8/1/08-01461

Final

Focused Feasibility Study for Site 7

Naval Amphibious Base Little Creek
Virginia Beach, Virginia

NAVFAC
Naval Facilities Engineering Command
NAVFAC MID-ATLANTIC

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Contract No. N62470-02-D-3052
CTO-0103

August 2008

Prepared by

CH2MHILL

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Executive Summary

This report presents the Focused Feasibility Study for Site 7, Amphibious Base Landfill, at Naval Amphibious Base Little Creek in Virginia Beach, Virginia. This report was prepared by CH2M HILL under the Naval Facilities Engineering Command, Mid-Atlantic Division, Comprehensive Long-term Environmental Action Navy III Contract N62470-02-D-3052, Contract Task Order 103, for submittal to NAVFAC Mid-Atlantic, the U.S. Environmental Protection Agency, and the Virginia Department of Environmental Quality.

Naval Amphibious Base Little Creek comprises 2,215 acres in Virginia Beach, Virginia, near the mouth of the Chesapeake Bay. Site 7 is located in the south-central part of the facility. It is bordered on the east by Helicopter Road, on the south by Amphibious Drive, on the north by Little Creek Cove, and on the west by the ordnance storage area. The 38-acre landfill operated between 1962 and 1979. A nonconforming permit was issued by the Commonwealth of Virginia Department of Health on August 28, 1979 to allow disposal on an interim basis at Site 7, as site conditions were not conducive for landfilling. Initially, the landfill operated as a trench-type landfill with open burning of refuse in the trenches. The landfill was later operated as an area landfill, with refuse spread over the ground and covered regularly. This type of landfilling operation has resulted in the current surface topography and elevation. A total of approximately 500,000 cubic yards of waste (Rogers, Golden, & Halpern, 1984) was disposed at Site 7. Most of the waste is presumed to be non-hazardous solid waste from base housing and other residential activities at the installation, although records documenting the types and quantities of waste placed in the landfill are not available.

Previous investigations conducted at Site 7, prior to Naval Amphibious Base Little Creek's listing on the National Priorities List in May 1999, included an Initial Assessment Study, a Round 1 Verification Step, an Interim Remedial Investigation, and a Remedial Investigation/Feasibility Study. Following these investigations, a Proposed Remedial Action Plan and Decision Document were prepared for the site. In 1998, the Remedial Action—debris removal and limited soil cover—was completed as part of the remedy. Soil cover and topsoil was placed on those areas where the existing soil cover was inadequate to support vegetation (mainly the area east of the canal and central area of the landfill). Additionally, a long-term monitoring program was initiated.

Following Naval Amphibious Base Little Creek's National Priorities Listing, a revised Remedial Investigation, which included a human health risk assessment and ecological risk assessment, was conducted. Unacceptable ecological risks in canal sediment were mitigated through an engineering evaluation/cost analysis and non-time critical removal action. The only unacceptable human health risks are associated with waste in place. Maintenance activities are ongoing. Recent maintenance activities were conducted to ensure a minimum of 2 feet of soil cover was placed over landfill contents and miscellaneous debris was removed. The long-term monitoring program was discontinued until the final remedy selection decision could be documented in a Record of Decision for the site.

The 1998 Remedial Action debris removal and soil cover remedy was implemented at Site 7 prior to Naval Amphibious Base Little Creek's placement on the National Priorities List.

This Focused Feasibility Study presents the presumptive remedy in accordance with U.S. Environmental Protection Agency's guidance document for application of the presumptive remedy process to municipal landfills *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (USEPA, 1991). The presumptive remedy approach eliminates the technology screening step from the Feasibility Study process. Consistent with this guidance, containment alternatives have been developed for soil and waste associated with Site 7. Under the presumptive remedy, land use controls will be employed and the use of groundwater will be restricted.

With the exception of a portion of the western drainage canal, where potential unacceptable risks to ecological receptors were identified, no unacceptable risks to human health and the environment were identified from exposure to soil, groundwater, sediment, or surface water at or beyond the boundaries of the landfill. The only unacceptable risk is exposure to landfill contents. Therefore, the Remedial Action Objective for Site 7 is to prevent human and ecological receptor exposure to landfill contents through containment alternatives (2 foot minimum soil cover) and land use controls. To monitor for a potential future release associated with waste remaining in place, groundwater long-term monitoring will be a component of the presumptive remedy. In accordance with Section 121 of the Comprehensive Environmental Response Compensation and Liability Act, a review will be conducted every 5 years to assess the continued protectiveness of the remedy.

Following the presumptive remedy approach, the alternatives evaluated in the Focused Feasibility Study are:

- Alternative 1 – No Action
- Alternative 2 – Maintenance of the existing soil cover, land use controls, and groundwater long-term monitoring

Alternative 1 is not protective of human health and the environment and does not meet the Remedial Action Objective. The presumptive remedy (Alternative 2) achieves the Remedial Action Objective for the site.

Acronyms and Abbreviations

ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action Navy
CTE	central tendency exposure
CTO	Contract Task Order
CWA	Clean Water Act
DD	Decision Document
EE/CA	Engineering Evaluation/Cost Analysis
EPC	exposure point concentration
ERA	Ecological Risk Assessment
FEMA	Federal Emergency Management Agency
FFS	Focused Feasibility Study
FS	Feasibility Study
GRA	General Response Action
HHRA	Human Health Risk Assessment
HQ	hazard quotient
IRA	Interim Removal Action
LTM	long-term monitoring
LUC	land use control
MCL	maximum contaminant level
NAB	Naval Amphibious Base
NAVFAC	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NPL	National Priorities List
NTCRA	Non-Time Critical Removal Action
PCB	polychlorinated biphenyl
PRAP	Proposed Remedial Action Plan
RA	Remedial Action
RAO	Remedial Action Objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision

SARA	Superfund Amendments and Reauthorization Act
SVOC	semi-volatile organic compound
TBC	to be considered
µg/L	micrograms per liter
USEPA	U.S. Environmental Protection Agency
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound
VWQS	Virginia Water Quality Standards

SECTION 1

Introduction

This Focused Feasibility Study (FFS) report was prepared by CH2M HILL under the Naval Facilities Engineering Command, Mid-Atlantic Division (NAVFAC), Comprehensive Long-term Environmental Action Navy (CLEAN) III Contract N62470-02-D-3052, Contract Task Order (CTO) 103, for submittal to NAVFAC Mid-Atlantic, U.S. Environmental Protection Agency (USEPA), and the Virginia Department of Environmental Quality (VDEQ).

1.1 Purpose and Organization

The FFS for Site 7, Former Amphibious Base Landfill, has been developed to evaluate the presumptive remedy, with respect to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) criteria, exposure to landfill contents, and soil and groundwater located within the boundary of the landfill. The FFS was developed in accordance with USEPA's presumptive remedy for municipal landfills guidance document *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (USEPA, 1991); *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills* (USEPA, 1996); and Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA).

This report contains the following sections:

- Section 1 - Introduction
- Section 2 - Remedial Action Objectives and General Response Actions
- Section 3 - Detailed Analysis of Remedial Alternatives
- Section 4 - Comparative Analysis
- Section 5 - References

Figures and tables referenced within the text are provided at the end of each section. Appendixes are provided at the end of the report.

1.2 Description and Background

Naval Amphibious Base (NAB) Little Creek is primarily an industrial facility that provides logistic facilities and support services for local commands, organizations, home-ported ships, and other units to meet the amphibious warfare training requirements of the armed forces of the United States. In addition to industrial land use, NAB Little Creek is also used for recreational, commercial, and residential purposes. The location of NAB Little Creek is shown in **Figure 1-1**.

The area surrounding the 2,215-acre NAB is low-lying and relatively flat and contains several fresh water lakes. Chubb Lake, Lake Bradford, Little Creek Reservoir/Lake Smith, and Lake Whitehurst are located on, or adjacent to, the base. Little Creek Reservoir/Lake

Smith, located south of the base, serves as a secondary drinking water supply for parts of the city of Norfolk. NAB Little Creek is bordered by three saltwater bodies: Little Creek Cove, Desert Cove, and Little Creek Channel, which connects the coves with the Chesapeake Bay. The Chesapeake Bay borders the facility to the north.

1.2.1 Site 7 Description and History

Site 7 consists of approximately 38 acres located in the south-central part of NAB Little Creek. The landfill is bordered on the east by Helicopter Road, on the south by Amphibious Drive, on the north by Little Creek Cove, and on the west by the ordnance storage area (**Figure 1-2**). In the western portion of Site 7, a drainage canal runs south to north into Little Creek Cove. A discontinuous portion of the landfill referred to as the "ear" is located west of the drainage canal. Two locked gates control vehicle access to the landfill across access roads on the site's eastern and western sides. The locked gate along the old western access road and dense vegetation along the western side prevent access to the ear area. The culvert providing access from the ear to the landfill collapsed in 2002 and was removed during the 2006 IRA. There is no longer access to the landfill from the west across the drainage canal and access from the north is limited by Desert Cove. A chain-link fence runs along the site's eastern and southern boundaries. Pedestrian access along the eastern and western borders is deterred by dense vegetation.

The Amphibious Base Landfill was operated between 1962 and 1979. Initially, waste disposal operations were conducted as a trench-type landfill with open burning of refuse in the trenches. The landfill was later operated as an area landfill, with refuse spread over the ground and covered regularly. It is estimated that the landfill contains approximately 500,000 cubic yards of waste; most of which is presumed to be solid waste from base housing and other residential activities at the installation. Waste oils and metals segregated from the waste were also reportedly disposed of in the landfill starting in 1970. After closure, the landfill continued to be used as a metal collection and transfer site, temporary storage site for wastes, and a burn area for scrap wood and trees. Open burning was halted in 1984. Waste storage activities at the site ceased in 1994. A soil cover (2 foot minimum) was placed over a portion of the landfill as part of a 1998 Remedial Action (RA).

1.3 Previous Investigations

Previous investigations conducted at Site 7, prior to NAB Little Creek's listing on the National Priorities List (NPL) in May 1999, include an Initial Assessment Study, a Round 1 Verification Step, an Interim Remedial Investigation, and a Remedial Investigation/ Feasibility Study (RI/FS). Following these investigations, the Proposed Remedial Action Plan (PRAP) and the Final Decision Document (DD) were prepared for the site. Detailed descriptions of these investigations and documents can be found in the *Final Remedial Investigation/Human Health Risk Assessment for Site 7* (CH2M HILL, 2004a).

A limited soil cover was placed over the Site 7 Amphibious Base Landfill (excluding the "ear") in accordance with the 1998 DD (CH2M HILL, 1998) agreed upon by the Navy, USEPA, and VDEQ. The soil cover remedy was constructed in 1999, and included the removal of 610 cubic yards of debris along the landfill shoreline and placement of soil cover and topsoil on those areas where the existing soil cover was inadequate to support

vegetation. A 12- to 18-inch-thick fill layer was placed over the central portion of the landfill where cover was inadequate, and a 6- to 8-inch topsoil cover was placed over the cover and remaining landfill area lacking adequate vegetation (OHM Remediation Services Corporation, 1999). Approximately 8,640 cubic yards of clean fill and 11,260 cubic yards of topsoil were placed on the landfill during the RA.

Following NAB Little Creek's NPL listing, a revised RI, which included a human health risk assessment (HHRA) and an ecological risk assessment (ERA), was conducted. The HHRA evaluated risks posed by surface and subsurface soil and groundwater. The only unacceptable human health risks identified at Site 7 are associated with the waste in place. The ERA identified potential ecological risk associated with sediments in the western drainage canal. Risks were associated with copper, lead, Aroclor® 1260, and five pesticides present in canal sediments. These risks were mitigated through an engineering evaluation/cost analysis (EE/CA) (CH2M HILL, 2005a) and non-time critical removal action (NTCRA). During development of the EE/CA for sediment removal, a series of site visits and test pitting activities identified areas where maintenance activities could improve the 1998 soil cover remedy (CH2M HILL, 2005c). In February 2007, a NTCRA was completed (AGVIQ/CH2M HILL, 2007). During the NTCRA, a total of 2,858.18 tons of sediment and debris were removed and the canal was backfilled with 1 foot of clean fill to its original depth. In addition, stabilization of the eastern bank of the canal and maintenance of the soil cover on the western edge of landfill was conducted (Figure 1-3).

Landfill operations and maintenance (O&M) activities were conducted January through July 2008 to extend the soil cover over the remaining portion of the landfill area (AGVIQ/ CH2M HILL, 2008). Vegetation was removed from the landfill and the northern boundary was stabilized with bamboo matting to prevent erosion and sedimentation in Little Creek Cove (Figure 1-3). An 18-inch thick layer of clean fill and a 6-inch layer of topsoil were placed over the landfill and seeded. Additionally, debris was removed from the pond and the adjacent landfill boundary was stabilized using concrete matting.

It was assumed there was no waste in place west of the drainage canal (the "ear") and the LUC boundary was initially drafted to encompass the landfill area east of the canal. However, the Navy, USEPA, and VDEQ agreed adequate data was not available to ensure the absence of waste in the "ear" area and in March 2008, 9 test pits were excavated to confirm the presence or absence of subsurface debris west of the drainage canal. Surface debris was scattered across the area. However, subsurface debris (battery, tire, crane foot, wood, and glass) was considered minimal and there was no evidence of landfilling consistent with trench, burn, and bury activities. Surface debris is likely the result of storage by facility personnel and will be removed.

1.4 Nature and Extent of Contamination

The following subsection presents the data collected for soil, groundwater, surface water, and sediment during the 1994 RI and 1998-2003 (Rounds 1-10) long-term monitoring (LTM) program. Sampling locations are shown on **Figure 1-4**.

1.4.1 Groundwater

Groundwater samples were collected and analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals. Total and dissolved concentrations of antimony, arsenic, and thallium exceeded federal maximum contaminant levels (MCLs). Maximum concentrations of total and dissolved arsenic, iron, manganese, thallium, and vanadium also exceeded background concentrations. Total beryllium, cadmium, and chromium exceeded MCLs and background concentrations, but dissolved concentrations were below these screening criteria. One VOC (methylene chloride) and two SVOCs (hexachlorobenzene and hexachlorobutadiene) were detected above their respective MCLs. There were no increases in inorganic or organic concentrations downgradient of the site, which would indicate a potential release.

A Kendall statistical analysis was completed for groundwater data collected from July 1993 through September 2003 to evaluate seasonal and spatial trends over time across the site and for groundwater samples collected from each monitoring well (CH2M HILL, 2005b). No organic constituents exhibited significant seasonal or spatial differences in concentrations in groundwater. For metals, 16 percent of the data set exhibited decreasing trends and 2 percent exhibited increasing trends. The decreasing trends were not specific to single parameters. The increasing trends were specific to dissolved selenium, total and dissolved thallium, and total and dissolved vanadium, which may be attributed to laboratory instrument interference and likely are not a result of contaminant migration.

1.4.2 Surface Water

Surface water samples were collected and analyzed for VOCs and total metals during the 1994 RI. During 1998-2000 (Rounds 1-4) LTM, surface water samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and total and dissolved metals. No SVOCs or pesticides/PCBs were detected above adjusted (x10) tap water risk-based concentrations (RBCs) and/or Virginia Water Quality Standards (VWQS) for human health in Rounds 1-4; therefore, during 2001-2003 (Rounds 5-10) LTM surface water was analyzed for VOCs and total and dissolved metals. VOCs, bromodichloromethane, and chloroform were detected above adjusted RBCs; however, they did not exceed VWQS. 1,1,2,2-tetrachloroethane was detected at a concentration of 1J microgram per liter (µg/L), above adjusted RBCs. Total and dissolved arsenic and dissolved thallium were detected in surface water above adjusted RBCs, while total and dissolved mercury was detected above VWQS. These exceedances did not consistently occur throughout LTM sampling rounds.

