to address associated lead contamination in the soil. The Navy and regulators signed a No-Further-Action Source Control ROD for the soil OU at this site after the action was completed.

One objective of the BGOURI at Site 15 was to further characterize the nature and extent of groundwater contamination to determine if the removal action was successful. The other objective of the RI was to quantify the risks to human receptors associated with the site. The first objective of the RI was completed by conducting a field sampling and analytical program. Samples were collected from four existing groundwater monitoring wells and analyzed during the RI. The results of the investigation indicated that residual contamination (i.e., metals) from the former SASDA is impacting the groundwater at the site. Because the groundwater is relatively acidic, it is likely that lead and the other detected metals will be mobile and migrate from the site. However, their mobility should decrease as they migrate toward and through the more reducing and more basic pH environment of Site 23 (Tank Farm). It also appears that a source of TCE that is unrelated to the site is impacting the Site 15 groundwater. It is believed that the source is unrelated to the site because TCE was not detected at the site during historical sampling events and the highest TCE concentration was detected downgradient of the site.

The HHRA results from this RI indicate that Site 15 groundwater does not pose a significant risk to construction workers but does pose potential risks to hypothetical human receptors. ICRs and HIs for construction workers exposed to groundwater at Site 15 were within USEPA and CTDEP acceptable levels. ICRs for future adult residents exposed to groundwater at Site 15 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. HIs for future adult residents exposed to groundwater at Site 15 exceeded USEPA's and CTDEP's acceptable level of 1.0 under the RME scenario. Chromium and silver were the major contributors to the HI. The IEUBK model was used to evaluate exposures of lead in groundwater by hypothetical residential children. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in groundwater at Site 15.

This RI completed the necessary characterization of the groundwater OU at this site. It is recommended that an FS be prepared for the groundwater OU to address contaminant migration issues and the potential residential risks associated with metals. The remedial alternatives evaluated in the FS should be streamlined because the site will be used for industrial purposes in the forseeable future, groundwater is classified as GB, and municipal water is the source of potable water at NSB-NLON. Alternatives that include groundwater monitoring and institutional controls would be appropriate to evaluate in the FS.

TABLE 11-1

SUMMARY OF THE SAMPLING AND ANALYTICAL PROGRAM FOR SITE 15 BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION NSB-NLON, GROTON, CONNECTICUT

Sample ID	VOCs	SVOCs	Metals	Misc[1]
GROUNDWATER SAMPLES				
S15MW1D01	X	X	X	X
S15MW1S01	X	X	X	X
S15MW2S01	X	X	X	X
FD0721001[2]	X	X	X	X
S15MW3S01	X	X	X	X

Notes:
1 Miscellaneous parameters include TSS and TDS.
2 Duplicate to S15MW02S01.

TABLE 11-2

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS - SITE 15
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location nsample sample sample_dat	15MW1D S15MW1D01 S15MW1D01 7/21/00	15MW1S S15MW1S01 S15MW1S01 7/21/00	15MW2S S15MW2S01 S15MW2S01 7/21/00	15MW2S S15MW2S01-D FD0721001 7/21/00	15MW3S S15MW3S01 S15MW3S01 7/23/00
Volatile Organics (ug/L)					
TRICHLOROETHENE	1 U	3.22 J	2.32 J	3.19 J	16
Semivolatile Organics (ug/L)					
ANTHRACENE	0.05 U	0.05 U	0.05 U	0.05 U	0.02 J
FLUORANTHENE	0.1 U	0.1 U	0.1 U	0.1 U	0.09 J
PYRENE	0.05 U	0.05 U	0.05 U	0.05 U	0.06
Total Metals (ug/L)					
ALUMINUM	4200	683 U	3040	3620	1650
BERYLLIUM	0.72 U	0.72 U	1.2 J	1.4	0.72 U
CADMIUM	0.25 U	0.99	3.2	3.4	0.25 U
CALCIUM	21600	18900	6740	8780	22500
CHROMIUM	47.9	121	24.2	7.9 J	21.1
COPPER	12.6 J	12.9 J	36.6	30.8	6.8 U
IRON	5430	1430	247 U	250 U	8600
LEAD	2.8 J	24.7	14.6	13.6	4.2
MAGNESIUM	8080	2320	1290	1560	4630
MANGANESE	871	31.3	172	215	309
NICKEL	34.4 U	77.6	28.5 U	16.2 U	13.8 U
POTASSIUM	6610	5950	1600	1930	5250
SILVER	79.1 J	5.2 UR	615 J	5.9 U	215 J
SODIUM	59800	46500	24800	28700	42200
ZINC	42 U	24.4 U	296	349	26 U
Miscellanoeus Parameters (mg/L)					
TOTAL DISSOLVED SOLIDS	276 J	215 J	146 J	170 J	10 UJ
TOTAL SUSPENDED SOLIDS	80 J	5 J	5 UJ	5 UJ	30 J

TABLE 11-3

CHEMICALS RETAINED AS COPCs IN SITE 15 GROUNDWATER
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Direct Contact	Migration Pathways	
		Surface Water	Volatilization
Volatile Organic Compounds			
Trichloroethene	X		
Metals			
Cadmium	X		
Chromium	X		
Lead	X	X	
Nickel	X		
Silver	X	X	
Zinc		X	

Notes:
X - Chemical is retained as a COC.

TABLE 11-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITE 15
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Spent Acid Storage and Disposal Area (Site 15)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																
79-01-6	TRICHLOROETHENE	2.32	J	16		ug/L	S15MW3S01	3/4	1	16	N/A	1.6 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
Semivolatile Organics																
120-12-7	ANTHRACENE	0.02	J	0.02	J	ug/L	S15MW3S01	1/4	0.05	0.02	N/A	180 N	2000 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
206-44-0	FLUORANTHENE	0.09	J	0.09	J	ug/L	S15MW3S01	1/4	0.1	0.09	N/A	150 N	280 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
129-00-0	PYRENE	0.06		0.06		ug/L	S15MW3S01	1/4	0.05	0.06	N/A	18 N	200 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Total Metals																
7429-90-5	ALUMINUM	1650		4200		ug/L	S15MW1D01	3/4	683	4200	3560	3600 N	N/A 50 to 200 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI
7440-41-7	BERYLLIUM	1.2	J	1.4		ug/L	S15MW2S01-D	1/4	0.72	1.4	ND	7.3 N	4 4 4	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-43-9	CADMIUM	0.99		3.4		ug/L	S15MW2S01-D	2/4	0.25	3.4	ND	1.8 N	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-70-2	CALCIUM	6740		22500		ug/L	S15MW3S01	4/4	N/A	22500	188000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-47-3	CHROMIUM	7.9	J	121		ug/L	S15MW1S01	4/4	N/A	121	49.9	110 (7)	50 100 N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-50-8	COPPER	12.6	J	36.6		ug/L	S15MW2S01	3/4	6.8	36.6	107	140 N	1300 1300 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON	1430		8600		ug/L	S15MW3S01	3/4	247 - 250	8600	28200	1100 N	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG, EPAI
7439-92-1	LEAD	2.8	J	24.7		ug/L	S15MW1S01	4/4	N/A	24.7	6.63	N/A	15 15 N/A	CTDEP RSR FED-AL CTDEP-MCL	YES	ASL
7439-95-4	MAGNESIUM	1290		8080		ug/L	S15MW1D01	4/4	N/A	8080	191000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7439-96-5	MANGANESE	31.3		871		ug/L	S15MW1D01	4/4	N/A	871	11700	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-02-0	NICKEL	77.6		77.6		ug/L	S15MW1S01	1/4	13.8 - 34.4	77.6	32.2	73 N	100 100 100	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-09-7	POTASSIUM	1600		6610		ug/L	S15MW1D01	4/4	N/A	6610	70800	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG

TABLE 11-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITE 15
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Spent Acid Storage and Disposal Area (Site 15)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7440-22-4	SILVER	79.1	J	615	J	ug/L	S15MW2S01	3/3	5.9	615	ND	18 N	36 100 50	CTDEP RSR FED-SMCL CTDEP-MCL	YES	ASL
7440-23-5	SODIUM	24800		59800		ug/L	S15MW1D01	4/4	N/A	59800	1900000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-66-6	ZINC	296		349		ug/L	S15MW2S01-D	1/4	24.4 - 42	349	131	1100 N	5000 5000 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
Miscellaneous Parameters																
000-09-0	TOTAL DISSOLVED SOLIDS	146	J	276	J	mg/L	S15MW1D01	3/4	10	276	6260	N/A	N/A 500 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL, BKG
000-08-9	TOTAL SUSPENDED SOLIDS	5	J	80	J	mg/L	S15MW1D01	3/4	5	80	236	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 The risk-based COPC screening level for tap water use is presented. The value is based on a target Hazard Quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
7 Value is for hexavalent chromium.

Associated Samples:
S15MW1D01
S15MW1S01
S15MW2S01
S15MW2S01-D
S15MW3S01

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
N/A = Not Applicable.
FED-MCL = Federal Maximum Contaminant Level (USEPA, August 2000).
FED-SMCL = Federal Secondary Maximum Contaminant Level (USEPA, August 2000).
FED-AL = Federal Action Level (USEPA, August 2000).
CTDEP-RSR = Connecticut DEP Remediation Standard Regulations, 1996.
CTDEP-MCL = Connecticut Maximum Contaminant Level.

Rationale Codes:
For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No Toxicity Information.
EPAI = USEPA Region 1 does not advocate evaluation of this chemical.

TABLE 11-5

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER AT SITE 15
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Spent Acid Storage and Disposal Area (Site 15)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	CTDEP Surface Water Criteria(5)	CTDEP Vol. Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organics															
79-01-6	TRICHLOROETHENE	2.32	J	16		ug/L	S15MW3S01	3/4	1	16	N/A	2340	219	NO	BSL
Semivolatile Organics															
120-12-7	ANTHRACENE	0.02	J	0.02	J	ug/L	S15MW3S01	1/4	0.05	0.02	N/A	1100000	N/A	NO	BSL
206-44-0	FLUORANTHENE	0.09	J	0.09	J	ug/L	S15MW3S01	1/4	0.1	0.09	N/A	3700	N/A	NO	BSL
129-00-0	PYRENE	0.06		0.06		ug/L	S15MW3S01	1/4	0.05	0.06	N/A	110000	N/A	NO	BSL
Total Metals															
7429-90-5	ALUMINUM	1650		4200		ug/L	S15MW1D01	3/4	683	4200	3560	N/A	NA	NO	NTX
7440-41-7	BERYLLIUM	1.2	J	1.4		ug/L	S15MW2S01-D	1/4	0.72	1.4	ND	4	NA	NO	BSL
7440-43-9	CADMIUM	0.99		3.4		ug/L	S15MW2S01-D	2/4	0.25	3.4	ND	6	NA	NO	BSL
7440-70-2	CALCIUM	6740		22500		ug/L	S15MW3S01	4/4	N/A	22500	188000	N/A	NA	NO	BKG
7440-47-3	CHROMIUM	7.9	J	121		ug/L	S15MW1S01	4/4	N/A	121	49.9	N/A	NA	NO	NTX
7440-50-8	COPPER	12.6	J	36.6		ug/L	S15MW2S01	3/4	6.8	36.6	107	48	NA	NO	BSL, BKG
7439-89-6	IRON	1430		8600		ug/L	S15MW3S01	3/4	247 - 250	8600	28200	N/A	NA	NO	BKG
7439-92-1	LEAD	2.8	J	24.7		ug/L	S15MW1S01	4/4	N/A	24.7	6.63	13	NA	YES	ASL
7439-95-4	MAGNESIUM	1290		8080		ug/L	S15MW1D01	4/4	N/A	8080	191000	N/A	NA	NO	BKG
7439-96-5	MANGANESE	31.3		871		ug/L	S15MW1D01	4/4	N/A	871	11700	N/A	NA	NO	BKG
7440-02-0	NICKEL	77.6		77.6		ug/L	S15MW1S01	1/4	13.8 - 34.4	77.6	32.2	880	NA	NO	BSL
7440-09-7	POTASSIUM	1600		6610		ug/L	S15MW1D01	4/4	N/A	6610	70800	N/A	NA	NO	BKG
7440-22-4	SILVER	79.1	J	615	J	ug/L	S15MW2S01	3/3	5.9	615	ND	12	NA	YES	ASL
7440-23-5	SODIUM	24800		59800		ug/L	S15MW1D01	4/4	N/A	59800	1900000	N/A	NA	NO	BKG
7440-66-6	ZINC	296		349		ug/L	S15MW2S01-D	1/4	24.4 - 42	349	131	123	NA	YES	ASL
Miscellaneous Parameters															
000-09-0	TOTAL DISSOLVED SOLIDS	146	J	276	J	mg/L	S15MW1D01	3/4	10	276	6260	N/A	NA	NO	BKG
000-08-9	TOTAL SUSPENDED SOLIDS	5	J	80	J	mg/L	S15MW1D01	3/4	5	80	236	N/A	NA	NO	BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Footnotes:
1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 Connecticut DEP Surface Water Protection criteria.
6 Connecticut DEP Volatilization criteria for residential exposures.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the CTDEP surface water protection or volatilization criteria.

Associated Samples:
S15MW1D01
S15MW1S01
S15MW2S01
S15MW2S01-D
S15MW3S01

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No Toxicity Information.

TABLE 11-6

SELECTION OF EXPOSURE PATHWAYS FOR SITE 15
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Groundwater	Overburden/Bedrock Aquifer	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	None Quant	Construction workers may have dermal contact with groundwater during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers do not have contact with groundwater.
				Residents	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Groundwater may be used as a potable water source in the future.
					Child	Ingestion Dermal	On-Site On-Site	None None	Exposures to a child resident are less than those for an adult resident.
		Air	Overburden/Bedrock Aquifer	Construction Workers	Adult	Inhalation	On-site	None	Construction workers exposure via volatilization is expected to be insignificant due to dilution with outdoor air.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers do not have contact with site groundwater.
				Residents	Adult	Inhalation	On-site	Quant	On-site residents may be exposed to volatile emissions from groundwater while showering.
					Child	Inhalation	On-site	None	Exposures to a child resident are less than those for an adult resident.

TABLE 11-7

EXPOSURE POINT CONCENTRATIONS FOR SITE 15
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Groundwater	
	RME[1] (ug/L)	CTE[1] (ug/L)
Volatile Organic Compounds		
Trichloroethene	16	5.51
Inorganics		
Cadmium	3.2	1.11
Chromium	121	53.6
Lead[2]	11.6	11.6
Nickel	77.6	29.0
Silver	615	303

Notes:

1 - The maximum detected concentration is used for the RME scenario and the average concentration is used for the CTE scenario.

2 - The average concentration is used for lead (USEPA, 1994).

TABLE 11-8

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 15
REASONABLE MAXIMUM EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	4.6E-10	- -	- -	- -	0.04	- -
Adult Resident	Groundwater	Ingestion	2.1E-06	- -	- -	Trichloroethene	4.8	Chromium, Silver
		Dermal Contact	2.6E-07	- -	- -	- -	0.2	- -
		Inhalation (1)	2.1E-06	- -	- -	Trichloroethene	0.07	- -
		Total	4.4E-06	- -	- -	Trichloroethene	5.1	Chromium, Silver

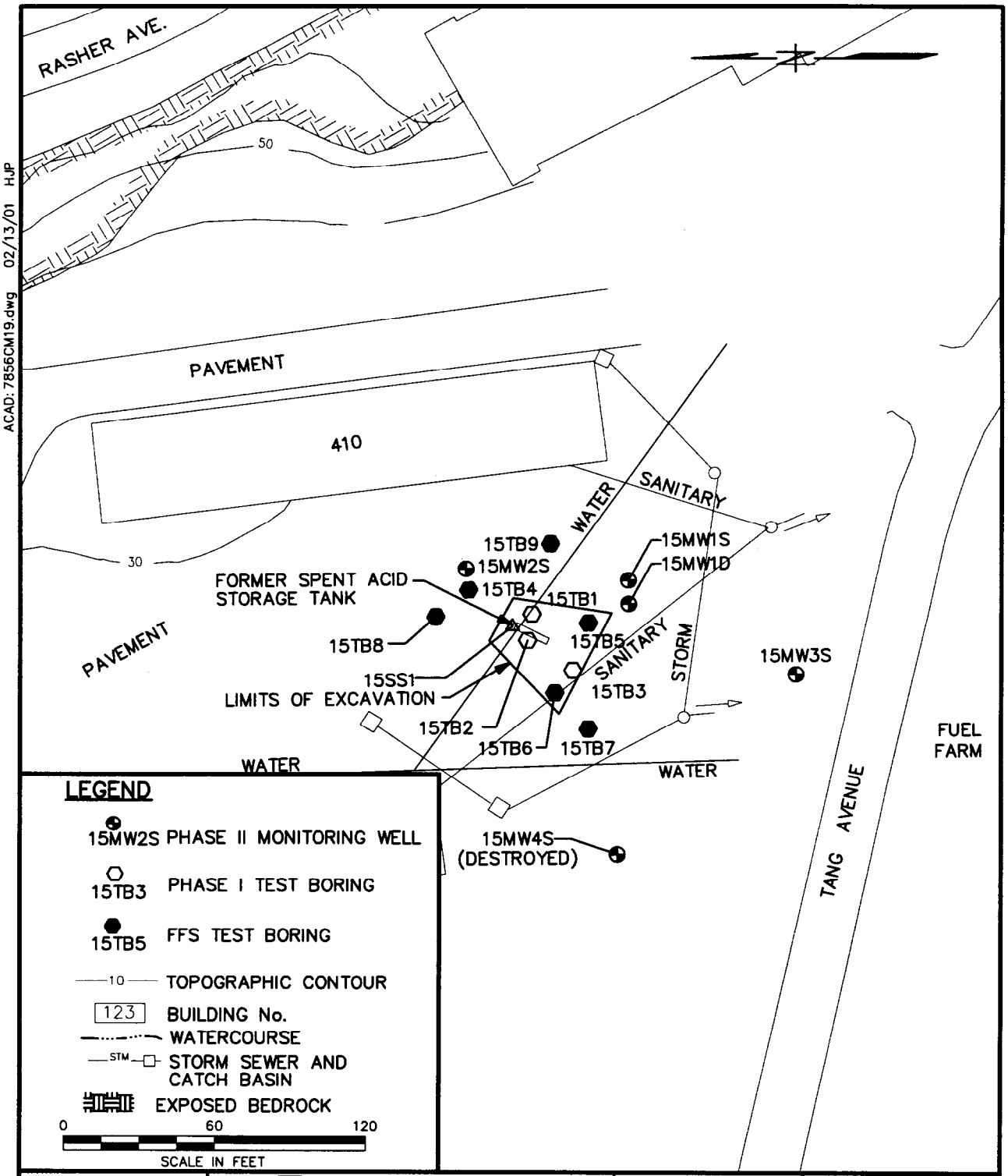
Notes:
1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

TABLE 11-9

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 15
CENTRAL TENDENCY EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	4.9E-11	- -	- -	- -	0.02	- -
Adult Resident	Groundwater	Ingestion	1.0E-07	- -	- -	- -	1.1	- -
		Dermal Contact	1.5E-08	- -	- -	- -	0.2	- -
		Inhalation (1)	1.0E-07	- -	- -	- -	0.01	- -
		Total	2.1E-07	- -	- -	- -	1.2	- -

Notes:
1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.



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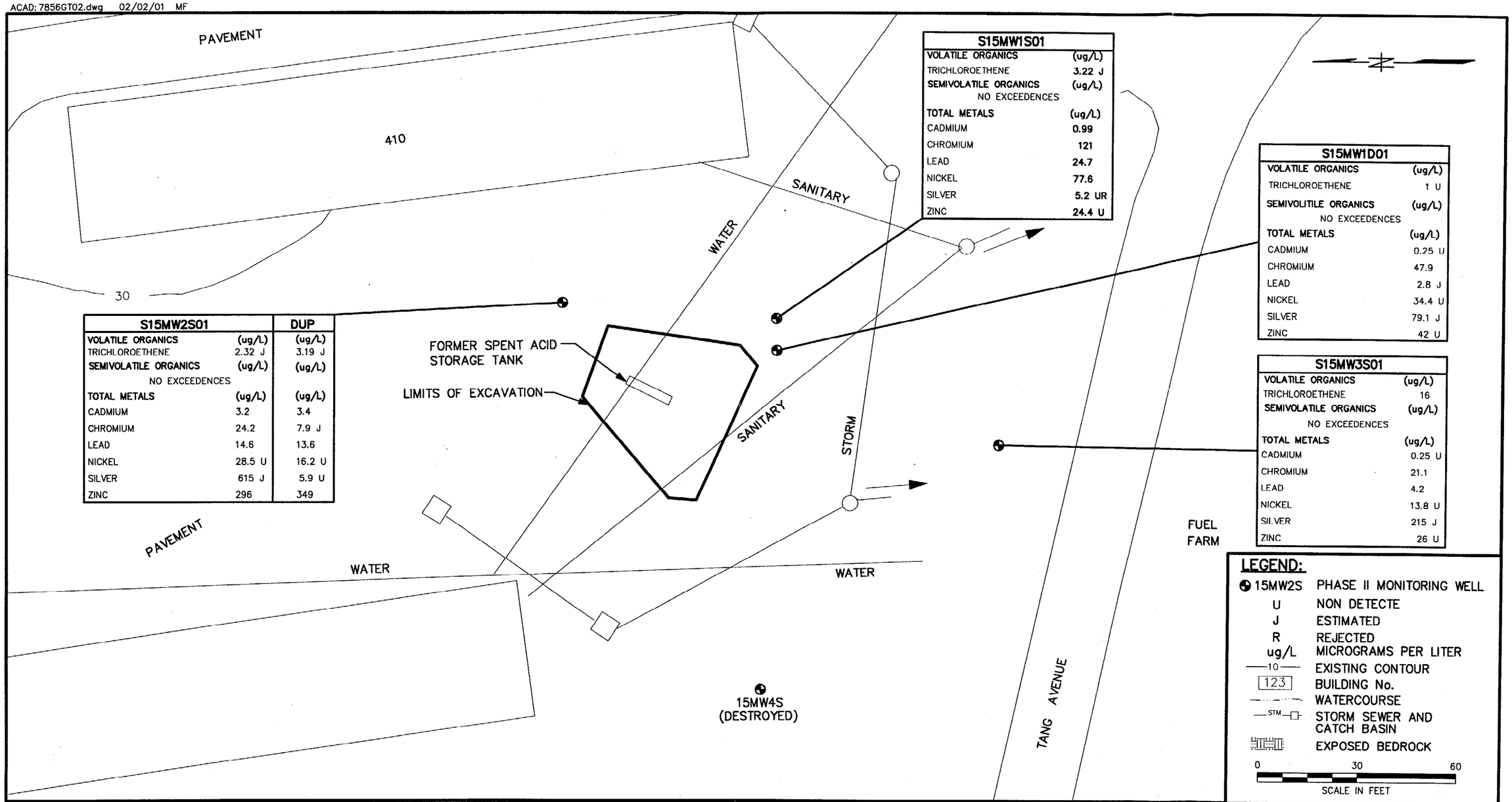
DRAWN BY HJP DATE 10/29/98	Tetra Tech NUS, Inc.	CONTRACT NO. 7856	OWNER NO. 0312
CHECKED BY DATE	SAMPLE LOCATIONS SITE 15–SPENT ACID STORAGE AND DISPOSAL AREA NSB–NLON, GROTON, CONNECTICUT	APPROVED BY J.P. Cole DATE 2-15-01	
COST/SCHED–AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 11–1	REV. 0

FORM CADD NO. TtNUS_AV.DWG – REV 0 – 1/22/98

ACAD: 7856GT02.dwg 02/02/01 MF



S15MW1S01	
VOLATILE ORGANICS	(ug/L)
TRICHLOROETHENE	3.22 J
SEMIVOLATILE ORGANICS	(ug/L)
NO EXCEEDENCES	
TOTAL METALS	(ug/L)
CADMIUM	0.99
CHROMIUM	121
LEAD	24.7
NICKEL	77.6
SILVER	5.2 UR
ZINC	24.4 U

S15MW1D01	
VOLATILE ORGANICS	(ug/L)
TRICHLOROETHENE	1 U
SEMIVOLITILE ORGANICS	(ug/L)
NO EXCEEDENCES	
TOTAL METALS	(ug/L)
CADMIUM	0.25 U
CHROMIUM	47.9
LEAD	2.8 J
NICKEL	34.4 U
SILVER	79.1 J
ZINC	42 U

S15MW2S01		DUP
VOLATILE ORGANICS	(ug/L)	(ug/L)
TRICHLOROETHENE	2.32 J	3.19 J
SEMIVOLATILE ORGANICS	(ug/L)	(ug/L)
NO EXCEEDENCES		
TOTAL METALS	(ug/L)	(ug/L)
CADMIUM	3.2	3.4
CHROMIUM	24.2	7.9 J
LEAD	14.6	13.6
NICKEL	28.5 U	16.2 U
SILVER	615 J	5.9 U
ZINC	296	349

S15MW3S01	
VOLATILE ORGANICS	(ug/L)
TRICHLOROETHENE	16
SEMIVOLATILE ORGANICS	(ug/L)
NO EXCEEDENCES	
TOTAL METALS	(ug/L)
CADMIUM	0.25 U
CHROMIUM	21.1
LEAD	4.2
NICKEL	13.8 U
SILVER	215 J
ZINC	26 U

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/8/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

COPCs IN GROUNDWATER
SITE 15 – SPENT ACID STORAGE AND DISPOSAL AREA
NSB-NLON, GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY DATE 2-15-01
APPROVED BY DATE
DRAWING NO. FIGURE 11-2
REV. 0

FORM CADD NO. TtNUS_BH.DGN – REV 0 – 1/20/98

12.0 SITE 18 – SOLVENT STORAGE AREA (BUILDING 33)

12.1 SITE DESCRIPTION

Site 18 consists of Building 33, the Solvent Storage Area. The location of Building 33 is shown on Figure 1-2 and Figure 12-1. According to the FFA (1995), this building has been used for the storage of gas cylinder and 55-gallon drums of solvents such as TCE and dichloroethene.

12.2 SITE INVESTIGATION

The solvent storage area at Building 33 was identified during the IAS for NSB-NLON that was conducted in March 1983. The site was identified as Study Area F in the FFA and is now identified as Site 18 for the IRP. No prior sampling activities were conducted at this site.

During the BGOURI, both soil and groundwater samples were collected to characterize this site. A summary of the sampling and analytical program is presented in Table 12-1. Five surface soil samples and five subsurface soil samples were collected during test boring activities at the site. The sample locations are shown on Figure 12-1. Three temporary groundwater monitoring wells (18TW1, 18TW2, and 18TW4) were installed in three of the test borings completed at Site 18. Temporary well 18TW1 was a dry well and could not be sampled. Groundwater samples were collected from temporary wells 18TW2 and 18TW4. A field duplicate sample was also collected from 18TW2. The methodology used to complete test borings and construct temporary monitoring wells, as well as the sampling techniques, are discussed in Sections 2.2 and 2.3.

12.3 PHYSICAL CHARACTERISTICS

This section presents a summary of physical characteristics for Site 18 based on available reference information and information gathered during this RI. Topography and surface features, surface water, soils, geology, and hydrogeology are discussed in the following subsections.

12.3.1 Topography and Surface Features

Site 18 is located north of the SASDA (Site 15) and the Tank Farm (Site 23). The ground surface topography around Building 33 is shown on Figure 1-3. As shown on the figure, a steep embankment exists on the northern and eastern sides of Building 33. The embankment slopes at an approximate gradient of 50 percent toward the south and west. The gradient flattens to approximately 5 percent on the southern and eastern sides of Building 33.

12.3.2 Surface Water

Surface water runoff from this site is collected by a storm sewer system. The storm sewer system passes through the Tank Farm and Goss Cove Landfill sites and eventually discharges to the Thames River.

12.3.3 Soil Characteristics

The SCS Soils Map (SCS, 1983) classifies the soil on the southern and western sides of Building 33 as Urban land. Upgradient of the site (north and east), bedrock exposures (Hollis-Charlton-Rock outcrop complex) are prevalent as the central bedrock high extends toward the south. The soils overlying the bedrock range from very stony fine sandy loam to gravelly loam.

12.3.4 Geology and Hydrogeology

Geology

Minimal subsurface investigation work has been performed at Site 18. The site has a veneer of silty sand overlying shallow metamorphic bedrock. The sand is fine to medium grained and contains trace to some gravel and rock fragments.

Hydrogeology

Groundwater levels were measured in temporary wells 18TW2 and 18TW4 on June 14, 2000. The elevations associated with these measurements are presented on Figure 12-1. The inferred direction of groundwater flow, based on the southern region potentiometric surface maps (Figures 4-12 through 4-15), is to the south.

Historic inferred shallow overburden and bedrock potentiometric surfaces in the vicinity of Building 33 are shown on Figures 1-5 and 1-6, respectively. The contours indicate that groundwater in both the overburden and the bedrock flows in a southwestward direction toward the SASDA and Tank Farm. Groundwater from this site will eventually discharge to the Thames River. The saturated thickness of the site is variable. In temporary well 18TW01, the saturated thickness of overburden was approximately 1 foot. In two other temporary wells, the bedrock surface was not encountered. The saturated thickness in these wells exceeded 5 feet.

12.4 NATURE AND EXTENT OF CONTAMINATION

This section presents an evaluation of the nature and extent of soil and groundwater contamination at Site 18. The discussion includes soil and groundwater data collected during the BGOURI. Since the

exposure scenarios for surface soil and subsurface soil are different, the discussion addresses each soil type separately. Soil and groundwater sample locations are shown on Figure 12-1.

A summary of the BGOURI sampling and analytical program for Site 18 is presented in Table 12-1. A complete summary of the Site 18 analytical data set is provided in Appendix B. Table 12-2 presents a summary of positive soil analytical results for Site 18. Table 12-3 presents a summary of SPLP results. Table 12-4 presents a summary of positive groundwater analytical results for Site 18.

As part of the HHRA, descriptive statistics (i.e., frequency of detections, minimum and maximum concentrations, range of detection limits, and the associated sample numbers) and the COPC screening criteria for each analyte detected at least once in soils at the Solvent Storage Area were tabulated. Analytical results for surface soils are summarized and screened in Tables 12-7 through 12-9. Different exposure scenarios (i.e., direct exposure and migration) are considered in each table. Analytical results for subsurface soil samples are summarized and screened in Tables 12-10 through 12-12. Analytical results for groundwater samples are summarized and screened in Tables 12-13 through 12-14. Tag maps of the chemicals determined to be COPCs based on the screening assessment were created to show the horizontal extent of contamination. Figure 12-2 shows the soil COPCs that exceeded direct exposure or migration screening criteria. The analytical detection limit for COPCs is presented on the tag maps if the COPC was not detected in a sample.

12.4.1 Surface Soil

For this discussion, surface soils are considered to be soil samples collected from 0 to 2 feet bgs. The nature and extent of each chemical fraction are discussed separately below.

Two VOCs (2-butanone and toluene) were detected at relatively low concentrations (i.e., below CTDEP pollutant mobility criteria) in Site 18 surface soil samples. 2-Butanone was detected in three of three samples at concentrations ranging from 2 J µg/kg to 4 J µg/kg. Toluene was detected in all five soil samples at concentrations ranging from 1 J µg/kg to 6 J µg/kg.

A total of 15 SVOCs were detected in Site 18 surface soil samples. All 15 were PAHs that were detected only in soil sample S18SB010001-SO. None of the detected concentrations exceeded direct contact exposure criteria or the CTDEP pollutant mobility criteria.

No pesticides or PCBs were detected in these samples.

Sixteen inorganics were detected in the soil samples collected from Site 18. Twelve of the 16 detected metals were present in all five samples. The maximum concentrations of metals were detected most

frequently in sample S18SB030001-SO. Although no concentrations of metals in surface soil samples exceeded the migration pathway screening criteria, arsenic, lead, and thallium were detected at concentrations that exceeded direct contact screening criteria and background concentrations. Arsenic and lead were detected in all five samples. The horizontal limits of arsenic above surface sol screening criteria were not established. Concentrations of arsenic in all five samples were above the risk-based screening level of 0.39 mg/kg. The concentrations of arsenic ranged from 1.9 to 4 mg/kg. Lead was detected in all five surface soil samples at concentrations below 10 mg/kg, except in sample S18SB050001 where was detected at a concentration of 430 mg/kg, which is above the risk-based screening level of 400 mg/kg. Thallium was detected in three of five samples. Thallium was detected at concentrations ranging from 0.43 J (S18SB050001-SO) to 0.64 J (S18SB030001-SO) mg/kg. The concentrations of thallium in samples S18SB030001-SO and S18SB040001-SO exceeded the risk-based screening level. Therefore, the northwestern limit of thallium at concentrations in excess of the screening criterion is not established.

The SPLP results for the Site 18 surface soil samples, presented in Table 12-9, indicate that antimony is of potential concern due to contaminant migration. The concentration of antimony (86 µg/L) detected in the leachate exceeded the CTDEP pollutant mobility criteria.

12.4.2 Subsurface Soil

For this discussion, subsurface soils are considered to be soil samples collected from 2 to 10 feet bgs. Five subsurface soil samples were collected at Site 18. The chemical fractions detected in these samples are discussed below.

Two VOCs (methylene chloride and toluene) were detected at relatively low concentrations (i.e., below direct contact and CTDEP pollutant mobility criteria) in Site 18 subsurface soil samples. Methylene chloride was detected in only sample S18SB020405-SO-D at a concentration of 67 J µg/kg, which is in excess only of the USEPA SSL for migration from soil to groundwater. Toluene was detected in three of five soil samples at concentrations ranging from 1 J µg/kg to 2 J µg/kg. None of the detected concentrations of toluene were in excess of either the direct contact exposure criteria or the CTDEP pollutant mobility criterion.

A total of 10 SVOCs were detected in Site 18 subsurface soil samples. All 10 were PAHs that were detected only in soil sample S18SB010506-SO. None of the detected concentrations exceeded direct contact exposure criteria or the CTDEP pollutant mobility criteria.

No pesticides or PCBs were detected in these samples.

Fifteen inorganics were detected in the five subsurface soil samples. All the same metals positively detected in surface soil samples were detected in the subsurface soil samples, except antimony. Of the 15 inorganics detected, manganese and thallium were the only compounds that were detected at concentrations in excess of any screening criteria. Manganese was detected in all five subsurface soil samples at concentrations ranging from 33 mg/kg to 220 mg/kg. However, only the concentration of manganese in sample S18SB040708-SO (220 mg/kg) exceeds background (188 mg/kg) and the direct contact screening criterion (180 mg/kg). Thallium was detected only once in sample S18SB040708-SO at a concentration of 0.75 mg/kg, which is in excess of background (0.29 mg/kg) and exceeds the direct contact screening criteria (0.52 mg/kg).

The concentration of thallium in subsurface soil sample S18SB040708 exceeded the USEPA SSL for migration from soil to groundwater. However, the SPLP results for the Site 18 subsurface soil samples, presented in Table 12-3, do not indicate that the inorganic poses a potential concern due to contaminant migration.

12.4.3 Groundwater

No VOCs, SVOCs, pesticides, or PCBs were detected in the groundwater samples collected at Site 18.

Aluminum, beryllium, calcium, iron, magnesium, manganese, potassium, and sodium were detected in one or both of the groundwater samples collected at Site 18. All these same metals were positively detected in the surface and subsurface soil samples, except beryllium. The concentrations of these metals were all below background except beryllium, which was not detected in background samples. The concentration of beryllium was below all direct contact screening criteria and CTDEP pollutant mobility criteria.

Cross contamination to Site 18 or from Site 18 is not expected. The groundwater samples showed only insignificant concentrations of inorganics. The HHRA showed that all detected compounds in soil did not pose a threat to human health.

12.5 CONTAMINANT FATE AND TRANSPORT

12.5.1 Contaminant Fate and Transport Processes

Five classes of chemicals were detected in five surface soil samples and five subsurface soil samples at Site 18 in the BGOURI: ketones, monocyclic aromatics, halogenated aliphatics, PAHs, and metals. One class of chemical, metals, was detected in the two groundwater samples collected at Site 18. No samples were collected at this site during previous investigations.

Ketones

One ketone (2-butanone) was detected in surface soil at Site 18 at concentrations well below screening levels. No ketones were detected in the five subsurface soil samples collected at the site. Ketones are highly volatile and soluble and do not readily adsorb to soil. Therefore, they are not considered to be persistent in the environment. Hydrolysis is generally not a significant fate process for this class of chemical, nor is bioconcentration significant. Once in the groundwater, ketones may slowly degrade. 2-Butanone is also a common laboratory and field contaminant often detected in environmental samples. This compound was not detected in the groundwater samples that were collected during the BGOURI, which indicates that this compound has not migrated to groundwater.

Monocyclic Aromatic Compounds

One monocyclic aromatic compound, toluene, was detected in surface and subsurface soil at Site 18 with maximum concentrations well below screening levels. Monocyclic aromatic compounds are not considered to be persistent in the environment, particularly in comparison to chemicals such as PAHs and PCBs. Vapor-phase toluene will be degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 3 days. In soil, toluene is expected to have high to moderate mobility based upon K_{oc} values in the range of 37 to 178. Volatilization from moist soil surfaces is expected to be an important fate process based on published Henry's Law constants. Toluene may volatilize from dry soil surfaces based upon its vapor pressure. Biodegradation is expected to occur rapidly in soil surfaces, with half-lives in the range of several hours to 71 days. If released into water, toluene is not expected to adsorb to suspended solids and sediment based on published K_{oc} values. This compound was not detected in the groundwater samples that were collected during the BGOURI, which indicates that this compound has not migrated to groundwater. Biodegradation is expected to occur rapidly in water, with reported half-lives of 4 and 56 days in aerobic and anaerobic water, respectively. Volatilization from water surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 1 hour and 4 days, respectively. Measured BCF values in fish suggest bioconcentration in aquatic organisms is low to moderate. Hydrolysis is not expected to be an important environmental fate process for toluene due to lack of hydrolyzable functional groups.

Halogenated Aliphatics

One halogenated aliphatic compound (methylene chloride) was detected in subsurface soil at the site. These chemicals have relatively high vapor pressures and, if released to air, will exist solely as a gas in the ambient atmosphere. The gas-phase of methylene chloride is likely to be degraded in the

atmosphere by reaction with photochemically produced hydroxyl radicals. In soil, it is expected to have very high mobility based on its estimated K_{oc} values. Volatilization from moist soil surfaces is expected to be an important fate process based on its Henry's Law constants. Methylene chloride may volatilize from dry soil surfaces based upon its vapor pressures. This compound was not detected in the groundwater samples that were collected during the BGOURI, which indicates that this compound has not migrated to groundwater.

Polynuclear Aromatic Hydrocarbons (PAHs)

Both low-molecular-weight and high-molecular-weight PAHs were detected in surface and subsurface soil samples at Site 18. PAHs are generally considered to be fairly immobile in the environment. As noted in Section 3.3, PAHs have very low solubilities, vapor pressures, and Henry's Law constants and high K_{oc}s and K_{ow}s. The low-molecular-weight PAHs (e.g., acenaphthene, anthracene, fluorene, phenanthrene) are more mobile (higher solubilities, etc.) than the high-molecular-weight PAHs [e.g., benzo(a)pyrene, benzo(a)anthracene, chrysene, etc.]. PAHs in soil are much more likely to bind to soil and be transported via mass transport mechanisms than go into solution. PAHs can be degraded via aerobic bacteria but may be relatively persistent in the absence of microbial population or macronutrients such as phosphorous and nitrogen. PAHs were not detected in the groundwater samples that were collected during the BGOURI, which indicates that these compounds have not migrated to groundwater.

Metals

Sixteen metals were detected in surface and subsurface soil samples and eight metals were detected in groundwater samples at Site 18. The concentrations of most of the detected metals were within naturally occurring background levels. As noted in Section 3.3, metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. The major fate mechanisms for metals are adsorption to the soil matrix (as compared to being part of the soil structure) and bioaccumulation.

Under normal conditions, metals are not very mobile in the environment. Because metals frequently remain bound to particulate matter, the major transport mechanism for metals is bulk movement processes (erosion). However, metals can become mobile in the environment under certain conditions. The mobility of metals is influenced primarily by their physical or chemical properties in conjunction with the physical and chemical properties of the soil matrix. Factors that assist in predicting the mobility of metals are the soil/pore water pH, REDOX potential, and cation exchange capacity. The mobility of metals generally increases with decreasing soil pH and cation exchange capacity. The effect of REDOX potential varies for each metal.

12.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific risk assessment for the identified exposure scenarios for Site 18. The risk assessment methodology was described in Section 3.4 and detailed calculations including RAGS Part D tables are presented in Appendix C.

12.6.1 Data Evaluation

COCs were identified for Site 18 using the risk-based screening levels, as discussed in Section 3.4.1. Tables 12-5 and 12-6 summarize the COCs retained for Site 18. A medium-specific discussion of COCs is presented in the following subsections. Within a given medium, discussions of direct contact exposure COCs (i.e., those chemicals detected at concentrations in excess of USEPA and CTDEP direct contact exposure criteria) and additional COCs are provided. Additional COCs are identified on chemical migration tendencies: migration from soil to groundwater, migration from groundwater to surface water, and migration of volatiles from soil and groundwater through building foundations into indoor air. These additional COCs are not quantitatively evaluated in the HHRA because they are not considered to be significant contributors to the direct contact exposure pathways identified for potential human receptors.

Surface Soil (0 to 2 feet)

A comparison of the maximum detected concentrations in surface soil to risk-based screening criteria is presented in Table 12-7. The maximum detected concentrations of the following chemicals in surface soil exceeded the direct contact risk-based COC screening levels and were retained as COCs for surface soil:

- Inorganics-arsenic, lead, and thallium

The maximum detected concentrations of all chemicals were less than the USEPA SSLs for soil to air; therefore, exposures through inhalation of fugitive dust and volatiles were not retained for evaluation in the risk assessment for surface soils at Site 18.

A comparison of the maximum detected concentration in surface soil to migration criteria is presented in Table 12-8. The maximum detected concentrations of all chemicals were less than their respective soil to groundwater migration criteria.

The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from soil to indoor air.

Under Connecticut RSR (CTDEP, 1996), concerns regarding the mobility of inorganics in soil are addressed using SPLP data. A comparison of site-specific SPLP data and RSRs is presented in Table 12-9. The maximum detected concentrations for antimony exceeded its CTDEP mobility criterion and, therefore, antimony was retained as a COC for the soil to groundwater migration pathway for surface soil. It should be noted that antimony was not detected in groundwater at Site 18.

Subsurface Soil (2 to 10 feet)

A comparison of the maximum detected concentrations in subsurface soil to risk-based screening criteria is presented in Table 12-10. The maximum detected concentrations of the following chemicals in subsurface soil exceeded the direct contact risk-based COC screening levels and were retained as COCs for subsurface soil:

- Inorganics-manganese and thallium

The maximum detected concentration of arsenic exceeded its respective USEPA Region IX PRG but was within background levels; consequently, arsenic was not retained as a COC for subsurface soil. Arsenic will be retained as a COC in the HHRA for those receptors that are exposed to both surface and subsurface soil. The maximum detected concentrations of all chemicals were less than the USEPA SSLs for soil to air; therefore, exposures through inhalation of fugitive dust and volatiles were not retained for evaluation in the risk assessment for subsurface soil at Site 18.

A comparison of the maximum detected concentration in subsurface soil to migration criteria is presented in Table 12-11. The maximum detected concentrations of the following chemicals exceeded their respective soil to groundwater migration criteria:

- VOCs-methylene Chloride
- Inorganics-thallium

The maximum detected concentration of methylene chloride exceeded its USEPA SSL for migration from soil to groundwater but was less than its CTDEP pollutant mobility criteria. Methylene chloride and thallium were not detected in groundwater at Site 18.

The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from soil to indoor air.

Under Connecticut RSR (CTDEP, 1996), concerns regarding the mobility of inorganics in soil are addressed using SPLP data. A comparison of site-specific SPLP data and RSRs is presented in Table 12-12. The

maximum detected concentrations for all inorganics were less than their respective CTDEP Mobility criteria; therefore, no inorganics were retained as COCs for the soil to groundwater migration pathway in subsurface soil.

Groundwater

A comparison of the maximum detected concentrations in groundwater to direct contact risk-based screening criteria is presented in Table 12-13. The maximum detected concentration of manganese exceeded its USEPA Region IX PRG but was within background levels. The maximum detected concentrations of all chemicals were below their respective direct contact screening criteria; therefore, there are no direct contact COCs for groundwater at Site 18.

A comparison of the maximum detected concentrations in groundwater to migration criteria is presented in Table 12-14. The maximum detected concentrations of all chemicals were below their respective screening criteria for protection of migration to surface water; therefore, there are no COCs for the potential migration of groundwater at Site 18.

The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from groundwater to indoor air.

12.6.2 Exposure Assessment

Potential receptors for exposures to soil at Site 18 included construction workers, full-time employees, older child trespassers, and future residents. No COCs were identified for groundwater; consequently, exposures to groundwater were not evaluated for groundwater at Site 18. Exposure assumptions for these receptors were presented in Table 3-14. Potential exposure pathways are summarized in Table 12-15.

Construction workers were assumed to be exposed to surface and subsurface soil. Potential exposure pathways included incidental ingestion, dermal contact, and inhalation of dust and volatile emissions.

Full-time employees may be exposed to site media while performing site inspections or daily duties. This receptor was only evaluated for exposures to surface soil. Potential exposure pathways included incidental ingestion, dermal contact, and inhalation of dust and volatile emissions.

Older child trespassers may be exposed to soil while trespassing on or near the site while exploring, playing, or performing other activities. This receptor was only evaluated for exposures to surface soil.

Potential exposure pathways included incidental ingestion, dermal contact, and inhalation of dust and volatile emissions.

Future child and adult residents were assumed to be exposed to surface soil and subsurface soil. Potential exposure pathways for soil included incidental ingestion, dermal contact, and inhalation of dust and volatile emissions. As previously discussed, future residential receptors are not potential receptors under current land use and are included only to provide an indication of potential risks if the facility were to close and then be developed for residential use.

Exposure point concentrations for Site 18 are presented in Table 12-16. As discussed in Section 3.4, since fewer than 10 surface soil samples were collected, the maximum detected concentration and average concentration were used for the exposure point concentrations for surface soil under the RME and CTE, respectively. The 95 percent UCL was used as the exposure point concentration for exposures to all soil under the RME and CTE scenarios.

12.6.3 Risk Characterization

Potential ICRs and HIs were calculated for construction workers, full-time employees, older child trespassers, and future residents exposed to soil using the methodology presented in Section 3.4. No COCs were identified for groundwater; therefore, no ICRs or HIs were calculated for exposures to groundwater. The results are summarized in Tables 12-17 and 12-18 and are discussed below. Sample calculations and chemical-specific risks in RAGS Part D format are provided in Appendix C.

Carcinogenic Risks

ICRs for Site 18 ranged from 3.3×10^{-8} for older child residents (CTE) to 3.0×10^{-6} for future child residents (RME). All ICRs for exposures to soil at Site 18 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and less than CTDEP's acceptable level of 1×10^{-5} for cumulative exposures. Although all ICRs were less than CDTEP's target level for cumulative exposures, chemical-specific ICRs for arsenic (full-time workers, future child residents, and future adult residents) exceeded CTDEP's target level of 1×10^{-6} for individual chemicals. It should be noted that the maximum detected concentration of arsenic was less than its CTDEP RSRs for residential exposures.

Noncarcinogenic Risks

All HIs for exposure to soil at Site 18 were less than USEPA's and CTDEP's acceptable level of 1.0. HIs for Site 18 ranged from 0.003 for older child residents (CTE) to 0.1 for child residents (RME).

Exposure to Lead

Lead was identified as a COPC in surface soil at Site 18. Lead was detected at a maximum concentration of 430 mg/kg, which exceeds the OSWER soil screening level of 400 mg/kg for residential land use.

USEPA's IEUBK model was used to evaluate exposures to lead in soil by future child residents. As recommended by the model, the average concentration of lead in surface/subsurface soil of 47.6 mg/kg was used as the exposure point concentration for soil. Lead was not detected in groundwater, so the model default value of 4 µg/L was used as the exposure point concentration for groundwater. Default parameters were used for the rest of the model input parameters. IEUBK model outputs are included in Appendix C. The estimated geometric mean blood-lead level for children exposed to lead in surface/subsurface soil was 2.0 µg/dL, which is less than the level of concern of 10 µg/dL. The IEUBK Model estimates that 0.03 percent of children are expected to have blood-lead levels greater than 10 µg/dL. These results indicate that no adverse effects are anticipated for hypothetical future child residents exposed to lead in surface/subsurface soil Site 18.

As discussed in Section 3.4.2.7, USEPA recommends that exposures to lead by nonresidential adults can be evaluated by use of a slope-factor approach developed by the USEPA Technical Review Workgroup for Lead (USEPA, 1996c). As recommended by the model, the average concentration of lead in surface soil of 93.7 mg/kg was used for the exposure point concentration. The incidental ingestion rate was assumed to be 100 mg/day, which is the recommended value for contact intensive scenarios. The exposure frequency was assumed to be 150 days/year (full-time workers). Default parameters were used for the rest of the model input parameters. The model estimated that the 95th percentile blood-lead concentration among fetuses born to women having site exposures ranged from 4.5 µg/dl to 7.3 µg/dL, which is less than the acceptable level of 10 µg/dL. The model estimates that the probability that the fetal blood level exceeds 10 µg/dL ranged from 0.1 to 2, percent which is less than the acceptable level of 5 percent, indicating that adverse effects are not anticipated for nonresidential adults exposed to lead in surface soil at the Site 18.

12.6.4 Summary of Previous Risk Assessments

Site 18 was not investigated during the previous investigations; therefore, no human health risk assessments were previously prepared for the site.

12.6.5 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment, in general, was presented in Section 3.4.5. Site-specific uncertainties for Site 18 are discussed below.

Elimination of Chemicals as COCs on the Basis of Background

In accordance with U.S. Navy policy, chemicals were eliminated as COCs on the basis of comparison to background. Manganese in groundwater was the only chemical with a maximum detected concentration that exceeded its direct contact screening criteria but was not retained as a COC on the basis of background. Exposures to groundwater were not evaluated in the HHRA since no COCs were identified for groundwater at Site 18, although potential receptors for exposures to groundwater would be construction workers and adult residents. Potential risks from dermal exposures to manganese in water are insignificant (USEPA, 2000e); consequently, the elimination of manganese as a COC on the basis of background would not affect risk estimates for the construction worker since this receptor would only be evaluated for dermal exposures to groundwater. Potential exposure pathways for future adult residents include ingestion and dermal contact with groundwater. If exposures to manganese in groundwater by a future adult resident were evaluated in the HHRA, then the resulting HQ for manganese would be 0.4, which is less than the USEPA and CTDEP acceptable level of 1.0, indicating that no adverse health effects are anticipated for adult residents exposed to manganese in groundwater at Site 18.

Exposure Point Concentrations

The maximum detected concentration was used as the exposure point concentration for exposures to surface soil under the RME scenario since fewer than 10 samples were collected at Site 18. As a result of using the maximum detected concentration, the estimates of risk for exposure to surface soil are most likely to be overstated since it is unlikely that potential receptors would be exposed to the maximum concentration over the entire exposure period.

Lack of Dermal Absorption Values for Some Chemicals

No dermal absorption value was available for thallium. Consequently, dermal exposures to thallium in soil could not be evaluated. The lack of a dermal absorption value for thallium does not significantly impact the estimated risks. The highest HI for exposures to thallium in soil occurred for a child resident (HI = 0.03) under the RME scenario. The HI would still be less than the acceptable level of 1.0, even with 100 percent dermal absorption of thallium (HI = 0.09). Therefore, there is no significant uncertainty due to the lack of a dermal absorption for thallium.

12.7 SUMMARY AND RECOMMENDATIONS

12.7.1 Summary of Nature and Extent of Contamination

Five surface soil samples, five subsurface soil samples, and two groundwater samples were collected and analyzed to characterize the nature and extent of contamination at Site 18. Two VOCs were detected in surface soil samples and two were detected in subsurface soil samples. 2-Butanone and methylene chloride were detected only in surface and subsurface soil samples, respectively. Toluene was detected in both surface and subsurface soil samples. None of the concentrations of VOCs detected in surface soil samples exceeded any relevant screening criteria. Methylene chloride was detected in one subsurface soil sample at a concentration that exceeded USEPA's SSL for soil to groundwater.

Fifteen SVOCs were detected in surface soil samples and 10 were detected in subsurface soil samples collected from Site 18. All 15 surface soil SVOCs were detected in one surface soil sample (S18SB010001-SO) and were PAHs. Similarly, all 10 subsurface soil SVOCs were detected in one sample and were PAHs. None of the detected concentrations of SVOCs exceeded any of the relevant screening criteria.

No pesticides or PCBs were detected in any Site 18 soil samples.

Sixteen inorganics were detected in surface soil samples and 15 inorganics were detected in subsurface soil samples. All the same metals positively detected in surface soil samples were detected in subsurface soil samples except antimony. Arsenic, lead, and thallium were detected in surface soil samples at concentrations that exceeded direct contact screening criteria and background concentrations. Of the 15 inorganics detected in subsurface soil samples, manganese and thallium were the only metals detected at concentrations in excess of any screening criteria. Manganese and thallium were only detected once in individual samples at concentrations that exceeded screening criteria.

The SPLP results for Site 18 surface soil samples indicate that only antimony poses a potential concern. The concentration of thallium in subsurface soil sample S18SB040708 exceeded the USEPA SSL for migration from soil to groundwater. However, the SPLP results for the Site 18 subsurface soil samples do not indicate that any inorganic poses a potential concern due to contaminant migration.

No VOCs, SVOCs, pesticides, or PCBs were detected in the groundwater samples collected at Site 18. Aluminum, beryllium, calcium, iron, magnesium, manganese, potassium, and sodium were detected in one or both of the groundwater samples collected at Site 18. All these same metals were positively detected in the surface and subsurface soil samples except beryllium. The concentrations of these metals were all below background except beryllium, which was not detected in background samples. The

concentration of beryllium was below all direct contact screening criteria and CTDEP pollutant mobility criteria.

12.7.2 Summary of Human Health Risk Assessment

The following items summarize the HHRA for Site 18:

- The HHRA for Site 18 considered exposures to soil by construction workers, full-time employees, older child trespassers, and future residents. No COCs were identified for groundwater; therefore, exposures to groundwater were not quantitatively evaluated in the HHRA. Potential exposure pathways for soil included incidental ingestion and dermal contact. The maximum detected concentrations of all chemicals were less than USEPA SSLs for migration from soil to air. Consequently, potential exposures via inhalation of fugitive dust and volatiles were not evaluated.

- The maximum detected concentration of arsenic, lead, and thallium in surface soil and manganese and thallium in subsurface soil exceeded the direct contact risk-based COC screening levels and were retained for evaluation in the HHRA.

- The maximum detected concentrations of methylene chloride and thallium exceeded their respective soil to groundwater migration criteria. Methylene chloride and thallium were not detected in groundwater at Site 18.

- The maximum detected concentrations of all chemicals in surface and subsurface soil were less than the CTDEP criteria for migration from soil to indoor air.

- All ICRs for exposure to soil at Site 18 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. Chemical-specific ICRs for arsenic (full-time workers, future child residents, and future adult residents) exceeded CTDEP's target level of 1×10^{-6} for individual chemicals. It should be noted that the maximum detected concentration of arsenic was less than its CTDEP RSRs for residential exposures.

- All HIs for exposure to soil at Site 18 were less than USEPA's and CTDEP's acceptable level of 1.0.

- The maximum detected concentration of lead in soil exceeded the OSWER screening level of 400 mg/kg for residential exposures by children. USEPA's IEUBK model was used to evaluate exposures to lead in soil by hypothetical residential children. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in soil at Site 18. Exposures to

lead by nonresidential adults were evaluated by use of a slope-factor approach developed by the USEPA Technical Review Workgroup for Lead. The slope-factor approach indicated that adverse effects are not anticipated for nonresidential adults exposed to lead in surface soil at the Site 18.

- The maximum detected concentration of manganese in groundwater exceeded it screening criteria but was within background levels, consequently manganese was not retained as COCs in the HHRA. ICRs and HIs would still have been within USEPA and CTDEP target levels if manganese had been evaluated in the HHRA.

12.7.3 Recommendations

One objective of the RI at Site 18 was to perform an initial characterization of the nature and extent of contamination at the site because no sampling or analytical programs had been completed at the site in the past. Another objective of the RI was to quantify the risks to human receptors associated with the site.

The first objective of the RI was completed by conducting a field sampling and analytical program. The program for this site focused on soil and groundwater. Both surface soil and subsurface soil samples were collected and analyzed. Three temporary groundwater monitoring wells were installed; however, only two were sampled during the RI because one well was dry.

The nature and extent of contamination and HHRA results from this RI indicate that past storage of solvents at Building 33 (Site 18) has not significantly impacted the surrounding media and the site does not pose significant risks to any potential human receptors. No groundwater COPCs were identified at Site 18. All ICRs for exposure to soil at Site 18 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. All HIs for exposure to soil at Site 18 were less than USEPA's and CTDEP's acceptable level of 1.0. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in soil at Site 18, and the slope-factor approach developed by the USEPA Technical Review Workgroup for lead indicated that adverse effects are not anticipated for nonresidential adults exposed to lead in surface soil at the Site 18

Even though several chemicals (i.e., methylene chloride, thallium, and antimony) were detected at concentrations that exceed screening criteria for contaminant migration from soil to groundwater, the groundwater analytical data do not indicate that the site soils have impacted the groundwater.

The results of this RI do not indicate that subsequent rounds of investigation are necessary to further characterize this site. In addition, the results do not suggest that an FS is necessary for this site. Therefore, it is recommended that a no-further-action decision document be prepared for this site.

TABLE 12-1

SUMMARY OF THE SAMPLING AND ANALYTICAL PROGRAM FOR SITE 18
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Sample ID	VOCs	SVOCs	Metals	Misc[1]	Pesticides /PCBs	SPLP Metals	SPLP Pesticides/ PCBs
SOIL							
S18SB010001	X	X	X		X	X	X
S18SB010506	X	X	X		X	X	X
S18SB020001	X	X	X		X	X	X
S18SB020405	X	X	X		X	X	X
S18SB030001	X	X	X		X	X	X
S18SB030708	X	X	X		X	X	X
S18SB040001	X	X	X		X	X	X
S18SB040708	X	X	X		X	X	X
S18SB050001	X	X	X		X	X	X
S18SB050405	X	X	X		X	X	X
GROUNDWATER							
S18TW0201	X	X	X	X	X		
S18TW0201-D	X	X	X	X	X		
S18TW0401	X	X	X	X	X		

Note:
1 Miscellaneous parameters includes TSS and TDS.