The Kendall statistical analysis of surface water data collected from June 1998 through September 2003 indicates 93 percent of the 351 constituents detected exhibited no significant change in concentration over time (CH2M HILL, 2005b). Arsenic, copper, lead, manganese, mercury, and thallium exhibited significant changes over time, among locations, and/or across seasons. However, surface water at Site 7 is tidally influenced, and statistical changes of inorganics are likely the result of tidal fluctuation and turbidity at the time of sample collection and not indicative of a site release.

1.4.3 Sediment

Sediment samples were collected in conjunction with surface water and analyzed for VOCs, total metals, and cyanide during the 1994 RI, and for SVOCs, pesticides/PCBs, total metals,

and cyanide during 1998-2003 (Rounds 1-10) LTM. Metals and pesticides in the western tidal canal and tidal pond exhibited the greatest exceedances of the Biological Technical Assistance Group ecological screening values.

According to the Kendall test, ninety-nine percent of the 351 constituents detected were not statistically significant, indicating that sediment concentrations are stable over time (CH2M HILL, 2005b). Metals and pesticides/PCBs exhibited significant changes over time, among locations, and/or across seasons. These changes were primarily located in the western tidal canal and pond area.

1.4.4 Soil

During the 1994 RI and 1998-2003 (Rounds 1-10) LTM, surface and subsurface soil samples were collected at Site 7 and analyzed for VOCs, SVOCs, pesticides/PCBs, and metals and cyanide. VOCs, SVOCs, pesticides/PCBs were detected at low concentrations, generally estimated near reporting limits, within the footprint of the landfill. Maximum concentrations of aluminum, barium, beryllium, chromium, cobalt, iron, lead, manganese, nickel, vanadium, and zinc exceeded their respective background values.

1.4.5 Contaminant Fate and Transport

The primary mechanism for contaminant transport from the site is believed to be leaching of contaminants from soil/waste through precipitation and infiltration to groundwater as groundwater migrates through Site 7 and discharges to Little Creek Cove. Because much of the site is covered by 24 inches of clean fill, direct exposure to waste in place by human and ecological receptors is prevented. In addition, the soil cover prevents erosion and deposition of potentially contaminated soil surrounding the waste remaining in place.

1.5 Human Health Risk Assessment

In April 2004, the Final RI/ HHRA revision (CH2M HILL, 2004a) was completed for Site 7. Groundwater (excluding LS07-MW06 on the "ear"), surface water, and sediment data from Rounds 5, 6, and 7 used in the risk assessment. These sampling events were conducted in February/March 2001, October 2001, and February 2002. The groundwater, surface water, and sediment data collected prior to these dates were not included in the risk assessment because these more recent samples are most representative of current site conditions for these media. Soil data collected during the FWES RI/FS and during the February 2002 sampling event were evaluated in the risk assessment.

Exposure point concentrations (EPCs) used to calculate risks for soil, sediment, and surface water are summarized in Appendix E, Tables 3.11 through 3.15 of the RI/HHRA (CH2M HILL, 2004a), and a summary of reasonable maximum exposure (RME) and central tendency exposure (CTE) cancer risks and non-cancer hazards for these media is presented on **Tables 1-1** and **1-2**, respectively.

Based on the March 2008 test pitting results, the human health risk assessment for groundwater was revised to include groundwater data collected from LS07-MW06 located on the "ear" area. The receptor scenarios and groundwater data set (LTM Rounds 5, 6, and 7) including LS07-MW06 were used to recalculate risk associated with exposure to

groundwater in the revised 2008 HHRA. Monitoring well LS07-MW05 was not sampled during LTM Rounds 5, 6, and 7; therefore, was not included in the revised groundwater risk assessment. The revised groundwater HHRA tables are presented in **Appendix A.** A summary of RME and CTE cancer risks and non-cancer hazards for groundwater is presented on **Tables 1-3** and **1-4**, respectively. The results of the 2004 soil, sediment, and surface water HHRA and updated 2008 groundwater HHRA are summarized below.

1.5.1 Soil

Exposure to surface and subsurface soil were evaluated separately for four different areas within Site 7: the weigh station area, "the ear" to the west of the landfill, the perimeter of the site, and the area of the landfill covered with clean fill. Potential risks associated with exposure to site soil were quantitatively evaluated for the following receptors: current maintenance workers, current adolescent trespassers/visitors, future construction workers, future industrial workers, and future adult and child residents. The RME EPCs were calculated as the 95 percent upper confidence limit (95% UCL) of the arithmetic mean concentration. The maximum detected concentration was used in place of the 95% UCL when the calculated 95% UCL was greater than the maximum detected value or when the soil exposure area data set was fewer than 5 samples (CH2M HILL, 2004a). This resulted in a conservative estimate of the risks associated with exposure to the soil by the potential receptors. If the site were evaluated as one exposure area (single data set), the EPC would likely be less than the maximum detected concentration, resulting in a less-conservative estimate of risk.

All non-cancer hazards and cancer risks for the current-use scenarios are within USEPA's acceptable risk ranges. Additionally, RME cancer risks associated with future exposure to site soil are within or below USEPA's acceptable risk range for all future receptor exposure scenarios evaluated. The RME non-cancer hazard for the future child resident is greater than 1 for all soil areas evaluated. The RME non-cancer hazard for the future adult resident is greater than 1 for site perimeter soil. Additionally, site perimeter soil may present an RME non-cancer hazard greater than 1 for the future industrial and construction worker. The kidney target organ effect HQ for adult and child residents and industrial worker exposure to site perimeter soil is greater than 1 due to vanadium in Site 7 soil. However, there are no unacceptable future hazards associated with exposure to site soil based on CTE calculations. Therefore, with the exception of exposure to waste remaining in place, under the CTE scenario there are no unacceptable risks associated with site soil.

1.5.2 Surface Water and Sediment

Exposure to surface water and sediment for current adult and adolescent trespassers/ visitors and current site workers (Little Creek Cove only) were quantitatively evaluated in four different areas on or adjacent to Site 7: the canal on the west side of Site 7, the canal on the east side of Site 7, the Pond, and Little Creek Cove. RME cancer risks and non-cancer hazards were below or within USEPA's acceptable risk levels; therefore, no unacceptable human health risks are associated with exposure to surface water and sediment at Site 7.

1.5.3 Groundwater

Groundwater in the vicinity of Site 7 is not currently used as a potable water supply, and there is no complete exposure pathway. Exposure to groundwater as a potable water supply was quantitatively evaluated as a worst–case scenario for future adult and child residents, future industrial workers, and future construction workers.

RME cancer risks and non-cancer hazards associated with future construction workers exposed to site groundwater are within USEPA acceptable risk range. Based on RME calculations, cancer risks and non-cancer hazards associated with future resident's (adult and child) potable use of groundwater at Site 7 are above EPA's target levels due to the presence of arsenic, iron, and manganese (**Table 1-3**). Considerations for risk management of arsenic, iron, and manganese in groundwater at Site 7 with respect to background data, source removal, lack of a plume, groundwater classification, and the site specific geochemistry of arsenic are discussed below. These risk management considerations are presented on the basis of flexibilities included in the December 2004 Statement to Tier I Teams (**Appendix B**).

Arsenic

Potential risk associated with arsenic was identified for future residential use of Columbia aquifer groundwater as a potable source. Concentrations of arsenic in site groundwater during the most recent sampling round (February 2004) were below the groundwater MCL (5 µg/L) in all samples with the exception of total and dissolved concentrations of arsenic in the samples from LS07-MW06 (**Appendix B, Table B-1**). Consequently, this risk management discussion is specifically intended to address arsenic in the samples from this well.

- *Geochemistry:* Naturally occurring arsenic in soils may be released to groundwater under reducing conditions through a process called dissimilatory iron reduction. The reaction occurs when reducing conditions result in the enhanced solubility of ferrous iron oxyhydroxide minerals that contain adsorbed arsenic. As the ferric minerals dissolve, arsenic is released to the groundwater and ferric iron is converted to ferrous iron. The reducing conditions necessary to facilitate this reaction may be produced by decaying organic matter or degradation of organic contaminants (Welch et al., 2000). According to the boring log for SB06, which was located in the same location as LS07-MW06, organic material consisting of moist wood fragments and pine needles was present within the screened interval of LS07-MW06. This organic material may be decaying and facilitating dissimilatory iron reduction as oxygen is consumed. Although no samples have been collected from LS07-MW06 for laboratory geochemical analysis, field data indicate that dissolved oxygen concentrations are generally low (less than 1 mg/L during six of the eight rounds of sampling) (**Appendix B, Table B-2**). Oxidation reduction potential (ORP) has also been less than -50 mV for the five most recent rounds of sampling, indicating that slightly reducing conditions favorable for arsenic mobilization are present in the vicinity of this well.

- *Background:* Total arsenic concentrations detected in samples included in the risk assessment ranged from not detected to 30.6 µg/L (LS07-MW06). Dissolved concentrations ranged from not detected to 22.5 µg/L (LS07-MW06). All historical arsenic concentrations are included in **Appendix B, Table A.** The total and dissolved

background UTL for arsenic in groundwater are both 4 µg/L; however, the maximum background concentrations of total and dissolved arsenic, detected in monitoring well LBG-MW11, were 105 and 78 µg/L, respectively. These concentrations were not included during UTL calculations because they were believed to be anomalous (outliers). It is important to note LBG-MW11 is located adjacent to a surface water body and epic photos indicate this well is located in a former wetland area. LBG-MW11 was last sampled in 2001 as part of the background study (CH2M HILL, 2000). During this investigation, geochemical samples were not collected and water quality parameters were not recorded. Although these data are not available for evaluation and comparison to LS07-MW06, arsenic concentrations in the samples from LBG-MW11 may be representative of background concentrations under reducing conditions and therefore, may be more appropriate than the UTLs for comparison to data from wells such as LS07-MW06.

- *No Source*: LS07-MW06 is located in the "ear" area west of a drainage channel which hydraulically divides the area around the well from the main portion of the Site 7 landfill to the east. During the most recent round of sampling for each site well, detections of total and dissolved arsenic greater than the MCL were only identified in LS07-MW06 (**Figure 1-5**). The only waste materials identified in the area surrounding LS07-MW06 were wood pilings and other inert surface debris. In April 2008, the wood pilings were sampled and analyzed for arsenic. Arsenic was not detected and a majority of the pilings were removed from the site in June 2008. Therefore, no apparent source of arsenic is present in the "ear" area in the vicinity of LS07-MW06.

- *Well Classification:* Virginia Private Well Regulations (12VAC5-630-380) prohibit the construction of Class III (private wells constructed as a source of drinking water) water wells in swampy areas, low areas, or areas subject to flooding. Monitoring well LS07-MW06 is located in the 100 year flood plain defined by the Federal Emergency Management Agency (FEMA), as shown in **Appendix B**. Because a drinking water well is not likely to be installed in the portion of Site 7 in which arsenic concentrations are greater than MCLs, risk management consideration is warranted.

Iron

- *Background Study*: Total iron concentrations detected in monitoring wells LS07-MW01, LS07-MW03, and LS07-MW06 ranged from 2,950 (LS07-MW01) to 15,500 µg/L (LS07-MW06). Dissolved concentrations ranged from 1,320 (LS07-MW01) to 13,900 µg/L (LS07-MW06). The total and dissolved background UTLs for iron in groundwater are 11,200 and 17,100 µg/L, respectively. Total iron concentrations are statistically similar to background concentrations whereas dissolved iron concentrations are below background. The above discussions regarding source removal and groundwater classification also apply to risk management of iron.

Manganese

- *Background Study*: Total manganese concentrations detected in monitoring wells LS07-MW01, LS07-MW03, and LS07-MW06 ranged from 33 (LS07-MW01) to 1,590 µg/L (LS07-MW06). Dissolved concentrations ranged from 29.8 (LS07-MW01) to 1,570 µg/L (LS07-MW06). The total and dissolved background UTLs for manganese in groundwater are 1,500 and 1,510 µg/L, respectively. Detections at Site 7 are either below or

comparable to background. The above discussions regarding source removal and groundwater classification also apply to risk management of manganese.

1.6 Ecological Risk Assessment

The *Final Ecological Risk Assessment, Site 7 – Amphibious Base Landfill, Naval Amphibious Base Little Creek, Virginia Beach, Virginia,* was completed in November 2004 (CH2M HILL, 2004b). In terrestrial areas of the site, three metals (lead, vanadium, and zinc) exceeded surface soil screening values based upon effects to terrestrial flora and background concentrations. These exceedances were primarily located in the vicinity of the former metal collection and transfer site (weigh station area). Site 7 is densely vegetated with a variety of herbaceous and small woody plants, with no areas of bare soils evident. Additionally, mean HQs for these constituents based upon soil fauna screening values are less than one. Thus, risks to lower trophic level organisms are acceptable in the terrestrial portions of the site. Risks to upper trophic level terrestrial receptors are also acceptable as there were no HQs greater than one for terrestrial-based food web exposures.

Potential ecological risks associated with sediment and surface water in aquatic/wetland areas with good habitat quality (Little Creek Cove and the adjacent vegetated wetlands) were low based upon the frequency and magnitude of screening value exceedances. The highest potential ecological risks in wetland/ aquatic habitats on Site 7 were in the central portion of the western drainage canal. Copper, lead, Aroclor® 1260, and five pesticides were identified as constituents of concern in sediments from the central portion of the western drainage canal. The highest concentrations of copper and Aroclor® 1260, and most of the pesticides, were confined to the northern part of this canal reach at sample location SD202 (**Figure 1-4**). The likely source is landfill wastes placed in this area prior to the soil cover maintenance and canal bank stabilization. The available data suggested that potential exposures and risks to lower-trophic-level receptors were possible in the central portion of the western drainage canal, although the habitat value of this drainage canal is minimal. In addition, these potential risks are likely to be spatially restricted since the available data do not indicate that these chemicals are migrating to areas with better quality habitat (e.g., Little Creek Cove).

During a September 2004 conference call, the Navy, in partnership with USEPA and VDEQ, agreed to implement an Interim Removal Action (IRA) in the western drainage canal between SD218 and a point just north of the abutment to Amphibious Drive (**Figure 1-4**) to remove sediment presenting potentially unacceptable ecological risks as identified in the ERA. Following the completion of the IRA, no unacceptable ecological risks would remain from exposure to Site 7 media (soil, surface water, and sediment). The IRA was completed in February 2007 (AGVIQ/CH2M HILL, 2007) in accordance with the EE/CA and IRA Work Plan. No further action is required to address ecological risks at the site.