TABLE 12-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 18
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	S18SB01	S18SB01	S18SB02	S18SB02	S18SB02	S18SB02
matrix	SS	SB	SS	SB	SB	SB
nsample	S18SB010001-SO	S18SB010506-SO	S18SB020001-SO	S18SB020405-SO	S18SB020405-SO-AVG	S18SB020405-SO-D
sample	S18SB010001	S18SB010506	S18SB020001	S18SB020405	S18SB020405	FD0612001
top_depth	0	5	0	4	4	4
bottom_dep	1	6	1	5	5	5
sample_dat	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00
Volatile Organics (ug/kg)						
2-BUTANONE	10 UR	10 UR	4 J	11 UJ	11 UJ	12 UR
METHYLENE CHLORIDE	9 U	8 U	5 U	5 U	34.75 J	67 J
TOLUENE	2 J	5 U	1 J	2 J	2 J	6 U
Semivolatile Organics (ug/kg)						
ACENAPHTHENE	26 J	170 U	180 U	190 U	190 U	190 U
ANTHRACENE	33 J	170 U	180 U	190 U	190 U	190 U
BENZO(A)ANTHRACENE	71 J	26 J	180 U	190 U	190 U	190 U
BENZO(A)PYRENE	54 J	22 J	180 U	190 U	190 U	190 U
BENZO(B)FLUORANTHENE	51 J	22 J	180 U	190 U	190 U	190 U
BENZO(G,H,I)PERYLENE	68 J	29 J	180 U	190 U	190 U	190 U
BENZO(K)FLUORANTHENE	51 J	21 J	180 U	190 U	190 U	190 U
CARBAZOLE	27 J	170 U	180 U	190 U	190 U	190 U
CHRYSENE	74 J	30 J	180 U	190 U	190 U	190 U
FLUORANTHENE	170 J	66 J	180 U	190 U	190 U	190 U
FLUORENE	24 J	170 U	180 U	190 U	190 U	190 U
INDENO(1,2,3-CD)PYRENE	61 J	25 J	180 U	190 U	190 U	190 U
NAPHTHALENE	19 J	170 U	180 U	190 U	190 U	190 U
PHENANTHRENE	150 J	51 J	180 U	190 U	190 U	190 U
PYRENE	130 J	49 J	180 U	190 U	190 U	190 U
Inorganics (mg/kg)						
ALUMINUM	6500	5300	8800	6200	4750	3300
ANTIMONY	0.62 UJ	0.55 UJ	0.64 UJ	0.55 UJ	0.545 UJ	0.54 UJ
ARSENIC	1.9	0.77 J	3.1	1.2 J	0.755 J	0.62 U
BARIUM	24	39	35	30	24	18
CALCIUM	1000 J	1100 J	1400 J	1100 J	770 J	440 J
CHROMIUM	9.5	8.9	13	10	6.75	3.5 J
COPPER	7.1	11	12	10	7.05	4.1
IRON	7500 J	7800 J	8700 J	6100 J	4650 J	3200 J
LEAD	2.5	2.4	25	1.9	1.425	0.95 J
MAGNESIUM	1900	2400	2500	2000	1550	1100
MANGANESE	110 J	170 J	130 J	110 J	105 J	100 J
POTASSIUM	870	1800	1300	1400	1145	890
SILVER	1.6	2.1 J	1.5 J	1.2 U	1.15 U	1.1 U
THALLIUM	0.48 U	0.42 U	0.49 U	0.43 U	0.425 U	0.42 U
VANADIUM	16	17	18	14	8.575	6.3 U
ZINC	19 U	30	21 U	17 U	14 U	11 U

TABLE 12-2

SUMMARY OF POSITIVE SOIL ANALYTICAL RESULTS FOR SITE 18
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	S18SB03	S18SB03	S18SB04	S18SB04	S18SB05	S18SB05
matrix	SS	SB	SS	SB	SS	SB
nsample	S18SB030001-SO	S18SB030708-SO	S18SB040001-SO	S18SB040708-SO	S18SB050001-SO	S18SB050405-SO
sample	S18SB030001	S18SB030708	S18SB040001	S18SB040708	S18SB050001	S18SB050405
top_depth	0	7	0	7	0	4
bottom_dep	1	8	1	8	1	5
sample_dat	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00
Volatile Organics (ug/kg)						
2-BUTANONE	4 J	10 UR	2 J	10 UR	13 UR	11 UJ
METHYLENE CHLORIDE	5 U	14 U	5 U	27 U	14 U	24 U
TOLUENE	2 J	1 J	3 J	1 J	6 J	6 UJ
Semivolatile Organics (ug/kg)						
ACENAPHTHENE	200 U	180 U	190 U	180 U	180 U	200 U
ANTHRACENE	200 U	180 U	190 U	180 U	180 U	200 U
BENZO(A)ANTHRACENE	200 U	180 U	190 U	180 U	180 U	200 U
BENZO(A)PYRENE	200 U	180 U	190 U	180 U	180 U	200 U
BENZO(B)FLUORANTHENE	200 U	180 U	190 U	180 U	180 U	200 U
BENZO(G,H,I)PERYLENE	200 U	180 U	190 U	180 U	180 U	200 U
BENZO(K)FLUORANTHENE	200 U	180 U	190 U	180 U	180 U	200 U
CARBAZOLE	200 U	180 U	190 U	180 U	180 U	200 U
CHRYSENE	200 U	180 U	190 U	180 U	180 U	200 U
FLUORANTHENE	200 U	180 U	190 U	180 U	180 U	200 U
FLUORENE	200 U	180 U	190 U	180 U	180 U	200 U
INDENO(1,2,3-CD)PYRENE	200 U	180 U	190 U	180 U	180 U	200 U
NAPHTHALENE	200 U	180 U	190 U	180 U	180 U	200 U
PHENANTHRENE	200 U	180 U	190 U	180 U	180 U	200 U
PYRENE	200 U	180 U	190 U	180 U	180 U	200 U
Inorganics (mg/kg)						
ALUMINUM	15000	1400	15000	8100	8700	6500
ANTIMONY	0.6 UJ	0.5 UJ	0.67 UJ	0.57 UJ	0.73 J	0.54 UJ
ARSENIC	4	0.58 U	2.5	0.65 U	2.3	0.75 J
BARIUM	33	7.7 U	38	43	36	42
CALCIUM	480 J	880 J	180 U	700 J	750 J	990 J
CHROMIUM	19	1.6 U	14	9.4	13	9.8
COPPER	8.4	4	4.2	7	11	6.7
IRON	13000 J	1700 J	13000 J	8500 J	9500 J	7000 J
LEAD	5.5	0.39 U	5.3	2.2	430	1.6
MAGNESIUM	2800	360	1400	2100	2600	2300
MANGANESE	110 J	33 J	82 J	220 J	110 J	170 J
POTASSIUM	420	300	330	1700	1200	1900
SILVER	3.4	1.1 U	3.2	2.2 J	2 J	1.3 J
THALLIUM	0.64 J	0.39 U	0.54 J	0.75 J	0.43 J	0.42 U
VANADIUM	33	4.1 U	25	17	21	15
ZINC	23	7.2 U	38	22	22	19 U

TABLE 12-3

SUMMARY OF SPLP SAMPLING AND ANALYTICAL PROGRAM FOR SITE 18
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	S18SB01	S18SB01	S18SB02	S18SB02	S18SB02	S18SB02	S18SB03	S18SB03	S18SB04	S18SB04	S18SB05	S18SB05
matrix	SPLP	SPLP	SPLP	SPLP	SPLP	SPLP	SPLP	SPLP	SPLP	SPLP	SPLP	SPLP
nsample	S18SB010001-SO-P	S18SB010506-SO-P	S18SB020001-SO-P	S18SB020405-SO-P	S18SB020405-SO-P-AVG	S18SB020405-SO-P-D	S18SB030001-SO-P	S18SB030708-SO-P	S18SB040001-SO-P	S18SB040708-SO-P	S18SB050001-SO-P	S18SB050405-SO-P
sample	S18SB010001	S18SB010506	S18SB020001	S18SB020405	S18SB020405	FD0612001	S18SB030001	S18SB030708	S18SB040001	S18SB040708	S18SB050001	S18SB050405
top_depth	0	5	0	4	4	4	0	7	0	7	0	4
bottom_dep	1	6	1	5	5	5	1	8	1	8	1	5
sample_dat	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00	6/12/00
PCBs (ug/L)												
AROCLOR-1016	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
AROCLOR-1221	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U	4 U
AROCLOR-1232	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
AROCLOR-1242	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
AROCLOR-1248	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
AROCLOR-1254	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
AROCLOR-1260	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Total Metals (ug/L)												
ALUMINUM	66 U	66 U	66 U	66 U	66 U	66 U	66 U	66 U	150 U	67 U	66 U	66 U
ANTIMONY	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	86	2.7 U
ARSENIC	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U
BARIUM	140 U	140 U	130 U	130 U	130 U	130 U	130 U	130 U	160 U	130 U	190 U	120 U
BERYLLIUM	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
CADMIUM	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U	0.54 U
CALCIUM	520 U	3000 U	2400 U	1600 U	1650 U	1700 U	850 U	2300 U	180 U	820 U	1700 U	310 U
CHROMIUM	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ	8.4 UJ
COBALT	5.2 U	5.2 U	5.2 U	5.2 U	5.2 U	5.2 U	5.2 U	5.2 U	5.2 U	5.2 U	5.2 U	5.2 U
COPPER	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U	5.4 U
IRON	22 U	22 U	22 U	22 U	22 U	22 U	37 U	22 U	57 U	34 U	32 U	28 U
LEAD	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U
MAGNESIUM	120	950	120	110 U	110 U	110 U	110 U	110 U	110 U	120	250 U	110 U
MANGANESE	19 U	46	3.5 U	3.5 U	10.375	19	3.5 U	7.5 U	5.9 U	3.5 U	10 U	3.5 U
MERCURY	0.12 U	0.13 U	0.13 U	0.28 U	0.23 U	0.18 U	0.14 U	0.12 U	0.1 U	0.13 U	0.19 U	0.14 U
NICKEL	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U	7.7 U
POTASSIUM	480 U	360 U	360 U	360 U	1330 U	2300 U	6600	360 U	390 U	370 U	510 U	540 U
SELENIUM	2.7 U	2.7 U	2.7 U	2.7 U	2.8 U	2.9 U	2.9 U	3.4 U	2.7 U	3.9 U	2.7 U	2.7 U
SILVER	5.7 U	5.7 U	5.7 U	5.7 U	5.575	8.3	18	5.7 U	5.7 U	5.7 U	5.7 U	5.7 U
SODIUM	3700 U	3900 U	3900 U	3400 U	3350 U	3300 U	4500 U	3400 U	680 U	1600 U	5900 U	5200 U
THALLIUM	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U
VANADIUM	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U
ZINC	30 U	32 U	15 U	15 U	18 U	21 U	17 U	17 U	260 U	85 U	20 U	19 U

TABLE 12-4

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR SITE 18
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location **loc** **nsample** **sample** **sample_dat**	**18TB2/18TW2** **18TW2** **S18TW0201** **S18TW0201** **6/14/00**	**18TB2/18TW2** **18TW2** **S18TW0201-D** **FD0614001** **6/14/00**	**18TB4/18TW4** **18TW4** **S18TW0401** **S18TW0401** **6/14/00**
ALUMINUM	189 U	211 U	880
BERYLLIUM	0.6 U	0.6 U	0.79 J
CALCIUM	25000	25200	9640
IRON	306	328	1030
MAGNESIUM	1590 U	1650 U	2630
MANGANESE	111	111	322
POTASSIUM	1660 U	1670 U	2570
SODIUM	9570	9900	15100
Miscellaneous Parameters (mg/L)			
TOTAL DISSOLVED SOLIDS	146	174	111
TOTAL SUSPENDED SOLIDS	5 U	5 U	39

TABLE 12-5

CHEMICALS RETAINED AS COPCs AT SITE 18
DIRECT CONTACT EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

	Surface Soil		Subsurface Soil		Groundwater	
Chemical	Direct Contact	Soil to Air	Direct Contact	Soil to Air	Direct Contact	Groundwater to Indoor Air
Metals						
Arsenic	X					
Lead	X					
Manganese			X			
Thallium	X		X			

Notes:
X - Chemical is retained as a COC.

TABLE 12-6

CHEMICALS RETAINED AS COPCs AT SITE 18
POTENTIAL MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

	Surface Soil		Subsurface Soil		Groundwater	
Chemical	Soil to Groundwater	Soil to Indoor Air	Soil to Groundwater	Soil to Indoor Air	Groundwater to Surface Water	Groundwater to Indoor Air
Volatile Organic Compounds						
Methylene Chloride			X			
Metals						
Antimony	X					
Thallium			X			

Notes:
X - Chemical is retained as a COC.

TABLE 12-7

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SURFACE SOIL AT SITE 18
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Solvent Storage Area (Site 18)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																	
78-93-3	2-BUTANONE	0.002	J	0.004	J	mg/kg	S18SB020001-SO, S18SB030001-SO	3/3	---	0.002	NA	730	N	NA 500	SSL-INH CTRESSOIL	NO	BSL
108-88-3	TOLUENE	0.001	J	0.006	J	mg/kg	S18SB050001-SO	5/5	---	0.001	NA	52	N	650 500	SSL-INH CTRESSOIL	NO	BSL
Semivolatile Organics																	
83-32-9	ACENAPHTHENE	0.026	J	0.026	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.026	NA	370	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
120-12-7	ANTHRACENE	0.033	J	0.033	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.033	NA	2200	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
56-55-3	BENZO(A)ANTHRACENE	0.071	J	0.071	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.071	NA	0.62	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
50-32-8	BENZO(A)PYRENE	0.054	J	0.054	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.054	NA	0.062	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
205-99-2	BENZO(B)FLUORANTHENE	0.051	J	0.051	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.051	NA	0.62	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.068	J	0.068	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.068	NA	230(7)	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.051	J	0.051	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.051	NA	6.2	C	NA 8.4	SSL-INH CTRESSOIL	NO	BSL
86-74-8	CARBAZOLE	0.027	J	0.027	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.027	NA	2.4	N	NA 31	SSL-INH CTRESSOIL	NO	BSL
218-01-9	CHRYSENE	0.074	J	0.074	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.074	NA	62	C	NA 84	SSL-INH CTRESSOIL	NO	BSL
206-44-0	FLUORANTHENE	0.17	J	0.17	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.17	NA	230	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
86-73-7	FLUORENE	0.024	J	0.024	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.024	NA	260	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.061	J	0.061	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.061	NA	0.62	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
91-20-3	NAPHTHALENE	0.019	J	0.019	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.019	NA	5.6	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
85-01-8	PHENANTHRENE	0.15	J	0.15	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.15	NA	230(7)	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
129-00-0	PYRENE	0.13	J	0.13	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.13	NA	230	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
Inorganics																	
7429-90-5	ALUMINUM	6500		15000		mg/kg	S18SB030001-SO, S18SB040001-SO	5/5	---	15000	17600	7600	N	NA NA	SSL-INH CTRESSOIL	NO	EPAI, BKG
7440-36-0	ANTIMONY	0.73	J	0.73	J	mg/kg	S18SB050001-SO	1/5	0.6 - 0.67	0.73	2.05	3.1	N	NA 27	SSL-INH CTRESSOIL	NO	BSL
7440-38-2	ARSENIC	1.9		4		mg/kg	S18SB030001-SO	5/5	---	4	3.6	0.39	C	750 10	SSL-INH CTRESSOIL	YES	ASL
7440-39-3	BARIUM	24		38		mg/kg	S18SB040001-SO	5/5	---	38	39	540	N	690000 4700	SSL-INH CTRESSOIL	NO	BSL,BKG
7440-70-2	CALCIUM	480	J	1400	J	mg/kg	S18SB020001-SO	4/5	180	1400	314	NA		NA NA	SSL-INH CTRESSOIL	NO	NUT

TABLE 12-7

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SURFACE SOIL AT SITE 18
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Solvent Storage Area (Site 18)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7440-47-3	CHROMIUM	9.5		19		mg/kg	S18SB030001-SO	5/5	---	19	19.3	30(8) C	270 100	SSL-INH CTRESSOIL	NO	BSL,BKG
7440-50-8	COPPER	4.2		12		mg/kg	S18SB020001-SO	5/5	---	12	17.9	290 N	NA 2500	SSL-INH CTRESSOIL	NO	BSL,BKG
7439-89-6	IRON	7500	J	13000	J	mg/kg	S18SB030001-SO, S18SB040001-SO	5/5	---	13000	16800	2300 N	NA NA	SSL-INH CTRESSOIL	NO	EPAI, BKG
7439-92-1	LEAD	2.5		430		mg/kg	S18SB050001-SO	5/5	---	430	17.5	400	NA 500	SSL-INH CTRESSOIL	YES	ASL
7439-95-4	MAGNESIUM	1400		2800		mg/kg	S18SB030001-SO	5/5	---	2800	2460	NA	NA NA	SSL-INH CTRESSOIL	NO	NUT
7439-96-5	MANGANESE	82	J	130	J	mg/kg	S18SB020001-SO	5/5	---	130	172	180 N	NA NA	SSL-INH CTRESSOIL	NO	BSL,BKG
7440-09-7	POTASSIUM	330		1300		mg/kg	S18SB020001-SO	5/5	---	1300	669	NA	NA NA	SSL-INH CTRESSOIL	NO	NUT
7440-22-4	SILVER	1.5	J	3.4		mg/kg	S18SB030001-SO	5/5	---	3.4	0.385	39 N	NA 340	SSL-INH CTRESSOIL	NO	BSL
7440-28-0	THALLIUM	0.43	J	0.64	J	mg/kg	S18SB030001-SO	3/5	0.48 - 0.49	0.64	0.105	0.52 N	NA 5.4	SSL-INH CTRESSOIL	YES	ASL
7440-62-2	VANADIUM	16		33		mg/kg	S18SB030001-SO	5/5	---	33	33.3	55 N	NA 470	SSL-INH CTRESSOIL	NO	BSL,BKG
7440-66-6	ZINC	22		38		mg/kg	S18SB040001-SO	3/5	19 - 21	38	25.6	2300 N	NA 20000	SSL-INH CTRESSOIL	NO	BSL

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COC.
5 The risk-based COPC screening level for residential land use is presented. The value is based on a target Hazard Quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000)
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
7 Pyrene is used as a surrogate for 2-methylnaphthalene, benzo(g,h,i)perylene, and phenanthrene.
8 Hexavalent Chromium.
9 OSWER soil screening level for residential land use (USEPA, July 1994).

Associated Samples:

S18SB010001-SO
S18SB020001-SO
S18SB030001-SO
S18SB040001-SO
S18SB050001-SO

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
SSL-INH = Soil Screening Level for transfers from soil to air (Inhalation) (USEPA, May 1996).
CTRESSOIL - CTDEP direct contact criteria for residential exposures.

Rationale Codes:

For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.

TABLE 12-8

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SURFACE SOIL AT SITE 18
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Solvent Storage Area (Site 18)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	EPA SSL-Soil to GW(5)	CTDEP Mobility Criteria(8)	CTDEP Soil Vapor Volatilization(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organics																
78-93-3	2-BUTANONE	0.002	J	0.004	J	mg/kg	S18SB020001-SO, S18SB030001-SO	3/3	---	0.004	NA	NA	80	2400	NO	BSL
108-88-3	TOLUENE	0.001	J	0.006	J	mg/kg	S18SB050001-SO	5/5	---	0.006	NA	12	67	760	NO	BSL
Semivolatile Organics																
83-32-9	ACENAPHTHENE	0.026	J	0.026	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.026	NA	570	84	NA	NO	BSL
120-12-7	ANTHRACENE	0.033	J	0.033	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.033	NA	12000	400	NA	NO	BSL
56-55-3	BENZO(A)ANTHRACENE	0.071	J	0.071	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.071	NA	2	1	NA	NO	BSL
50-32-8	BENZO(A)PYRENE	0.054	J	0.054	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.054	NA	8	1	NA	NO	BSL
205-99-2	BENZO(B)FLUORANTHENE	0.051	J	0.051	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.051	NA	NA	1	NA	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.068	J	0.068	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.068	NA	4200(6)	42	NA	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.051	J	0.051	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.051	NA	49	1	NA	NO	BSL
86-74-8	CARBAZOLE	0.027	J	0.027	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.027	NA	0.6	1	NA	NO	BSL
218-01-9	CHRYSENE	0.074	J	0.074	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.074	NA	160	1	NA	NO	BSL
206-44-0	FLUORANTHENE	0.17	J	0.17	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.17	NA	4300	56	NA	NO	BSL
86-73-7	FLUORENE	0.024	J	0.024	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.024	NA	560	56	NA	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.061	J	0.061	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.061	NA	14	1	NA	NO	BSL
91-20-3	NAPHTHALENE	0.019	J	0.019	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.019	NA	84	56	NA	NO	BSL
85-01-8	PHENANTHRENE	0.15	J	0.15	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.15	NA	4200(8)	40	NA	NO	BSL
129-00-0	PYRENE	0.13	J	0.13	J	mg/kg	S18SB010001-SO	1/5	0.18 - 0.2	0.13	NA	4200	40	NA	NO	BSL
Inorganics																
7429-90-5	ALUMINUM	6500		15000		mg/kg	S18SB030001-SO, S18SB040001-SO	5/5	---	15000	17600	NA	NA(9)	NA	NO	BKG
7440-36-0	ANTIMONY	0.73	J	0.73	J	mg/kg	S18SB050001-SO	1/5	0.6 - 0.67	0.73	2.05	5	NA(9)	NA	NO	BSL
7440-38-2	ARSENIC	1.9		4		mg/kg	S18SB030001-SO	5/5	---	4	3.6	29	NA(9)	NA	NO	BSL
7440-39-3	BARIUM	24		38		mg/kg	S18SB040001-SO	5/5	---	38	39	1600	NA(9)	NA	NO	BSL,BKG
7440-70-2	CALCIUM	480	J	1400	J	mg/kg	S18SB020001-SO	4/5	180	1400	314	NA	NA(9)	NA	NO	NUT
7440-47-3	CHROMIUM	9.5		19		mg/kg	S18SB030001-SO	5/5	---	19	19.3	38	NA(9)	NA	NO	BSL,BKG
7440-50-8	COPPER	4.2		12		mg/kg	S18SB020001-SO	5/5	---	12	17.9	NA	NA(9)	NA	NO	BKG
7439-89-6	IRON	7500	J	13000	J	mg/kg	S18SB030001-SO, S18SB040001-SO	5/5	---	13000	16800	NA	NA(9)	NA	NO	BKG
7439-92-1	LEAD	2.5		430		mg/kg	S18SB050001-SO	5/5	---	430	17.5	NA	NA(9)	NA	NO	NTX
7439-95-4	MAGNESIUM	1400		2800		mg/kg	S18SB030001-SO	5/5	---	2800	2160	NA	NA(9)	NA	NO	NTX
7439-96-5	MANGANESE	82	J	130	J	mg/kg	S18SB020001-SO	5/5	---	130	172	NA	NA(9)	NA	NO	BKG
7440-09-7	POTASSIUM	330		1300		mg/kg	S18SB020001-SO	5/5	---	1300	669	NA	NA(9)	NA	NO	BSL
7440-22-4	SILVER	1.5	J	3.4		mg/kg	S18SB030001-SO	5/5	---	3.4	0.385	34	NA(9)	NA	NO	NTX
7440-28-0	THALLIUM	0.43	J	0.64	J	mg/kg	S18SB030001-SO	3/5	0.48 - 0.49	0.64	0.105	0.7	NA(9)	NA	NO	BSL
7440-62-2	VANADIUM	16		33		mg/kg	S18SB030001-SO	5/5	---	33	33.3	6000	NA(9)	NA	NO	BSL,BKG
7440-66-6	ZINC	22		38		mg/kg	S18SB040001-SO	3/5	19 - 21	38	25.6	12000	NA(9)	NA	NO	BSL

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

TABLE 12-8

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SURFACE SOIL AT SITE 18
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COC.
5 USEPA Soil Screening Guidance, May 1996.
6 CTDEP Remediation Standard Regulations, 1996.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
8 Pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.
9 Mobilization criteria for inorganics developed to be compared to TCLP or SPLP.

Associated Samples:

S18SB010001-SO	S18SB040001-SO
S18SB020001-SO	S18SB050001-SO
S18SB030001-SO	

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen
NA = Not Applicable.

Rationale Codes:

For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.
NTX = No criteria available.

TABLE 12-9

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SURFACE SOIL AT SITE 18
MIGRATION PATHWAYS - SPLP RESULTS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Solvent Storage Area (Site 18)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	CTDEP Mobility Criteria(5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Inorganics														
7440-36-0	ANTIMONY	86		86		ug/L	S18SB050001-SO-P	1/5	2.7	86	NA	60	YES	ASL
7439-95-4	MAGNESIUM	120		120		ug/L	S18SB010001-SO-P, S18SB020001-SO-P	2/5	110 - 250	120	NA	NA	NO	NTX
7440-09-7	POTASSIUM	6600		6600		ug/L	S18SB030001-SO-P	1/5	360 - 510	6600	NA	NA	NO	NTX
7440-22-4	SILVER	18		18		ug/L	S18SB030001-SO-P	1/5	5.7	18	NA	360	NO	BSL

A shaded value indicates that the concentration used for screening exceeds the criterion.
A shaded chemical name indicates that the chemical has been selected as a COC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 SPLP analysis was not performed on background samples.
5 CTDEP Remediation Standard Regulations, 1996.
6 The chemical is selected as a COC if the maximum detected concentration exceeds the risk-based COC screening level.

Associated Samples:

S18SB010001-SO-P
S18SB020001-SO-P
S18SB030001-SO-P
S18SB040001-SO-P
S18SB050001-SO-P

Definitions:

C = Carcinogen.
COC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not available.

Rationale Codes:

For Selection as a COC:
ASL = Above COC Screening Level.

For Elimination as a COC:
BSL = Below COC Screening Level.
NTX = No criteria available.

TABLE 12-10

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SUBSURFACE SOIL AT SITE 18
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Solvent Storage Area (Site 18)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COC Screening Level(5)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																	
75-09-2	METHYLENE CHLORIDE	0.067	J	0.067	J	mg/kg	S18SB020405-SO-D	1/5	0.005 - 0.027	0.067	NA	8.9	C	13 82	SSL-INH CTRESSOIL	NO	BSL
108-88-3	TOLUENE	0.001	J	0.002	J	mg/kg	S18SB020405-SO	3/5	0.005 - 0.006	0.002	NA	52	N	650 500	SSL-INH CTRESSOIL	NO	BSL
Semivolatile Organics																	
56-55-3	BENZO(A)ANTHRACENE	0.026	J	0.026	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.026	NA	0.62	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
50-32-8	BENZO(A)PYRENE	0.022	J	0.022	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.022	NA	0.062	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
205-99-2	BENZO(B)FLUORANTHENE	0.022	J	0.022	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.022	NA	0.62	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.029	J	0.029	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.029	NA	230	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.021	J	0.021	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.021	NA	6.2	C	NA 8.4	SSL-INH CTRESSOIL	NO	BSL
218-01-9	CHRYSENE	0.03	J	0.03	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.03	NA	62	C	NA 84	SSL-INH CTRESSOIL	NO	BSL
206-44-0	FLUORANTHENE	0.066	J	0.066	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.066	NA	230	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.025	J	0.025	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.025	NA	0.62	C	NA 1	SSL-INH CTRESSOIL	NO	BSL
85-01-8	PHENANTHRENE	0.051	J	0.051	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.051	NA	230	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
129-00-0	PYRENE	0.049	J	0.049	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.049	NA	230	N	NA 1000	SSL-INH CTRESSOIL	NO	BSL
Inorganics																	
7429-90-5	ALUMINUM	1400		8100		mg/kg	S18SB040708-SO	5/5	---	8100	17600	7600	N	NA NA	SSL-INH CTRESSOIL	NO	BKG, EPAI
7440-38-2	ARSENIC	0.75	J	1.2	J	mg/kg	S18SB020405-SO	3/5	0.58 - 0.65	1.2	3.6	0.39	C	750 10	SSL-INH CTRESSOIL	NO	BKG
7440-39-3	BARIUM	18		43		mg/kg	S18SB040708-SO	4/5	7.7	43	57.2	540	N	690000 4700	SSL-INH CTRESSOIL	NO	BSL,BKG
7440-70-2	CALCIUM	440	J	1100	J	mg/kg	S18SB020405-SO, S18SB010506-SO	5/5	---	1100	499	NA		NA NA	SSL-INH CTRESSOIL	NO	NUT
7440-47-3	CHROMIUM	3.5	J	10		mg/kg	S18SB020405-SO	4/5	1.6	10	21.5	30(8)	C	270 100	SSL-INH CTRESSOIL	NO	BSL,BKG
7440-50-8	COPPER	4		11		mg/kg	S18SB010506-SO	5/5	---	11	25.6	290	N	NA 2500	SSL-INH CTRESSOIL	NO	BSL,BKG
7439-89-6	IRON	1700	J	8500	J	mg/kg	S18SB040708-SO	5/5	---	8500	17200	2300	N	NA NA	SSL-INH CTRESSOIL	NO	BKG, EPAI
7439-92-1	LEAD	0.95	J	2.4		mg/kg	S18SB010506-SO	4/5	0.39	2.4	17.5	400(9)		NA 500	SSL-INH CTRESSOIL	NO	BSL,BKG
7439-95-4	MAGNESIUM	360		2400		mg/kg	S18SB010506-SO	5/5	---	2400	3650	NA		NA NA	SSL-INH CTRESSOIL	NO	NUT,BKG

TABLE 12-10

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SUBSURFACE SOIL AT SITE 18
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Solvent Storage Area (Site 18)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COC Screening Level(5)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COC Flag	Rationale for Contaminant Deletion or Selection(6)
7439-96-5	MANGANESE	33	J	220	J	mg/kg	S18SB040708-SO	5/5	---	220	188	180	N	NA NA	SSL-INH CTRESSOIL	YES	ASL
7440-09-7	POTASSIUM	300		1900		mg/kg	S18SB050405-SO	5/5	---	1900	2580	NA		NA NA	SSL-INH CTRESSOIL	NO	NUT,BKG
7440-22-4	SILVER	1.3	J	2.2	J	mg/kg	S18SB040708-SO	3/5	1.1 - 1.2	2.2	0.385	39	N	NA 340	SSL-INH CTRESSOIL	NO	BSL
7440-28-0	THALLIUM	0.75	J	0.75	J	mg/kg	S18SB040708-SO	1/5	0.39 - 0.43	0.75	0.29	0.52	N	NA 5.4	SSL-INH CTRESSOIL	YES	ASL
7440-62-2	VANADIUM	14		17		mg/kg	S18SB010506-SO, S18SB040708-SO	4/5	4.1 - 6.3	17	35.1	55	N	NA 470	SSL-INH CTRESSOIL	NO	BSL,BKG
7440-66-6	ZINC	22		30		mg/kg	S18SB010506-SO	2/5	7.2 - 19	30	31.3	2300	N	NA 20000	SSL-INH CTRESSOIL	NO	BSL,BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COC.
5 The risk-based COC screening level for residential land use is presented. The value is based on a target hazard quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COC if the maximum detected concentration exceeds the risk-based COC screening level and/or an ARAR/TBC(s).
7 Pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.
8 Hexavalent Chromium.
9 OSWER soil screening level for residential land use (USEPA, July 1994).

Associated Samples:

S18SB010506-SO	S18SB030708-SO
S18SB020405-SO	S18SB040708-SO
S18SB020405-SO-D	S18SB050405-SO

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
SSL-INH = Soil Screening Level for transfers from soil to air (Inhalation) (USEPA, May 1996).
CTRESSOIL - CTDEP direct contact criteria for residential exposures.

Rationale Codes:

For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
EPAI = USEPA Region one does not advocate evaluation of this chemical.

TABLE 12-11

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SUBSURFACE SOIL AT SITE 18
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Solvent Storage Area (Site 18)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	EPA SSL-Soil to GW(5)	CTDEP Mobility Criteria(6)	CTDEP Soil Vapor Volatilization(6)	COC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organics																
75-09-2	METHYLENE CHLORIDE	0.067	J	0.067	J	mg/kg	S18SB020405-SO-D	1/5	0.005 - 0.027	0.067	NA	0.02	1	1200	YES	ASL
108-88-3	TOLUENE	0.001	J	0.002	J	mg/kg	S18SB020405-SO	3/5	0.005 - 0.006	0.002	NA	12	67	760	NO	BSL
Semivolatile Organics																
56-55-3	BENZO(A)ANTHRACENE	0.026	J	0.026	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.026	NA	2	1	NA	NO	BSL
50-32-8	BENZO(A)PYRENE	0.022	J	0.022	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.022	NA	8	1	NA	NO	BSL
205-99-2	BENZO(B)FLUORANTHENE	0.022	J	0.022	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.022	NA	5	1	NA	NO	BSL
191-24-2	BENZO(G,H,I)PERYLENE	0.029	J	0.029	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.029	NA	4200(8)	42	NA	NO	BSL
207-08-9	BENZO(K)FLUORANTHENE	0.021	J	0.021	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.021	NA	49	1	NA	NO	BSL
218-01-9	CHRYSENE	0.03	J	0.03	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.03	NA	160	1	NA	NO	BSL
206-44-0	FLUORANTHENE	0.066	J	0.066	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.066	NA	4300	56	NA	NO	BSL
193-39-5	INDENO(1,2,3-CD)PYRENE	0.025	J	0.025	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.025	NA	14	1	NA	NO	BSL
85-01-8	PHENANTHRENE	0.051	J	0.051	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.051	NA	4200(8)	40	NA	NO	BSL
129-00-0	PYRENE	0.049	J	0.049	J	mg/kg	S18SB010506-SO	1/5	0.18 - 0.2	0.049	NA	4200	40	NA	NO	BSL
Inorganics																
7429-90-5	ALUMINUM	1400		8,100		mg/kg	S18SB040708-SO	5/5	---	8,100	17,600	NA	NA(9)	NA	NO	BKG
7440-38-2	ARSENIC	0.75	J	1.2	J	mg/kg	S18SB020405-SO	3/5	0.58 - 0.65	1.2	3.60	29	NA(9)	NA	NO	BSL,BKG
7440-39-3	BARIUM	18		43		mg/kg	S18SB040708-SO	4/5	7.7	43	57.2	1600	NA(9)	NA	NO	BSL,BKG
7440-70-2	CALCIUM	440	J	1,100	J	mg/kg	S18SB020405-SO, S18SB010506-SO	5/5	---	1100	499	NA	NA(9)	NA	NO	NUT
7440-47-3	CHROMIUM	3.5	J	10		mg/kg	S18SB020405-SO	4/5	1.6	10	21.5	38	NA(9)	NA	NO	BSL,BKG
7440-50-8	COPPER	4		11		mg/kg	S18SB010506-SO	5/5	---	11	25.6	NA	NA(9)	NA	NO	BKG
7439-89-6	IRON	1700	J	8,500	J	mg/kg	S18SB040708-SO	5/5	---	8,500	17,200	NA	NA(9)	NA	NO	BKG
7439-92-1	LEAD	0.95	J	2.4		mg/kg	S18SB010506-SO	4/5	0.39	2.4	17.5	NA	NA(9)	NA	NO	BKG
7439-95-4	MAGNESIUM	360		2400		mg/kg	S18SB010506-SO	5/5	---	2400	3,650	NA	NA(9)	NA	NO	NUT,BKG
7439-96-5	MANGANESE	33	J	220	J	mg/kg	S18SB040708-SO	5/5	---	220	188	NA	NA(9)	NA	NO	BSL
7440-09-7	POTASSIUM	300		1900		mg/kg	S18SB050405-SO	5/5	---	1900	2,580	NA	NA(9)	NA	NO	NUT,BKG
7440-22-4	SILVER	1.3	J	2.2	J	mg/kg	S18SB040708-SO	3/5	1.1 - 1.2	2.2	0.385	34	NA(9)	NA	NO	BSL
7440-28-0	THALLIUM	0.75	J	0.75	J	mg/kg	S18SB040708-SO	1/5	0.39 - 0.43	0.75	0.29	0.7	NA(9)	NA	YES	ASL
7440-62-2	VANADIUM	14		17		mg/kg	S18SB010506-SO, S18SB040708-SO	4/5	4.1 - 6.3	17	35.1	6000	NA(9)	NA	NO	BSL,BKG
7440-66-6	ZINC	22		30		mg/kg	S18SB010506-SO	2/5	7.2 - 19	30	31.3	12000	NA(9)	NA	NO	BSL,BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COC.

TABLE 12-11

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SUBSURFACE SOIL AT SITE 18
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 Atlantic Environmental Services, April 1995. Background concentrations of Inorganics in Soil - Naval Submarine Base - New London. If the maximum detected concentration of an inorganic is less than the background concentration, then that metal is not selected as a COC.
5 USEPA Soil Screening Level Guidance, May 1996, DAF = 20.
6 CTDEP Remediation Standard Regulations, 1996.
7 The chemical is selected as a COC if the maximum detected concentration exceeds the risk-based COC screening level and/or an ARAR/TBC(s).
8 Pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene
9 Mobilization criteria for inorganics developed to be compared to TCLP or SPLP

Associated Samples:

S18SB010506-SO	S18SB030708-SO
S18SB020405-SO	S18SB040708-SO
S18SB020405-SO-D	S18SB050405-SO

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:

For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.

TABLE 12-12

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR SUBSURFACE SOIL AT SITE 18
MIGRATION PATHWAYS - SPLP RESULTS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Solvent Storage Area (Site 18)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	CTDEP Mobility Criteria(5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Inorganics														
7439-95-4	MAGNESIUM	120		950		ug/L	S18SB010506-SO-P	2/5	110	950	NA	NA	NO	NTX
7439-96-5	MANGANESE	19		46		ug/L	S18SB010506-SO-P	2/5	3.5 - 7.5	46	NA	NA	NO	NTX
7440-22-4	SILVER	8.3		8.3		ug/L	S18SB020405-SO-P-D	1/5	5.7	8.3	NA	360	NO	BSL

A shaded value indicates that the concentration used for screening exceeds the criterion.
A shaded chemical name indicates that the chemical has been selected as a COC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 SPLP analysis was not performed on background samples.
5 CTDEP Remediation Standard Regulations, 1996.
6 The chemical is selected as a COC if the maximum detected concentration exceeds the risk-based COC screening level.

Associated Samples:

S18SB010506-SO-P	S18SB030708-SO-P
S18SB020405-SO-P	S18SB040708-SO-P
S18SB020405-SO-P-D	S18SB050405-SO-P

Definitions:

C = Carcinogen.
COC = Chemical of Potential Concern.
J = Estimated Value
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:

For Selection as a COC:
ASL = Above COC Screening Level.

For Elimination as a COC:
BSL = Below COC Screening Level.
NTX = No criteria available.

TABLE 12-13

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 18
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Solvent Storage Area (Site 18)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Total Metals																
7429-90-5	ALUMINUM	880		880		ug/L	S18TW0401	1/2	189 - 211	880	3560	3600 N	N/A 50 to 200 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI, BKG
7440-41-7	BERYLLIUM	0.79	J	0.79	J	ug/L	S18TW0401	1/2	0.6	0.79	ND	7.3 N	4 4 4	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-70-2	CALCIUM	9640		25200		ug/L	S18TW0201-D	2/2	---	25200	188000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7439-89-6	IRON	306		1030		ug/L	S18TW0401	2/2	---	1030	28200	1100 N	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPA1, BKG
7439-95-4	MAGNESIUM	2630		2630		ug/L	S18TW0401	1/2	1590 - 1650	2630	191000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7439-96-5	MANGANESE	111		322		ug/L	S18TW0401	2/2	---	322	11700	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-09-7	POTASSIUM	2570		2570		ug/L	S18TW0401	1/2	1660 - 1670	2570	70800	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-23-5	SODIUM	9570		15100		ug/L	S18TW0401	2/2	---	15100	1900000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
Miscellaneous Parameters																
000-09-0	TOTAL DISSOLVED SOLIDS	111		174		mg/L	S18TW0201-D	2/2	---	174	6260	N/A	N/A 500 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	NV
000-08-9	TOTAL SUSPENDED SOLIDS	39		39		mg/L	S18TW0401	1/2	5	39	236	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Footnotes:
1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data
5 The risk-based COPC screening level for tap water use is presented. The value is based on a target Hazard Quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).

Associated Samples:
S18TW0201
S18TW0201-D
S18TW0401

Rationale Codes:
For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
N/A = Not Applicable.
FED-MCL = Federal Maximum Contaminant Level (USEPA, August 2000).
FED-SMCL = Federal Secondary Maximum Contaminant Level (USEPA, August 2000).
FED-AL = Federal Action Level (USEPA, August 2000).
CTDEP-RSR = Connecticut DEP Remediation Standard Regulations, 1996.
CTDEP-MCL = Connecticut Maximum Contaminant Level.

For Elimination as a COC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No Toxicity Information.
EPAI = USEPA Region 1 does not advocate evaluation of this chemical.

TABLE 12-14

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 18
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Solvent Storage Area (Site 18)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	CTDEP Surface Water Criteria(5)	CTDEP Vol. Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Total Metals															
7429-90-5	ALUMINUM	880		880		ug/L	S18TW0401	1/2	189 - 211	880	3560	N/A	N/A	NO	BKG
7440-41-7	BERYLLIUM	0.79	J	0.79	J	ug/L	S18TW0401	1/2	0.6	0.79	ND	4	NA	NO	BSL
7440-70-2	CALCIUM	9640		25200		ug/L	S18TW0201-D	2/2	---	25200	188000	N/A	N/A	NO	NTX, BKG
7439-89-6	IRON	306		1030		ug/L	S18TW0401	2/2	---	1030	28200	N/A	N/A	NO	NTX, BKG
7439-95-4	MAGNESIUM	2630		2630		ug/L	S18TW0401	1/2	1590 - 1650	2630	191000	N/A	N/A	NO	NTX, BKG
7439-96-5	MANGANESE	111		322		ug/L	S18TW0401	2/2	---	322	11700	N/A	N/A	NO	NTX, BKG
7440-09-7	POTASSIUM	2570		2570		ug/L	S18TW0401	1/2	1660 - 1670	2570	70800	N/A	N/A	NO	NTX, BKG
7440-23-5	SODIUM	9570		15100		ug/L	S18TW0401	2/2	---	15100	1900000	N/A	N/A	NO	NTX, BKG
Miscellaneous Parameters															
000-09-0	TOTAL DISSOLVED SOLIDS	111		174		mg/L	S18TW0201-D	2/2	---	174	6260	N/A	N/A	NO	NTX, BKG
000-08-9	TOTAL SUSPENDED SOLIDS	39		39		mg/L	S18TW0401	1/2	5	39	236	N/A	N/A	NO	NTX, BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Footnotes:
1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 Connecticut DEP Surface Water Protection criteria.
6 Connecticut DEP Volatilization criteria for residential exposures.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the CTDEP surface water protection or volatilization criteria.

Associated Samples:
S18TW0201
S18TW0201-D
S18TW0401

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No Toxicity Information.

TABLE 12-15

SELECTION OF EXPOSURE PATHWAYS FOR SITE 18
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Soil	Surface Soil	Surface Soil	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction workers may have contact with surface soil during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Full-time employees may contact surface soil during normal work activities.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	Quant Quant	Trespassers may be exposed to surface soil while at the site.
		Air	Surface Soil	Construction Workers	Adult	Inhalation	On-site	Quant	Construction workers may be exposed to fugitive dust and volatile emissions during construction activities.
				Full-time Employees	Adult	Inhalation	On-site	Quant	Full-time employees may be exposed to fugitive dust and volatile emissions during work activities.
				Trespassers	Adolescents	Inhalation	On-Site	Quant	Trespassers may be exposed to fugitive dust and volatile emissions from soil.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Construction workers may have contact with subsurface soil during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employees are not exposed to subsurface soil.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers are not exposed to subsurface soil.
		Air	Subsurface Soil	Construction Workers	Adult	Inhalation	On-site	None	Construction workers are not likely to be exposed to fugitive dust and volatile emissions during construction activities.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to subsurface soil.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers are not exposed to subsurface soil.
Future	Surface Soil	Surface Soil	Surface Soil	Residents	Child	Ingestion Dermal	On-Site On-Site	Quant Quant	Child residents may contact surface soil.
					Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Adult residents may contact surface soil.
		Air	Surface Soil	Residents	Child	Inhalation	On-site	Quant	Child residents may be exposed to fugitive dust and volatile emissions from surface soil.
					Adult	Inhalation	On-site	Quant	Adult residents may be exposed to fugitive dust and volatile emissions from surface soil.
	Subsurface Soil	Subsurface Soil	Subsurface Soil	Residents	Child	Ingestion Dermal	On-Site On-Site	Quant Quant	Child residents may contact subsurface soil that has been brought to the surface.
					Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Adult residents may contact subsurface soil that has been brought to the surface.
		Air	Subsurface Soil	Residents	Child	Inhalation	On-site	Quant	Child residents may be exposed to fugitive dust and volatile emissions from subsurface soil that has been brought to the surface.
					Adult	Inhalation	On-site	Quant	Adult residents may be exposed to fugitive dust and volatile emissions from subsurface soil that has been brought to the surface.

TABLE 12-15

SELECTION OF EXPOSURE PATHWAYS FOR SITE 18
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Groundwater	Overburden Aquifer	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	None Quant	Construction workers may have dermal contact with groundwater during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Groundwater may not be used as a drinking water source in the future.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers do not have contact with groundwater.
				Residents	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Groundwater may be used as a potable water source in the future.
					Child	Ingestion Dermal	On-Site On-Site	None None	Exposures to a child resident are less than those for an adult resident
		Air	Overburden Aquifer	Construction Workers	Adult	Inhalation	On-site	None	Construction workers may be exposed to chemicals that have volatilized from groundwater during excavation activities.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to chemicals volatiliizing from groundwater.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers do not have contact with site groundwater.
				Residents	Adult	Inhalation	On-site	Quant	On-site residents may be exposed to volatile emmissions from groundwater while showering or via vapor intrusion.
					Child	Inhalation	On-site	None	Exposures to a child resident are less than those for an adult resident

TABLE 12-16

EXPOSURE POINT CONCENTRATIONS FOR SITE 18
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Surface Soil		All Soil	
	RME	CTE	RME	CTE
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Inorganics				
Arsenic	4 (1)	2.76 (1)	4 (3)	4 (3)
Lead	94 (2)	94 (2)	48 (2)	48 (2)
Manganese	NA	NA	154 (4)	154 (4)
Thallium	0.64 (1)	0.42 (1)	0.549 (4)	0.549 (4)

Notes:

1 - Fewer than 10 soil samples were collected; therefore, the maximum detected concentration is used for RME and the average detected concentration is used for CTE.

2 - The average concentration is used for lead (USEPA, 1994).

3 - UCL was greater than than the maxmium detected concentration; therefore, the maxmum detected concentration is used as the exposure point concentration.

4 - 95 percent UCL.

TABLE 12-17

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 18
REASONABLE MAXIMUM EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

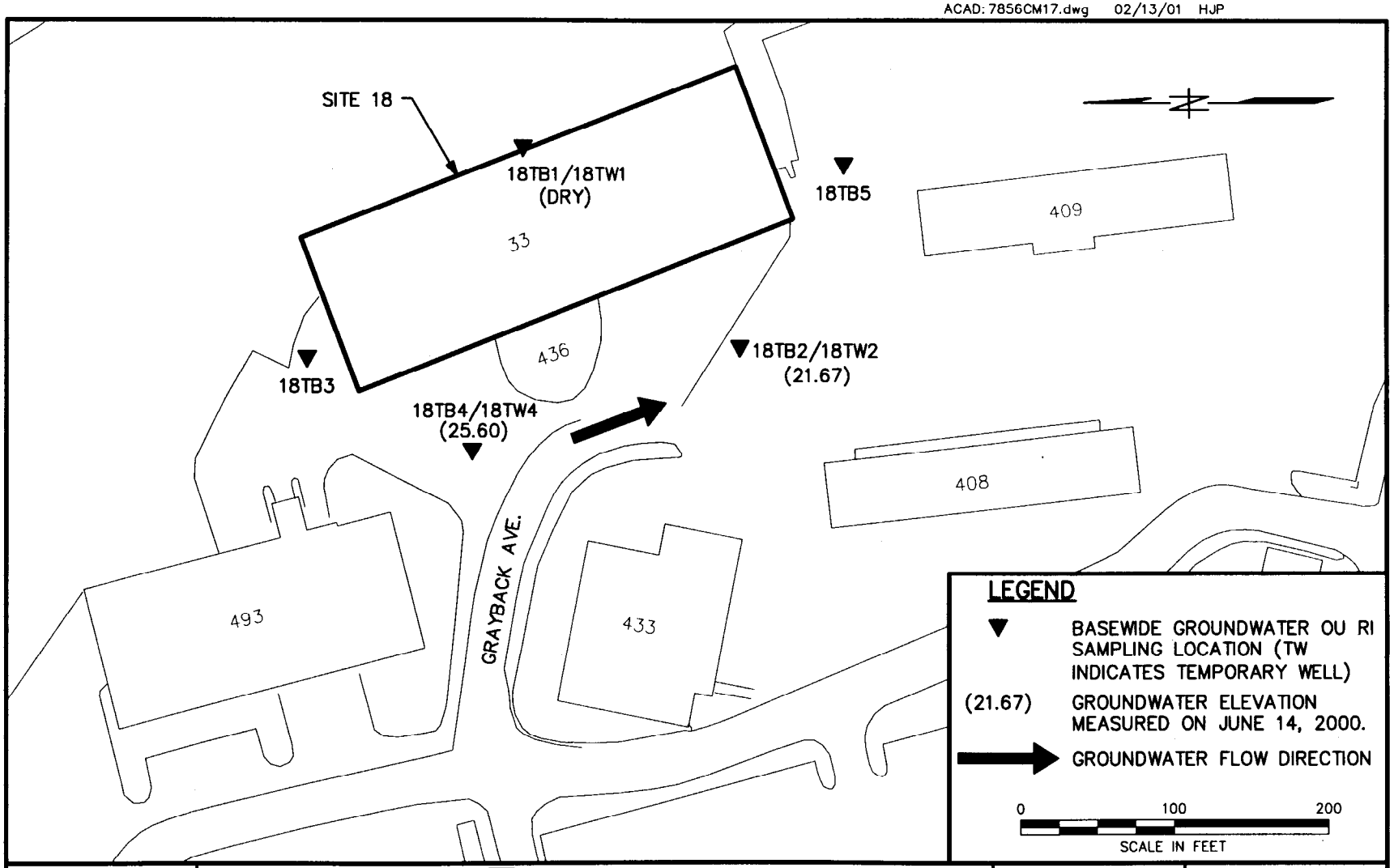
Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Surface/Subsurface Soil	Ingestion	1.9E-07	- -	- -	- -	0.05	- -
		Dermal Contact	9.2E-09	- -	- -	- -	0.001	- -
		Total	2.0E-07	- -	- -	- -	0.05	- -
Full-Time Workers	Surface Soil	Ingestion	1.3E-06	- -	- -	Arsenic	0.01	- -
		Dermal Contact	2.9E-07	- -	- -	- -	0.002	- -
		Total	1.5E-06	- -	- -	Arsenic	0.01	- -
Older Child Trespassers	Surface Soil	Ingestion	6.6E-07	- -	- -	- -	0.02	- -
		Dermal Contact	1.2E-07	- -	- -	- -	0.002	- -
		Total	7.8E-07	- -	- -	- -	0.02	- -
Child Resident	Surface/Subsurface Soil	Ingestion	2.8E-06	- -	- -	Arsenic	0.1	- -
		Dermal Contact	1.8E-07	- -	- -	- -	0.005	- -
		Total	3.0E-06	- -	- -	Arsenic	0.1	- -
Adult Resident	Surface/Subsurface Soil	Ingestion	1.2E-06	- -	- -	Arsenic	0.01	- -
		Dermal Contact	9.6E-08	- -	- -	- -	0.0006	- -
		Total	1.3E-06	- -	- -	Arsenic	0.01	- -

TABLE 12-18

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 18
CENTRAL TENDENCY EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Surface/Subsurface Soil	Ingestion	6.4E-08	- -	- -	- -	0.02	- -
		Dermal Contact	6.1E-10	- -	- -	- -	0.0001	- -
		Total	6.5E-08	- -	- -	- -	0.02	- -
Full-Time Employees	Surface Soil	Ingestion	1.0E-07	- -	- -	- -	0.004	- -
		Dermal Contact	4.7E-09	- -	- -	- -	0.0001	- -
		Total	1.1E-07	- -	- -	- -	0.005	- -
Older Child Trespassers	Surface Soil	Ingestion	2.9E-08	- -	- -	- -	0.003	- -
		Dermal Contact	3.3E-09	- -	- -	- -	0.0002	- -
		Total	3.3E-08	- -	- -	- -	0.003	- -
Child Resident	Surface/Subsurface Soil	Ingestion	4.7E-07	- -	- -	- -	0.06	- -
		Dermal Contact	1.8E-08	- -	- -	- -	0.001	- -
		Total	4.9E-07	- -	- -	- -	0.06	- -
Adult Resident	Surface/Subsurface Soil	Ingestion	1.8E-07	- -	- -	- -	0.007	- -
		Dermal Contact	4.0E-09	- -	- -	- -	0.00009	- -
		Total	1.8E-07	- -	- -	- -	0.007	- -

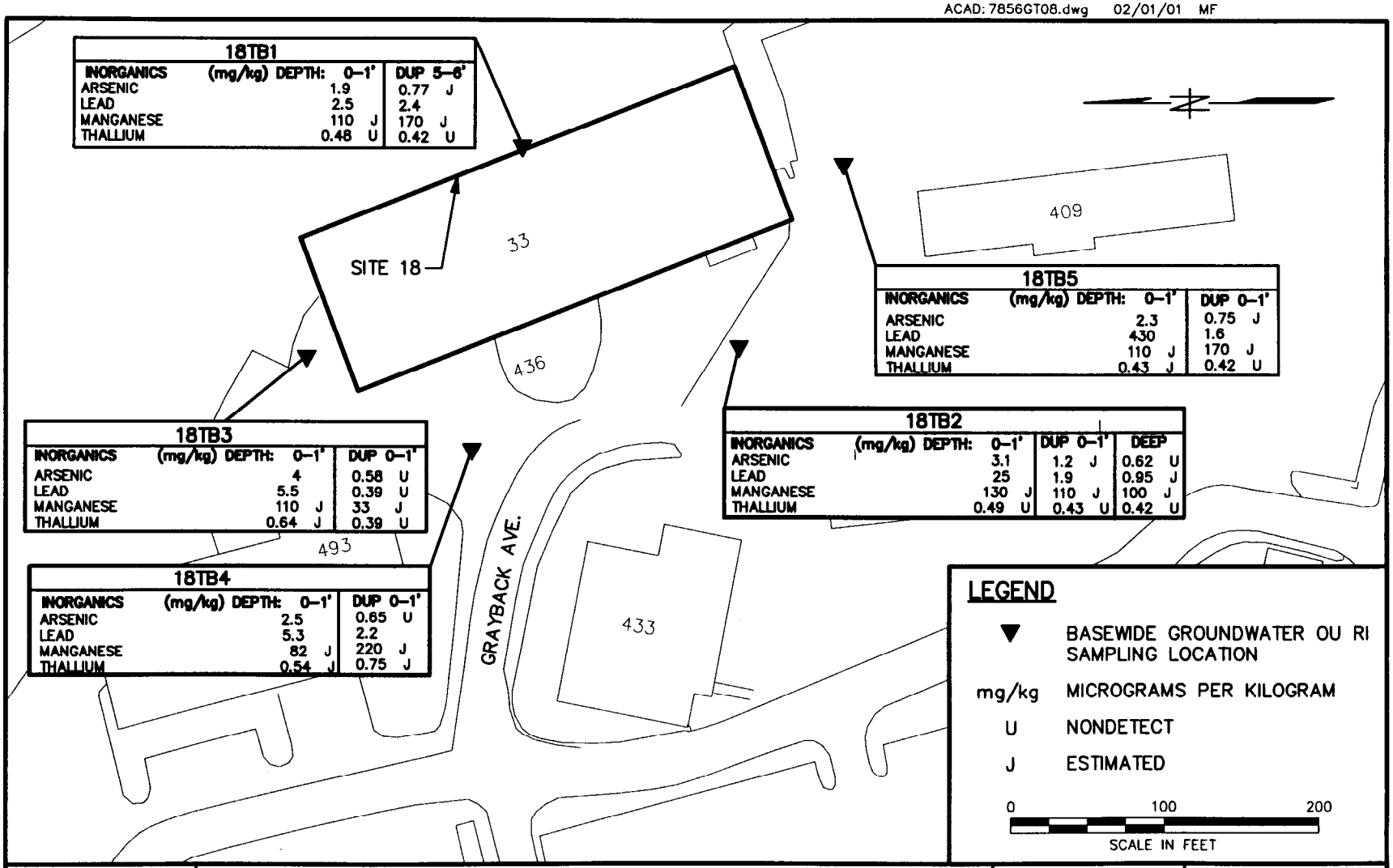
ACAD: 7856CM17.dwg 02/13/01 HJP



DRAWN BY HJP DATE 12/28/00	Tetra Tech NUS, Inc.	CONTRACT NO. 7856	OWNER NO. 0312
CHECKED BY DATE	SAMPLE LOCATIONS SITE 18–SOLVENT STORAGE AREA (BUILDING 33) NSB–NLON GROTON, CONNECTICUT	APPROVED BY DATE 2-15-01	
COST/SCHED–AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 12–1	REV. 0

FORM CADD NO. TtNUS_AH.DWG - REV 0 - 1/22/98

ACAD: 7856GT08.dwg 02/01/01 MF



18TB1

INORGANICS (mg/kg) DEPTH:	0–1'	DUP 5–6'
ARSENIC	1.9	0.77 J
LEAD	2.5	2.4
MANGANESE	110 J	170 J
THALLIUM	0.48 U	0.42 U

18TB5

INORGANICS (mg/kg) DEPTH:	0–1'	DUP 0–1'
ARSENIC	2.3	0.75 J
LEAD	430	1.6
MANGANESE	110 J	170 J
THALLIUM	0.43 J	0.42 U

18TB2

INORGANICS (mg/kg) DEPTH:	0–1'	DUP 0–1'	DEEP
ARSENIC	3.1	1.2 J	0.62 U
LEAD	25	1.9	0.95 J
MANGANESE	130 J	110 J	100 J
THALLIUM	0.49 U	0.43 U	0.42 U

18TB3

INORGANICS (mg/kg) DEPTH:	0–1'	DUP 0–1'
ARSENIC	4	0.58 U
LEAD	5.5	0.39 U
MANGANESE	110 J	33 J
THALLIUM	0.64 J	0.39 U

18TB4

INORGANICS (mg/kg) DEPTH:	0–1'	DUP 0–1'
ARSENIC	2.5	0.65 U
LEAD	5.3	2.2
MANGANESE	82 J	220 J
THALLIUM	0.54 J	0.75 J

DRAWN BY HJP DATE 12/28/00	Tetra Tech NUS, Inc.	CONTRACT NO. 7856	OWNER NO. 0312
CHECKED BY DATE	COPCs IN SOIL SITE 18–SOLVENT STORAGE AREA (BUILDING 33) NSB–NLON GROTON, CONNECTICUT	APPROVED BY DPlenore DATE 2-15-01	
COST/SCHED–AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 12–2	REV. 0

FORM CADD NO. TtNUS_AH.DWG - REV 0 - 1/22/98

13.0 SITE 23 – TANK FARM

13.1 SITE DESCRIPTION

In the early 1940s, Crystal Lake was drained and dredged to allow for construction of the nine concrete USTs (see Figure 13-1). When construction was complete, the former lake bed was reportedly filled with soils excavated from a small hill west of the tank area and graded to create a level surface for development at NSB-NLON.

Each of the nine USTs had a holding capacity of 750,000 gallons. No. 6 fuel oil was stored in tanks OT-1 through OT-3 from the date of construction until they were removed from service in the summer of 1991. Tanks OT-7 through OT-9, which were decommissioned in the summer of 1990, were used exclusively for storage of diesel during all 48 years of service.

A reduced demand for diesel fuel at NSB-NLON in the mid-1970s led to the decommissioning and demolition of tank OT-6. Details regarding demolition procedures were not on file at NSB-NLON. The reduced demand for diesel also led to the modification of tank OT-5 for waste oil storage purposes. Tank OT-4 was used to store tank bottom wastes from OT-1. Tank OT-5 was used as part of an oil/water separator system. Tanks OT-4 and OT-5 were reportedly decommissioned after the installation of a new 30,000-gallon waste oil underground tank (OT-10) in 1990. Tanks OT-1 through OT-9 have been demolished and closed in place. Tank closure was accomplished following RCRA closure requirements by demolishing the tank roof supports and allowing the roof to collapse into the tank. The void was then filled with gravel, and the site was restored using soil and topsoil.

Evidence of releases of petroleum products from these tanks and their associated piping and, possibly, from other nearby sources was detected during previous investigations. Historical sampling locations are shown on Figure 13-1. Both soil and groundwater contamination have been identified. Petroleum hydrocarbons have been detected periodically at the outfall of the Tank Farm storm sewer system. A number of petroleum releases have been documented by the Navy in the vicinity of the Tank Farm at NSB-NLON from 1989 through 1999.

The Tank Farm features are shown on Figure 13-1 and include the following:

- Nine former 110-foot-diameter, 11-foot-high USTs (OT-1 to OT-9)
- A 30,000-gallon, double-walled UST (OT-10)
- An oil/water separator (at OT-10)
- A 10,000-gallon waste oil tank (at OT-10)

- A fuel oil loading area adjacent to Building 482
- Tanker truck dumping pad and trough (at OT-10)
- Associated UST piping systems
- The MWR Recreation Center (Building 461)
- Buildings 310, 322, and O-831
- Six baseball/softball fields
- A restroom facility (Building 445)
- AS/SVE facility for NEX service station
- Two 150,000-gallon diesel above-ground storage tanks

East of the Tank Farm are two high-rise barracks (Buildings 442 and 447). The site is bounded to the south by Crystal Lake Road. Located on Crystal Lake Road are four rental units, a long-term parking facility, and a dry cleaning facility.

The base command building (Building 138), legal services (Building 137), and public works (Building 135) lie to the west. The Tank Farm is bounded on the north side by Tang Avenue. A carpentry and maintenance building (Building 406), the Naval Exchange (NEX) department store and grocery store, the NEX gasoline service station (Building 428), and warehouses (Buildings 408, 409, and 410) are located on the northern side of Tang Avenue. Six baseball/recreational fields and a number of parking areas are located above the Tank Farm.

Product Transfer Lines

Product (No. 6 fuel oil or diesel fuel) was historically delivered via barge to a pier where it was pumped via pipelines to the Tank Farm USTs through the Building 332 valve house. Product was then transferred via pipeline from the USTs to the power plant or the submarines at the Lower Subase on an as-needed basis.

The No. 6 fuel oil transfer lines were situated within concrete-lined trenches, but were removed because No. 6 fuel oil is no longer used at NSB-NLON. The diesel lines have no trenches. Portions of the diesel fuel lines on the Lower Base were recently replaced. The lines located on the Upper Base are cathodically protected.

Storm Drainage System

The Tank Farm originally contained an extensive drainage system consisting of numerous catch basins, corrugated metal pipe, perforated corrugated metal pipe, vitrified clay pipe, and reinforced concrete pipe. According to NSB-NLON personnel, the drainage system served approximately one-third of the entire

facility. Portions of the drainage system were installed with perforated corrugated metal pipe to depress the water table in the Tank Farm. The surface water and groundwater collected by the storm sewer system ultimately discharge to a boomed area of the Thames River adjacent to the Goss Cove Landfill. Based on known elevations of storm sewer catch basins, the elevation of the drainage system is below the process piping.

The drainage system was rehabilitated in 2000. The original combined groundwater and stormwater system was separated into a deep groundwater and a new shallow stormwater system. The old deteriorated pipes in the groundwater collection system were slip-lined to improve their integrity and conductance. The old tank ring-drains (French drains) were not rehabilitated, but their connection with the groundwater collection system was maintained. Groundwater testing is currently ongoing and the results will be used to determine if some form of groundwater treatment is necessary. Preliminary results from this testing program are discussed in Section 13.2.

As part of the drainage system rehabilitation project, contaminated soil and free product were also remediated. Contaminated soil and free product, which were previously identified during the Tank Farm Site Investigation Addendum (TtNUS, 1999c) in the vicinity of the former UST OT-3, were removed and disposed off site.

Tank Underdrain System

The nine former USTs (OT-1 to OT-9) at the Tank Farm were each rated for a nominal capacity of 750,000 gallons or approximately 100,000 cubic feet. Each tank was approximately 110 feet in diameter and 11 feet in depth. Depending on the season, the depth to groundwater in some areas of the site may be as little as 2 feet below grade. Groundwater at a depth of 2 feet would convert to a hydraulic pressure of 2.6 pounds per square inch exerted over the entire floor of one empty tank or an upward force of approximately 1,400 tons. The floor of the tank would rise, with or without its walls.

Tank stability was obtained using a combination of a site-wide drainage system, a series of columns inside the tanks, and an underdrain system. A site-wide stormwater drainage/dewatering system was installed and french drains were installed around OT-1, OT-2, OT-3, OT-4, and OT-5. A series of 37 columns transmitted the weight of the tank roof and overlying fill to the floor of the tank.

13.2 SITE INVESTIGATIONS

The details of all investigations, including historical and current, conducted at the Tank Farm are provided in the following subsections.

13.2.1 Diesel Tank Investigation (Fuss & O'Neill, 1989)

In June 1989, Fuss & O'Neill, Incorporated (F&O) was contracted by the Department of the Navy to perform a soil and groundwater investigation near storage tanks OT-4, OT-7, OT-8, and OT-9 (F&O, September 1989). The investigation was conducted at the request of CTDEP to confirm that the tanks were intact and leakage was not occurring. Prior to the investigation, CTDEP had recommended that the tanks be decommissioned because of their age. As an alternative, an agreement was reached between the Navy and CTDEP, that allowed the tanks to remain in service pending the outcome of the F&O investigation.