Table 1-1
Summary Soil, Sediment, and Surface Water RME Cancer Risks and Hazard Indices based on the 2004 HHRA
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Receptor	Media	Exposure Route	Cancer Risk	COPCs with Cancer Risks >10^{-4}	Hazard Index	COPCs with HQ > 1
Current Maintenance Worker	Surface Soil Weigh Station Area	Ingestion	8.9E-08		5.9E-03	
		Inhalation	NA		NA	
		Dermal Contact	1.0E-07		1.9E-02	
		Total	1.9E-07		2.5E-02	
	Surface Soil Area to West of Landfill, the "Ear"	Ingestion	1.2E-07		4.0E-03	
		Inhalation	NA		NA	
		Dermal Contact	5.9E-08		8.7E-03	
		Total	1.7E-07		1.3E-02	
	Surface Soil Site Perimeter	Ingestion	1.4E-07		1.1E-02	
		Inhalation	NA		NA	
		Dermal Contact	1.7E-07		6.2E-02	
		Total	3.1E-07		7.4E-02	
		Receptor Total	6.8E-07		1.1E-01	
Current/Future Trespasser/Visitor Adolescent	Surface Soil Weigh Station Area	Ingestion	3.8E-07		7.0E-02	
		Inhalation	NA		NA	
		Dermal Contact	1.3E-07		6.9E-02	
		Total	5.1E-07		1.4E-01	
	Surface Soil Area to West of Landfill, the "Ear"	Ingestion	5.0E-07		4.8E-02	
		Inhalation	NA		NA	
		Dermal Contact	7.5E-08		3.1E-02	
		Total	5.7E-07		7.8E-02	
	Surface Soil Site Perimeter	Ingestion	6.1E-07		1.3E-01	
		Inhalation	NA		NA	
		Dermal Contact	2.1E-07		2.2E-01	
		Total	8.3E-07		3.5E-01	
	Surface Water Little Creek Cove	Ingestion	3.7E-07		6.3E-03	
		Inhalation	NA		NA	
		Dermal Contact	6.9E-08		1.2E-03	
		Total	4.4E-07		7.5E-03	
	Surface Water Pond	Ingestion	2.8E-07		4.9E-03	
		Inhalation	NA		NA	
		Dermal Contact	1.6E-08		2.7E-04	
		Total	3.0E-07		5.1E-03	
	Sediment Pond	Ingestion	2.1E-07		1.8E-02	
		Inhalation	NA		NA	
		Dermal Contact	1.1E-07		3.4E-02	
		Total	3.2E-07		5.3E-02	
	Surface Water Canal on West Side of Site	Ingestion	7.2E-07		1.2E-02	
		Inhalation	NA		NA	
		Dermal Contact	5.7E-08		9.9E-04	
		Total	7.8E-07		1.3E-02	
	Sediment Canal on West Side of Site	Ingestion	1.7E-07		7.3E-03	
		Inhalation	NA		NA	
		Dermal Contact	9.0E-08		3.2E-02	
		Total	2.6E-07		3.9E-02	
	Sediment Canal on East Side of Site	Ingestion	1.4E-07		2.4E-03	
		Inhalation	NA		NA	
		Dermal Contact	7.4E-08		1.3E-03	
		Total	2.1E-07		3.7E-03	
		Receptor Total	4.2E-06		6.9E-01	

Table 1-1
Summary Soil, Sediment, and Surface Water RME Cancer Risks and Hazard Indices based on the 2004 HHRA
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Receptor	Media	Exposure Route	Cancer Risk	COPCs with Cancer Risks >10^{-4}	Hazard Index	COPCs with HQ > 1
Current/Future Trespasser/Visitor Adult	Surface Water Little Creek Cove	Ingestion	7.1E-07		4.6E-03	
		Inhalation	NA		NA	
		Dermal Contact	1.8E-07		1.2E-03	
		Total	8.9E-07		5.8E-03	
	Surface Water Pond	Ingestion	5.5E-07		3.5E-03	
		Inhalation	NA		NA	
		Dermal Contact	4.1E-08		2.7E-04	
		Total	5.9E-07		3.8E-03	
	Sediment Pond	Ingestion	4.0E-07		1.3E-02	
		Inhalation	NA		NA	
		Dermal Contact	2.5E-07		2.9E-02	
		Total	6.5E-07		4.2E-02	
	Surface Water Canal on West Side of Site	Ingestion	1.4E-06		9.1E-03	
		Inhalation	NA		NA	
		Dermal Contact	1.5E-07		9.6E-04	
		Total	1.5E-06		1.0E-02	
	Sediment Canal on West Side of Site	Ingestion	3.2E-07		5.3E-03	
		Inhalation	NA		NA	
		Dermal Contact	2.0E-07		2.7E-02	
		Total	5.2E-07		3.2E-02	
	Sediment Canal on East Side of Site	Ingestion	2.7E-07		1.7E-03	
		Inhalation	NA		NA	
		Dermal Contact	1.7E-07		1.1E-03	
		Total	4.3E-07		2.8E-03	
		Receptor Total	4.6E-06		9.7E-02	
Current/Future Site Worker	Surface Water Little Creek Cove	Ingestion	2.6E-07		1.6E-03	
		Inhalation	NA		NA	
		Dermal Contact	1.7E-08		1.1E-04	
		Total	2.8E-07		1.7E-03	
Future Resident Adult	Soil Weigh Station Area	Ingestion	NA		1.9E-01	
		Inhalation	NA		NA	
		Dermal Contact	NA		4.4E-01	
		Total	NA		6.3E-01	
	Soil Area to West of Landfill, the "Ear"	Ingestion	NA		2.0E-01	
		Inhalation	NA		NA	
		Dermal Contact	NA		2.1E-01	
		Total	NA		4.1E-01	
	Soil Site Perimeter	Ingestion	NA		3.9E-01	
		Inhalation	NA		NA	
		Dermal Contact	NA		**1.4E+00**	Vanadium (1.4)
		Total	NA		**1.8E+00**	
	Soil Covered Area	Ingestion	NA		1.2E-01	
		Inhalation	NA		NA	
		Dermal Contact	NA		3.3E-01	
		Total	NA		4.5E-01	
		Receptor Total	NA		**3.3E+00**	

Table 1-1
Summary Soil, Sediment, and Surface Water RME Cancer Risks and Hazard Indices based on the 2004 HHRA
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Receptor	Media	Exposure Route	Cancer Risk	COPCs with Cancer Risks >10^{-4}	Hazard Index	COPCs with HQ > 1
Future Resident Child	Soil Weigh Station Area	Ingestion	NA		**1.7E+00**	
		Inhalation	NA		NA	
		Dermal Contact	NA		5.8E-01	
		Total	NA		**2.3E+00**	
	Soil Area to West of Landfill, the "Ear"	Ingestion	NA		**1.9E+00**	
		Inhalation	NA		NA	
		Dermal Contact	NA		2.8E-01	
		Total	NA		**2.2E+00**	
	Soil Site Perimeter	Ingestion	NA		**3.7E+00**	Vanadium (2.6)
		Inhalation	NA		NA	
		Dermal Contact	NA		**1.9E+00**	Vanadium (1.9)
		Total	NA		**5.5E+00**	
	Soil Covered Area	Ingestion	NA		**1.1E+00**	
		Inhalation	NA		NA	
		Dermal Contact	NA		4.3E-01	
		Total	NA		**1.6E+00**	
		Receptor Total	NA		**1.2E+01**	
Future Resident Child/Adult	Soil Weigh Station Area	Ingestion	8.3E-06		NA	
		Inhalation	NA		NA	
		Dermal Contact	3.0E-06		NA	
		Total	1.1E-05		NA	
	Soil Area to West of Landfill, the "Ear"	Ingestion	1.1E-05		NA	
		Inhalation	NA		NA	
		Dermal Contact	1.7E-06		NA	
		Total	1.3E-05		NA	
	Soil Site Perimeter	Ingestion	1.8E-05		NA	
		Inhalation	NA		NA	
		Dermal Contact	5.4E-06		NA	
		Total	2.3E-05		NA	
	Soil Covered Area	Ingestion	1.6E-05		NA	
		Inhalation	NA		NA	
		Dermal Contact	8.9E-06		NA	
		Total	2.5E-05		NA	
		Receptor Total	7.1E-05		NA	
Future Industrial Worker	Soil Weigh Station Area	Ingestion	1.8E-06		1.3E-01	
		Inhalation	NA		NA	
		Dermal Contact	1.5E-06		4.0E-01	
		Total	3.4E-06		5.4E-01	
	Soil Area to West of Landfill, the "Ear"	Ingestion	2.4E-06		1.4E-01	
		Inhalation	NA		NA	
		Dermal Contact	1.2E-06		1.9E-01	
		Total	3.6E-06		3.3E-01	
	Soil Site Perimeter	Ingestion	3.9E-06		2.8E-01	
		Inhalation	NA		NA	
		Dermal Contact	2.4E-06		**1.3E+00**	Vanadium (1.3)
		Total	6.4E-06		**1.6E+00**	
	Soil Covered Area	Ingestion	3.6E-06		8.8E-02	
		Inhalation	NA		NA	
		Dermal Contact	5.8E-06		3.0E-01	
		Total	9.4E-06		3.9E-01	
		Receptor Total	2.3E-05		**2.8E+00**	

Table 1-1
Summary Soil, Sediment, and Surface Water RME Cancer Risks and Hazard Indices based on the 2004 HHRA
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Receptor	Media	Exposure Route	Cancer Risk	COPCs with Cancer Risks >10^{-4}	Hazard Index	COPCs with HQ > 1
Future Construction Worker	Soil Weigh Station Area	Ingestion	1.8E-07		3.0E-01	
		Inhalation	NA		NA	
		Dermal Contact	3.2E-08		1.3E-01	
		Total	2.1E-07		4.3E-01	
	Soil Area to West of Landfill, the "Ear"	Ingestion	2.3E-07		3.5E-01	
		Inhalation	NA		NA	
		Dermal Contact	1.8E-08		7.2E-02	
		Total	2.5E-07		4.2E-01	
	Soil Site Perimeter	Ingestion	3.8E-07		6.7E-01	
		Inhalation	NA		NA	
		Dermal Contact	5.8E-08		4.9E-01	
		Total	4.3E-07		**1.2E+00**	
	Soil Covered Area	Ingestion	3.4E-07		2.1E-01	
		Inhalation	NA		NA	
		Dermal Contact	9.6E-08		1.1E-01	
		Total	4.4E-07		3.2E-01	
		Receptor Total	1.3E-06		**2.3E+00**	

Table 1-2
Summary of Soil, Sediment, and Surface Water CTE Cancer Risks and Hazard Indices based on the 2004 HHRA
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Receptor	Media	Exposure Route	Cancer Risk	COPCs with Cancer Risks >10^{-4}	Hazard Index	COPCs with HQ> 1
Future Resident Adult	Soil Site Perimeter	Ingestion	NA		3.0E-02	
		Inhalation	NA		NA	
		Dermal Contact	NA		9.2E-02	
		Total	NA		1.2E-01	
Future Resident Child	Soil Weigh Station Area	Ingestion	NA		3.9E-01	
		Inhalation	NA		NA	
		Dermal Contact	NA		2.1E-01	
		Total	NA		6.0E-01	
	Soil Area to West of Landfill, the "Ear"	Ingestion	NA		1.9E-01	
		Inhalation	NA		NA	
		Dermal Contact	NA		6.1E-02	
		Total	NA		2.5E-01	
	Soil Site Perimeter	Ingestion	NA		8.3E-01	
		Inhalation	NA		NA	
		Dermal Contact	NA		1.2E-01	
		Total	NA		9.5E-01	
	Soil Covered Area	Ingestion	NA		1.5E-01	
		Inhalation	NA		NA	
		Dermal Contact	NA		7.4E-02	
		Total	NA		2.3E-01	
		Receptor Total	NA		**2.0E+00**	
Future Industrial Worker	Soil Site Perimeter	Ingestion	NA		2.8E-02	
		Inhalation	NA		NA	
		Dermal Contact	NA		4.8E-02	
		Total	NA		7.6E-02	
Future Construction Worker	Soil Site Perimeter	Ingestion	NA		6.3E-02	
		Inhalation	NA		NA	
		Dermal Contact	NA		2.1E-02	
		Total	NA		8.4E-02	

Table 1-3
Summary of Groundwater RME Cancer Risks and Hazard Indices based on the Revised 2008 HHRA for Groundwater
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Receptor	Media	Exposure Route	Cancer Risk	COPCs with Cancer Risks >10-4	Hazard Index	COPCs with HQ > 1
Future Resident Adult	Groundwater	Ingestion	NA		**4.9E+00**	Arsenic (2.6), Manganese (1.6)
		Inhalation	NA		N/A	
		Dermal Contact	NA		3.2E-01	
		Total	NA		**5.2E+00**	Arsenic (2.6), Manganese (1.8)
Future Resident Child	Groundwater	Ingestion	NA		**1.1E+01**	Arsenic (6.0), Iron (1.1), Manganese (3.6)
		Inhalation	NA		N/A	
		Dermal Contact	NA		9.5E-01	
		Total	NA		**1.2E+01**	Arsenic (6.0), Iron (1.1), Manganese (4.2)
Future Resident Child/Adult	Groundwater	Ingestion	**6.3E-04**	Arsenic (6.3E-04)	NA	
		Inhalation	NA		NA	
		Dermal Contact	3.6E-06		NA	
		Total	**6.3E-04**	Arsenic (6.3E-04)	NA	
Future Industrial Worker	Groundwater	Ingestion	**1.5E-04**	Arsenic (1.5E-04)	**1.7E+00**	
		Inhalation	N/A		NA	
		Dermal Contact	N/A		NA	
		Total	**1.5E-04**	Arsenic (1.5E-04)	**1.7E+00**	
Future Construction Worker	Groundwater	Ingestion	NA		NA	
		Inhalation	NA		NA	
		Dermal Contact	1.3E-07		3.6E-01	
		Total	1.3E-07		3.6E-01	

Table 1-4
Summary of Groundwater CTE Cancer Risks and Hazard Indices based on the Revised 2008 HHRA for Groundwater
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Receptor	Media	Exposure Route	Cancer Risk	COPCs with Cancer Risks >10-4	Hazard Index	COPCs with HQ> 1
Future Resident Adult	Groundwater	Ingestion	NA		**1.1E+00**	
		Inhalation	NA		N/	
		Dermal Contact	NA		4.7E-02	
		Total	NA		**1.2E+00**	
Future Resident Child	Groundwater	Ingestion	NA		**3.7E+00**	Arsenic (1.4), Manganese (1.6)
		Inhalation	NA		NA	
		Dermal Contact	NA		1.1E-01	
		Total	NA		**3.8E+00**	Arsenic (1.4), Manganese (1.7)
Future Resident Child/Adult	Groundwater	Ingestion	8.0E-05		NA	
		Inhalation	NA		NA	
		Dermal Contact	2.0E-07		NA	
		Total	8.0E-05		NA	
Future Industrial Worker	Groundwater	Ingestion	9.2E-06		7.4E-01	
		Inhalation	N/A		NA	
		Dermal Contact	N/A		NA	
		Total	9.2E-06		7.4E-01	

\\aphrodite\Proj\USNavFacEngCom\LittleCreek\MapFiles\Site7\FFS\Figure 1-1 - Site Location Map.mxd

Legend

Area of Investigation

Installation Boundary

N
W E
S

0 1,250 2,500 5,000 Feet

Figure 1-1
Site Location Map
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

\\aphrodite\Proj\USNavFacEngCom\LittleCreek\MapFiles\Site7\FFS\Figure 1-2 - Site 7 Focused Feasibility.mxd

Legend

- Fence Line
- Landfill Boundary
- Installation Boundary
- Area of Investigation

N
W E
S

0 125 250 500 Feet

Figure 1-2
Site Layout Map
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

CH2MHILL

\\aphrodite\Proj\USNavFacEngCom\LittleCreek\MapFiles\Site7\FFS\Figure 1-3 - Landfill Soil Cover.mxd