During the F&O investigation, dissolved-phase constituents of petroleum were detected in groundwater samples collected from monitoring wells (MW-1 through MW-12) near tanks OT-7 through OT-9. BTEX and a petroleum scan were the only constituents analyzed at these tanks. No. 2 fuel oil and benzene (2.4 µg/L), were detected in the groundwater near tank OT-7 at MW-1. No. 2 fuel oil was detected in the groundwater near tank OT-8 at monitoring wells MW-6 and MW-7 at 52 mg/L and 5.0 mg/L, respectively. Benzene, toluene, ethylbenzene, and xylenes (BTEX) were also detected in the groundwater sample from MW-7 at 47 µg/L, 7.2 µg/L, 55 µg/L and 81 µg/L, respectively. No volatile aromatics were detected at other well locations constructed in proximity to this tank. No. 2 fuel oil was also detected in the groundwater near tank OT-9. Water samples obtained from monitoring wells MW-9, MW-10 and MW-11 showed levels of No. 2 fuel oil at 10.6, 4.8, and 14 mg/L, respectively.

Monitoring wells were not installed at OT-4; however, four test borings (TB-1 through TB-4) were installed in the vicinity of the tank. TPH was detected at 940 mg/kg in a soil sample collected at the top of the water table in nearby boring TB-4. Benzene was also detected at 2.4 µg/kg. These findings, combined with the later discovery of fuel oil in the UST farm storm drainage system, prompted the Department of the Navy to also evaluate the condition of the three No. 6 fuel oil tanks (OT-1, OT-2 and OT-3).

It should be noted that F&O did not report the presence of free-phase oil in any of the 12 monitoring wells (MW-1 to MW-12) installed during this 1989 investigation.

13.2.2 No. 6 Oil Tank Investigation (ERM, 1991)

ERM conducted an investigation of No. 6 fuel oil tanks OT-1 through OT-3 in the spring of 1991 (ERM, 1991). The investigation revealed the presence of soil and groundwater contamination near tank OT-2. For this investigation, monitoring wells ERM-1 through ERM-19 were installed. TPH was detected in soil samples from ERM-5 (2 to 4 feet) and ERM-7 (4 to 6 feet) at 545 µg/kg and 6,930 µg/kg, respectively. Dissolved-phase constituents of petroleum were detected in groundwater samples collected from monitoring wells on the north (ERM-5, 2,586 µg/L total BTEX), west (ERM-7 70 µg/L total BTEX), and

southwest (ERM-8 3,755 µg/L total BTEX) side of the tank. Soil and groundwater contamination near tank OT-1 was not detected. At OT-3, 25 µg/L of total BTEX was detected in well ERM-11, north of the tank.

Free-phase fuel was discovered by ERM in well MW-7 during a well gauging task. The discovery was immediately reported to the NSB-NLON Public Works Department manager. Recommendations included investigating the extent of free-phase fuel and remediation efforts.

13.2.3 Waste Oil Tank OT-5 (GZA, 1991)

GZA conducted a limited environmental study in 1991 at the Waste Oil Tank No. 5 (OT-5) site, located between Tang Avenue and Sculpin Avenue at NSB-NLON (GZA, December 1991). The study included the development of a site topographic plan, a limited subsurface exploration program, the sampling of residual waste in OT-5, and the chemical screening and/or analyses of soil, waste oil, and sludge samples. The purpose of the study was to characterize the nature and extent of contaminants at the site to aid in the development of specifications for the abandonment of Tank OT-5 in place.

On the basis of the work conducted as part of this study, GZA reached the following conclusions:

- Tank OT-5 is a 750,000-gallon underground concrete tank constructed in the early 1940s. OT-5 was initially used as a No. 6 fuel oil storage tank but was converted between 1976 and 1981 to a waste oil storage tank. The waste deposited in OT-5 was reported to consist predominantly of oily bilge water pumped from Navy vessels. Abandonment of OT-5 began in 1989; demolition work was terminated when PCBs were discovered in the waste oil sludge at the bottom of the tank.

- Four shallow auger borings (GZ-1 through GZ-4) were completed as part of this study to depths of 20 to 22 feet around the perimeter of OT-5. The subsurface conditions in the vicinity of OT-5 consist of sand and gravel fill to a depth of less than 5 feet, underlain by a silty fine sand fill with trace amounts of organics, to depths of 14 to 18 feet below ground surface. Underlying the fill is a stratum of dense, naturally deposited, stratified sand, gravel, and silt. Groundwater was encountered at depths ranging from 5.7 to 8.2 feet below existing ground surface. Based on the area geology and surrounding topography, GZA predicted that groundwater flow across the site is generally to the west, toward the Thames River.

- During the field exploration and sampling program, a total of 39 soil samples were collected from the auger borings. Additionally, two waste oil sludge and two waste oil samples were collected from within OT-5. A series of chemical screenings and/or analyses were performed on the samples.

- The results of the chemical screening and analyses performed on the soil samples identified at least two areas of contamination in the soil surrounding OT-5. One area was detected by analyses of a sample collected from a depth of 10 to 12 feet at boring GZ-1, about 4 to 6 feet below the existing groundwater table. The soil sample at this location contained fuel oil and pesticides. Boring GZ-1 is located on the downgradient side of OT-5. The occurrence of petroleum contamination below the groundwater level may indicate that leakage from OT-5 has occurred. The second area of contaminated soil was detected in samples collected from depths of 0 to 2 and 5 to 7 feet at boring GZ-4. The soil samples collected at this location contained fuel oil and pesticides. The sample collected from 0 to 2 feet also contained PCBs. The occurrence of contamination above the groundwater table and the proximity of GZ-4 to the former fill opening and current truck dumping pad suggest that surficial spills have occurred in the past.

- The 3.3 feet of residual material inside OT-5 consisted of three separate layers: floating oil product, water, and sludge/sediments. The floating oil layer was approximately 1 to 2 inches in thickness, and the sludge layer was roughly 6 inches thick; the remainder was water. The sludge thickness was observed to be greater in one of two sump pits located in the floor of OT-5. The waste oil and waste oil sludge were very high in petroleum hydrocarbon content, with measured levels ranging from 110,000 to 540,000 ppm. Aroclor 1260 was detected at concentrations ranging from 36,000 to 650,000 ppb. Several pesticide compounds were also detected. Total organics analysis indicated the presence of the following compounds: methylene chloride, PCE, toluene, ethylbenzene, acetone, 2-butanone (MEK), and total xylenes. Concentrations of these compounds ranged from 7.7 to 52 ppm. The use of detergents to clean the bilges or lower hulls of the submarines serviced at NSB-NLON suggests that emulsified hydrocarbons may have been present in the water layer, in addition to volatiles.

In 1993, the floating product and some tank sludge were removed and incinerated off site as Toxic Substance Control Act (TSCA) waste.

13.2.4 Site Characterization - Waste Oil Tank OT-5 (Halliburton NUS, 1994a)

Halliburton NUS conducted a site characterization in 1994 to collect the necessary data to further determine the environmental impact of OT-5 on the surrounding media and to collect the necessary data to adequately abandon or close the tank. The Site Characterization Report (Halliburton NUS, 1994a) concluded that, based on the analytical results obtained from the investigation, the contents of OT-5 have not significantly affected the subsurface soil below the tank or the underlying groundwater. The majority of soil contamination was detected at a depth of 2 to 4 feet, which is above the tank. With the exception of a single detection of PCE (6 µg/L), no contaminants were detected in the groundwater at concentrations exceeding federal drinking water standards.

During 1994, Halliburton NUS prepared a design for the closure of OT-5. This design included removal and treatment of approximately 710,000 gallons of water and 40,000 gallons of thick sludge. Tank contents have been removed, and the tank has been cleaned. In addition, at the time of the Tank Farm Site Investigation, the tank had been demolished and closed in-place, and the site was backfilled and restored.

13.2.5 Site Characterization - OT-10, Building 325, and Building 89 (Halliburton NUS, 1995)

Sampling activities were conducted in 1995 by Halliburton NUS to characterize the conditions of the soil and groundwater around the waste oil tanks at OT-10, the No. 2 fuel oil tanks at Building 325, and the fuel oil tank at Building 89. Because of the differences in the proposed future use of each tank and the regulatory requirements associated with each, the field activities that were performed at each tank were conducted independently. The OT-10 tanks will be kept in service; therefore, field samples were collected to confirm that the tanks are operating properly and can remain in service.

The samples that were collected were analyzed and the results were summarized and compared to CTDEP cleanup standards in the Site Characterization Report (Halliburton NUS, 1995). Based on the comparisons, it was determined that unacceptable levels of contamination were not detected at OT-10 and, therefore, no remediation is necessary.

13.2.6 Site Investigation for the Tank Farm (B&R Environmental, 1997e)

B&R Environmental conducted an investigation of the Tank Farm during 1995 and 1996. The primary objectives of the investigation were to define the extent of soil and groundwater contamination in the UST farm, evaluate the impacts of the UST farm on the stormwater discharge, and develop preliminary recommendations for remedial action, should it be necessary. To characterize the site, B&R Environmental performed an integrated field investigation consisting of subsurface geophysical surveys, soil borings, monitoring well installation, investigation of underground pipelines, sediment sampling, and surface water sampling.

The results of previous investigations were used to guide the scope of this investigation. In addition, a Site Characterization and Analysis Penetrometer System (SCAPS) investigation and a subsurface geophysical survey were performed prior to the field investigation. The SCAPS investigation was performed by NFESC and the Public Works Center, Jacksonville, Florida. The SCAPS investigation was used to collect real-time analytical data for PAH components of petroleum hydrocarbons using a specially engineered, truck-mounted cone penetrometer system. The system that was used incorporates a laser fluorescent system that excites the electrons of PAHs. When the laser is extinguished, light is emitted as

the electrons return to their normal state. The resulting fluorescent light signal is sent back to the surface, where it is spectrally dispersed, and an examination of the energy is performed. Collected data on spectral wavelengths are then compared to wavelengths associated with standard solutions containing known concentrations of site contaminants.

A geophysical survey was performed to locate the existing storm sewer system. The survey was also used to assist in safe placement of soil borings and groundwater monitoring wells.

When the preliminary field investigation activities were completed, a field investigation was performed from September through November 1995. The field investigation included installation and sampling of soil borings, permanent groundwater monitoring wells, and temporary groundwater monitoring wells. In addition, Geoprobe® soil sampling, surface water, stream sediment, and catch basin sediment sampling were performed.

Based on the results of the 1995 field investigation, several data gaps were identified within the UST farm. In December 1996, B&R Environmental performed additional field investigation activities, including the installation and sampling of soil borings and temporary wells. In addition, test pits were excavated to verify the perimeter location of one tank.

The results of the 1995 and 1996 investigations were compared to state and federal cleanup criteria. Site contaminants that were present above detection limits were compared to the applicable medium-specific cleanup criteria. Each UST, the loading area, the fuel pipeline, and the results of the site-wide investigation were then evaluated to determine if chemicals exist at levels that exceed the cleanup criteria.

The most prevalent COPCs were TPH and inorganics. The presence of inorganics, however, appears to be a result of the type of fill material used to construct the UST farm and of the high background levels throughout the NSB-NLON. Therefore, it was determined that there is no cost-effective means for reducing concentrations of inorganic contamination within the UST farm.

After each site was evaluated, the need for either no further action or for remedial action was determined. The following criteria were used to determine the type of action for each site:

- Detection of COPCs in specific site media
- Requirements for interim remedial action due to immediate human or environmental hazards

No further action was recommended at OT-1, OT-2, OT-3, OT-4, OT-5, OT-6, OT-7, OT-9 and the loading area. OT-8 was found to have free product in one of the associated wells and TPH contamination in the soil and groundwater. Therefore, two options, one consisting of the modification of an existing interim product removal system and a second consisting of the excavation of contaminated soil and product removal, were recommended at OT-8. Excavation and off-site disposal were recommended at two locations on the Upper Subase fuel pipeline system to remediate soil contaminated with TPH.

13.2.7 Hydrogeologic Study at the Tank Farm (TtNUS, 1999a)

TtNUS conducted a hydrogeologic study at the Tank Farm between May 1998 and August 1998. The study was completed to provide information required to complete the design of the replacement storm sewer system for the Tank Farm. This replacement was completed in the Tank Farm area in 2000. The following tasks were completed as part of the study:

- Water-level elevations were measured in the stream east of Building 447.
- Dry-weather groundwater flow rates were measured in the Tank Farm storm sewer system.
- Four bedrock monitoring wells (23MW01D through 23MW04D) were installed in the vicinity of the Tank Farm.
- Two rounds of water levels were measured in the Tank Farm monitoring wells.
- A groundwater flow model (MODFLOW) was developed for the Tank Farm and surrounding area, and the model was used to evaluate existing conditions and potential design scenarios.

13.2.8 Tank Farm Site Investigation Report Addendum (TtNUS, 1999e)

The Tank Farm site in the vicinity of OT-2 and OT-3 was further investigated in 1999 as part of the Tank Farm SI Addendum. The additional investigation was necessary because the Navy detected and identified weathered diesel fuel in the storm sewers in this area subsequent to the Tank Farm SI. Nineteen temporary groundwater monitoring wells were installed on a grid system established within the investigation area during the period of June 10, 1999 to June 14, 1999. Soil samples were collected during the installation of the borings for the temporary wells. The wells were installed and sampled in conjunction with seven existing permanent monitoring wells (i.e., ERM-11, ERM-17, HNUS-4, HNUS-7, FD-1, FD-2, and FD-3).

The soil in the investigation area was sampled and analyzed for BTEX, SVOCs, and TPH. Toluene, ethylbenzene, total xylenes, bis(2-ethylhexyl) phthalate, 16 PAHs, and TPH were detected at various frequencies in the soil samples. The PAH contamination previously identified in the soil by the SCAPs survey north of OT-3 was confirmed by the current investigation. The soil contamination was generally located in the vicinity of HNUS-7, 23TW14, 23TW17, and 23TW18. The volume of contaminated soil was estimated to be approximately 1,070 cubic yards. It was speculated that the contamination was diesel fuel that leaked from the historic diesel fuel lines along Tang Avenue. The contaminated soil was present at depths of approximately 6 to 12 feet below the ground surface, generally in the region just above and below the water table.

The groundwater in the investigation area was sampled and analyzed for BTEX and SVOCs. BTEX compounds were detected at various frequencies in the seven wells that were sampled, but all the concentrations of BTEX compounds were below the applicable screening criteria. Nine PAHs were also detected in the groundwater samples collected during the Tank Farm SI Addendum.

Two rounds of free-product measurements were taken in the wells. Trace amounts of floating product were detected in three wells (23TW14, FD-1, and FD-2). Free-product samples were collected from FD-1 and 23TW14 and were analyzed for GRO, DRO, and fingerprint analysis. The results of the analysis indicated that the free product in 23TW14 is diesel fuel. The analyses completed on the product sample from FD-1 did not identify the type of product. The presence of water in the sample from FD-1 may have impacted the results of the analysis.

The following conclusions were reached from the investigation:

- No BTEX compounds were identified as COCs; therefore, it seems as though the AS/SVE is addressing the BTEX plume associated with the NEX Gas Station.

- The free product detected in 23TW14 was identified as diesel fuel. The volume of free product floating on the water table was estimated to be approximately 20 gallons. It is likely that the product is from the historical diesel fuel lines along Tang Avenue. The two PAH COCs identified in the groundwater at 23TW14 and 23TW18 are most likely related to diesel fuel.

- The groundwater sink in the vicinity of HNUS-7 may be related to the ring drain that is present around OT-3. This sink may be causing contaminated groundwater and free product to migrate horizontally towards HNUS-7 and vertically to the storm sewer system. The storm sewer system discharges directly to the Thames River.

- The RAC should complete a remedial action to address the free product and the groundwater PAH COCs identified in the investigation area during the Tank Farm storm sewer rehabilitation project in the fall of 1999.

13.2.9 Preliminary Results from Tank Farm Dewatering System

The Tank Farm storm sewer system was rehabilitated and the contaminated soil and free product encountered during the Tank Farm Site Investigation Addendum were addressed by the Navy's Remedial Action Contractor (RAC). As part of the rehabilitation, the deep groundwater collection system and the storm sewer system were separated. Since the project was completed, the Navy has sampled and analyzed the groundwater that is collected by the system. Preliminary analytical results from the program are provided in the Site 23 subsection of Appendix B. The results show that high levels of suspended solids were present in the groundwater shortly after construction activities were completed resulting in high concentrations of metals. However, the latest round of results indicates that suspended solids concentrations have decreased significantly and metals concentrations are similar to background groundwater concentrations. In addition, the results show that only low-concentrations of fuel-related compounds have been detected during the sampling rounds. Flow rate data for the collection system are also provided in Appendix B. Daily flow rates through the system have ranged from approximately 75,000 to 122,000 gallons per day.

13.2.10 Basewide Groundwater OU RI

During the BGOURI, both soil and groundwater samples were collected from Site 23 to further characterize the site. Two new deep overburden monitoring wells (23MW02S and 23MW04S) were installed during the investigation. Two soil samples were collected during boring activities for the wells and analyzed to determine the soil's characteristics for groundwater fate and transport modeling purposes. The samples were analyzed for bulk density, porosity, pH, and TOC, and the results are provided in Appendix B. The methodology used to complete soil sampling was discussed in Section 2.2.

Seven overburden and three bedrock permanent monitoring wells were sampled during the RI. A summary of the sampling and analytical program for these wells is presented in Table 13-1. The analytical program for the Site 23 wells included natural-attenuation-specific parameters. The 10 monitoring wells that were sampled are shown on Figure 13-1. A field duplicate was also collected from monitoring well 23MW02D. Samples from two of the 10 monitoring wells were filtered in the field and analyzed for dissolved metals. The methodology used to complete groundwater sampling was discussed in Section 2.3.

13.3 PHYSICAL CHARACTERISTICS

This section presents a summary of physical characteristics for the Tank Farm based on information generated during the site investigation for the Tank Farm and the BGOURI. Topography and surface features, surface water, soils, geology, and hydrogeology are discussed in the following subsections.

13.3.1 Topography and Surface Features

At NSB-NLON, the bedrock highs slope downward to two small, west-trending valleys. Bedrock outcrops are prevalent along steep topographic slopes. In addition to the large bedrock highs, there are several small sub-ridges are visible as bedrock outcrops at the facility.

In the southern valley, the ground elevation slopes mildly from approximately 50 feet in the eastern portion to near sea-level along the Thames River. Historically, in the area of the Tank Farm, there was a topographic depression at the former Crystal Lake between Tang Avenue and Crystal Lake Road. The topographic depression was filled during construction of the Tank Farm. Surface elevations at the Tank Farm range from 18 to 25 feet msl. Figure 1-3 shows surface topography at the Tank Farm.

13.3.2 Surface Water

Due to the cover material and topography of the Tank Farm, a majority of the rain that falls on this site will infiltrate into the ground. Groundwater at this site is collected by a dewatering system. Surface runoff from some portions of the site is collected by a stormwater collection system. Both groundwater and surface water collected by the systems discharge to the Thames River at the Goss Cove Landfill.

13.3.3 Soil Characteristics

The United States SCS soils map of NSB-NLON (SCS, 1983) classifies the soils at the Tank Farm as Udorthents-Urban land. The Udorthents-Urban land is defined as excessively to moderately drained soils that have been disturbed by cutting and filling.

13.3.4 Geology and Hydrogeology

Geology

The predominant geology observed during the Tank Farm Site Investigation was fill and re-worked soils. These soils were generally silty, fine- to medium-textured sands with trace amounts of rock fragments present. These soils were typically classified as SM under the Unified Soil Classification System. Soil color varied from shades of brown to gray, and soil density was variable.

Below the fill deposits are natural alluvium consisting primarily of silty sand. The thickness of the alluvium is variable. In the western portion of the site, the alluvium extends to a depth of over 50 feet.

Four bedrock monitoring wells were installed in the vicinity of the Tank Farm during the hydrogeologic investigation that was conducted in 1998. The depth to bedrock encountered during the installation of these wells varied between 15 feet and 58 feet, depending on location. The greatest depths to bedrock were encountered in wells 23MW01D and 23MW04D along the eastern and western boundaries, respectively, of the Tank Farm. The shallowest depths to bedrock were encountered in wells 23MW02D and 23MW03D in the central portion of the Tank Farm, along its northern and southern boundaries, respectively.

Figure 4-16 is a geologic cross section that includes the Tank Farm.

Hydrogeology

Groundwater is present in both the overburden and bedrock underlying Site 23. Six comprehensive rounds of water-level measurements (November 1995, December 1996, May 1998, August 1998, June 2000, and August 2000) have been taken in the Tank Farm overburden monitoring wells. Figure 1-5 shows the shallow overburden potentiometric surface that was created using the November 1995 water levels. Figures 4-12 and 4-14 show groundwater flow patterns in the shallow overburden across Site 23, based on the June and August 2000 rounds of water-level measurements (see Tables 2-2 and 2-3). Figures 4-13 and 4-15 show groundwater flow patterns for the shallow bedrock during the same time periods. Previously inferred bedrock groundwater contours are shown on Figure 1-6.

The figures show that shallow overburden groundwater generally flows into the central area of Site 23, then to the west toward the Thames River. The flow pattern reflects the presence of the tank underdrain system and the groundwater collection system in this area, both of which act as groundwater sinks (collection points). The shallow groundwater flow gradient varies widely across the site but averages about 0.01.

For the bedrock, groundwater flow is generally to the west and southwest. The Tank Farm underdrains and groundwater collection system that have a significant influence on shallow groundwater flow patterns do not affect the bedrock groundwater flow directions to any significant degree. The flow gradient in the bedrock averages about .014 across Site 23.

Rising-head slug tests were performed in seven overburden (fill materials) monitoring wells (HNUS-4, HNUS-8, HNUS-12, HNUS-18, HNUS-22, 23MW02S, and 23MW04S) and two bedrock wells (23MW02D

and 23MW04D). The data were analyzed using the Hvorslev Method. The resulting hydraulic conductivities ranged from 0.9 ft/day (23MW02S) to 6.76 ft/day (HNUS-22) for overburden wells, with an average hydraulic conductivity of 2.3 ft/day. For bedrock wells, the hydraulic conductivities were 0.73 ft/day (23MW04D) and 652 ft/day (23MW02D). The huge range is typical of the difference between highly transmissive bedrock fractures and less transmissive fractures.

Using an average gradient of 0.01, an average hydraulic conductivity of 2.3 ft/day, and an assumed porosity of 0.3, the average groundwater flow velocity in the overburden is approximately 0.8 ft/day. The two laboratory-measured porosities (i.e., 0.42 and 0.47) for the Tank Farm were considered too high and were not used for the calculation.

13.4 NATURE AND EXTENT OF CONTAMINATION

This section presents an evaluation of the nature and extent of groundwater contamination at Site 23. The discussion includes historical soil and groundwater data collected during the site investigation at the Tank Farm (B&R Environmental, 1997e) and groundwater (total and dissolved) data collected during the BGOURI. Groundwater and soil sample locations are shown on Figure 13-1.

13.4.1 Historic Site Investigation

Soil, overburden groundwater, surface water, and sediment sampling was conducted at the Tank Farm during the Site Investigation at the Tank Farm (B&R Environmental, 1997e). Based upon the results of the aforementioned investigation, the nature and extent of contamination of the soil and groundwater at the Tank Farm are discussed on a matrix-specific basis in the following subsections.

13.4.1.1 Soil

Several VOCs, including one ketone, four monocyclic aromatics, four chlorinated aliphatics, and carbon disulfide, were detected in the Tank Farm soil samples. With the exception of methylene chloride, the aforementioned VOCs were infrequently detected (i.e., approximately 10 percent of the samples). Methylene chloride, which is a common laboratory contaminant, was detected at concentrations ranging from 0.003 mg/kg to 0.009 mg/kg.

Four monocyclic aromatic compounds were detected at relatively high concentrations but at various sample locations and various depths. Benzene was detected at a maximum concentration of 0.0335 mg/kg. Ethylbenzene was reported at maximum concentration of 0.4 mg/kg, and total xylenes were reported at a maximum concentration of 0.656 mg/kg. The data suggest that contamination is spread across the site and may not be related to a specific tank.

Twenty-five SVOCs were detected in the Tank Farm soil samples; 15 of these SVOCs were PAHs. Maximum concentrations of 11 of these 15 PAHs were detected in the soil sample collected from a depth interval of 4 to 6 feet bgs from location HNUS-24. Maximum concentrations of PAHs ranged from 0.021 mg/kg (acenaphthylene) to 1.7 mg/kg [benzo(a)pyrene]. 2-Methylnaphthalene, 4-chloro-3-methylphenol, benzoic acid, di-n-butyl phthalate, di-n-octyl phthalate, diethyl phthalate, dimethyl phthalate, and dibenzofuran were also each detected in from one to eight samples. Bis(2-ethylhexyl) phthalate was detected in 12 of 36 samples collected.

Eight pesticides were detected in the Tank Farm soil samples. Maximum detected concentrations were associated with sample locations HNUS 23 and 24. These two borings were located very close to (less than 50 feet from) Crystal Lake Road. 4,4'-DDT and 4,4'-DDE were the most frequently detected pesticides (detected in six and five out of 33 soil samples, respectively). The remaining pesticides and PCBs were detected in from one to three soil samples. 4,4'-DDT was detected at a maximum concentration of 0.11 mg/kg.

Twenty-two metals and cyanide were detected in the Tank Farm soil samples. Nine of these metals were detected in 36 out of 36 soil samples and four other metals were detected in 35 out of 36 samples. Maximum concentrations of 10 metals were detected in the soil sample collected from a depth interval of 19 to 21 feet from boring OT-S004. The entire Tank Farm was constructed on fill material.

13.4.1.2 Groundwater

Appendix D presents descriptive statistics and associated screening criteria for each analyte detected at least once in groundwater samples collected from Site 23.

Overburden Wells

Twelve VOCs, including four monocyclic aromatics, six chlorinated aliphatics, one ketone, and methyl-tert-butyl-ether, were detected in the groundwater samples collected from overburden wells. The reported concentrations of most of these VOCs were relatively low, ranging from 1 µg/L to 18 µg/L. However, reported concentrations of the monocyclic aromatics (benzene, ethylbenzene, toluene, and total xylenes) ranged from 0.5 µg/L (benzene and total xylenes) to 4,810 µg/L (total xylenes). The maximum concentrations of these chemicals were associated with groundwater samples collected from wells ERM-14 and ERM-15, which are located near the intersection of Flier Avenue and Tang Avenue.

As shown on Appendix D, 16 SVOCs were detected in the groundwater samples collected from Tank Farm overburden wells. Various classes of SVOCs, including PAHs and phthalates, as well as

2,6-dinitrotoluene, 2-methylnaphthalene, carbazole, and dibenzofuran, were detected. In general, SVOCs were infrequently detected (detected in from one to four samples out of a total of 27 samples) at relatively low concentrations. Concentrations of all but four SVOCs (2-methylnaphthalene, fluorene, naphthalene, and phenanthrene) ranged from 0.5 µg/L to 16 µg/L. The concentrations of the four aforementioned SVOCs ranged from 0.7 µg/L to 740 µg/L.

Heptachlor was detected at a concentration of 0.05 µg/L in one groundwater sample collected from temporary well SB/TW-7. No other pesticides or PCBs were detected in any of the groundwater samples collected from the overburden wells at the Tank Farm.

Twenty-one metals were detected in the unfiltered groundwater samples collected from the Tank Farm overburden wells, and 13 metals were detected in the associated filtered groundwater samples. In general, reported concentrations of metals in filtered and unfiltered samples were relatively similar (i.e., at the same order of magnitude). Exceptions to this statement include reported results for aluminum, chromium, copper, iron, and zinc. Maximum concentrations of all metals except aluminum, barium, chromium, copper, iron, manganese, mercury, potassium, silver, sodium, and zinc in filtered samples and of copper, lead, and zinc in unfiltered samples exceeded respective concentrations of these metals detected in unfiltered samples collected from off-site residential wells. A majority of the maximum concentrations were associated with samples collected from wells TW-6 and OT-GW04.

DRO, GRO, and TPH were also detected in the overburden groundwater samples. DRO was detected in eight out of eight samples analyzed, at concentrations ranging from 210 to 2,800 µg/L. GRO was detected in six out of eight samples, at concentrations ranging from 10 to 140 µg/L. TPH was detected in 17 out of 89 samples analyzed, at concentrations ranging from 500 to 4,920,000 µg/L.

Analyses for several general chemistry parameters, including chloride, methane, nitrite, sulfate, and TOC, were also performed for selected groundwater samples collected from the Tank Farm overburden wells. Analytical results for these parameters are summarized in Appendix D

13.4.2 Basewide Groundwater OU RI

A summary of the BGOURI sampling and analytical program for Site 23 is presented in Table 13-1. A complete summary of the Site 23 analytical data set is provided in Appendix B. Table 13-2 presents a summary of positive groundwater (total and dissolved) analytical results for Site 23. The soil samples collected during the BGOURI were analyzed for miscellaneous parameters in support of modeling efforts and are not discussed as part of the nature and extent of contamination.

As part of the HHRA, descriptive statistics (i.e., frequency of detections, minimum and maximum concentrations, range of detection limits, and the associated sample numbers) and the COPC screening criteria for each analyte detected at least once in groundwater at the Tank Farm were tabulated. Analytical results for groundwater are summarized and screened in Tables 13-6 and 13-7. Different exposure scenarios (i.e., direct exposure and migration) are considered in each table. Tag maps of the chemicals determined to be COPCs based on the screening assessment were created to show the horizontal extent of contamination. Figures 13-2 and 13-3 show COPCs that exceeded direct exposure or migration screening criteria. The analytical detection limit for COPCs is presented on the tag maps if the COPC was not detected in a sample.

Overburden Wells

Xylenes were the only VOCs detected and these were present only in sample S23MW02S01. Concentrations of these compounds were below direct contact criteria and CTDEP pollutant mobility criteria.

Naphthalene was the only SVOC detected and it was detected in only sample S23MW02S01. Naphthalene was detected at a concentration of 1.4 µg/L, which is greater than the direct contact criterion of 0.62 µg/L but is below the CTDEP the pollutant mobility criterion.

No pesticide compounds were detected in the overburden groundwater samples at Site 23.

Sixteen total inorganics were detected in the overburden groundwater samples collected from Site 23. The maximum detected concentration of 13 of the 15 detected metals were found in sample S23MW02S01. Calcium, magnesium, manganese, potassium, and sodium were the only metals detected in all seven overburden groundwater samples. The remaining metals were detected much less frequently. The only metals detected above background concentrations were arsenic, cadmium, nickel, and lead. Of these metals, only the maximum detected concentration (31.2 µg/L S23MW02S01) of lead was in excess of both direct contact criteria and CTDEP pollutant mobility criteria. Additionally, the only detection of arsenic (4.7 µg/L S23HNUS1101) was in excess of the CTDEP pollutant mobility criteria. Cadmium and nickel were both only detected in sample S23MW02S01, and their respective concentrations were below both direct contact criteria and CTDEP pollutant migration criteria. It should be noted that the TDS and TSS content in sample S23MW02S01 were higher than in any other samples. This could potentially impact the concentrations of metals in this sample.

Samples S23HNUS201-F and S23MW02S01-F were filtered and analyzed for dissolved metals. Barium, magnesium, manganese, potassium, and sodium were detected in both samples. Arsenic and lead were also detected but only in sample S23MW02S01-F. Arsenic, barium, and lead were present at

concentrations in excess of filtered background values. However, the concentrations of arsenic, barium, and lead were below both direct contact criteria and CTDEP pollutant mobility criteria.

The maximum detected concentrations of xylenes, naphthalene, and metals were all detected in well S23MW02S. This well is located on the northeastern side of tank OT-7.

Bedrock Wells

PCE was the only VOC detected in the three bedrock groundwater samples collected. PCE was detected only in sample S23MW03D01 at a concentration of 3 µg/L, which is in excess of direct contact criteria but below CTDEP pollutant mobility criteria. PCE was not detected in overburden groundwater samples.

No semivolatiles or pesticides were detected in the bedrock groundwater samples at Site 23.

Eleven inorganics were detected in the bedrock groundwater samples collected from Site 23. The maximum detected concentration of seven of these 11 detected metals were found in sample S23MW03D01. This well is located approximately 120 feet north of tank OT-3. Calcium, cobalt, iron, potassium, and sodium were the only metals detected in all three bedrock groundwater samples. Concentrations of all the detected metals were below background, direct contact criteria, and CTDEP pollutant migration criteria.

13.5 CONTAMINANT FATE AND TRANSPORT

13.5.1 Chemical-Specific Evaluation

Five classes of chemicals were detected in groundwater at Site 23 in the BGOURI: monocyclic aromatics, halogenated aliphatics, dissolved gases (methane), PAHs, and metals. These classes were also detected in groundwater in previous investigations at the site. However, acetone, methyl tert-butyl ether, phthalates, one pesticide (heptachlor), and 2,6-dinitrotoluene were detected in groundwater in the previous investigations but not in the BGOURI.

Monocyclic Aromatic Compounds

One fuel-related monocyclic aromatic compound (i.e., xylenes) was detected in 1 of 10 shallow groundwater samples in the 2000 remedial investigation at concentrations well below screening levels (2 to 5 µg/L). This contrasts significantly with the results of previous investigations in which other monocyclic aromatics (e.g., benzene) were detected at much higher concentrations. Monocyclic aromatics were also detected in soil in previous investigations. Monocyclic aromatic compounds are not considered to be persistent in the environment, particularly in comparison to chemicals such as PCBs and

PAHs. They may migrate through the soil column when solubilized by infiltrating precipitation. Some portion of these chemicals is retained by the soil, but most of them will continue migrating downward until they reach the water table. Bioconcentration in aquatic animals is not expected to be significant for monocyclic aromatics. They are subject to degradation via the action of both soil and aquatic microorganisms. Although these compounds are amenable to microbial degradation, it is not anticipated that degradation will occur at an appreciable rate. Based on the area geology and surrounding topography, the groundwater flow across the site is generally to the west, toward the Thames River. In surface water, xylenes are not expected to adsorb to sediment or particulate matter. This compound is expected to volatilize from water surfaces, given its experimental Henry's Law constant. Estimated half-lives for a model river and model lake are 3 and 99 hours, respectively. The potential for bioconcentration in aquatic organisms is low based on an estimated BCF values.

Halogenated Aliphatics

One halogenated aliphatic (PCE) was reported in one bedrock groundwater sample collected in the BGOURI at a concentration of 3 µg/L. PCE was detected in 5 of 37 groundwater samples (maximum concentration = 10 µg/L) and 1 of 36 soil samples (11 µg/kg) in previous investigations at the site. Halogenated aliphatic hydrocarbons such as PCE are relatively water soluble and have a low capacity for retention by soil organic carbon and, therefore, PCE is frequently detected in groundwater. PCE may migrate through the soil column after being released by a spill event or by a subsurface release when solubilized by infiltrating precipitation. Some portion of PCE may be retained by the soil, but most of the chemical will continue migrating downward until it reaches the water table. At that time, migration is primarily lateral with the hydraulic gradient. Since groundwater flow across the site is toward the Thames River, PCE in groundwater may migrate to the river. If PCE is released to water, it will be subject to rapid volatilization, with estimated half-lives ranging from less than 1 day to several weeks. It will not be expected to significantly biodegrade, bioconcentrate in aquatic organisms, or significantly adsorb to sediment. PCE will not be expected to significantly hydrolyze in soil or water under normal environmental conditions.

It is unlikely that appreciable degradation of halogenated aliphatics has occurred at Site 23 because PCE has been only detected in a few samples. Two potential degradation products of PCE, 1,1,1-TCA and 1,1-DCA, were detected in the previous investigations in a few samples but no degradation products were detected in on-site groundwater samples in the BGOURI.

Polynuclear Aromatic Hydrocarbons (PAHs)

One low-molecular-weight PAH, naphthalene, was detected in one of 10 groundwater samples at Site 23 at a concentration of 1.4 µg/L. Low-and high-molecular-weight PAHs were detected in soil and

groundwater in previous investigations at low frequencies. For example, naphthalene was previously detected in 4 of 27 groundwater samples, as reported in the Existing Data Summary Report for the site (TtNUS, May 1999c). The presence of naphthalene and other PAHs in groundwater at the site is evidence of releases of petroleum products from the tanks and their associated piping. PAHs are generally considered to be fairly immobile in the environment. As noted in Section 3.3, PAHs have very low solubilities, vapor pressures, and Henry's Law constants and high K_{oc}s and K_{ow}s. The low-molecular-weight PAHs (e.g., acenaphthene, anthracene, fluorene, naphthalene, and phenanthrene) are more mobile (higher solubilities, etc.) than the high-molecular-weight PAHs [e.g., benzo(a)pyrene, benzo(a)anthracene, chrysene, etc.]. PAHs in soil are much more likely to bind to soil and be transported via mass transport mechanisms than go into solution. However, naphthalene is expected to be only adsorbed moderately to soil and to undergo biodegradation. Naphthalene is more water soluble than most other PAHs (Table 3-5) and is, therefore, more likely to exist in the dissolved phase and to move with groundwater. In groundwater, biodegradation may occur if conditions are aerobic. If naphthalene migrated to the Thames River, it would be expected to be lost by various processes, including volatilization, photolysis, adsorption, and biodegradation. The principal loss processes depend on local conditions, but half-lives can be expected to range from a couple of days to a few months. When adsorbed to sediment, biodegradation generally occurs much more rapidly than in the overlying water column. Based on a BCF of 420 (Table 3-5), bioconcentration is expected to occur to a moderate extent but, since depuration and metabolism readily proceed in aquatic organisms, this is expected to be a short-term problem (TOXNET, December 2000). If released to the atmosphere, naphthalene rapidly photodegrades (half-life of 3 to 8 hours).

Metals

Seventeen metals were detected in groundwater samples at Site 23 in the BGOURI. The list of detected metals is similar to that of previous investigations except that beryllium, selenium, and silver were detected in past investigations but not in the 2000 samples. The concentrations of metals in the BGOURI were generally lower than those of previous investigations. As noted in Section 3.3, metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. The major fate mechanisms for metals are adsorption to the soil matrix (as compared to being part of the soil structure) and bioaccumulation.

In addition, under normal conditions, metals are not very mobile in the environment. Because metals frequently remain bound to particulate matter, the major transport mechanism for metals is bulk movement processes (erosion). However, metals can become mobile in the environment under certain conditions. The mobility of metals is influenced primarily by their physical or chemical properties in conjunction with the physical and chemical properties of the soil matrix. Factors that assist in predicting the mobility of metals are the soil/pore water pH, REDOX potential, and cation exchange capacity. The

mobility of metals generally increases with decreasing soil pH and cation exchange capacity. The effect of REDOX potential varies for each metal.

Groundwater samples S23MW02S01 and S23HNUS201 were analyzed for total metals and nine dissolved metals (antimony, arsenic, barium, calcium, magnesium, manganese, potassium, sodium, and vanadium). A comparison of the total and dissolved concentrations indicates that there was little difference between the total and dissolved concentrations for these metals, with the possible exception of calcium (unfiltered = 94,100 µg/L, filtered = 45,100 µg/L) and lead (unfiltered = 31.2 µg/L, filtered = 10 µg/L). These data indicate the metals detected in these samples are more likely to be in the dissolved phase rather than bound to particulate matter.

13.5.2 Natural Attenuation Evaluation

This section contains the site-specific natural attenuation evaluation. The procedure used to conduct the evaluation is summarized in Section 3.3.4. This evaluation is preliminary, and it is understood that additional data collection activities and data evaluation would be necessary before monitored natural attenuation is selected as a remedial alternative.

As stated in Section 3.3.4, the goals of the assessment are as follows:

- To determine if natural attenuation of petroleum and chlorinated hydrocarbons is currently occurring in the groundwater.
- To determine the process by which natural attenuation is occurring in the groundwater.
- To determine if natural attenuation and/or bioremediation are viable processes for remediation of petroleum and chlorinated hydrocarbons in the groundwater.

The three lines of evidence that can be used to estimate natural attenuation of petroleum and chlorinated hydrocarbons are as follows:

- Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points.
- Hydrogeological and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the site and the rate at which such processes will reduce contaminant concentrations to required levels.

- Data from field or microcosm studies that directly demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern.

The first and second lines of evidence are used to assess natural attenuation in this RI. The following natural attenuation evaluation is segregated into three subsections (i.e., hydrogeology, chemicals of concern, and geochemical). These three subsections provide the necessary information to prove or disprove that natural attenuation is occurring via the two lines of evidence discussed above. The results of the assessment are summarized in the conclusions section (13.5.2.2).

13.5.2.1 Evaluation

Hydrogeology

Hydrogeological data are important in natural attenuation assessments to show groundwater flow directions and possible contaminant migration pathways from source areas to downgradient receptors. The data can also be incorporated into a groundwater contaminant fate and transport model to predict the effects of natural attenuation in the future. For this assessment, the data will only be used to show groundwater flow directions and possible contaminant migration pathways.

Two rounds of water-level measurements were taken at select monitoring wells in the Southern Region during this RI. Measurements were taken in overburden and bedrock monitoring wells. The measurements were used to create potentiometric surface maps for the overburden and bedrock aquifers. Figures 4-12 and 4-14 depict the June 2000 and August 2000 overburden potentiometric surface maps, respectively. Figures 4-13 and 4-15 depict the June 2000 and August 2000 bedrock potentiometric surface maps, respectively.

From the figures, it is evident that the overall groundwater flow direction is from east to west toward the Thames River. The overburden maps show that groundwater flow from the south and north becomes channelized and flows in an east-west direction toward the Thames River. This flow pattern may be the result of the underdrain system present within the Tank Farm and/or geological conditions present prior to the construction of the Tank Farm. The Tank Farm was constructed on the bed of the former Crystal Lake.

Another observation that can be made from the figures is that water levels were generally higher in June 2000 than in August 2000. Water levels were measured in several overburden/bedrock well clusters during August 2000. There is a downward gradient in monitoring well cluster 23MW02S/D and an upward gradient in 23MW01S/D and 23MW04S/D.

In addition to the contaminant sources located within the Tank Farm (i.e., former USTs and product transfer lines), there are three potential contaminant sources located upgradient of the Tank Farm: SASDA, NEX Gas Station, and Solvent Storage Area (Building 33). Another contaminant source, Fusconi Dry Cleaners, is located downgradient of the Tank Farm. Previous investigations have shown that the Dry Cleaners is the source of the PCE that has been detected in Goss Cove Landfill monitoring wells. Goss Cove is located downgradient of the Tank Farm and Fusconi Dry Cleaners. The locations of all these source areas are shown on Figures 1-2 and 10-1.

Chemicals of Concern

Analytical data for groundwater samples are summarized in Table 13-2. Groundwater COPCs for the Tank Farm are depicted on Figure 13-2 (overburden) and Figure 13-3 (bedrock). From the table and figures, it can be seen that tetrachloroethene, xylenes, and naphthalene were the only compounds detected in groundwater that are susceptible to biodegradation. These compounds were detected at low frequency (1 out of 10) and at low concentrations (i.e., below or slightly above risk-based screening criteria). This information does not indicate that there is a significant existing source of contamination to groundwater or a contaminant plume present in the groundwater within the Tank Farm.

Because natural attenuation results from the effects of several processes, including adsorption, dispersion, dilution, chemical stabilization, etc., metals can also be considered during natural attenuation assessments. However, for this RI, only organic contaminants are being evaluated for natural attenuation.

Historical groundwater analytical results (Appendix D) for the Tank Farm show that PCE, xylenes, and naphthalene were previously detected more frequently and at higher concentrations in groundwater samples. This information suggests that contaminant concentrations are decreasing with time. It is important to note that the Navy has completed remedial actions [i.e., contaminated soil and free-product (fuel oil) removal near former UST OT-8, soil removal along Tang Avenue, and contaminated soil and free-product (fuel oil) removal near former OT-3 and along the historical storm sewer system] at this site. An AS/SVE system has operated within the boundary of this site to remediate BTEX plumes from the upgradient NEX Gas Station site. It is likely that the decreasing contaminant concentrations are the result of both the active remedial actions and natural attenuation processes.

Analytical data from the SASDA site, which is located upgradient of the Tank Farm site, show that TCE was detected in 3 of 4 samples at concentrations ranging from nondetect to 16 µg/L. This chlorinated solvent is susceptible to biodegradation via reductive dechlorination. This compound was not detected in any of the groundwater samples collected during historical sampling efforts at the SASDA, and no

daughter products were detected during current or historical sampling events above detection limit. TCE was also not detected during historical or current sampling efforts at the Tank Farm; therefore, TCE does not seem to be impacting the Tank Farm groundwater. Although not evident, natural attenuation processes must be attenuating the TCE before it reaches the Tank Farm.

Daughter products of PCE or TCE were not detected above detection limit in groundwater samples collected at the Tank Farm. This indicates that biodegradation via reductive dechlorination is not occurring at detectable levels at this site.

Geochemical

The analytical results for the geochemical parameters collected for this natural attenuation assessment are summarized in Table 4-3. The sample numbers for the Tank Farm begin with "S23." Tag maps of the significant geochemical parameters were also prepared and are presented on Figures 4-31 through 4-42.

Dissolved oxygen concentrations ranged from nondetect to 5.0 mg/L. Dissolved oxygen concentrations indicative of anaerobic conditions were detected in monitoring wells HNUS-11, HNUS-13, and 23MW02S. The dissolved oxygen concentrations detected in monitoring wells HNUS-2 and HNUS-5 were slightly above the criteria for anaerobic conditions (i.e., 0.5 mg/L). The dissolved oxygen concentrations in bedrock wells indicate that groundwater is aerobic. Low dissolved oxygen concentrations correspond with the detection of organic contaminants in 23MW02S. However, no organic contaminants were detected in the other monitoring wells with low dissolved oxygen. Because no contaminant plume was detected, it is difficult to determine a trend in the dissolved oxygen concentrations relative to natural attenuation processes. One variable that could be affecting the evaluation is the limited number of wells included in the natural attenuation assessment.

REDOX potentials measured in Site 23 groundwater ranged from –122 mV to 172 mV. REDOX potentials indicative of anaerobic, reductive conditions were measured in groundwater at monitoring wells HNUS-2, HNUS-5, HNUS-11, 23MW02S, and 23MW03D. With the exception of 23MW03D, this list of wells correlates well with the list of wells with low dissolved oxygen concentrations. Therefore, it is likely that reductive conditions exist at these wells. The cause of the reductive conditions at 23MW02S and 23MW03D may be biological activity related to the low levels of organic contamination detected at these wells. The reductive conditions may also be the result of natural conditions (e.g., a thick organic peat layer was encountered during the soil removal action near the former UST OT-8).

Nitrate concentrations detected in Tank Farm groundwater samples ranged from nondetect to >0.55 mg/L. Nitrate was not detected in monitoring wells HNUS-2, HNUS-11, and 23MW02S. Nitrite concentrations ranged from nondetect to 0.028 mg/L. Nitrite was detected in samples from both

overburden and bedrock monitoring wells (Overburden - HNUS-20 and 23MW04S; Bedrock - 23MW02D, 23MW03D, and 23MW04D). Ammonia concentrations ranged from nondetect to 6.9 J mg/L. Ammonia was detected in all but one of the monitoring wells (i.e., 23MW03D) that were sampled. Based on the low concentrations of nitrate and the positive detections of nitrite and ammonia, it appears that denitrification is occurring within the Tank Farm.

Divalent iron [Iron (II)] was detected in 6 of 10 monitoring wells in the Tank Farm. The concentrations ranged from 0.7 mg/L to 6.2 mg/L. Iron reduction is occurring in the vicinity of monitoring wells HNUS-2, HNUS-11, and 23MW02S. These wells also had low dissolved oxygen concentrations and negative REDOX potentials, which confirms that reducing conditions are present in Tank Farm groundwater. Based on the detection of low levels of divalent iron, iron reduction may also be occurring in the vicinity of monitoring wells HNUS-5 and 23MW02D.

Soluble manganese [Mn (II)] was detected in groundwater samples from the Tank Farm, indicating that manganese reduction is occurring. Significant concentrations of soluble manganese were detected in monitoring wells HNUS-2, HNUS-11, and 23MW02S. As discussed above, other variables indicative of a reducing environment were also detected in these same wells.

Analytical data do not suggest that sulfate reduction is a significant biodegradation process that is occurring within the Tank Farm groundwater. Sulfate concentrations ranged from 7.6 mg/L to 47.2 mg/L. Sulfide was not detected in any groundwater sample, and hydrogen sulfide was only detected in one sample (i.e., HNUS-5 at 1 mg/L).

Significant concentrations of methane (i.e., approximately 200 µg/L) were detected in samples from monitoring wells HNUS-2, HNUS-11, and 23MW02S. Concentrations in these wells ranged from 150 µg/L to 920 µg/L, and concentrations in the remaining wells ranged from nondetect to 21 µg/L. These data suggest that methanogenesis is occurring in the groundwater in the vicinity of these wells. Carbon dioxide measurements were generally uniform in all Tank Farm wells, ranging from nondetect to 200 mg/L, with most concentrations between 25 mg/L and 85 mg/L. Low carbon dioxide concentrations did not correlate with high methane concentrations as is expected during methanogenesis. This may indicate that there is an ample supply of carbon dioxide to fuel methanogenesis. One anomalous carbon dioxide concentration (>2,500 mg/L) was measured in 23MW03D. This result is likely the result of poor monitoring well construction versus natural conditions.

Ethane and ethene, which are end products of dechlorination of chlorinated solvents, were not detected in any groundwater samples collected at the Tank Farm. This information correlates with the limited, low-level detection of a parent chlorinated solvent (tetrachloroethene) in the Tank Farm groundwater and no

detections of daughter products (i.e., TCE, 1,2-DCE, or vinyl chloride). These data suggest that, despite conditions that are amenable to reductive dechlorination, definitive evidence of complete dechlorination is missing.

Chloride concentrations ranged from 6.55 mg/L to 124 mg/L. The highest concentrations of chloride were detected in HNUS-2, HNUS-11, and 23MW02S. As discussed above, other variables indicative of a reducing environment were also detected in these same wells. However, no significant sources of chlorinated solvents were detected in the vicinity of these wells that would correlate with reductive dechlorination occurring at them. Therefore, this information is inconclusive.

The pH of the Tank Farm groundwater was slightly acidic, with values ranging from 5.56 to 6.74. This range is similar to values measured in background wells 23MW01S and 23MW01D and are within the optimal range for bioactivity. Alkalinity and pH values correlated well throughout the Tank Farm. Higher values of pH and alkalinity were detected in monitoring wells HNUS-2, HNUS-11, and 23MW02S. Available data indicate that biological activity is probably occurring in these wells. Lower pH and alkalinity values were detected in remaining wells where biological activity is probably not occurring at significant levels. One anomalous pH value (i.e., 11.72) was measured in monitoring well 23MW03D. As discussed above, this value is most likely the result of poor monitoring well construction versus natural conditions. Upgradient of the Tank Farm, a pH of 4.44 was measured in the SASDA monitoring well 15MW2S. This pH suggests that there is residual contamination still remaining at the SASDA.

TOC concentrations in the groundwater at the Tank Farm ranged from 1 mg/L to 9 mg/L. These concentrations do not suggest that a significant source of natural or anthropogenic carbon is present in the groundwater.

13.5.2.2 Conclusion

Groundwater analytical results from this RI do not suggest that there are significant amounts of petroleum or chlorinated hydrocarbons present in the groundwater at the Tank Farm. Low concentrations of PCE, xylenes, and naphthalene were detected at low frequency in the groundwater samples.

Hydrogeological data were used sparingly during the assessment because of the lack of contaminant plume(s) or source area(s). The hydrogeologic and chemical data show that upgradient source areas do not seem to be impacting the Tank Farm groundwater.

The geochemical data collected during the RI indicate that biodegradation processes are occurring in the groundwater, most notably in the vicinity of monitoring wells HNUS-2, HNUS-11, and 23MW02S. The processes that are occurring include denitrification, iron reduction, manganese reduction, and

methanogenesis. These reducing conditions are amenable to degradation of petroleum hydrocarbons and reductive dechlorination of chlorinated solvents (i.e., PCE and TCE).

Collectively, the hydrogeologic, chemistry, and geochemical data indicate that historical and active remedial actions, as well as natural attenuation processes, have or are degrading organic contaminants to relatively insignificant levels in the Tank Farm groundwater. It is likely that natural attenuation of residual petroleum hydrocarbons is occurring since known historical sources were located in the Tank Farm. Natural attenuation of chlorinated solvents is most likely not occurring at detectable levels because no known sources were present in the Tank Farm and daughter products were not detected in the groundwater. Based on this information, it is not recommended that a comprehensive monitored natural attenuation remedial action be pursued for this site.

13.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific HHRA for the identified exposure scenarios for Site 23. The risk assessment methodology was described in Section 3.4 and detailed calculations including RAGS Part D tables are presented in Appendix C. A summary of previous HHRAs for the site is also presented.

13.6.1 Data Evaluation

COPCs were identified for Site 23 using the risk-based screening levels, as discussed in Section 3.4.1. Table 13-3 summarizes the COPCs retained for Site 23. A discussion of direct contact exposure COPCs (i.e., those chemicals detected at concentrations in excess of USEPA and CTDEP direct contact exposure criteria) and additional COPCs is provided below. Additional COPCs are identified on chemical migration tendencies: migration groundwater to surface water and migration of volatiles from groundwater through building foundations into indoor air. These additional COPCs are not quantitatively evaluated in the HHRA because they are not considered to be significant contributors to the direct contact exposure pathways identified for potential human receptors.

A comparison of the maximum detected concentrations in groundwater to direct contact risk-based screening criteria is presented in Table 13-4. The maximum detected concentrations of the following chemicals in groundwater exceeded the direct contact risk-based COPC screening levels and were retained as COPCs for groundwater:

- VOCs-tetrachloroethene
- SVOCs-naphthalene
- Metals-lead

The maximum detected concentration of manganese exceeded its USEPA Region IX PRG but was within background levels; consequently, manganese was not retained as a COPC.

A comparison of the maximum detected concentration in groundwater to migration criteria is presented in Table 13-5. The maximum detected concentrations of the following chemicals exceeded their respective screening criteria for protection of migration to surface water:

- Metals-arsenic and lead

The maximum detected concentrations of all chemicals were less than the CTDEP criteria for migration from groundwater to indoor air.

13.6.2 Exposure Assessment

Only groundwater samples were collected during the current investigation. Consequently, only exposures to groundwater were evaluated in the risk assessment for Site 23. Potential receptors included construction workers and future residents. Exposure assumptions for these receptors were presented in Table 3-14. Potential exposure pathways are summarized in Table 13-6.

Construction workers could come into contact with groundwater while excavating building foundations. In such an instance, construction workers could be exposed to the groundwater via dermal contact.

Potential exposure pathways for future adult residents exposed to groundwater included ingestion, dermal contact, and inhalation of volatile emissions. As previously discussed, future residential receptors are not potential receptors under current land use and are included only to provide an indication of potential risks if the facility were to close and then be developed for residential use.

As discussed in Section 3.4, the maximum detected concentration and average concentration were used for the exposure point concentrations for the RME and CTE, respectively. Exposure point concentrations for Site 23 are presented in Table 13-7.

13.6.3 Risk Characterization

Potential ICRs and HIs were calculated for construction workers and adult residents exposed to groundwater using the methodology presented in Section 3.4. The results are summarized in Tables 13-8 and 13-9 and are discussed below. Sample calculations and chemical-specific risks in RAGS Part D format are provided in Appendix C.

The result of the human health risk assessment indicate that cancer risks for future adult residents exposed to groundwater were within EPA's acceptable cancer risk range, but exceeded CTDEP's acceptable risk levels. Hazard indices for future adult residents exposed to groundwater were within EPA's and CTDEP's acceptable levels. Even though the calculations were not performed, cancer risks for future child residents would also be expected to be within EPA's acceptable cancer risk range but exceed CTDEP's acceptable risk levels and hazard indices would be expected to be within EPA's and CTDEP's acceptable levels.

Carcinogenic Risks

ICRs for construction workers exposed to groundwater were 1.3×10^{-9} and 1.1×10^{-10} for the RME and CTE scenarios, respectively, which were less than USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures.

The ICRs for future adult residents exposed to groundwater were 4.5×10^{-6} and 1.6×10^{-7} for the RME and CTE scenarios, respectively, which were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and less than CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. The chemical-specific ICR for tetrachloroethene under the RME scenario exceeded CTDEP's target level of 1×10^{-6} for individual chemicals, although the maximum detected concentration for tetrachloroethene was less than its CTDEP RSR.

Noncarcinogenic Risks

HIs for construction workers exposed to groundwater were 0.0002 and 0.0001 for the RME and CTE scenarios, respectively, which were less than USEPA's and CTDEP's acceptable level of 1.0.

HIs for adult residents exposed to groundwater were 0.02 and 0.005 for the RME and CTE scenarios, respectively, which were less than USEPA's and CTDEP's acceptable level of 1.0.

Lead

Lead was identified as a COPC in groundwater at Site 23. Lead was detected at a maximum concentration of 31.2 µg/L, which exceeds the Safe Drinking Water Act action level and CTDEP RSR of 15 µg/L.

USEPA's IEUBK model was used to evaluate exposures to lead in groundwater by future child residents. As recommended by the model, the average concentration of lead in groundwater of 6.11 µg/L was used for the exposure point concentration. Default parameters were used for the rest of the model input

parameters. IEUBK model outputs are included in Appendix C. The estimated geometric mean blood-lead level for children exposed to lead in groundwater was 3.8 µg/dL, which is less than the level of concern of 10 µg/dL. The IEUBK Model estimates that 2 percent of children are expected to have blood-lead levels greater than 10 µg/dL. These results indicate that no adverse effects are anticipated for hypothetical future child residents exposed to lead in groundwater at Site 23.

13.6.4 Summary of Previous Risk Assessments

A quantitative HHRA based upon groundwater analytical data was not previously performed for the Tank Farm. However, qualitative evaluations of data (screening level assessments) were performed for groundwater samples collected from the Tank Farm as part of the Site Characterization of Waste Oil Tank 5 (HNUS, 1994a) and the Site Investigation of the Tank Farm (B&R Environmental, 1997e).

Only four groundwater samples were collected and analyzed during the Site Characterization of Waste Oil Tank 5 (HNUS, 1994a). Analytical results for these samples were evaluated against federal and CTDEP MCLs. PCE, which was detected in only one groundwater sample at a concentration of 6 µg/L, was the only chemical detected at a concentration exceeding one of the criteria (federal MCL of 5 µg/L).

The historic screening level assessment described in the Site Investigation Report for Tank Farm Investigation (B&R Environmental, 1997e) considered CTDEP surface water protection criteria, as well as CTDEP volatilization criteria for industrial land use. The volatilization criteria were developed to ensure that human health is not adversely affected from inhalation of volatile pollutants that have entered or may enter a building or other structure. The volatilization criteria apply to any site that has groundwater contaminated with VOCs and the water table is within 15 feet of the ground surface or any building. USEPA Region III Tap Water Ingestion Values, CTDEP groundwater protection criteria, and federal and CTDEP MCLs were not used in the historical screening level assessment since the groundwater at NSB-NLON is classified as GB and is not used for drinking water or other domestic purposes. The following 12 chemicals exceeded at least one of the two groundwater criteria included in the historical screening level assessment (B&R Environmental, 1997e):

- benzene
- acenaphthene
- benzo(a)anthracene
- phenanthrene
- arsenic
- beryllium
- chromium
- copper
- lead
- mercury
- nickel
- zinc

13.6.5 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment, in general, was presented in Section 3.4.5. Site-specific uncertainties for Site 23 are discussed below.

Elimination of Chemicals as COPCs on the Basis of Background

In accordance with Navy policy (Navy, 2000), chemicals were eliminated as COPCs on the basis of comparison to background. Manganese was the only chemical in groundwater with a maximum detected concentration that exceeded the direct contact screening criteria but was not retained as a COPC on the basis of background. Potential risks from dermal exposures to manganese in water is insignificant (USEPA, 2000e); consequently, the elimination of manganese as a COPC on the basis of background does not affect the risk estimates for the construction worker since this receptor was only evaluated for dermal exposures to groundwater. Future adult residents were evaluated for ingestion and dermal contact with groundwater; therefore, the estimated risks would be higher for the future adult resident if exposures to manganese were evaluated in the HHRA. If exposures to manganese in groundwater by a future adult resident were evaluated in the HHRA, then the resulting HI would be 3.9, which exceeds the USEPA and CTDEP acceptable level of 1.0.

13.7 SUMMARY AND RECOMMENDATIONS

13.7.1 Nature and Extent of Contamination

Historically, in the overburden groundwater wells, concentrations of monocyclic aromatics (benzene, ethylbenzene, toluene, and xylenes) ranged from 0.5 µg/L to 4,810 µg/L, and PAHs ranged from 0.7 µg/L to 740 µg/L. Overburden groundwater data collected during the BGOURI contained xylenes (5 µg/L) and naphthalene (1.4 µg/L) in only well S23MW02S. This suggests that concentrations of fuel-related contamination have decreased significantly over time.

In general, VOCs and SVOCs were detected very infrequently during the BGOURI. Metals were the most frequently detected analytes and this is likely because the Tank Farm area comprises primarily of fill material. Field and analytical data from this BGOURI show that no organic or inorganic contaminant plumes are shown to exist at Site 23. The maximum detected concentrations of xylenes, naphthalene, and metals were all found in well S23MW02S, which is located northeast of tank OT-7. Arsenic, cadmium, nickel, and lead were the only metals detected in overburden groundwater at concentrations above background.

PCE and metals were the only compounds detected in bedrock groundwater wells sampled during the BGOURI. The majority of maximum detections were found in S23MW03D. Monocyclic aromatics and

PAHs were not detected in any bedrock wells, and, conversely, PCE was not detected in any overburden groundwater wells.

13.7.2 Contaminant Fate and Transport

One fuel-related monocyclic aromatic compound (i.e., xylenes) was detected in one shallow groundwater sample during the BGOURI. This contrasts with the results of previous investigations in which other monocyclic aromatics (e.g., benzene) were detected at much higher concentrations. Monocyclic aromatics were also detected in soil in previous investigations. Monocyclic aromatic compounds are not considered to be persistent in the environment, particularly in comparison to chemicals such as PCBs and PAHs.

One halogenated aliphatic (PCE) was detected in one bedrock groundwater sample collected during the BGOURI. PCE was also detected infrequently and at low concentrations in groundwater and soil samples during previous investigations at the site. Halogenated aliphatic hydrocarbons such as PCE are relatively water soluble and have a low capacity for retention by soil organic carbon and, therefore, PCE is frequently detected in groundwater. Leaching from soil may account for the presence of PCE in groundwater at the site.

One low-molecular-weight PAH, naphthalene, was detected infrequently at low concentrations in the groundwater at Site 23. Low-and high-molecular weight PAHs were detected in soil and groundwater in previous investigations at low frequencies. The presence of naphthalene and other PAHs in groundwater at the site is evidence of releases of petroleum products from the former USTs and their associated piping. Naphthalene is expected to be only adsorbed moderately to soil and to undergo biodegradation. Naphthalene is more water soluble than most other PAHs and is, therefore, more likely to exist in the dissolved phase and to move with groundwater.