Legend

- Landfill Boundary *(Final Boundary will be determined following completion of landfill survey)*
- 1998 Soil Cover
- 2007 Soil Cover Maintenance
- 2008 Soil Cover Maintenance
- Installation Boundary

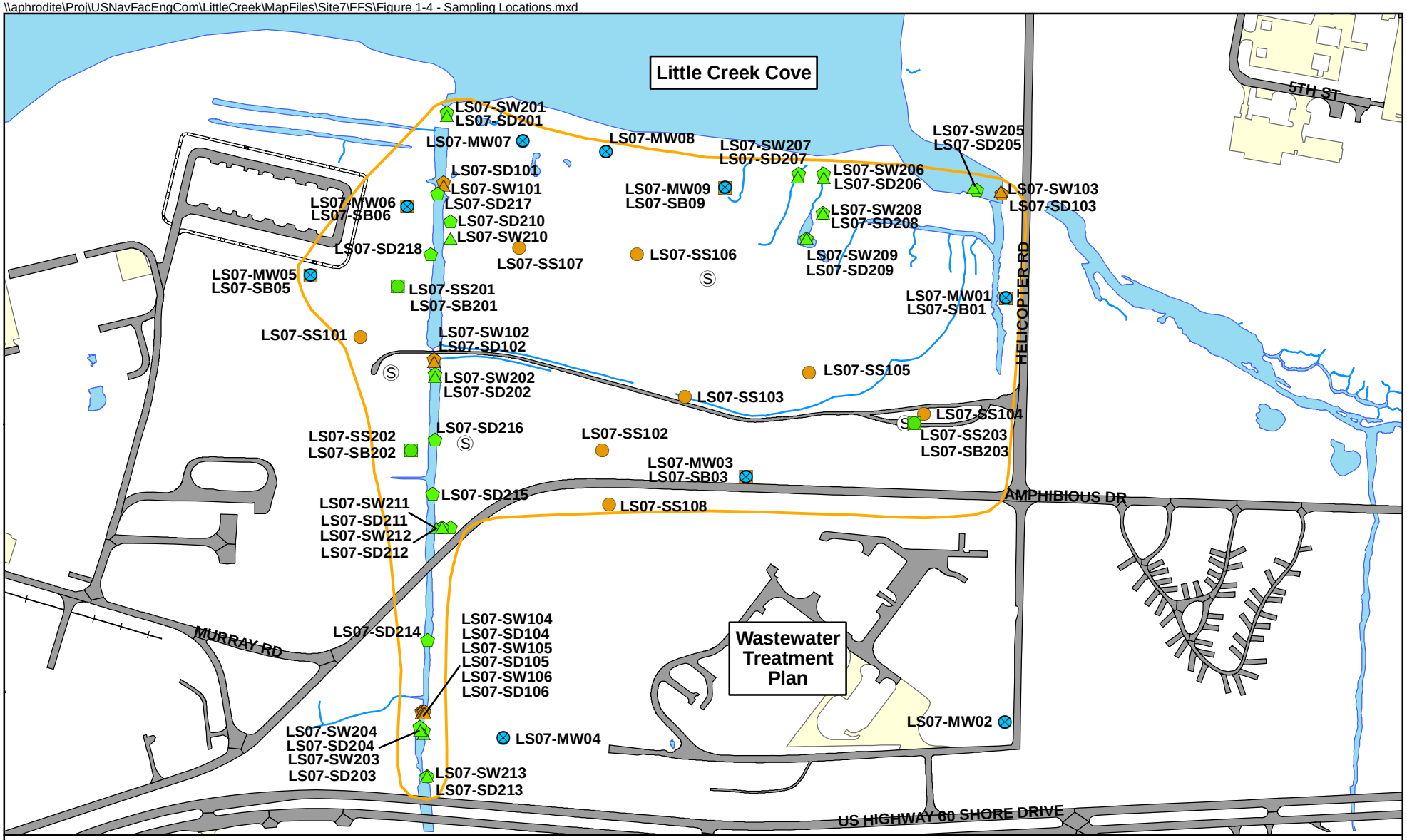
N
W E
S

0 100 200
Feet

Figure 1-3
Landfill Soil Cover
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

CH2MHILL

\\aphrodite\Proj\USNavFacEngCom\LittleCreek\MapFiles\Site7\FFS\Figure 1-4 - Sampling Locations.mxd



Legend

- Monitoring Well
- 1994 RI Surface Soil Stations
- 1994 RI Subsurface Soil Stations
- 1994 RI Surface Water Stations
- 1994 RI Sediment Stations
- 1994 RI Shelby Tube
- LTM Surface Soil Stations
- LTM Subsurface Soil Stations
- LTM Surface Water Stations
- LTM Sediment Stations
- Area of Investigation

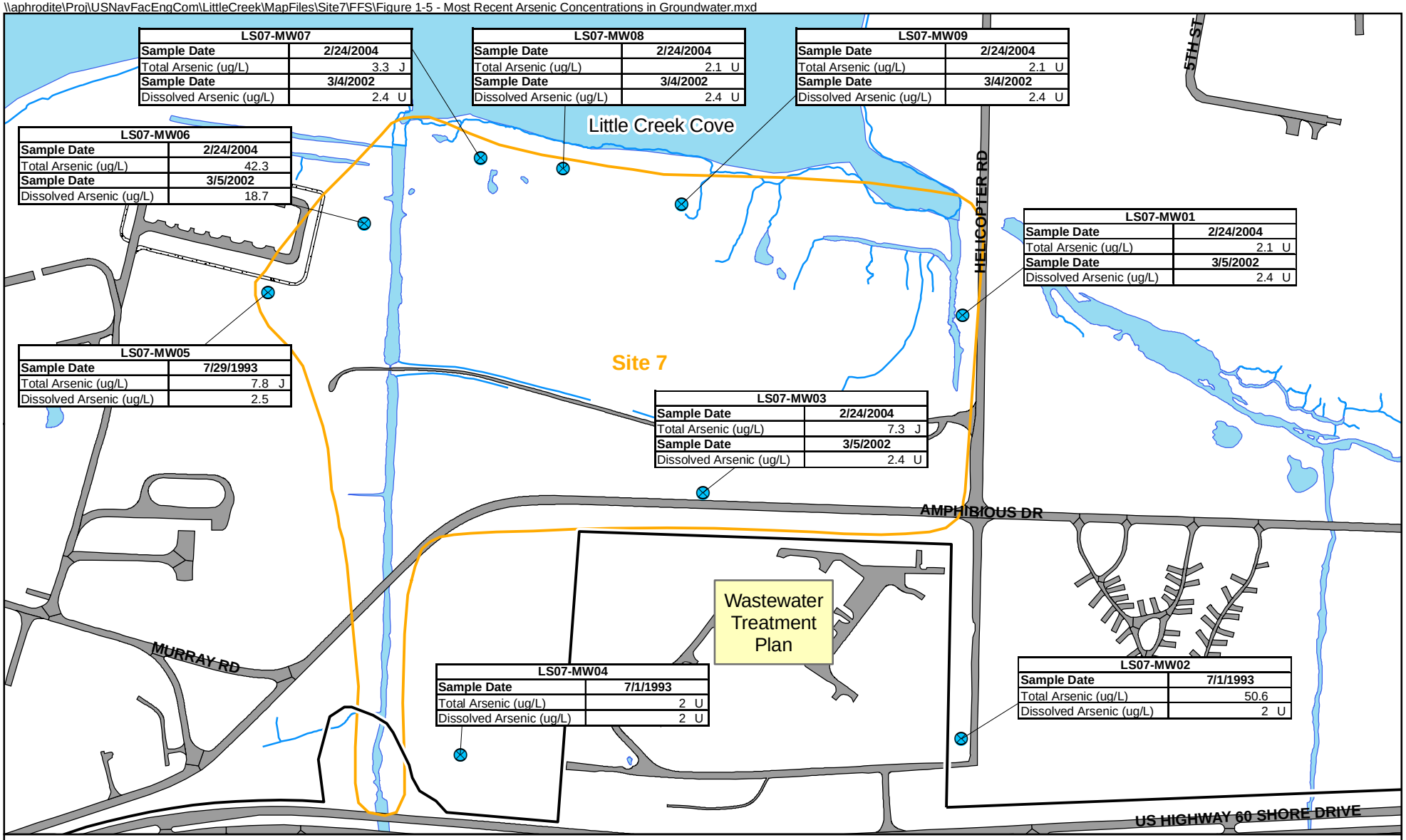
N W E S

0 100 200 400 Feet

Figure 1-4
Sampling Locations
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

CH2MHILL

\\aphrodite\Proj\USNavFacEngCom\LittleCreek\MapFiles\Site7\FFS\Figure 1-5 - Most Recent Arsenic Concentrations in Groundwater.mxd



Legend

- Monitoring Well
- Area of Investigation
- Installation Boundary

Notes:
Data from monitoring wells 1, 3, and 6 were included in the risk assessment

Figure 1-5
Most Recent Arsenic Concentrations in Groundwater
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

CH2MHILL

SECTION 2

Remedial Action Objectives and General Response Actions

This section presents general and site-specific remedial action objectives (RAOs) and identification of corresponding applicable or relevant and appropriate requirements (ARARs) for Site 7.

2.1 Presumptive Remedy

Presumptive remedies are preferred technologies for common categories of sites and are expected to be used at all appropriate sites. Presumptive remedies are expected to ensure the consistent selection of RAs and reduce the cost and time required to assess similar sites.

Characteristics of a landfill for applicability of the presumptive remedy include:

- Under current site conditions risks are low-level
- Treatment of wastes is usually impractical because of the volume and heterogeneity of the waste
- Waste types include household, commercial, nonhazardous sludge, and industrial solid wastes
- Lesser quantities of hazardous wastes are present as compared to municipal wastes
- Land application units, surface impoundments, injection wells, and waste piles are not included

The USEPA guidance document *Presumptive Remedies: Polices and Procedures* (USEPA, 1993) indicates that, after a site is confirmed as being a type for which presumptive remedies exist, an FFS that eliminates the technology identification and screening step should be prepared. The FFS would limit its consideration to the No Action alternative and the presumptive remedies.

2.2 General Remedial Action Objectives

General RAOs are defined by the NCP and CERCLA, as amended by SARA, which is applicable to all Superfund sites. CERCLA defines the statutory requirements for developing remedies. The NCP requires that the selected remedy meet the following objectives:

- Each RA selected shall be protective of human health and the environment [40 Code of Federal Regulations (CFR) 300.430 (f)(ii)(A)].

- Onsite RAs that are selected must attain those ARARs that are identified at the time of the Record of Decision (ROD) signature [40 CFR 300.430(f)(ii)(B)].
- Each RA selected shall be cost-effective. A remedy shall be cost-effective if its costs are proportional to its overall effectiveness [40 CFR 300.430 (f)(ii)(D)].
- Each RA shall use permanent solutions and alternative treatment technologies or resource-recovery technologies to the maximum extent practicable [40 CFR 300.430 (f)(ii)(E)].

The statutory scope of CERCLA as amended by SARA includes the following general objectives for RAs at all CERCLA sites:

- RAs "shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and of control of further releases at a minimum which assures protection of human health and the environment" (Section 121(d)(1)).
- RAs in which treatments that "permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants is a principal element, are to be preferred" (Section 121(b)(1)). If the treatment or recovery technologies selected are not a permanent solution, an explanation must be published (Section 121 (b)(1)).
- The least-favored RAs are those that include "offsite transport and disposal of hazardous substances or contaminated materials without treatment" where practicable treatment technologies are available (Section 121(b)(1)).
- The selected remedy must comply with or attain the level of any standard, requirement, criteria, or limitation under any federal environmental law or any promulgated standard, requirement, criteria, or limitation under a state environmental or facility siting law that is more stringent than any federal standard, requirement, criteria, or limitation (Section 121(d)(2)(A)).

2.3 Site-Specific Remedial Action Objective

The site-specific RAO is established based on the nature and extent of contamination, the resources that are currently and/or potentially threatened, and the potential for human and environmental exposure (USEPA, 1988). The potential exposure routes and risks for Site 7 were identified in the revised RI/HHRA (CH2M HILL, 2004a). The only unacceptable risks associated with Site 7 following the IRA are from exposure to landfill contents.

The RAO for Site 7 is to prevent human and ecological receptor exposure to landfill contents through containment alternative (2 foot soil cover) and land use controls.

2.3.1 Applicable or Relevant and Appropriate Requirements

As required by Section 121 of CERCLA, RAs must attain a degree of cleanup, which assures protection of human health and the environment. Additionally, CERCLA RAs that leave hazardous substances, pollutants, or contaminants on site must meet, upon completion, a

level or standard of control that at least attains standards, requirements, limitations, or criteria that are "applicable or relevant and appropriate" under the circumstances of the release. These requirements are known as "ARARs" and are derived from both federal and state (Commonwealth of Virginia) laws.

Definitions of ARARs, as well as other advisories, criteria, or to be considered (TBC) guidance are given below:

- *Applicable requirements* are cleanup standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, or contaminant, RA, location, or other circumstance at a CERCLA site.
- *Relevant and appropriate requirements* are cleanup standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, although not "applicable" to a hazardous substance, pollutant, contaminant, RA, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited (appropriate) to the particular site. Requirements must be relevant and appropriate to be an ARAR of this type.
- *TBC criteria* are non-promulgated, non-enforceable guidelines or criteria that may be useful for establishing a cleanup level or designing the RA, especially when no ARARs exist or they are not sufficiently protective. Examples of TBCs include USEPA Drinking Water Health Advisories and secondary MCLs.

Section 121(d)(4) of CERCLA allows the selection of a remedial alternative that will not attain all ARARs if any of six conditions for a waiver of ARARs exist. These conditions are: 1) the RA is an interim measure whereby the final remedy will attain the ARAR upon completion, 2) compliance will result in greater risk to human health and the environment than other options, 3) compliance is technically impracticable, 4) an alternative RA will attain the equivalent of the ARAR, 5) for state requirements, the state has not consistently applied the requirement in similar circumstances, and 6) compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the facility with the availability of CERCLA money for response at other facilities.

Subsection 121(d) of CERCLA also requires that remedies comply with federal and state substantive requirements that qualify as ARARs. Federal, state, or local permits need not be obtained for removal actions or RAs implemented on site, but their substantive requirement must be obtained. "On site" is interpreted by USEPA to include the aerial extent of contamination and all suitable areas in reasonable proximity to the contamination necessary for implementation of the response action.

There are three categories of ARARs: chemical-specific, location-specific, and action-specific. They are based on the manner in which they are applied. Many requirements are combinations of the different ARAR categories. ARARs considered applicable, relevant and appropriate, or TBC for Site 7 are presented in **Appendix C**. An explanation of each of the ARAR categories follows.

- *Chemical-specific ARARs:* Health- or risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Federal MCLs established under the Safe Drinking Water Act are examples of chemical-specific ARARs.
- *Location-specific ARARs:* Restrictions based on the concentration of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain RAs or may apply only to certain portions of a site. Examples of this type of ARAR include federal and state laws for hazardous waste facilities and sites on the National Register of Historic Places.
- *Action-specific ARARs:* Refers to the requirements that set controls or restrictions on particular activities related to the management of hazardous substances, pollutants, or contaminants. Resource Conservation and Recovery Act (RCRA) regulations for closure of hazardous waste storage units, RCRA incineration standards, and pretreatment standards under the Clean Water Act (CWA) for discharges to publicly owned treatment works are examples of action-specific ARARs.

2.3.2 Preliminary Remediation Goals

No unacceptable risks to human health and the environment were identified from exposure to soil, groundwater, sediment, or surface water at or beyond the boundaries of the landfill. The only unacceptable risk is assumed from landfill contents remaining on site; therefore, quantitative preliminary remediation goals are not necessary.

2.4 General Response Actions

General response actions (GRAs) are broad classes of responses, remedies, or technologies developed to meet RAOs. For Site 7, the following GRAs were considered:

- No Action: No Action involves no RAs and is included as a baseline for comparison.
- Maintenance of the existing soil cover, LUCs, and Groundwater LTM: The soil cover and LUCs do not reduce toxicity, mobility, or volume of contamination and waste, but reduce the potential for receptor contact with landfill contents. Groundwater LTM would monitor for a potential release from the landfill and offsite migration of contaminants.

2.4.1 Identification and Screening of Technology Types and Process Options

No specific remedial technologies or process options were screened as part of this presumptive remedy FFS. Therefore, the GRAs—1) No Action and 2) maintenance of the existing soil cover, LUCs, and groundwater LTM—have been chosen as the remedial alternatives for consideration at Site 7.

SECTION 3

Detailed Analysis of Remedial Alternatives

This section identifies, describes, and evaluates in detail the presumptive remedy alternative with respect to the No Action baseline and the criteria set forth in the NCP.

3.1 Evaluation Criteria

The detailed analysis of alternatives was conducted in accordance with the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (USEPA, 1988) and the NCP (Part 300.430(e)), including the February 1990 revisions. In conformance with the NCP, seven of the following nine criteria were evaluated in the detailed analysis:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost
- State acceptance (not evaluated at this time)
- Community acceptance (not evaluated at this time)

State acceptance and community acceptance criteria will be evaluated by addressing comments received after the public comment period for the Proposed Plan. This evaluation will be presented in the Responsiveness Summary of the ROD. A detailed description of each criterion is provided on **Table 3-1**.

3.2 Description and Evaluation of Remedial Alternatives

A description of No Action and the presumptive remedy is presented below, and an evaluation of the alternatives with respect to seven of the nine NCP criteria is provided in **Table 3-2**.

3.2.1 Alternative 1 – No Action

Consideration of this alternative is required under the NCP and serves as the baseline for comparison of other alternatives. Under this alternative, no additional effort or resources would be expended at Site 7.

3.2.2 Alternative 2 – Maintenance of the Existing Soil Cover, LUCs, and Groundwater LTM

Alternative 2 consists of the maintenance of the existing 24-inch soil cover, implementation of LUCs, and groundwater LTM. Alternative 2 is considered a presumptive containment

alternative. The initial limited soil cover was installed in 1997 (CH2M HILL, 1997) and in 2008 the vegetation covering the remaining portion of the landfill was removed and a 24-inch soil cover was established over the entire landfill area (Agviq-CH2M HILL Joint Venture, 2008). **Figure 3-1** outlines the LUC boundary and proposed groundwater LTM monitoring wells.

LUCs will prevent unrestricted exposure to landfill contents by restricting intrusive digging/excavation within the defined LUC boundary. Signage with notification of environmental concerns and imposed digging/excavation restrictions will be posted along the perimeter of the defined LUC boundary.

Although there is no expected future land use of this site, a remedial design for LUCs for Site 7 will be developed to include provisions that would require a reevaluation of potential risks should an unlimited use/unrestricted exposure land use or a No Action decision be sought for the site. It is anticipated the site will be evaluated not less than every 5 years under CERCLA to determine the continuing effectiveness, protectiveness, and need for LUCs. The objectives of the remedial design for LUCs for Site 7 will be addressed in the ROD.

Post-ROD operation and maintenance activities at Site 7 will include soil cover maintenance and inspection, erosion and stormwater controls maintenance, and mowing. In addition, a LUC will be placed on the site to prohibit the use of groundwater as a potable water source. A groundwater monitoring program was initiated in 1998 and discontinued in 2003 pending the completion of the 2006 NTCRA (AGVIQ/CH2M HILL, 2007). Groundwater LTM is a component of this remedial alternative to ensure offsite migration does not occur.

Table 3-1
Descriprtion of Evaluation Criteria
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Evaluation Criteria	Description
Overall Protection of Human Health and Environment	This evaluation criterion is an assessment of whether each alternative achieves and maintains adequate protection of human health and the environment. A remedy is protective if it eliminates, reduces, or controls all current and potential risks posed by the site through each exposure pathway. Adequate engineering controls, land use controls, or a combination of the two can be implemented to control exposure and thereby ensure reliable protection of human health and the environment over time. In addition, implementation of a remedy cannot result in unacceptable short-term risks or cross-media impacts on human health and the environment.
Compliance with ARARs	Compliance with ARARs is a statutory requirement of remedy selection. This criterion is used to determine whether the selected alternative would meet the federal, state, and local ARARs identified in Appendix A. Under CERCLA, if an ARAR is not feasible, a waiver with one of six acceptable justifications may be submitted for approval. A discussion of each alternative's compliance with chemical-, location-, and action-specific ARARs is included in Appendix A.
Long-Term Effectiveness and Permanence	Long-term reliability and effectiveness reflects CERCLA's emphasis on implementing remedies that will protect human health and the environment in the long term. Under this criterion, results of a remedial alternative are evaluated in terms of the risk remaining at the site after response objectives are met. The primary focus of the evaluation is the extent and effectiveness of the actions or controls that may be required to manage the risk posed by treatment residuals or untreated wastes. Factors to be considered and addressed are magnitude of residual risk, adequacy of controls, and reliability of controls. Magnitude of residual risk is the assessment of the risk remaining from untreated waste or treatment residuals after remediation. Adequacy and reliability of controls is the evaluation of the controls that can be used to manage treatment residuals or untreated wastes that remain onsite. The evaluation may include an assessment of containment systems and institutional controls to determine whether they are sufficient to ensure that any exposure to human and environmental receptors is within protective levels.
Reduction of Toxicity, Mobility, or Volume	This criterion addresses the statutory preference for remedies that employ treatment to significantly reduce the toxicity, mobility, or volume of the hazardous substances. That preference is satisfied when treatment is used to reduce the principal threats at a site by destroying toxic chemicals or reducing the total mass or total volume of affected media. This criterion is specific to evaluating only how the treatment reduces toxicity, mobility, and volume. Specifically, the analysis will examine the magnitude, significance and irreversibility of reductions. This criterion can not be applied to the presumptive remedy approach because capping technologies are considered containment measures.
Short-Term Effectiveness	This criterion examines the short-term impacts associated with implementing the alternative. Implementation may affect workers, neighboring communities, or the surrounding environment. Short-term effectiveness also includes potential threats to human health and the environment associated with excavation, treatment and transportation of hazardous substances; potential cross-media impacts of the remedy; and the time required to achieve protection of human health and the environment.
Implementability	The implementability criterion evaluates the technical and administrative feasibility of executing an alternative and the availability of various services and materials required during its implementation. Technical feasibility includes construction, operation, reliability of technology, ease of undertaking additional remedial action, and monitoring. Administrative feasibility refers to the activities needed to coordinate with other offices and agencies (e.g., local permits). Availability of services and materials includes availability of adequate off-site treatment, storage capacity, and disposal services; necessary equipment and specialists; construction services and materials; and prospective technologies.
Cost	Cost includes capital costs, and annual operation and maintenance (O&M) costs incurred over the life of the remedial action. The focus during the detailed analysis is on the net present worth (NPW) of these costs. In accordance with EPA guidance (EPA, 1988a), the cost estimates are prepared to have an accuracy in the range of –30 to +50 percent. The exact accuracy of each cost estimate depends upon the assumptions made and the availability of costing information. The present worth costs will be calculated assuming the current discount rate established by the Office of Management and Budget (OMB), cost estimates in the planning years in constant dollars, and a period of performance that would vary depending on the activity, but would not exceed 30 years.
State Acceptance	This criterion evaluates the technical and administrative issues and concerns the state may have regarding the alternatives. State acceptance criterion is not discussed in this report, but will be presented in the ROD following receipt of State comments regarding the FFS and Proposed Plan.
Community Acceptance	This criterion evaluates the issues and concerns the public may have regarding each of the alternatives. As with state acceptance, this criterion is not discussed in this report, and will be addressed in the ROD following receipt of USEPA and public comments regarding the FFS and Proposed Plan documented during the public comment period.

Notes:
1) Costs are based on USEPA, 2000, *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 540-R-00-002).

Table 3-2
Detailed Analysis of Remedial Alternatives
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Soil Cover, Land Use Controls, and Groundwater LTM
Overall Protection of Human Health and Environment		
Exposure to Landfill Contents	No reduction in human health or ecological risks posed by exposure to landfill contents. A soil cover is currently in place, however a No Action alternative would not prevent unlimited site use and potential exposure to landfill contents. The alternative also presents uncertainty in determining whether a site release and offsite migration is occurring.	Human health and ecological risks posed by potential exposure to landfill contents are prevented by the physical barrier of the soil cover. LUCs will be implemented to ensure the soil cover will not be altered or disturbed and site use does not change. Groundwater LTM will be conducted to monitor for a potential future site release and migration of contaminants.
Compliance with ARARs		
Chemical, Location, and Action-Specific ARARs	Will not comply with ARARs.	Will comply with all ARARs (Appendix A).
Long-Term Effectiveness and Permanence		
Exposure to Landfill Contents	Residual risk remains at the site. A No Action alternative would not prohibit unlimited site use in the future. Although a soil cover is currently in place and is protective, no O&M requirements are associated with this alternative. Therefore, there are no additional measures taken to ensure long-term effectiveness and permanence. The alternative also presents uncertainty in determining whether a potential future site release and migration is occurring.	A soil cover is currently in place and protective. Soil cover O&M and LUCs will be implemented to ensure potential future risk to human and ecological receptors is prevented. Groundwater LTM will be conducted to monitor for a potential future site release and migration of contaminants.
Reduction of Toxicity, Mobility, or Volume		
Exposure to Landfill Contents	No active treatment measures are associated with this alternative and there is no reduction in toxicity, mobility, or volume. No preventative measures will be taken to prohibit potential future site release and migration of associated contaminants.	No active treatment measures are associated with this alternative and there is no reduction in toxicity, mobility, or volume. However, the existing soil cover provides containment of landfill contents and potential future site releases and migration of associated contaminants will be monitored through groundwater LTM.
Type and Quantity of Residuals Remaining After Remediation	All landfill contents remain onsite below existing soil cover. Volume of landfill contents will not change and is estimated to be 500,000 cu.yds.	All landfill contents remain onsite below existing soil cover. Volume of landfill contents will not change and is estimated to be 500,000 cu.yds.

Table 3-2
Detailed Analysis of Remedial Alternatives
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Soil Cover, Land Use Controls, and Groundwater LTM
Short-Term Effectiveness		
Exposure to Landfill Contents	A soil cover is currently in place and protective. No additional activities will be conducted under the No Action alternative; therefore, no short-term impacts will result.	A soil cover is currently in place and protective. Soil cover O&M and groundwater LTM activities may pose minimal risk to site workers, however appropriate health and safety measures will be taken.
Implementability		
Ability to Construct and Operate	All design and construction activities associated with the soil cover are complete.	All design and construction activities associated with the soil cover are complete. Operation and maintenance will maintain soil cover integrity and groundwater LTM will monitor for potential future site release and migration of associated contaminants.
Ease of Implementing Additional Action if Needed	Not Applicable.	Very easy to implement additional action.
Ability to Monitor Effectiveness	Not Applicable.	Remedy effectiveness will be monitored through quarterly landfill integrity inspections, groundwater LTM, and five-year site reviews.
Cost		
Capital Cost	$0	$31,860
Annual O&M Cost if performed today (Years 1-4, 6-9, 11-14, 16-19, 21-24, 26-29)	$0	$67,789
Annual O&M Cost if performed today (Years 5, 10, 15, 20, 25, 30)	$0	$129,890
Present-Worth (30 years @ 3.0% Discount Rate/4% Inflation)	$0	$2,728,125

Notes:
1) Costs are based on USEPA, 2000, *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 540-R-00-002).
2) Cost estimate is provided in Appendix B.

\\aphrodite\Proj\USNavFacEngCom\LittleCreek\MapFiles\Site7\FFS\Figure 3-1 - Alternative2 Design.mxd

Legend

- Proposed Annual Groundwater Monitoring Well
- Proposed LUC Boundary
- Landfill Boundary *(Final Boundary will be determined following completion of landfill survey)*
- Fence
- Installation Boundary
- Groundwater Flow Direction

N W E S

0 100 200 Feet

Figure 3-1
Alternative 2 Design
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

CH2MHILL

SECTION 4

Comparative Analysis

4.1 Comparative Analysis

In the following comparative analysis, the No-Action and presumptive remedy alternatives are evaluated in relation to one another and with respect to the NCP criteria. **Table 4-1** summarizes the comparative analysis.

4.1.1 Overall Protection of Human Health and the Environment

Alternative 1 does not meet the RAO and does not provide protection for human and ecological receptors to contact landfill contents. Although a soil cover is currently in place, Alternative 1 would not prevent potential exposure to landfill contents or provide measures for determining if a site release and migration of contaminants is occurring. Alternative 2 meets the RAO by preventing potential human and ecological risks posed by direct contact with landfill contents by means of a durable physical barrier provided by the soil cover. LUCs will ensure the soil cover is not altered or disturbed and site use does not change. In addition, groundwater LTM will monitor for a potential future site release and migration of contaminants.

4.1.2 Compliance with ARARs

Alternative 1 does not comply with ARARs. Alternative 2 will comply with all ARARs (**Appendix C**).

4.1.3 Long-Term Effectiveness and Permanence

Alternative 1 does not provide any long-term effectiveness and permanence. Although a soil cover is currently in place, Alternative 1 would not prevent potential exposure to landfill contents or provide measures for determining if a site release and migration of contaminants is occurring. Alternative 2 provides an effective, long-term means by which the potential for exposure to landfill contents is prevented. The permanence of Alternative 2 will be ensured through inspection and maintenance of the existing soil cover and implementation of LUCs to ensure potential future risk to human and ecological receptors is prevented. Groundwater LTM will monitor for a potential future site release and migration of contaminants.

4.1.4 Reduction of Toxicity, Mobility, and Volume

Neither alternative reduces toxicity, mobility, or volume.

4.1.5 Short-Term Effectiveness

In the short term, neither alternative increases risks at the landfill. No additional activities will be conducted under Alternative 1; therefore, no short-term impacts will result. Under

Alternative 2, soil cover maintenance and groundwater LTM activities may pose minimal risk to site workers; however health and safety measures will be implemented.

4.1.6 Implementability

All design and construction activities associated with the soil cover are complete. No effort is required to implement Alternative 1. Alternative 2, soil cover maintenance, LUCs, and groundwater LTM, is easily implemented.

4.1.7 Cost

There is no cost associated with Alternative 1. For Alternative 2, the direct costs ($31,860) are associated with LUC boundary surveying. Indirect costs for Alternative 2 vary per year and are comprised of long-term maintenance of the soil cover, groundwater LTM, and five year reviews. The total present cost of Alternative 2, evaluated over a period of 30 years, is $2,653,552. Cost estimates for Alternatives 1 and 2 are provided in **Appendix D**.