A preliminary evaluation of natural attenuation data (i.e., hydrogeologic, chemistry, and geochemical data) indicates that historical and active remedial actions, as well as natural attenuation processes, have or are degrading organic contaminants to relatively insignificant levels in the Tank Farm groundwater. It is likely that natural attenuation of residual petroleum hydrocarbons is occurring since known historical sources were located in the Tank Farm. Natural attenuation of chlorinated solvents is most likely not occurring at detectable levels because no known sources were present in the Tank Farm and daughter products were not detected in the groundwater. It was not recommended that a comprehensive monitored natural attenuation remedial action be pursued for this site.

Seventeen metals were detected in groundwater samples at Site 23 in the BGOURI. The list of detected metals is similar to that of previous investigations except that beryllium, selenium, and silver were

detected in past investigations but not in the BGOURI. Metals are highly persistent environmental contaminants. They do not biodegrade, photolyze, hydrolyze, etc. The major fate mechanisms for metals are adsorption to the soil matrix (as compared to being part of the soil structure) and bioaccumulation. A comparison of the total and dissolved concentrations indicates that there was little difference between the total and dissolved concentrations for these metals, with the possible exception of lead (unfiltered = 31.2 µg/L, filtered = 10 µg/L).

13.7.3 Human Health Risk Assessment

The following items summarize the HHRA for Site 23:

- The HHRA for Site 23 considered exposures to construction workers and future adult residents. No soil samples were collected at Site 23; therefore, only exposures to groundwater were evaluated. Potential exposure pathways for groundwater included dermal contact for construction workers and incidental ingestion, dermal contact, and inhalation of volatile emissions for future adult residents.

- The maximum detected concentrations of tetrachloroethene, naphthalene, and lead exceeded the direct contact risk-based COPC screening levels and were retained for quantitative evaluation in the HHRA.

- Maximum detected concentrations of arsenic and lead exceeded CTDEPs screening criteria for protection of migration of groundwater to surface water.

- The maximum detected concentrations of all chemicals in groundwater were less than the CTDEP criteria for migration from groundwater to indoor air.

- ICRs and HIs for construction workers exposed to groundwater at Site 23 were within USEPA and CTDEP acceptable levels for the RME and CTE scenarios.

- ICRs for adult residents exposed to groundwater at Site 23 were less than or within USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. The chemical-specific ICR for PCE exceeded CTDEP's target level of 1×10^{-6} for individual chemicals, although the maximum detected concentration for tetrachloroethene was less than its CTDEP RSR.

- HIs for adult residents exposure to groundwater at Site 23 were less than USEPA's and CTDEP's acceptable level of 1.0 for the RME and CTE scenarios.

- The result of the human health risk assessment indicate that cancer risks for future adult residents exposed to groundwater were within EPA's acceptable cancer risk range, but exceeded CTDEP's acceptable risk levels. Hazard indices for future adult residents exposed to groundwater were within EPA's and CTDEP's acceptable levels. Even though the calculations were not performed, cancer risks for future child residents would also be expected to be within EPA's acceptable cancer risk range but exceed CTDEP's acceptable risk levels and hazard indices would be expected to be within EPA's and CTDEP's acceptable levels.

- The maximum detected concentration of lead in groundwater exceeded the Safe Drinking Water Act action level and CTDEP RSR of 15 µg/L. The IEUBK model was used to evaluate exposures to lead in groundwater by hypothetical residential children. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in groundwater at Site 23.

- The maximum detected concentration of manganese in groundwater exceeded its screening criteria but was within background levels, consequently manganese was not retained as COCs in the HHRA. HIs for adult residents exposed to manganese in groundwater would exceed the acceptable level of 1 if manganese were evaluated in the HHRA.

13.7.4 Recommendations

Petroleum contamination related to the former USTs and their associated piping were identified during previous investigations at Site 23. The Navy has conducted three removal actions to address the identified contamination. Soil and free product were removed in the vicinity of OT-8 and OT-3 during the removal actions. Contaminated soil was also removed along Tank Avenue. In addition, BTEX compounds were historically detected in the groundwater in the Tank Farm, and it was determined that the contamination was related to leaking USTs from an adjacent site (i.e., NEX Gas Station). The leaking USTs have been fixed, and an AS/SVE system was installed to address the associated BTEX plumes.

Petroleum contamination was also historically detected in stormwater/groundwater collected from the Tank Farm. This stormwater/groundwater discharged to the Thames River at Goss Cove Landfill. Typically, the contamination was detected during a storm event when high surface water flow rates passed through the combined storm sewer/groundwater collection system. To minimize this problem, the combined system was separated into a shallow surface water collection system and a deep groundwater collection system. A sampling and analysis program is currently being conducted to determine if any treatment of the groundwater is necessary prior to discharge to the Thames River. Preliminary results from the program indicate that treatment may not be necessary, but a final decision on treatment will be

made after more data are collected and the Navy consults further with the regulators (i.e., USEPA and CTDEP).

The objectives of the BGOURI at Site 23 were to further characterize the nature and extent of groundwater contamination and to quantify the risks to human receptors from the groundwater. Groundwater sampling results for Site 23 indicate that the water quality is generally good, with only sporadic, low-concentration detections of VOCs, SVOCs, and metals in site monitoring wells. A preliminary evaluation of natural attenuation data indicated that biodegradation and other natural attenuation processes may be acting to reduce organic contaminants to relatively insignificant levels in the Tank Farm. However, it was not recommended that a monitored natural attenuation alternative be pursued for the site.

The HHRA determined that risks posed by exposure of construction workers to groundwater at Site 23 are within USEPA and CTDEP acceptable levels, assuming that the workers are exposed to the maximum observed concentrations of site contaminants. Risks for adult residents exposed to groundwater at Site 23 were less than or within USEPA and CTDEP acceptable levels, assuming that the resident is exposed to the maximum observed concentrations of site contaminants. However, the chemical-specific ICR for PCE exceeded CTDEP's target level of 1×10^{-6} for individual chemicals, although the maximum detected concentration for PCE was less than its CTDEP RSR. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in groundwater at Site 23.

Based on the results of the risk assessment and the fact that the groundwater at Site 23 is not used for human consumption and it is not likely to be used for human consumption in the foreseeable future because of its current classification (i.e., GB groundwater which indicates not suitable for direct human consumption without treatment), an FS is not currently warranted for this site. However, it is recommended that the decision for preparation of an FS for the groundwater OU at the Tank Farm be postponed until site conditions stabilize and the results of the current sampling and analysis program for the groundwater collection system determine the trends in groundwater contaminant concentrations. If the results of the monitoring program support the determination that there are no unacceptable risks to human health or the environment, then an FS will not be prepared and the Navy will pursue a no-further-action ROD for the groundwater OU. If the results suggest that further actions are required, then the Navy will prepare an FS for the groundwater OU to develop appropriate remedial alternatives.

TABLE 13-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM FOR SITE 23 BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION NSB-NLON, GROTON, CONNECTICUT

Sample ID	VOCs	SVOCs	Metals	Misc[1]	Pesticides/ PCBs
GROUNDWATER SAMPLES					
OVERBURDEN					
S23MW02S01	X	X	X	X	X
S23MW02S01-F			X		
S23HNUS2001	X	X	X	X	X
S23HNUS201	X	X	X	X	X
S23HNUS201-F			X		
S23MW04S01	X	X	X	X	X
S23HNUS501	X	X	X	X	X
S23HNUS1101	X	X	X	X	X
S23HNUS1301	X	X	X	X	X
BEDROCK					
FD0806001	X	X	X	X	X
S23MW02D01	X	X	X	X	X
S23MW03D01	X	X	X	X	X
S23MW04D01	X	X	X	X	X
SOIL SAMPLES					
S23SB02S0810				X	
S23SB04S1012				X	

Notes:

1 Miscellaneous groundwater parameters include natural attenuation parameters, TSS, and TDS. Miscellaneous soil parameters include TOC, bulk density, pH, and porosity.

2 Samples with an "F" suffix are filtered.

TABLE 13-2

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITE 23
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	HNUS-11	HNUS-13	HNUS-20	HNUS-2	HNUS-2	HNUS-5	23MW02D	23MW02D	23MW02S	23MW02S	23MW03D	23MW04D	23MW04S
nsample	S23HNUS1101	S23HNUS1301	S23HNUS2001	S23HNUS201	S23HNUS201-F	S23HNUS501	S23MW02D01	S23MW02D01-D	S23MW02S01	S23MW02S01-F	S23MW03D01	S23MW04D01	S23MW04S01
sample	S23HNUS1101	S23HNUS1301	S23HNUS2001	S23HNUS201	S23HNUS201-F	S23HNUS501	S23MW02D01	FD0806001	S23MW02S01	S23MW02S01-F	S23MW03D01	S23MW04D01	S23MW04S01
sample_dat	8/6/00	8/7/00	8/5/00	8/3/00	8/4/00	8/3/00	8/6/00	8/6/00	8/6/00	8/6/00	8/6/00	8/3/00	6/25/00
Volatile Organics (ug/L)													
M+P-XYLENES	2 U	2 U	2 U	2 U		2 U	2 U	2 U	2		2 U	2 U	2 UJ
O-XYLENE	1 U	1 U	1 U	1 U		1 U	1 U	1 U	3		1 U	1 U	1 UJ
TETRACHLOROETHENE	1 U	1 U	1 U	1 U		1 U	1 U	1 U	1 U		3	1 U	1 UJ
XYLENES, TOTAL	1 U	1 U	1 U	1 U		1 U	1 U	1 U	5		1 U	1 U	1 UJ
Dissolved Gases (ug/L)													
METHANE	260	14	1 U	150		21	1	1	920		1 U	1 U	1
Semivolatile Organics (ug/L)													
NAPHTHALENE	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	1.4		0.5 U	0.5 U	5 U
Total Metals (ug/L)													
ALUMINUM	81.6 U	83.9 U	130 U	146 U		211 U	50.5 U	74.4 U	2030		591 U	188 U	890
ARSENIC	4.7	2.3 U	2.3 U	2.3 U		2.3 U	2.3 U	2.3 U	2.3 U		2.3 U	2.3 U	2.3 U
BARIUM	35.7 U	37 U	64.4	42.8		27.2	21.3 U	24.2 U	176		30.8 U	18 U	29.2 U
CADMIUM	0.25 U	0.25 U	0.63	0.25 U		0.25 U	0.25 U	0.25 U	0.25 U		0.25 U	0.25 U	0.25 U
CALCIUM	45200	11200	31300	38100		21800	6270	6430	59300		94100	9060	13800
CHROMIUM	6.2 U	6.2 U	6.2 U	6.2 U		6.2 U	6.2 U	6.2 U	43.2		39.9	10.2 J	10.3 J
COBALT	4.2 U	4.2 U	4.2 U	4.2 U		4.5 J	4.2 U	6.4 J	6.4 J		5.5 J	5.3 J	5.2 U
COPPER	6.8 U	6.8 U	6.8 U	6.8 U		6.8 J	6.8 U	6.8 U	10.7 J		6.8 U	6.8 U	6.8 U
IRON	16500	733	175 U	5370		1080	2380	2620	24800		551	202	1230
LEAD	4.8 J	13.2	1.8 U	1.9 J		1.8 U	1.8 U	1.8 U	31.2		5.5 J	1.8 U	1.8 U
MAGNESIUM	5360	2340	3940	4280		3410	1610	1630	7840		544 U	2670	4300
MANGANESE	2170	90.9	41.4 J	1220		297	48.3	50	3380		8.8 U	12.1 U	138
NICKEL	9.2 U	9.2 U	9.2 U	9.2 U		9.2 U	9.2 U	9.2 U	33.5		10 J	9.2 U	9.9 U
POTASSIUM	4640	2800	5690	6160		4270	1170	1310	7790		3940	2730	5350
SODIUM	57800	31000	8750	99200 J		28100 J	8660	8660	45200		29000	7790 J	10900
VANADIUM	6.3 U	6.3 U	6.3 U	6.3 U		6.3 U	6.3 U	6.3 U	6.3 U		6.4 J	6.3 U	8.2 U
ZINC	14.4 U	12.8 U	18.3 U	13 U		33.4 U	15.3 U	14.4 U	68.4		43.1 U	10.9 U	21.3 U
Dissolved Metals (ug/L)													
ARSENIC					2.3 U					3.1 J			
BARIUM					33.8					150			
CALCIUM					33000					45100			
IRON					4410					15400			
LEAD					1.8 U					10			
MAGNESIUM					3770					5830			
MANGANESE					977					2650			

TABLE 13-2

SUMMARY OF POSITIVE GROUNDWATER ANALYTICAL RESULTS FOR PERMANENT WELLS AT SITE 23
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	HNUS-11	HNUS-13	HNUS-20	HNUS-2	HNUS-2	HNUS-5	23MW02D	23MW02D	23MW02S	23MW02S	23MW03D	23MW04D	23MW04S
nsample	S23HNUS1101	S23HNUS1301	S23HNUS2001	S23HNUS201	S23HNUS201-F	S23HNUS501	S23MW02D01	S23MW02D01-D	S23MW02S01	S23MW02S01-F	S23MW03D01	S23MW04D01	S23MW04S01
sample	S23HNUS1101	S23HNUS1301	S23HNUS2001	S23HNUS201	S23HNUS201-F	S23HNUS501	S23MW02D01	FD0806001	S23MW02S01	S23MW02S01-F	S23MW03D01	S23MW04D01	S23MW04S01
sample_dat	8/6/00	8/7/00	8/5/00	8/3/00	8/4/00	8/3/00	8/6/00	8/6/00	8/6/00	8/6/00	8/6/00	8/3/00	6/25/00
POTASSIUM					5500					7340			
SODIUM					82600 J					49300			
Miscellaneous Parameters (mg/L)													
ALKALINITY	164	22	27.5	191		75.5	18	18.5	185		348	34	76.6
AMMONIA				0.54 J		0.25 J						0.16 J	
AMMONIA, AS NITROGEN	0.77 J	0.14 J	0.13 J				0.18 J	0.14 J	6.9 J		0.1 UJ		0.16
CHLORIDE	91.7	49.1	6.55	78.6		23.2	10.5	10.5	124		34.6	6.6	20.7
HARDNESS as CaCO3	135	37.6	94.4	113		68.5	22.3	22.8	180		257	33.6	80.6
SULFATE	10.2	15.8	47.2	10.5		14.6	11.1	9.75	7.6		14.8	10.5	14
TOTAL DISSOLVED SOLIDS	338 J	132 J	199 J	389 J		139 J	73.8 J	66.2	519 J		298 J	76.2 J	108
TOTAL ORGANIC CARBON	3.9	1.5	3	7.8 J		3.3	1	1.1	8		1.4	1 J	9
TOTAL SUSPENDED SOLIDS	25 J	5 UJ	5 UJ	5 UJ		5 UJ	6 J	5 U	169 J		14 J	8 J	32

TABLE 13-3

CHEMICALS RETAINED AS COPCs IN GROUNDWATER AT SITE 23
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Direct Contact	Migration Pathways	
		Surface Water	Volatilization
Volatile Organic Compounds			
Tetrachloroethene	X		
Semivolatile Organic Compounds			
Naphthalene	X		
Metals			
Arsenic		X	
Lead	X	X	

Notes:
X - Chemical is retained as a COC.

TABLE 13-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 23
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tank Farm (Site 23)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																
	M+P-XYLENES	2		2		ug/L	S23MW02S01	1/7	2	2	N/A	140 (7) N	530 10000 10000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
95-47-6	O-XYLENE	3		3		ug/L	S23MW02S01	1/7	1	3	N/A	140 (7) N	530 10000 10000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
127-18-4	TETRACHLOROETHENE	3		3		ug/L	S23MW03D01	1/3	1	3	N/A	1.1 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
1330-20-7	XYLENES, TOTAL	5		5		ug/L	S23MW02S01	1/7	1	5	N/A	140 N	530 10000 10000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Dissolved Gases																
74-82-8	METHANE	1		920		ug/L	S23MW02S01	7/10	1	920	N/A	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
Semivolatile Organics																
91-20-3	NAPHTHALENE	1.4		1.4		ug/L	S23MW02S01	1/7	0.5 - 5	1.4	N/A	0.62 N	280 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
Total Metals																
7429-90-5	ALUMINUM	890		2030		ug/L	S23MW02S01	1/7	50.5 - 591	2030	3560	3600 N	N/A 50 to 200 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI, BKG
7440-38-2	ARSENIC	4.7		4.7		ug/L	S23HNUS1101	1/7	2.3	4.7	1.92	N/A	50 50 50	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-39-3	BARIUM	27.2		176		ug/L	S23MW02S01	1/7	18 - 37	176	227	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-43-9	CADMIUM	0.63		0.63		ug/L	S23HNUS2001	4/7	0.25	0.63	ND	1.8 N	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-70-2	CALCIUM	6270		94100		ug/L	S23MW03D01	10/10	N/A	94100	188000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-47-3	CHROMIUM	10.2	J	43.2		ug/L	S23MW02S01	4/10	6.2	43.2	49.9	110 (8) N	50 100 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-48-4	COBALT	4.5	J	6.4	J	ug/L	S23MW02S01	4/10	4.2 - 5.2	6.4	48.6	220 N	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-50-8	COPPER	6.8	J	10.7	J	ug/L	S23MW02S01	2/10	6.8	10.7	107	140 N	1300 1300 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON	202		24800		ug/L	S23MW02S01	9/10	175	24800	28200	1100 N	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI, BKG

TABLE 13-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 23
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tank Farm (Site 23)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7439-92-1	LEAD	1.9	J	31.2		ug/L	S23MW02S01	5/10	1.8	31.2	6.63	N/A	15 15 N/A	CTDEP RSR FED-AL CTDEP-MCL	YES	ASL
7439-95-4	MAGNESIUM	1610		7840		ug/L	S23MW02S01	9/10	544	7840	191000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7439-96-5	MANGANESE	41.4	J	3380		ug/L	S23MW02S01	8/10	8.8 - 12.1	3380	11700	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-02-0	NICKEL	10	J	33.5		ug/L	S23MW02S01	2/10	9.2 - 9.9	33.5	32.2	73 N	100 100 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-09-7	POTASSIUM	1170		7790		ug/L	S23MW02S01	10/10	N/A	7790	70800	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-23-5	SODIUM	7790	J	99200	J	ug/L	S23HNUS201	10/10	N/A	99200	1900000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-62-2	VANADIUM	6.4	J	6.4	J	ug/L	S23MW03D01	1/10	6.3 - 8.2	6.4	10.2	26 N	50 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-66-6	ZINC	68.4		68.4		ug/L	S23MW02S01	1/10	10.9 - 43.1	68.4	131	1100 N	5000 5000 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL, BKG
Dissolved Metals																
7440-38-2	ARSENIC, FILTERED	3.1	J	3.1	J	ug/L	S23MW02S01-F	1/2	2.3	3.1	2.55	N/A	50 50 50	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-39-3	BARIUM, FILTERED	33.8		150		ug/L	S23MW02S01-F	2/2	N/A	150	124	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-70-2	CALCIUM, FILTERED	33000		45100		ug/L	S23MW02S01-F	2/2	N/A	45100	152000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON, FILTERED	4410		15400		ug/L	S23MW02S01-F	2/2	N/A	15400	25300	1100 N	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI, BKG
7439-92-1	LEAD, FILTERED	10		10		ug/L	S23MW02S01-F	1/2	1.8	10	2.52	N/A	15 15 N/A	CTDEP RSR FED-AL CTDEP-MCL	NO	BSL
7439-95-4	MAGNESIUM, FILTERED	3770		5830		ug/L	S23MW02S01-F	2/2	N/A	5830	150000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-96-5	MANGANESE, FILTERED	977		2650		ug/L	S23MW02S01-F	2/2	N/A	2650	9400	170 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-09-7	POTASSIUM, FILTERED	5500		7340		ug/L	S23MW02S01-F	2/2	N/A	7340	60000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-23-5	SODIUM, FILTERED	49300		82600	J	ug/L	S23HNUS201-F	2/2	N/A	82600	1580000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG

TABLE 13-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 23
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tank Farm (Site 23)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Miscellaneous Parameters																
E-14506	ALKALINITY	18		348		mg/L	S23MW03D01	10/10	N/A	348	1950	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
7664-41-7	AMMONIA	0.16	J	0.54	J	mg/L	S23HNUS201	3/3	N/A	0.54	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
7664-41-7	AMMONIA, AS NITROGEN	0.13	J	6.9	J	mg/L	S23MW02S01	6/7	100	6.9	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
000-02-0	CHLORIDE	6.55		124		mg/L	S23MW02S01	10/10	N/A	124	4540	N/A	N/A 250 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
E-11778	HARDNESS as CaCO3	22.3		257		mg/L	S23MW03D01	10/10	N/A	257	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
14808-79-8	SULFATE	7.6		47.2		mg/L	S23HNUS2001	10/10	N/A	47.2	45.2	N/A	N/A 250 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
000-09-0	TOTAL DISSOLVED SOLIDS	66.2		519	J	mg/L	S23MW02S01	10/10	N/A	519	6260	N/A	N/A 500 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-44-0	TOTAL ORGANIC CARBON	1	J	9		mg/L	S23MW04S01	10/10	N/A	9	37.7	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
000-08-9	TOTAL SUSPENDED SOLIDS	6	J	169	J	mg/L	S23MW02S01	6/10	5000	169	236	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data .
5 The risk-based COPC screening level for tap water use is presented. The value is based on a target Hazard Quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
7 Value is for total xylenes.
8 Value is for hexavalent chromium.

Associated Samples:

S23HNUS1101	S23MW02D01	S23MW04S01
S23HNUS1301	S23MW02D01-D	
S23HNUS2001	S23MW02S01	
S23HNUS201	S23MW02S01-F	
S23HNUS201-F	S23MW03D01	
S23HNUS501	S23MW04D01	

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern
J = Estimated Value
N = Noncarcinogen.
N/A = Not Applicable.
FED-MCL = Federal Maximum Contaminant Level (USEPA, August 2000).
FED-SMCL = Federal Secondary Maximum Contaminant Level (USEPA, August 2000).
FED-AL = Federal Action Level (USEPA, August 2000)
CTDEP-RSR = Connecticut DEP Remediation Standard Regulations, 1996.
CTDEP-MCL = Connecticut Maximum Contaminant Level.

Rationale Codes:
For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC
NUT = Essential Nutrient.
NTX = No Toxicity Information.
EPAI = USEPA Region 1 does not advocate evaluation of this chemical.
NV = Miscellaneous parameters are not evaluated in human health risk assessments.

TABLE 13-5

OCCURRENCE, DISTRIBUITON, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 23
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tank Farm (Site 23)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	CTDEP Surface Water Criteria(5)	CTDEP Vol. Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics															
	M+P-XYLENES	2		2		ug/L	S23MW02S01	1/10	2	2	NA	NA	21300	NO	BSL
95-47-6	O-XYLENE	3		3		ug/L	S23MW02S01	1/10	1	3	NA	NA	21300	NO	BSL
127-18-4	TETRACHLOROETHENE	3		3		ug/L	S23MW03D01	1/10	1	3	NA	88	1500	NO	BSL
1330-20-7	XYLENES, TOTAL	5		5		ug/L	S23MW02S01	1/10	1	5	NA	NA	21300	NO	BSL
Dissolved Gases															
74-82-8	METHANE	1		920		ug/L	S23MW02S01	7/10	1	920	NA	N/A	N/A	NO	NTX
Semivolatile Organics															
91-20-3	NAPHTHALENE	1.4		1.4		ug/L	S23MW02S01	1/10	0.5 - 5	1.4	NA	N/A	N/A	NO	NTX
Total Metals															
7429-90-5	ALUMINUM	890		2030		ug/L	S23MW02S01	2/10	50.5 - 591	2030	3560	N/A	N/A	NO	BKG
7440-38-2	ARSENIC	4.7		4.7		ug/L	S23HNUS1101	1/10	2.3	4.7	1.92	4	N/A	YES	ASL
7440-39-3	BARIUM	27.2		176		ug/L	S23MW02S01	4/10	18 - 37	176	227	N/A	N/A	NO	BKG
7440-43-9	CADMIUM	0.63		0.63		ug/L	S23HNUS2001	1/10	0.25	0.63	ND	6	N/A	NO	BSL
7440-70-2	CALCIUM	6270		94100		ug/L	S23MW03D01	10/10	N/A	94100	188000	N/A	N/A	NO	BKG
7440-47-3	CHROMIUM	10.2	J	43.2		ug/L	S23MW02S01	4/10	6.2	43.2	49.9	N/A	N/A	NO	BKG
7440-48-4	COBALT	4.5	J	6.4	J	ug/L	S23MW02S01	4/10	4.2 - 5.2	6.4	48.6	N/A	N/A	NO	BKG
7440-50-8	COPPER	6.8	J	10.7	J	ug/L	S23MW02S01	2/10	6.8	10.7	107	48	N/A	NO	BSL, BKG
7439-89-6	IRON	202		24800		ug/L	S23MW02S01	9/10	175	24800	28200	N/A	N/A	NO	BKG
7439-92-1	LEAD	1.9	J	31.2		ug/L	S23MW02S01	5/10	1.8	31.2	6.63	13	N/A	YES	ASL
7439-95-4	MAGNESIUM	1610		7840		ug/L	S23MW02S01	9/10	544	7840	191000	N/A	N/A	NO	BKG
7439-96-5	MANGANESE	41.4	J	3380		ug/L	S23MW02S01	8/10	8.8 - 12.1	3380	11700	N/A	N/A	NO	BKG
7440-02-0	NICKEL	10	J	33.5		ug/L	S23MW02S01	2/10	9.2 - 9.9	33.5	32.2	880	N/A	NO	BSL
7440-09-7	POTASSIUM	1170		7790		ug/L	S23MW02S01	10/10	N/A	7790	70800	N/A	N/A	NO	BKG
7440-23-5	SODIUM	7790	J	99200	J	ug/L	S23HNUS201	10/10	N/A	99200	1900000	N/A	N/A	NO	BKG
7440-62-2	VANADIUM	6.4	J	6.4	J	ug/L	S23MW03D01	1/10	6.3 - 8.2	6.4	10.2	N/A	N/A	NO	BKG
7440-66-6	ZINC	68.4		68.4		ug/L	S23MW02S01	1/10	10.9 - 43.1	68.4	131	123	N/A	NO	BSL, BKG
Dissolved Metals															
7440-38-2	ARSENIC, FILTERED	3.1	J	3.1	J	ug/L	S23MW02S01-F	1/2	2.3	3.1	2.55	4	N/A	NO	BSL
7440-39-3	BARIUM, FILTERED	33.8		150		ug/L	S23MW02S01-F	2/2	N/A	150	124	N/A	N/A	NO	NTX
7440-70-2	CALCIUM, FILTERED	33000		45100		ug/L	S23MW02S01-F	2/2	N/A	45100	152000	N/A	N/A	NO	BKG
7439-89-6	IRON, FILTERED	4410		15400		ug/L	S23MW02S01-F	2/2	N/A	15400	25300	N/A	N/A	NO	BKG
7439-92-1	LEAD, FILTERED	10		10		ug/L	S23MW02S01-F	1/2	1.8	10	2.52	13	N/A	NO	BSL
7439-95-4	MAGNESIUM, FILTERED	3770		5830		ug/L	S23MW02S01-F	2/2	N/A	5830	150000	N/A	N/A	NO	BKG
7439-96-5	MANGANESE, FILTERED	977		2650		ug/L	S23MW02S01-F	2/2	N/A	2650	9400	N/A	N/A	NO	BKG
7440-09-7	POTASSIUM, FILTERED	5500		7340		ug/L	S23MW02S01-F	2/2	N/A	7340	60000	N/A	N/A	NO	BKG
7440-23-5	SODIUM, FILTERED	49300		82600	J	ug/L	S23HNUS201-F	2/2	N/A	82600	1580000	N/A	N/A	NO	BKG
Miscellaneous Parameters															
E-14506	ALKALINITY	18		348		mg/L	S23MW03D01	10/10	N/A	348	1950	N/A	N/A	NO	BKG
7664-41-7	AMMONIA	0.16	J	0.54	J	mg/L	S23HNUS201	3/3	N/A	0.54	ND	N/A	N/A	NO	NTX
7664-41-7	AMMONIA, AS NITROGEN	0.13	J	6.9	J	mg/L	S23MW02S01	6/7	100	6.9	ND	N/A	N/A	NO	NTX
000-02-0	CHLORIDE	6.55		124		mg/L	S23MW02S01	10/10	N/A	124	4540	N/A	N/A	NO	BKG

TABLE 13-5

OCCURRENCE, DISTRIBUITON, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 23
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tank Farm (Site 23)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	CTDEP Surface Water Criteria(5)	CTDEP Vol. Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
E-11778	HARDNESS as CaCO3	22.3		257		mg/L	S23MW03D01	10/10	N/A	257	ND	N/A	N/A	NO	NTX
14808-79-8	SULFATE	7.6		47.2		mg/L	S23HNUS2001	10/10	N/A	47.2	45.2	N/A	N/A	NO	NTX
000-09-0	TOTAL DISSOLVED SOLIDS	66.2		519	J	mg/L	S23MW02S01	10/10	N/A	519	6260	N/A	N/A	NO	BKG
7440-44-0	TOTAL ORGANIC CARBON	1	J	9		mg/L	S23MW04S01	10/10	N/A	9	37.7	N/A	N/A	NO	BKG
000-08-9	TOTAL SUSPENDED SOLIDS	6	J	169	J	mg/L	S23MW02S01	6/10	5000	169	236	N/A	N/A	NO	BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 Connecticut DEP Surface Water Protection criteria.
6 Connecticut DEP Volatilization criteria for residential exposures.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the CTDEP surface water protection or volatilization criteria.

Associated Samples:

S23HNUS1101	S23MW02D01	S23MW04S01
S23HNUS1301	S23MW02D01-D	
S23HNUS2001	S23MW02S01	
S23HNUS201	S23MW02S01-F	
S23HNUS201-F	S23MW03D01	
S23HNUS501	S23MW04D01	

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:

For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No Toxicity Information.

TABLE 13-6

SELECTION OF EXPOSURE PATHWAYS FOR SITE 23
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Groundwater	Overburden/Bedrock Aquifer	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	None Quant.	Construction workers may have dermal contact with groundwater during excavation activities.
				Full-time Employees	Adult	Ingestion Dermal	On-Site On-Site	None None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Ingestion Dermal	On-Site On-Site	None None	Trespassers do not have contact with groundwater.
				Residents	Adult	Ingestion Dermal	On-Site On-Site	None None	Residential land usage is not expected to occur at Site 23.
					Child	Ingestion Dermal	On-Site On-Site	None None	Residential land usage is not expected to occur at Site 23.
		Air	Overburden/Bedrock Aquifer	Construction Workers	Adult	Inhalation	On-site	None	Construction workers exposure via volatilization is expected to be insignificant due to dilution with outdoor air.
				Full-time Employees	Adult	Inhalation	On-site	None	Full-time employees are not exposed to groundwater.
				Trespassers	Adolescents	Inhalation	On-Site	None	Trespassers do not have contact with site groundwater.
				Residents	Adult	Inhalation	On-site	None	Residential land usage is not expected to occur at Site 23.
					Child	Inhalation	On-site	None	Residential land usage is not expected to occur at Site 23.