Table 4-1
Comparative Analysis of Remedial Alternatives
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Criteria	Alternative 1	Alternative 2
Overall Protection of Human Health and the Environment	1	4
Compliance with ARARs	1	4
Long-Term Effectiveness and Permanence	1	3
Reduction of Toxicity, Mobility, or Volume	1	2
Short-Term Effectiveness	4	3
Implementability	4	4
Cost	4	3
Total Score	**16**	**23**
1—poor 2—satisfactory 3—good 4—excellent		

SECTION 5

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Appendix A
Revised Groundwater HHRA Tables

TABLE 1

SELECTION OF EXPOSURE PATHWAYS

Site 7, NAB Little Creek

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
Future	Groundwater	Groundwater	Upper Aquifer - Tap Water	Resident	Adult	Dermal Absorption	On-site	Quant	Although unlikely because groundwater is brackish and discharges directly to Little Creek Cove, groundwater could be used as a potable water supply in the future.
						Ingestion	On-site	Quant	Although unlikely because groundwater is brackish and discharges directly to Little Creek Cove, groundwater could be used as a potable water supply in the future.
					Child	Dermal Absorption	On-site	Quant	Although unlikely because groundwater is brackish and discharges directly to Little Creek Cove, groundwater could be used as a potable water supply in the future.
						Ingestion	On-site	Quant	Although unlikely because groundwater is brackish and discharges directly to Little Creek Cove, groundwater could be used as a potable water supply in the future.
					Child/Adult	Dermal Absorption	On-site	Quant	Although unlikely because groundwater is brackish and discharges directly to Little Creek Cove, groundwater could be used as a potable water supply in the future.
						Ingestion	On-site	Quant	Although unlikely because groundwater is brackish and discharges directly to Little Creek Cove, groundwater could be used as a potable water supply in the future.
				Industrial Worker	Adult	Dermal Absorption	On-site	None	Assumed site workers would not shower regularly at base even if groundwater used as a potable water supply for base.
						Ingestion	On-site	Quant	Although unlikely because groundwater is brackish and discharges directly to Little Creek Cove, groundwater could be used as a potable water supply in the future.
			Upper Aquifer - Excavation Pit	Construction Worker	Adult	Dermal Absorption	On-site	Quant	Construction workers may contact groundwater during excavation activities.
						Ingestion	On-site	None	Ingestion of groundwater during construction activities expected to be minimal.
		Air	Upper Aquifer -Water Vapors at Showerhead	Resident	Adult	Inhalation	On-site	Quant	Although unlikely because groundwater is brackish and discharges directly to Little Creek Cove, groundwater could be used as a potable water supply in the future.
					Child	Inhalation	On-site	None	Children are assumed to take baths, not showers, resulting in minimal inhalation exposure.
					Child/Adult	Inhalation	On-site	None	Children are assumed to take baths, not showers, resulting in minimal inhalation exposure.
				Industrial Worker	Adult	Inhalation	On-site	None	Assumed site workers would not shower regularly at base even if groundwater used as a potable water supply for base.
			Upper Aquifer - Water Vapors at Excavation Pit	Construction Worker	Adult	Inhalation	On-site	Quant	Construction workers may inhale vapors from groundwater during excavation activities.

Table 2.1

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 7, NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Upper Aquifer -	67-64-1	Acetone	6.0E+00 J	6.0E+00 J	UG_L	LS07-MW06-01A	1/9	10 - 10	6.0E+00	N/A	5.5E+02 N	N/A		NO	BSL
Tap Water and Excavation Pit	108-88-3	Toluene	4.0E-01 J	2.0E+00 J	UG_L	LS07-MW01-01C	3/9	10 - 10	2.0E+00	N/A	2.3E+02 N	1.0E+02	MCL	NO	BSL
	84-74-2	Di-n-butylphthalate	1.2E+01	1.2E+01	UG_L	LS07-MW01-01C	1/9	10 - 12	1.2E+01	N/A	3.7E+02 N	N/A		NO	BSL
	7429-90-5	Aluminum	9.5E+01 J	1.3E+03	UG_L	LS07-MW01-02A	5/9	200 - 200	1.3E+03	7.1E+02	3.7E+03 N	50 - 200	SMCL	NO	BSL
	7440-38-2	Arsenic	2.2E+00 J	3.1E+01	UG_L	LS07-MW06-02A	4/9	10 - 10	3.1E+01	7.3E+01	4.5E-02 C	1.0E+01	MCL	YES	ASL
	7440-39-3	Barium	3.5E+00 J	3.0E+01 J	UG_L	LS07-MW03-01C	6/9	200 - 200	3.0E+01	1.3E+02	7.3E+02 N	2.0E+02	MCL	NO	BSL
	7440-41-7	Beryllium	3.0E-01 J	3.0E-01 J	UG_L	LS07-MW03-01C	1/9	5 - 5	3.0E-01	5.0E-01	7.3E+00 N	4.0E+00	MCL	NO	BSL
	7440-70-2	Calcium	7.6E+03	1.5E+05	UG_L	LS07-MW06-01C	9/9	5000 - 5000	1.5E+05	1.3E+05	N/A	N/A		NO	NUT
	7440-47-3	Chromium	9.3E-01 J	2.3E+01	UG_L	LS07-MW03-01A	4/9	10 - 10	2.3E+01	4.1E+00	1.1E+01 N	1.0E+02	MCL	YES	ASL
	7440-48-4	Cobalt	1.6E+00 J	1.3E+01 J	UG_L	LS07-MW03-02A	6/9	50 - 50	1.3E+01	2.6E+00	7.3E+01 N	N/A		NO	BSL
	7439-89-6	Iron	3.0E+03	1.6E+04	UG_L	LS07-MW06-02A	9/9	100 - 100	1.6E+04	7.1E+04	2.6E+03 N	3.0E+02	SMCL	YES	ASL
	7439-95-4	Magnesium	9.4E+03	1.3E+05	UG_L	LS07-MW06-01C LS07-MW06-02A	9/9	5000 - 5000	1.3E+05	4.6E+04	N/A	N/A		NO	NUT
	7439-96-5	Manganese	3.3E+01	1.6E+03	UG_L	LS07-MW06-02A	9/9	15 - 15	1.6E+03	1.5E+03	7.3E+01 N	5.0E+01	SMCL	YES	ASL
	7439-97-6	Mercury	8.0E-02 J	8.0E-02 J	UG_L	LS07-MW01-01A LS07-MW03-01A	2/9	0.2 - 0.3	8.0E-02	3.0E-01	1.1E+00 N	2.0E+00	MCL	NO	BSL
	7440-02-0	Nickel	1.4E+00 J	7.9E+00 J	UG_L	LS07-MW03-01A	4/9	40 - 40	7.9E+00	1.4E+01	7.3E+01 N	N/A		NO	BSL
	7440-09-7	Potassium	9.0E+03 J	2.9E+04 J	UG_L	LS07-MW06-02A	9/9	5000 - 5000	2.9E+04	3.7E+04	N/A	N/A		NO	NUT
	7782-49-2	Selenium	2.3E+00 J	2.3E+00 J	UG_L	LS07-MW06-02A	1/9	5 - 5	2.3E+00	8.0E+00	1.8E+01 N	5.0E+01	MCL	NO	BSL
	7440-23-5	Sodium	4.1E+04	4.0E+05	UG_L	LS07-MW01-01C	8/9	5000 - 5000	4.0E+05	3.4E+05	N/A	N/A		NO	NUT
	7440-62-2	Vanadium	1.9E+00 J	4.3E+00 J	UG_L	LS07-MW01-02A	2/9	50 - 50	4.3E+00	5.0E+00	3.7E+00 N	N/A		YES	ASL
	7440-66-6	Zinc	8.7E-01 J	1.6E+02	UG_L	LS07-MW03-01A	7/9	20 - 20	1.6E+02	5.9E+01	1.1E+03 N	5.0E+03	SMCL	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] 95%UTL for Groundwater from Little Creek Background Investigation.

[4] Risk-Based Concentration Table, October 16, 2007, U.S. EPA Region III, Jennifer Hubbard. Tap Water RBC.

RBC value for hexavalent chromium used for total chromium.

Cobalt was withdrawn from October 2005 RBC Table due to expiration of NCEA provisional toxicity values. Value is from the April 2005 RBC table.

RBC value for manganese-nonfood used as surrogate for manganese.

RBC value for mercuric chloride used as surrogate for mercury.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

J = Estimated Value

C = Carcinogenic

N = Noncarcinogenic

MCL = Federal Maximum Contaminant Level

SMCL = Secondary Maximum Contaminant Level

Table 2.2

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 7, NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Upper Aquifer - Water Vapors at Showerhead and Excavation Pit	67-64-1	Acetone	6.0E+00 J	6.0E+00 J	UG_L	LS07-MW06-01A	1/9	10 - 10	6.0E+00	N/A	5.5E+02 N	N/A		NO	BSL
	108-88-3	Toluene	4.0E-01 J	2.0E+00 J	UG_L	LS07-MW01-01C	3/9	10 - 10	2.0E+00	N/A	2.3E+02 N	1.0E+02	MCL	NO	BSL

[1] Minimum/Maximum detected concentrations.
[2] Maximum concentration is used for screening.
[3] 95%UTL for Groundwater from Little Creek Background Investigation.
[4] Risk-Based Concentration Table, October 16, 2007, U.S. EPA Region III, Jennifer Hubbard. Tap Water RBC.
[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
C = Carcinogenic
N = Noncarcinogenic
MCL = Federal Maximum Contaminant Level

Table 3.1.RME

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Site 7

NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Upper Aquifer - Tap Water and Water in Excavation Pit	Arsenic	ug/L	1.0E+01	2.8E+01	(NP)	3.1E+01		2.8E+01	UG_L	95% KM-b	1, 2, 3, 4
	Chromium	ug/L	3.5E+00	2.0E+01	(T)	2.3E+01		2.0E+01	UG_L	97.5% KM	1
	Iron	ug/L	8.8E+03	1.2E+04	(N)	1.6E+04		1.2E+04	UG_L	95% Stud-t	1, 2, 3, 4
	Manganese	ug/L	7.4E+02	1.1E+03	(N)	1.6E+03		1.1E+03	UG_L	95% Stud-t	2, 3, 4
	Vanadium	ug/L	2.2E+00	4.3E+00	(NP)	4.3E+00	J	4.3E+00	UG_L	95% KM-b	5

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate EPC and mean, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Options: 9.5% Kaplan-Meier Chebyshev (97.5% KM); 95% Student's-T test UCL (95% Stud-t); 95% Approximate Gamma (App. Gamma); Maximum Detected Value (Max)
95% Kaplan-Meier(t) (95% KM-t); 95% KM Percentile Bootstrap (95% KM-b)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because 95% UCL greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma
ug/L = micrograms per liter
J = Estimated Value

Table 3.1.CTE
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Site 7
NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Upper Aquifer - Tap Water and Water in Excavation Pit	Arsenic	ug/L	1.0E+01	1.8E+01	(NP)	3.1E+01		1.0E+01	UG_L	Mean-KM	1, 2, 3, 4
	Chromium	ug/L	3.5E+00	2.0E+01	(T)	2.3E+01		3.5E+00	UG_L	Mean-KM	1
	Iron	ug/L	8.8E+03	1.2E+04	(N)	1.6E+04		8.8E+03	UG_L	Mean-N	1, 2, 3, 4
	Manganese	ug/L	7.4E+02	1.1E+03	(N)	1.6E+03		7.4E+02	UG_L	Mean-N	2, 3, 4
	Vanadium	ug/L	2.2E+00	2.8E+00	(NP)	4.3E+00	J	2.2E+00	UG_L	Mean-KM	5

ProUCL, Version 4.0 used to determine distribution of data using the Shapiro-Wilk W Test. ProUCL used to calculate EPC and mean, following recommendations based on distribution and standard deviation in users guide (USEPA. April 2007. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).
Options: Kaplan-Meier Mean (Mean-KM); Normal Mean (Mean-N); Maximum Detected Value (Max)

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.
(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.
(3) Anderson-Darling Test indicates data are gamma distributed.
(4) Kolmogorov-Smirnov Test indicates data are gamma distributed.
(5) Distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed).
(6) Max value used because 95% UCL greater than max.

N = Normal
T = Log-Transformed
NP = Non-Parametric
G = Gamma
ug/L = micrograms per liter
J = Estimated Value

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Resident	Adult	Upper Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-W	Ingestion Rate of Water	2	liters/day	EPA, 1997	CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT
				EF	Exposure Frequency	350	days/year	EPA, 1991	
				ED	Exposure Duration	24	years	EPA, 1991	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	days	EPA, 1989	
		Child	Upper Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	CDI (mg/kg-day) =
				IR-W	Ingestion Rate of Water	1	liters/day	EPA, 1997	CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT
				EF	Exposure Frequency	350	days/year	EPA, 1991	
				ED	Exposure Duration	6	years	EPA, 1991	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				BW	Body Weight	15	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
		Child/Adult	Upper Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	CDI (mg/kg-day) =
				IR-W-A	Ingestion Rate of Water, Adult	2	liters/day	EPA, 1997	CW x IR-W-Adj x EF x CF2 x 1/AT
				IR-W-C	Ingestion Rate of Water, Child	1	liters/day	EPA, 1997	
				IR-W-Adj	Ingestion Rate of Water, Age-adjusted	1.09	liter-year/kg-day	calculated	IR-W-Adj (liter-year/kd-day) =
				EF	Exposure Frequency	350	days/year	EPA, 1991	(ED-C x IR-W-C / BW-C) +
				ED-A	Exposure Duration, Adult	24	years	EPA, 1991	(ED-A x IR-W-A / BW-A)
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				BW-A	Body Weight , Adult	70	kg	EPA, 1991	
				BW-C	Body Weight, Child	15	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
	Industrial Worker	Adult	Upper Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	CDI (mg/kg-day) =
				IR-W	Ingestion Rate of Water	1	liters/day	EPA, 1991	CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT
				EF	Exposure Frequency	250	days/year	EPA, 1991	
				ED	Exposure Duration	25	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	

TABLE 4.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Resident	Adult	Upper Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2004	
				K_p	Permeability Coefficient	chemical specific	cm/hr	EPA, 2004	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2004	Kp x CW x t_{event} x CF2 x CF3
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2004	Organics :
				t_{event}	Event Time	0.58	hr/event	EPA, 2004	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	18,000	cm^2	EPA, 2004	2 x FA x Kp x CW x (sqrt((6 x τ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2004	x CF2 x CF3
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED	Exposure Duration	24	years	EPA, 2004	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	70	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + 3B^2)/(1+B)^2)) x CF2 x CF3
				AT-N	Averaging Time (Non-Cancer)	8,760	days	EPA, 1989	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				CF3	Conversion Factor 3	0.001	l/cm^3	- -	
		Child	Upper Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2004	
				K_p	Permeability Coefficient	chemical specific	cm/hr	EPA, 2004	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2004	Kp x CW x t_{event} x CF2 x CF3
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2004	Organics :
				t_{event}	Event Time	1.0	hr/event	EPA, 2004	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	6,600	cm^2	EPA, 2004	2 x FA x Kp x CW x (sqrt((6 x τ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2004	x CF2 x CF3
				EF	Exposure Frequency	350	days/year	EPA, 2004	
				ED	Exposure Duration	6	years	EPA, 2004	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	15	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + 3B^2)/(1+B)^2)) x CF2 x CF3
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				CF3	Conversion Factor 3	0.001	l/cm^3	- -	