TABLE 13-7

EXPOSURE POINT CONCENTRATIONS FOR SITE 23
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Chemical	Groundwater	
	RME[1]	CTE[1]
	(ug/L)	(ug/L)
Volatile Organic Compounds		
Trichloroethene	3	0.750
Semivolatile Organic Compounds		
Naphthalene	1.4	0.590
Inorganics		
Lead[2]	6.11	6.11

Notes:
1 -The maximum detected concentration is used for the RME scenario and the average concentration is used for the CTE scenario.
2 -The average concentration is used for lead USEPA, 1994).

TABLE 13-8

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 23
REASONABLE MAXIMUM EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	1.3E-09	- -	- -	- -	0.0002	- -
Adult Resident	Groundwater	Ingestion	1.8E-06	- -	- -	Tetrachloroethene	0.01	- -
		Dermal Contact	8.5E-07	- -	- -	- -	0.005	- -
		Inhalation (1)	1.8E-06	- -	- -	Tetrachloroethene	0.008	- -
		Total	4.5E-06	- -	- -	Tetrachloroethene	0.02	- -

Notes:
1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

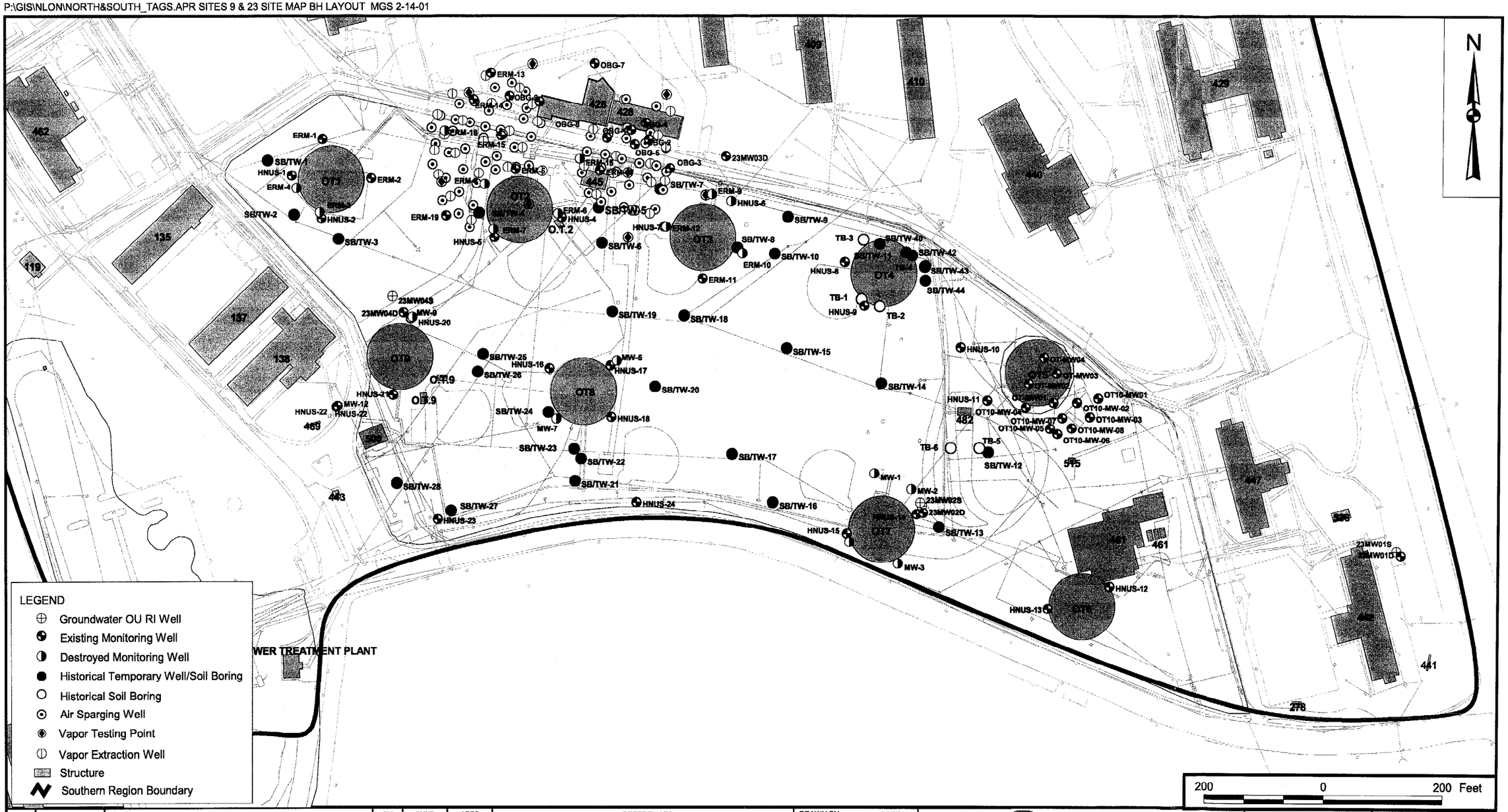
TABLE 13-9

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 23
CENTRAL TENDENCY EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	1.1E-10	- -	- -	- -	0.0001	- -
Adult Resident	Groundwater	Ingestion	6.4E-08	- -	- -	- -	0.001	- -
		Dermal Contact	3.5E-08	- -	- -	- -	0.003	- -
		Inhalation (1)	6.4E-08	- -	- -	- -	0.001	- -
		Total	1.6E-07	- -	- -	- -	0.005	- -

Notes:
1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

P:\GIS\NLON\NORTH&SOUTH_TAGS.APR SITES 9 & 23 SITE MAP BH LAYOUT MGS 2-14-01



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

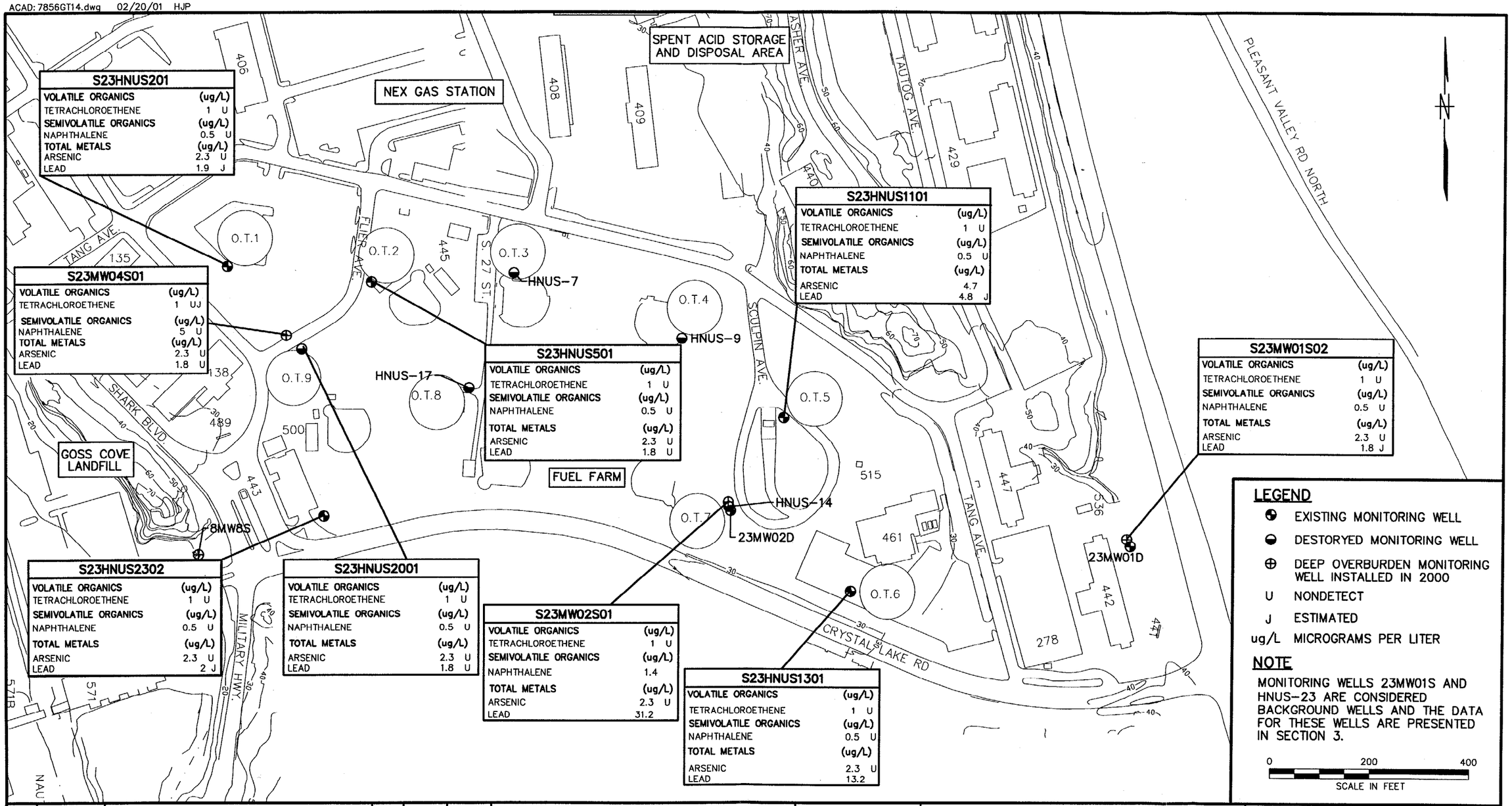
DRAWN BY	DATE
J. LAMEY	7/1/99
CHECKED BY	DATE
COST/SCHEDULE-AREA	
SCALE	
AS NOTED	

Tetra Tech NUS, Inc.

SITE MAP
SITE 23-TANK FARM
NSB-NLON, GROTON, CT

CONTRACT NUMBER	OWNER NUMBER
5083	204
APPROVED BY: AP_Greene	DATE: 2-21-01
APPROVED BY:	DATE:
DRAWING NO. FIGURE 13-1	REV 0

ACAD: 7856GT14.dwg 02/20/01 HJP



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/11/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

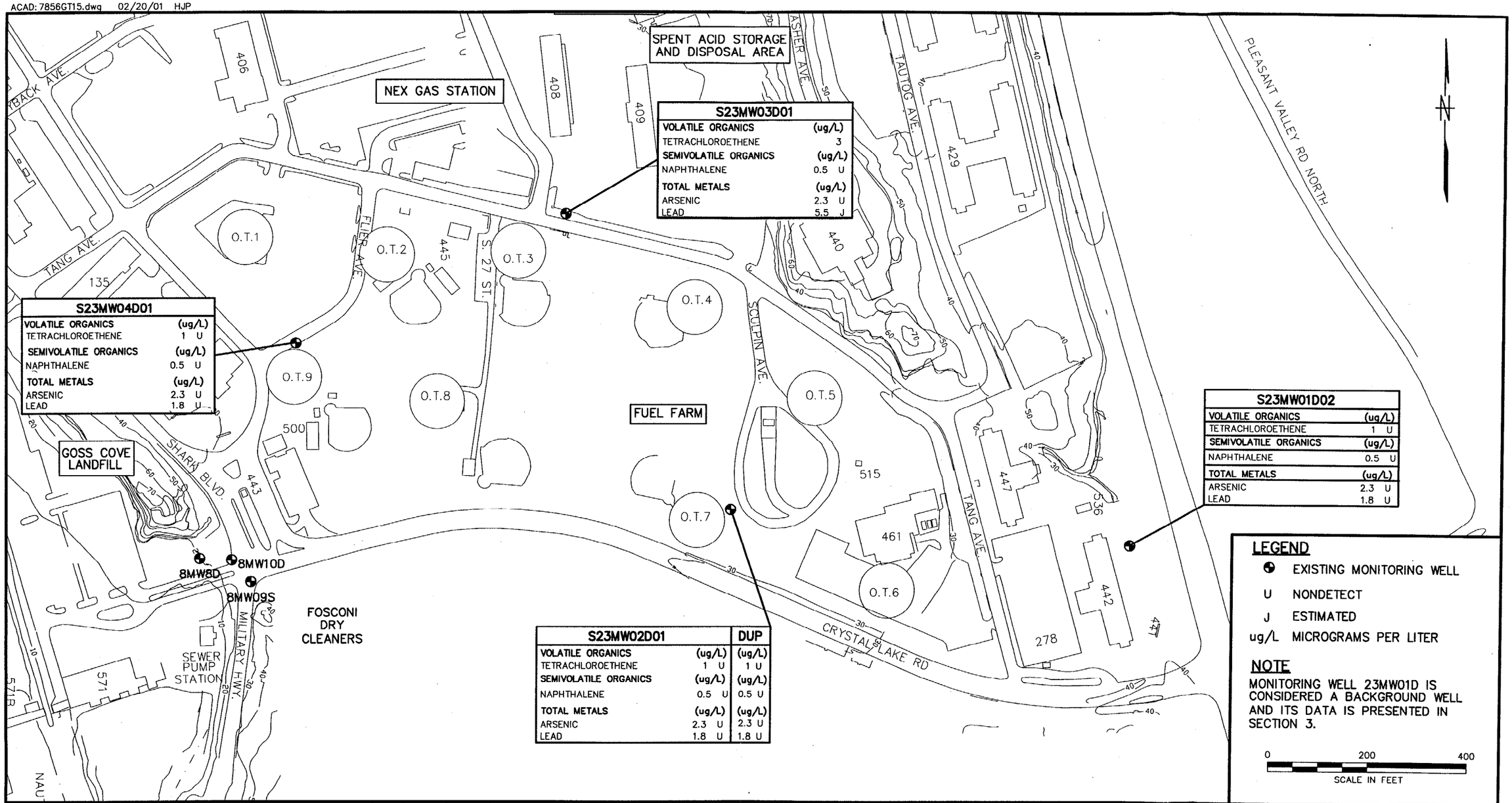
Tetra Tech NUS, Inc.

COPCs IN GROUNDWATER
OVERBURDEN WELLS
SITE 23 – TANK FARM
NSB-NLON, GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY David P. Lecone DATE 2/21/01
APPROVED BY DATE
DRAWING NO. FIGURE 13-2
REV. 0

FORM CADD NO. T+NUS_BH.DGN - REV 0 - 1/20/98

ACAD: 7856GT15.dwg 02/20/01 HJP



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/11/00
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

COPCs IN GROUNDWATER
BEDROCK WELLS
SITE 23 – TANK FARM
NSB-NLON, GROTON, CONNECTICUT

CONTRACT NO. 7856
OWNER NO. 0312
APPROVED BY D.T. Carcone DATE 2/21/01
APPROVED BY DATE
DRAWING NO. FIGURE 13-3
REV. 0

FORM CADD NO. TtNUS_BH.DGN - REV 0 - 1/20/98

14.0 CONCLUSIONS

The scope of work defined in the Work Plan and Sampling and Analysis Plan for the Basewide Groundwater Operable Unit Remedial Investigation, Naval Submarine Base-New London, Groton, Connecticut (TtNUS, 2000a) was successfully executed and the results of the investigation are summarized in this report. Ten IRP sites were included in the RI. The primary focus of the RI was the groundwater OU at each site; however, the soil OU was also investigated at several sites. The data that were gathered during the investigation at eight sites were evaluated in conjunction with historic data to determine the environmental concerns related to the sites and to develop recommendations for the sites. For two sites, RI constituted the initial investigation.

One of the three following recommendations was made for each of the sites:

- Prepare no-further-action decision document.
- Proceed to a FS.
- Continue an existing Groundwater Monitoring Program.

No further action was recommended for Sites 7 (soil), 16, and 18. An FS was recommended for Sites 3/14, 7 (groundwater), 15, and 20. Continuation of existing groundwater monitoring programs was recommended for Sites 2, 8, and 23.

Additional information that supports these site-specific recommendations is summarized below. The information is a condensed version of the more detailed summary and conclusion sections found in the individual sections of the report (Sections 5 through 13).

14.1 SITE 2 – AREA A WETLAND AND LANDFILL

The Navy completed a soil remedial action at Site 2 that consisted of the construction of an engineered cap over the Area A Landfill and an upgradient trench to reduce the amount of shallow groundwater reaching the landfill. The BGOURI activities for Site 2 focused on evaluating the current groundwater conditions at the site. The monitoring wells included in the Groundwater Monitoring Program for the Area A Landfill were the only wells sampled during the BGOURI, and the results presented in this RI constitute the results for Round 4 of the monitoring program for Site 2. Based on the most recent groundwater data, the impacts of Site 2 on groundwater downgradient of the landfill are minimal, with only sporadic detections of acetone and several metals at concentrations above screening criteria.

The HHRA determined that risks posed by exposure of construction workers to groundwater at Site 2 are within USEPA and CTDEP acceptable levels, assuming that the workers are exposed to the maximum observed concentrations of site contaminants. Screening criteria for groundwater to surface water were exceeded for two metals (using maximum detected concentrations); however, with isolated exceptions, metals detections are within the background concentration range.

The BGOURI sampling results indicated that groundwater impacts associated with Site 2 are minimal and localized. A quarterly Groundwater Monitoring Program is currently being implemented at Site 2. This report recommends that the program be continued to gather data to evaluate long-term trends in contaminant concentrations. Should groundwater data indicate the need for additional remedial action evaluation at some point in the future, an FS should be performed at that time.

14.2 SITES 3 AND 14 - AREA A DOWNSTREAM WATERCOURSES/OBDA AND OBDANE

A significant remedial action was completed for Site 3 soil and sediment in 2000. Approximately 18,050 tons of soil and sediment contaminated with pesticides and metals were excavated from Site 3 waterbodies. The excavated material was disposed off site, and each water body was restored. A previously unknown source area was discovered during the remedial action at Site 3, located north of Stream 5 and east of the Small Arms Range. It is recommended that the soil OU associated with this source area be investigated further and addressed independently of this BGOURI. A removal action will likely be appropriate for this source area.

The Navy intends to address contaminated soil and rubble present at the OBDANE through a non-time-critical removal action. The removal action is scheduled for the spring of 2001.

Groundwater sampling results for Sites 3 and 14 indicate that the water quality is generally good, with only sporadic, low-concentration detections of VOCs and metals in site monitoring wells. The major contaminant of concern in the soil and sediment, DDTR, was detected in only one sample and it is likely that the detection is associated with high levels of dissolved solids in the groundwater sample versus dissolved pesticides. The data indicate that there are multiple minor sources of chlorinated solvents that are leaching to groundwater, but the sources are not significant enough to create discernible contaminant plumes. A preliminary evaluation of natural attenuation data indicated that biodegradation and other natural attenuation processes are acting to reduce organic contaminants to relatively insignificant levels in the Area A Downstream and that it is likely that monitored natural attenuation would be viable for the source area impacting 2DMW29S.

The HHRA determined that risks posed by exposure of construction workers to groundwater at Sites 3 and 14 are within USEPA and CTDEP acceptable levels, assuming that the workers are exposed to the

maximum observed concentrations of site contaminants. The HHRA also determined that risks posed by exposure of hypothetical future residents to groundwater at Sites 3 and 14 are outside USEPA and CTDEP acceptable levels, assuming the residents are exposed to the maximum observed concentrations of site contaminants. Arsenic, benzo(a)pyrene, TCE, and vinyl chloride were the major contributors to the ICRs, and thallium was the major contributor to the HIs. It should be noted that the groundwater is classified by CTDEP as GB groundwater (i.e., not suitable for direct human consumption without treatment) and it is not likely that the groundwater will be used for human consumption in the forseeable future.

Even though contaminant concentrations were generally low and risks are acceptable under the current land use scenario, an FS was recommended for the groundwater OU associated with Sites 3 and 14. The recommendation was made primarily because land use could change in the future that could result in unacceptable risks to potential residential receptors and there are no current controls on land use.

14.3 SITE 7 – TORPEDO SHOPS

A small soil removal action was completed at the Torpedo Shops to address TPH contamination from an UST. This removal action was performed under the CTDEP's UST Program and not CERCLA. Soils adjacent to Building 325 with TPH concentrations in excess of 500 mg/kg were excavated and disposed at an off-site location.

The leach fields that were historically used at Site 7 for wastewater disposal and were the primary suspected sources for releases have been permanently decommissioned. All the buildings at Site 7 are connected to public water and sewer, essentially cutting off this potential migration pathway for contaminants.

Organic contaminant detections in soils were scattered and were primarily PAHs, which are typically found near paved areas because they are a primary component of road tars. Metals detections above background were scattered and were in general only slightly above the background concentrations. Groundwater sampling results for the Torpedo Shops indicate that there are only sporadic, low-concentration detections of contaminants in site monitoring wells. There are no discernible contaminant plumes of any size, indicating that there are no significant sources leaching contamination to groundwater at Site 7.

Cumulative carcinogenic and noncarcinogenic risks posed by exposure to soils at Site 7 do not pose an unacceptable risk via direct contact exposures. Exposure of construction workers to groundwater at Site 7 is within acceptable levels. Future residential groundwater usage risks were marginally above the acceptable risk range based on maximum concentrations. The groundwater, however, is classified by

CTDEP as GB groundwater (i.e., not suitable for direct human consumption without treatment) and it is not expected that it will be used for human consumption in the foreseeable future.

Because the risks associated with Site 7 soil are within USEPA and CTDEP acceptable risk ranges, an FS for the soil OU at Site 7 was not recommended. A no-further-action decision document should be prepared for this OU. However, even though contaminant concentrations were generally low and risks are acceptable under the current land use scenario, it was recommended that an FS be prepared for the groundwater OU associated with Site 7. The recommendation for the groundwater was made primarily because land use could change in the future that could result in unacceptable risks to potential receptors and there are no current controls on land use.

14.4 SITE 20 - AREA A WEAPONS CENTER

A small soil removal action is planned for the Area A Weapons Center to address soil contaminated with PAHs and metals. The removal action, scheduled to be completed in the spring of 2001, will address all the known soil contamination that could be affecting the groundwater at the site.

In general, organic and inorganic contaminants were detected infrequently and at low concentrations in the groundwater at Site 20. TCE and benzo(a)pyrene were the only organic contaminants identified as groundwater COPCs. Metals identified as COPCs were antimony, arsenic, nickel, silver, thallium, and zinc. High levels of TSS and TDS in one sample may be the reason for the elevated concentrations of two metals. All the organic and inorganic COPCs were identified in samples from overburden monitoring wells.

Risks posed by exposure of construction workers to groundwater at Site 20 are within acceptable levels. For future residential groundwater usage the calculated risks were above the CTDEP acceptable levels and were marginally above the USEPA acceptable risk range based on maximum concentrations. The groundwater, however, is classified by CTDEP as GB groundwater (i.e., not suitable for direct human consumption without treatment) and it is not expected that it will be used for human consumption in the foreseeable future.

Even though contaminant concentrations were generally low and risks are acceptable under the current land use scenario, it is recommended that an FS be prepared for the groundwater OU associated with Site 20. The recommendation was made primarily because land use could change in the future that could result in unacceptable risks to potential residential receptors and there are no current controls on land use.

14.5 SITE 16 – HOSPITAL INCINERATOR

For the Site 16 investigation, both surface soil and subsurface soil samples were collected and analyzed. Temporary groundwater monitoring wells were proposed to be installed and sampled at this site in the final Work Plan; however, they were not installed or sampled because of the shallow depth of bedrock at this site.

The nature and extent and HHRA results from this RI indicate that the past operation of the skid-mounted incinerator at Site 16 has not significantly impacted the surrounding soil and the site soils do not pose significant risks to any potential human receptors.

Even though several chemicals were detected at concentrations that exceed screening criteria for contaminant migration from soil to groundwater, it is unlikely that the groundwater beneath this site is impacted because of the following reasons:

- The CTDEP pollutant migration criteria, which were used to identify migration COPCs, are overly conservative and the COPCs at this site (i.e., dioxins/furans, PCBs, and metals) are not typically mobile in dissolved phase.

- Asphalt paving covers a majority of the site and limits infiltration through the soil and erosion of surface soil.

- Relatively competent bedrock is very shallow at this site and it is likely that it would impede vertical contaminant migration.

The results of the RI did not indicate that subsequent rounds of investigation were necessary to further characterize the site. In addition, the results did not suggest that an FS was necessary for this site. Therefore, it was recommended that a no-further-action decision document be prepared for the site.

14.6 SITE 8 – GOSS COVE LANDFILL

A remedial action is currently being conducted for the soil OU at Site 8. The main components of the remedial action are the installation of an engineered landfill cap and implementation of institutional controls. A secondary component of the remedial action is the decommissioning of the existing storm sewer and the installation of a replacement storm sewer system. The Navy plans to implement a Groundwater Monitoring Program when the remedial action for the soil is complete. A draft Groundwater Monitoring Plan (TtNUS, 2000) was prepared and is currently under regulatory review.

It is expected that chlorinated solvent concentrations within the Site 8 groundwater will decrease when the upgradient source from the Fusconi Dry Cleaners is addressed. The CTDEP and Fusconi's consultant are currently working to address this problem.

The analytical data from this RI indicate that sources of VOCs, SVOCs, and metals within the fill material are continuing to impact the shallow groundwater at the site. Based on contaminant fate and transport information, it is likely that these chemicals are mobile and are being transported in the groundwater to the Thames River. However, the results of the human health risk assessment showed that all ICRs for construction workers exposed to groundwater at Site 8 were less than or within target risk ranges.

The results of this investigation confirmed the conceptual site model developed during the previous investigations. Based on this RI's findings, it is recommended that the Navy complete the soil OU remedial action, implement land use controls, and begin the Groundwater Monitoring Plan as soon as the action is finalized. Installation of the engineered cap should significantly reduce vertical contaminant migration from the unsaturated soil to the groundwater, which in turn will reduce any lateral contaminant migration from the groundwater to the Thames River. This theory will be confirmed by execution of the Groundwater Monitoring Plan. It is recommended that the decision for preparation of an FS for the groundwater OU at Goss Cove Landfill be postponed until site conditions stabilize and the groundwater monitoring program determines the trends in groundwater contaminant concentrations. If the results of the monitoring program support the determination that there are no unacceptable risks to human health or the environment, then an FS will not be prepared and the Navy will pursue a no-further-action ROD for the groundwater OU. If the results suggest that further actions are required, then the Navy will prepare an FS for the groundwater OU to develop appropriate remedial alternatives.

14.7 SITE 15 – SPENT ACID STORAGE AND DISPOSAL AREA

A removal action was previously conducted at this site to remove an UST and to address associated lead contamination in the soil. The Navy and regulators signed a No-Further-Action Source Control ROD for the soil OU at this site after the action was completed.

Samples were collected from four existing groundwater monitoring wells and analyzed during the RI. The results of the investigation indicate that residual contamination (i.e., metals) from the former SASDA is impacting the groundwater at the site. Because the groundwater is relatively acidic, it is likely that lead and the other detected metals will be mobile and migrate from the site. However, their mobility should decrease as they migrate toward and through the more reducing and more basic pH environment of Site 23 (Tank Farm). It also appears that a source of TCE that is unrelated to the site is impacting the Site 15 groundwater.

The HHRA results from this RI indicate that Site 15 groundwater does not pose a significant risk to construction workers but does pose potential risks to hypothetical human receptors. ICRs and HIs for construction workers exposed to groundwater at Site 15 were within USEPA and CTDEP acceptable levels. ICRs for future adult residents exposed to groundwater at Site 15 were less than or within acceptable risk level. HIs for future adult residents exposed to groundwater at Site 15 exceeded the acceptable level of 1.0 under the RME scenario. Chromium and silver were the major contributors to the HI. The IEUBK model was used to evaluate exposures of lead in groundwater by hypothetical residential children. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in groundwater at Site 15.

This RI completed the necessary characterization of the groundwater OU at this site. It is recommended that an FS be prepared for the groundwater OU to address contaminant migration issues and the potential risks associated with metals to potential future residential receptors.

14.8 SITE 18 – SOLVENT STORAGE AREA (BUILDING 33)

For this initial site assessment at Site 18, both surface soil and subsurface soil samples were collected and analyzed. Three temporary groundwater monitoring wells were installed; however, only two were sampled during the RI because one well was dry.

The nature and extent of contamination and HHRA results from this RI indicate that past storage of solvents at Building 33 (Site 18) has not significantly impacted the surrounding media and the site does not pose significant risks to any potential human receptors. All ICRs for exposure to soil at Site 18 were less than or within target risk ranges. All HIs for exposure to soil at Site 18 were less than the acceptable level of 1.0. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in soil at Site 18, and the slope-factor approach developed by the USEPA Technical Review Workgroup for lead indicated that adverse effects are not anticipated for nonresidential adults exposed to lead in surface soil at the Site 18

The groundwater analytical data did not indicate that the site soils have impacted the groundwater. The results of this RI do not indicate that subsequent rounds of investigation are necessary to further characterize this site or that an FS is necessary. Therefore, it was recommended that a no-further-action decision document be prepared for Site 18.

14.9 SITE 23 – TANK FARM

Petroleum contamination related to the former USTs and their associated piping was identified during previous investigations at Site 23. The Navy has conducted three removal actions to address the

identified contamination. Soil and free product were removed in the vicinity of OT-8 and OT-3 during the removal actions. Contaminated soil was also removed along Tang Avenue. In addition, BTEX compounds were historically detected in the groundwater in the Tank Farm and it was determined that the contamination was related to leaking USTs from an adjacent site (i.e., NEX Gas Station). The leaking USTs have been fixed and an AS/SVE system was installed to address the associated BTEX plumes.

Petroleum contamination was also historically detected in stormwater/groundwater collected from the Tank Farm. This stormwater/groundwater discharged to the Thames River at Goss Cove Landfill. Typically, the contamination was detected during a storm event when high surface water flow rates passed through the combined storm sewer/groundwater collection system. To minimize this problem, the combined system was separated into a shallow surface water collection system and a deep groundwater collection system. A sampling and analysis program is currently being conducted to determine if any treatment of the groundwater is necessary prior to discharge to the Thames River. Preliminary results from the program indicate that treatment may not be necessary, but a final decision on treatment will be made after more data collected and the Navy consults further with the regulators (i.e., USEPA and CTDEP).

Groundwater sampling results for Site 23 indicate that the water quality is generally good, with only sporadic, low-concentration detections of VOCs, SVOCs, and metals in site monitoring wells. A preliminary evaluation of natural attenuation data indicated that biodegradation and other natural attenuation processes may be acting to reduce organic contaminants to relatively insignificant levels in the Tank Farm. However, it was not recommended that a monitored natural attenuation alternative be pursued for the site.

The HHRA determined that risks posed by exposure of construction workers to groundwater at Site 23 are within USEPA and CTDEP acceptable levels. Risks for adult residents exposed to groundwater at Site 23 were less than or within USEPA and CTDEP acceptable levels. However, the chemical-specific ICR for PCE exceeded CTDEP's target level of 1×10^{-6} for individual chemicals, although the maximum detected concentration for PCE was less than its CTDEP RSR. The IEUBK model indicated that no adverse effects are anticipated for hypothetical future child residents exposed to lead in groundwater at Site 23.

Based on the results of the risk assessment and the fact that the groundwater at Site 23 is not used for human consumption and it is not likely to be used for human consumption in the foreseeable future because of its current classification (i.e., GB groundwater which indicates not suitable for direct human consumption without treatment), an FS was not recommended for this site. However, it was recommended that the decision for preparation of an FS for the groundwater OU at the Tank Farm be

postponed until site conditions stabilize and the results of the current sampling and analysis program for the groundwater collection system determine the trends in groundwater contaminant concentrations. If the results of the monitoring program support the determination that there are no unacceptable risks to human health or the environment, then an FS will not be prepared and the Navy will pursue a no-further-action ROD for the groundwater OU. If the results suggest that further actions are required, then the Navy will prepare an FS for the groundwater OU to develop appropriate remedial alternatives.

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