TABLE 4.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Resident	Child/Adult	Upper Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	CDI (mg/kg-day) = DA-Adj x EF x 1/AT
				DAevent-A	Dermally Absorbed Dose per Event, Adult	calculated	mg/cm^2-event	calculated	
				DAevent-C	Dermally Absorbed Dose per Event, Child	calculated	mg/cm^2-event	calculated	DA-Adj = (Daevent-A x SA-A x ED-A x 1/BW-A)
				DA-Adj	Dermally Absorbed Dose, Age-adjusted	calculated	mg-year/event-kg	calculated	+ (Daevent-C x SA-C x ED-C x 1/BW-C)
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2004	
				K_p	Permeability Coefficient	chemical specific	cm/hr	EPA, 2004	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2004	Kp x CW x t_{event} x CF2 x CF3
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2004	Organics :
				t_{event}-A	Event Time, Adult	0.58	hr/event	EPA, 2004	t_{event}<t*: DAevent (mg/cm^2-event) =
				t_{event}-C	Event Time, Child	1.0	hr/event	EPA, 2004	2 x FA x Kp x CW x (sqrt((6 x τ x t_{event})/π))
				SA-A	Skin Surface Area, Adult	18,000	cm^2	EPA, 2004	x CF2 x CF3
				SA-C	Skin Surface Area, Child	6,600	cm^2	EPA, 2004	
				EV	Event Frequency	1	events/day	EPA, 2004	t_{event}>t*: DAevent (mg/cm^2-event) =
				EF	Exposure Frequency	350	days/year	EPA, 2004	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				ED-A	Exposure Duration, Adult	24	years	EPA, 2004	((1 + 3B + 3B^2)/(1+B)^2)) x CF2 x CF3
				ED-C	Exposure Duration, Child	6	years	EPA, 2004	
				BW-A	Body Weight, Adult	70	kg	EPA, 1991	
				BW-C	Body Weight, Child	15	ke	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				CF3	Conversion Factor 3	0.001	l/cm^3	- -	
	Construction Worker	Adult	Alluvial Aquifer - Water in Excavation Pit	CW	Chemical Concentration in Water	See Table 3.2.RME	µg/l	See Table 3.2.RME	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2004	
				K_p	Permeability Coefficient	chemical specific	cm/hr	EPA, 2004	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2004	Kp x CW x t_{event} x CF2 x CF3
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2004	Organics :
				t_{event}	Event Time	8	hr/day	(1)	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	5,700	cm^2	EPA, 2004, (3)	2 x FA x Kp x CW x (sqrt((6 x τ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2004	x CF2 x CF3
				EF	Exposure Frequency	125	days/year	(2)	
				ED	Exposure Duration	1	years	EPA, 1991	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	70	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + 3B^2)/(1+B)^2)) x CF2 x CF3

TABLE 4.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont.)	Construction Worker (cont.)	Adult	Alluvial Aquifer - Water in Excavation Pit	AT-N	Averaging Time (Non-Cancer)	365	days	EPA, 1989	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				CF3	Conversion Factor 3	0.001	l/cm^3	- -	

(1) Professional Judgement based on construction activities that would occur 8 hrs per day for the RME.

(2) Assumed duration of construction project may be 1/2 a year.

(3) Skin surface area in contact with groundwater assumed to be hands, forearms, lower legs, and feet.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

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

TABLE 4.1.CTE
VALUES USED FOR DAILY INTAKE CALCULATIONS
CENTRAL TENDENCY EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Resident	Adult	Alluvial Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-W	Ingestion Rate of Water	1.4	liters/day	EPA, 1993	CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT
				EF	Exposure Frequency	234	days/year	EPA, 1993	
				ED	Exposure Duration	9	years	EPA, 1993	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
		Child	Alluvial Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	CDI (mg/kg-day) =
				IR-W	Ingestion Rate of Water	1	liters/day	EPA, 1997	CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT
				EF	Exposure Frequency	234	days/year	EPA, 1993	
				ED	Exposure Duration	6	years	EPA, 1991	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				BW	Body Weight	15	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
		Child/Adult	Alluvial Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	CDI (mg/kg-day) =
				IR-W-A	Ingestion Rate of Water, Adult	1.4	liters/day	EPA, 1993	CW x IR-W-Adj x EF x CF2 x 1/AT
				IR-W-C	Ingestion Rate of Water, Child	1	liters/day	EPA, 1997	
				IR-W-Adj	Ingestion Rate of Water, Age-adjusted	0.58	liter-year/kg-day	calculated	IR-W-Adj (liter-year/kd-day) =
				EF	Exposure Frequency	234	days/year	EPA, 1993	(ED-C x IR-W-C / BW-C) +
				ED-A	Exposure Duration, Adult	9	years	EPA, 1993	(ED-A x IR-W-A / BW-A)
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				BW-A	Body Weight , Adult	70	kg	EPA, 1991	
				BW-C	Body Weight, Child	15	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
	Industrial Worker	Adult	Alluvial Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	CDI (mg/kg-day) =
				IR-W	Ingestion Rate of Water	1	liters/day	EPA, 1991	CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT
				EF	Exposure Frequency	219	days/year	EPA, 1993	
				ED	Exposure Duration	5	years	EPA, 1993	
				BW	Body Weight	70	kg	EPA, 1991	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	1,825	days	EPA, 1989	

TABLE 4.1.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Resident	Adult	Alluvial Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	Chemical specific	dimensionless	EPA, 2004	
				K_p	Permeability Coefficient	Chemical specific	cm/hr	EPA, 2004	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	Chemical specific	hr/event	EPA, 2004	Kp x CW x t_{event} x CF2 x CF3
				t*	Time to Reach Steady-state	Chemical specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	Chemical specific	dimensionless	EPA, 2004	Organics :
				t_{event}	Event Time	0.25	hr/event	EPA, 2004	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	18,000	cm^2	EPA, 2004	2 x FA x Kp x CW x (sqrt((6 x τ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2004	x CF2 x CF3
				EF	Exposure Frequency	234	days/year	EPA, 1993	
				ED	Exposure Duration	9	years	EPA, 2001	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	70	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				CF3	Conversion Factor 3	0.001	l/cm^3	- -	
		Child	Alluvial Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	Chemical specific	dimensionless	EPA, 2004	
				K_p	Permeability Coefficient	Chemical specific	cm/hr	EPA, 2004	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	Chemical specific	hr/event	EPA, 2004	Kp x CW x t_{event} x CF2 x CF3
				t*	Time to Reach Steady-state	Chemical specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	Chemical specific	dimensionless	EPA, 2004	Organics :
				t_{event}	Event Time	0.33	hr/event	EPA, 2004	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	6,600	cm^2	EPA, 2004	2 x FA x Kp x CW x (sqrt((6 x τ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2004	x CF2 x CF3
				EF	Exposure Frequency	234	days/year	EPA, 1993	
				ED	Exposure Duration	6	years	EPA, 2001	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	15	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				CF3	Conversion Factor 3	0.001	l/cm^3	- -	

TABLE 4.1.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Resident	Child/Adult	Alluvial Aquifer - Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	CDI (mg/kg-day) = DA-Adj x EF x 1/AT
				DAevent-A	Dermally Absorbed Dose per Event, Adult	Calculated	mg/cm^2-event	calculated	
				DAevent-C	Dermally Absorbed Dose per Event, Child	Calculated	mg/cm^2-event	calculated	DA-Adj = (Daevent-A x SA-A x ED-A x 1/BW-A)
				DA-Adj	Dermally Absorbed Dose, Age-adjusted	Calculated	mg-year/event-kg	calculated	+ (Daevent-C x SA-C x ED-C x 1/BW-C)
				FA	Fraction absorbed water	Chemical specific	dimensionless	EPA, 2004	
				K_p	Permeability Coefficient	Chemical specific	cm/hr	EPA, 2004	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	Chemical specific	hr/event	EPA, 2004	Kp x CW x t_{event} x CF2 x CF3
				t*	Time to Reach Steady-state	Chemical specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	Chemical specific	dimensionless	EPA, 2004	Organics :
				t_{event}-A	Event Time, Adult	0.25	hr/event	EPA, 2004	t_{event}<t*: DAevent (mg/cm^2-event) =
				t_{event}-C	Event Time, Child	0.33	hr/event	EPA, 2004	2 x FA x Kp x CW x (sqrt((6 x τ x t_{event})/π))
				SA-A	Skin Surface Area, Adult	18,000	cm^2	EPA, 2004	x CF2 x CF3
				SA-C	Skin Surface Area, Child	6,600	cm^2	EPA, 2004	
				EV	Event Frequency	1	events/day	EPA, 2004	t_{event}>t*: DAevent (mg/cm^2-event) =
				EF	Exposure Frequency	234	days/year	EPA, 1993	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				ED-A	Exposure Duration, Adult	9	years	EPA, 2001	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3
				ED-C	Exposure Duration, Child	6	years	EPA, 2001	
				BW-A	Body Weight, Adult	70	kg	EPA, 1991	
				BW-C	Body Weight, Child	15	ke	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				CF3	Conversion Factor 3	0.001	l/cm^3	- -	
	Construction Worker	Adult	Alluvial Aquifer - Water in Excavation Pit	CW	Chemical Concentration in Water	See Table 3.2.CTE	µg/l	See Table 3.2.CTE	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	Chemical specific	dimensionless	EPA, 2004	
				K_p	Permeability Coefficient	Chemical specific	cm/hr	EPA, 2004	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	Chemical specific	hr/event	EPA, 2004	Kp x CW x t_{event} x CF2 x CF3
				t*	Time to Reach Steady-state	Chemical specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	Chemical specific	dimensionless	EPA, 2004	Organics :
				t_{event}	Event Time	4	hr/day	(1)	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	5,700	cm^2	EPA, 2001, (3)	2 x FA x Kp x CW x (sqrt((6 x τ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2001	x CF2 x CF3
				EF	Exposure Frequency	125	days/year	(2)	
				ED	Exposure Duration	1	years	EPA, 1991	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	70	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF2 x CF3

TABLE 4.1.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont.)	Construction Worker (cont.)	Adult	Alluvial Aquifer - Water in Excavation Pit	AT-N	Averaging Time (Non-Cancer)	365	days	EPA, 1989	
				CF2	Conversion Factor 2	0.001	mg/µg	- -	
				CF3	Conversion Factor 3	0.001	l/cm^3	- -	

(1) Professional judgement assuming 1/2 RME value for CT.

(2) Assumed duration of construction project may be 1/2 a year.

(3) Skin surface area in contact with groundwater assumed to be hands, forearms, lower legs, and feet.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2001: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

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

TABLE 5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

Site 4, NWS Yorktown

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
1,3-Dinitrobenzene	Chronic	1.0E-04	mg/kg-day		0.0E+00	mg/kg-day			IRIS	6/4/2008
	Subchronic		mg/kg-day		0.0E+00	mg/kg-day				
Arsenic	Chronic	3.0E-04	mg/kg-day	95%	3.0E-04	mg/kg-day	Skin, Vascular	3/1	IRIS	6/4/2008
	Subchronic	3.0E-04	mg/kg-day	95%	3.0E-04	mg/kg-day	Skin, Vascular	3	HEAST	07/01/97
Chromium (hexavalent)	Chronic	3.0E-03	mg/kg-day	2.5%	7.5E-05	mg/kg-day	Not identified	300/3	IRIS	5/19/2008
	Subchronic	2.0E-02	mg/kg-day	2.5%	5.0E-04	mg/kg-day	Not identified	100	HEAST	7/1/1997
Iron	Chronic	7.0E-01	mg/kg/day	100%	7.0E-01	mg/kg/day	Gastrointestinal, Blood, Liver	1	NCEA (R3)	10/11/07
	Subchronic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese (nonfood)	Chronic	2.0E-02	mg/kg-day	4%	8.0E-04	mg/kg-day	CNS	1/1	IRIS	05/05/08
	Subchronic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	Chronic	1.0E-03	mg/kg-day	2.6%	2.6E-05	mg/kg-day	Kidney	300	NCEA (R3)	10/11/07
	Subchronic	7.0E-03	mg/kg-day	2.6%	1.8E-04	mg/kg-day	Lifetime	100	HEAST	07/01/97

NA = Not Applicable or Not Available.

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evalution Manual (Part E, Supplemetnal Guidance for Dermal Risk Assessment). Final. Section 4.2 and Exhibit 4-1. USEPA recommends that the oral RfD should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%. Constituents that do not have oral absorption efficiencies reported on this table were assumed to have an oral absorption efficiency of 100%.

(2) Provide equation for derivation in text.

(3) For IRIS values, provide the date IRIS was searched.
For HEAST values, provide the date of HEAST.
For NCEA values, provide the date of the article provided by NCEA.

Definitions:

ATSDR = Agency for Toxic Substances and Disease Registry
IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
NCEA = National Center for Environmental Assessment
CNS = Central Nervous System
NOAEL = No adverse effect level
R3 = cited in Region 3 Risk-Based Concentration Table (October 11, 2007)

TABLE 5.2

NON-CANCER TOXICITY DATA -- INHALATION

Site 7 NAB Little Creek

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2) (MM/DD/YY)
1,3-Dinitrobenzene	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	Chronic	3.0E-05	mg/m^3	8.6E-06	mg/kg-day	Lung	3/1	Cal-EPA	1997
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium (hexavalent)	Chronic	1.1E-04	mg/m^3	3.0E-05	mg/kg-day	Respiratory System	300/1	IRIS	05/19/08
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	Chronic	NA	NA	NA	NA	NA	NA	NA	NA
	Subchronic	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	Chronic	5.0E-05	mg/m^3	1.4E-05	mg/kg-day	CNS	1000/1	IRIS	05/19/08
	Subchronic	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	Chronic	NA	NA	NA	NA	NA	NA	NA	NA
	Subchronic	NA	NA	NA	NA	NA	NA	NA	NA

NA = Not Applicable

(1) Provide equation used for derivation in text.

(2) For IRIS values, provide the date IRIS was searched.

For NCEA values, provide the date of the article provided by NCEA.

Definitions: IRIS = Integrated Risk Information System

ATSDR MRL = Agency for Toxic Substances and Disease Registry

NCEA = National Center for Environmental Assessment

PPRTV = Provisional Peer-Reviewed Toxicity Values

R3 = cited in Region 3 Risk-Based Concentration Table (October 11, 2007)

CNS = Central nevous system.

TABLE 6.1

CANCER TOXICITY DATA -- ORAL/DERMAL

Site 7, NAB Little Creek

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	EPA Carcinogen Group	Source	Date (2) (MM/DD/YY)
Arsenic	1.5E+00	95%	1.5E+00	(mg/kg-day) $^{-1}$	A	IRIS	5/5/2008
Chromium (hexavalent)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (nonfood)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A

NA-Not available

IRIS = Integrated Risk Information System

Cal EPA = California Environmental Protection Agency

NCEA = National Center for Environmental Assessment

PPRTV = Provisional Peer-Reviewed Toxicity Value

R3 = cited in Region 3 Risk-Based Concentration Table (October 11, 2007)

(1) Refer to RAGS, Part E. July 2004.

(2) For IRIS values, provide the date IRIS was searched.
For CalEPA values, provide the date CalEPA database was searched.
For RBC values, provide the date of last change in the Tables.

EPA Carcinogen Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

TABLE 6.2

CANCER TOXICITY DATA -- INHALATION

Site 7, NAB Little Creek

Chemical of Potential Concern	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guidance Description	Source	Date (2) (MM/DD/YY)
Arsenic	4.0E-03	$(ug/m3)^{-1}$	3500	1.5E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	5/5/2008
Chromium (hexavalent)	1.2E-02	$(ug/m3)^{-1}$	3500	4.1E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	5/19/2008
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	D	IRIS	5/5/2008
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA

IRIS = Integrated Risk Information System

Cal EPA = California Environmental Protection Agency

NCEA = National Center for Environmental Assessment

NA = Not Available

(1) Adjustment Factor applied to Unit Risk to calculate Inhalation Slope Factor = 70kg x 1/20 m^3/day x 1000 ug/mg

(2) For IRIS values, provide the date IRIS was searched.
For CalEPA values, provide the date CalEPA database was searched.
For RBC values, provide the date of last change in the Tables.

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Upper Aquifer Tap Water	Ingestion													
				Arsenic	2.8E+01	ug/L	N/A	N/A	N/A	N/A	N/A	7.7E-04	mg/kg/day	3.0E-04	mg/kg/day	2.6E+00
				Chromium	2.0E+01	ug/L	N/A	N/A	N/A	N/A	N/A	5.6E-04	mg/kg/day	3.0E-03	mg/kg/day	1.9E-01
				Iron	1.2E+04	ug/L	N/A	N/A	N/A	N/A	N/A	3.2E-01	mg/kg/day	7.0E-01	mg/kg/day	4.6E-01
				Manganese	1.1E+03	ug/L	N/A	N/A	N/A	N/A	N/A	3.1E-02	mg/kg/day	2.0E-02	mg/kg/day	1.6E+00
				Vanadium	4.3E+00	ug/L	N/A	N/A	N/A	N/A	N/A	1.2E-04	mg/kg/day	1.0E-03	mg/kg/day	1.2E-01
			Exp. Route Total								N/A					4.9E+00
			Dermal Absorption													
				Arsenic	2.8E+01	ug/L	N/A	N/A	N/A	N/A	N/A	4.0E-06	mg/kg/day	3.0E-04	mg/kg/day	1.3E-02
				Chromium	2.0E+01	ug/L	N/A	N/A	N/A	N/A	N/A	5.8E-06	mg/kg/day	7.5E-05	mg/kg/day	7.8E-02
				Iron	1.2E+04	ug/L	N/A	N/A	N/A	N/A	N/A	1.7E-03	mg/kg/day	7.0E-01	mg/kg/day	2.4E-03
				Manganese	1.1E+03	ug/L	N/A	N/A	N/A	N/A	N/A	1.6E-04	mg/kg/day	8.0E-04	mg/kg/day	2.0E-01
				Vanadium	4.3E+00	ug/L	N/A	N/A	N/A	N/A	N/A	6.1E-07	mg/kg/day	2.6E-05	mg/kg/day	2.4E-02
			Exp. Route Total								N/A					3.2E-01
		Exposure Point Total									N/A					5.2E+00
	Exposure Medium Total										N/A					5.2E+00
Medium Total											N/A					5.2E+00
									Total of Receptor Risks Across All Media		N/A			Total of Receptor Hazards Across All Media		5.2E+00

Notes-

NA = Not applicable.

DAevent for exposure to groundwater while showering is calculated on Table 7.1.RME Supplement A.

Table 7.1.RME Supplement A
Calculation of DAevent
Resident Adult Ground Water
Site 7, NAB Little Creek

Chemical of Potential Concern	Water Concentration (CW) (μg/L)	Permeability Coefficient[1] (Kp) (cm/hr)	B[1] (dimensionless)	Lag Time[1] (τ_{event}) (hr)	t*[1] (hr)	Fraction Absorbed Water[1] (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
Arsenic	2.8E+01	1.0E-03	NA	NA	NA	NA	0.58	1.6E-08	1
Chromium	2.0E+01	2.0E-03	NA	NA	NA	NA	0.58	2.4E-08	1
Iron	1.2E+04	1.0E-03	NA	NA	NA	NA	0.58	6.8E-06	1
Manganese	1.1E+03	1.0E-03	NA	NA	NA	NA	0.58	6.6E-07	1
Vanadium	4.3E+00	1.0E-03	NA	NA	NA	NA	0.58	2.5E-09	1

Inorganics: DAevent (mg/cm2-event) =
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (eq 1)

Organics: DAevent (mg/cm2-event) =
If $t_{event} < t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} > t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[\frac{t_{event}}{1+B} + 2 \times \tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
NA - not applicable.

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Upper Aquifer Tap Water	Ingestion													
				Arsenic	2.8E+01	ug/L	N/A	N/A	N/A	N/A	N/A	1.8E-03	mg/kg/day	3.0E-04	mg/kg/day	6.0E+00
				Chromium	2.0E+01	ug/L	N/A	N/A	N/A	N/A	N/A	1.3E-03	mg/kg/day	3.0E-03	mg/kg/day	4.4E-01
				Iron	1.2E+04	ug/L	N/A	N/A	N/A	N/A	N/A	7.5E-01	mg/kg/day	7.0E-01	mg/kg/day	1.1E+00
				Manganese	1.1E+03	ug/L	N/A	N/A	N/A	N/A	N/A	7.3E-02	mg/kg/day	2.0E-02	mg/kg/day	3.6E+00
				Vanadium	4.3E+00	ug/L	N/A	N/A	N/A	N/A	N/A	2.7E-04	mg/kg/day	1.0E-03	mg/kg/day	2.7E-01
			Exp. Route Total								N/A					1.1E+01
			Dermal Absorption													
				Arsenic	2.8E+01	ug/L	N/A	N/A	N/A	N/A	N/A	1.2E-05	mg/kg/day	3.0E-04	mg/kg/day	4.0E-02
				Chromium	2.0E+01	ug/L	N/A	N/A	N/A	N/A	N/A	1.7E-05	mg/kg/day	7.5E-05	mg/kg/day	2.3E-01
				Iron	1.2E+04	ug/L	N/A	N/A	N/A	N/A	N/A	4.9E-03	mg/kg/day	7.0E-01	mg/kg/day	7.0E-03
				Manganese	1.1E+03	ug/L	N/A	N/A	N/A	N/A	N/A	4.8E-04	mg/kg/day	8.0E-04	mg/kg/day	6.0E-01
				Vanadium	4.3E+00	ug/L	N/A	N/A	N/A	N/A	N/A	1.8E-06	mg/kg/day	2.6E-05	mg/kg/day	7.0E-02
			Exp. Route Total								N/A					9.5E-01
		Exposure Point Total									N/A					1.2E+01
	Exposure Medium Total										N/A					1.2E+01
Medium Total											N/A					1.2E+01
									Total of Receptor Risks Across All Media		N/A			Total of Receptor Hazards Across All Media		1.2E+01

Notes-

NA = Not applicable.

DAevent for exposure to groundwater while bathing is calculated on Table 7.2.RME Supplement A.

Table 7.2.RME Supplement A
Calculation of DAevent
Resident Child Ground Water
Site 7, NAB Little Creek

Chemical of Potential Concern	Water Concentration (CW) (μg/L)	Permeability Coefficient[1] (Kp) (cm/hr)	B[1] (dimensionless)	Lag Time[1] (τ_{event}) (hr)	t*[1] (hr)	Fraction Absorbed Water[1] (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
Arsenic	2.8E+01	1.0E-03	NA	NA	NA	NA	1	2.8E-08	1
Chromium	2.0E+01	2.0E-03	NA	NA	NA	NA	1	4.1E-08	1
Iron	1.2E+04	1.0E-03	NA	NA	NA	NA	1	1.2E-05	1
Manganese	1.1E+03	1.0E-03	NA	NA	NA	NA	1	1.1E-06	1
Vanadium	4.3E+00	1.0E-03	NA	NA	NA	NA	1	4.3E-09	1

Inorganics: DAevent (mg/cm2-event) =
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (eq 1)

Organics: DAevent (mg/cm2-event) =
If $t_{event} < t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} > t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[\frac{t_{event}}{1+B} + 2 \times \tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
NA - not applicable.

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Upper Aquifer Tap Water	Ingestion													
				Arsenic	2.8E+01	ug/L	4.2E-04	mg/kg/day	1.5E+00	mg/kg/day	6.3E-04	N/A	N/A	N/A	N/A	N/A
				Chromium	2.0E+01	ug/L	3.0E-04	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Iron	1.2E+04	ug/L	1.7E-01	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Manganese	1.1E+03	ug/L	1.7E-02	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Vanadium	4.3E+00	ug/L	6.4E-05	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
			Exp. Route Total								6.3E-04					0.0E+00
			Dermal Absorption													
				Arsenic	2.8E+01	ug/L	2.4E-06	mg/kg/day	1.5E+00	mg/kg/day	3.6E-06	N/A	N/A	N/A	N/A	N/A
				Chromium	2.0E+01	ug/L	1.5E-04	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Iron	1.2E+04	ug/L	4.2E-02	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Manganese	1.1E+03	ug/L	4.1E-03	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Vanadium	4.3E+00	ug/L	1.6E-05	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
			Exp. Route Total								3.6E-06					0.0E+00
		Exposure Point Total									6.3E-04					0.0E+00
	Exposure Medium Total										6.3E-04					0.0E+00
Medium Total											6.3E-04					0.0E+00
									Total of Receptor Risks Across All Media		6.3E-04			Total of Receptor Hazards Across All Media		0.0E+00

Notes-
NA = Not applicable.

TABLE 7.4.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Upper Aquifer Tap Water	Ingestion													
				Arsenic	2.8E+01	ug/L	9.9E-05	mg/kg/day	1.5E+00	mg/kg/day	1.5E-04	2.8E-04	mg/kg/day	3.0E-04	mg/kg/day	9.2E-01
				Chromium	2.0E+01	ug/L	7.1E-05	mg/kg/day	N/A		N/A	2.0E-04	mg/kg/day	3.0E-03	mg/kg/day	6.7E-02
				Iron	1.2E+04	ug/L	4.1E-02	mg/kg/day	N/A		N/A	1.1E-01	mg/kg/day	7.0E-01	mg/kg/day	1.6E-01
				Manganese	1.1E+03	ug/L	4.0E-03	mg/kg/day	N/A		N/A	1.1E-02	mg/kg/day	2.0E-02	mg/kg/day	5.6E-01
				Vanadium	4.3E+00	ug/L	1.5E-05	mg/kg/day	N/A		N/A	4.2E-05	mg/kg/day	1.0E-03	mg/kg/day	4.2E-02
			Exp. Route Total								1.5E-04					1.7E+00
		Exposure Point Total									1.5E-04					1.7E+00
	Exposure Medium Total										1.5E-04					1.7E+00
Medium Total											1.5E-04					1.7E+00
										Total of Receptor Risks Across All Media	1.5E-04				Total of Receptor Hazards Across All Media	1.7E+00

Notes-
NA = Not applicable.

TABLE 7.5.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Water in Excavation Pit	Dermal Absorption	Arsenic	2.8E+01	ug/L	9.0E-08	mg/kg/day	1.5E+00	mg/kg/day	1.3E-07	6.3E-06	mg/kg/day	3.0E-04	mg/kg/day	2.1E-02
				Chromium	2.0E+01	ug/L	1.3E-07	mg/kg/day	N/A		N/A	9.1E-06	mg/kg/day	5.0E-04	mg/kg/day	1.8E-02
				Iron	1.2E+04	ug/L	3.7E-05	mg/kg/day	N/A		N/A	2.6E-03	mg/kg/day	7.0E-01	mg/kg/day	3.7E-03
				Manganese	1.1E+03	ug/L	3.6E-06	mg/kg/day	N/A		N/A	2.5E-04	mg/kg/day	8.0E-04	mg/kg/day	3.2E-01
				Vanadium	4.3E+00	ug/L	1.4E-08	mg/kg/day	N/A		N/A	9.6E-07	mg/kg/day	1.8E-04	mg/kg/day	5.3E-03
			Exp. Route Total								1.3E-07					3.6E-01
		Exposure Point Total									1.3E-07					3.6E-01
	Exposure Medium Total										1.3E-07					3.6E-01
Medium Total											1.3E-07					3.6E-01
Total of Receptor Risks Across All Media											1.3E-07	Total of Receptor Hazards Across All Media				3.6E-01

Notes-

NA = Not applicable.

DAevent for exposure to shallow aquifer groundwater during excavation activities calculated on Table 7.5.RME Supplement A.

Table 7.5.RME Supplement A
Calculation of DAevent
Construction Worker
Site 7, NAB Little Creek

Chemical of Potential Concern	Water Concentration (CW) (µg/L)	Permeability Coefficient[1] (Kp) (cm/hr)	B[1] (dimensionless)	Lag Time[1] (τ_{event}) (hr)	t*[1] (hr)	Fraction Absorbed Water[1] (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
Arsenic	2.8E+01	1.0E-03	NA	NA	NA	NA	8	2.3E-07	1
Chromium	2.0E+01	2.0E-03	NA	NA	NA	NA	8	3.3E-07	1
Iron	1.2E+04	1.0E-03	NA	NA	NA	NA	8	9.3E-05	1
Manganese	1.1E+03	1.0E-03	NA	NA	NA	NA	8	9.1E-06	1
Vanadium	4.3E+00	1.0E-03	NA	NA	NA	NA	8	3.4E-08	1

Inorganics: DAevent (mg/cm2-event) =
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (eq 1)

Organics: DAevent (mg/cm2-event) =
If tevent<t*, then DAevent =
2 x FA x Kp x CW x (sqrt((6 x τ_{event} x t_{event})/π)) x 0.001 mg/ug x 0.001 l/cm^3 (eq 2)

If tevent>t*, then DAevent =
FA x Kp x CW x (t_{event}/(1+B) + 2 x τ_{event} x ((1 + 3xB + $3xB^2$)/$(1+B)^2$) x 0.001 mg/ug x 0.001 l/cm^3 (eq 3)

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
NA - not applicable.

TABLE 7.1.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Upper Aquifer Tap Water	Ingestion													
				Arsenic	1.0E+01	ug/L	N/A	N/A	N/A	N/A	N/A	1.3E-04	mg/kg/day	3.0E-04	mg/kg/day	4.3E-01
				Chromium	3.5E+00	ug/L	N/A	N/A	N/A	N/A	N/A	4.5E-05	mg/kg/day	3.0E-03	mg/kg/day	1.5E-02
				Iron	8.8E+03	ug/L	N/A	N/A	N/A	N/A	N/A	1.1E-01	mg/kg/day	7.0E-01	mg/kg/day	1.6E-01
				Manganese	7.4E+02	ug/L	N/A	N/A	N/A	N/A	N/A	9.4E-03	mg/kg/day	2.0E-02	mg/kg/day	4.7E-01
				Vanadium	2.2E+00	ug/L	N/A	N/A	N/A	N/A	N/A	2.8E-05	mg/kg/day	1.0E-03	mg/kg/day	2.8E-02
			Exp. Route Total								N/A					1.1E+00
			Dermal Absorption													
				Arsenic	1.0E+01	ug/L	N/A	N/A	N/A	N/A	N/A	4.1E-07	mg/kg/day	3.0E-04	mg/kg/day	1.4E-03
				Chromium	3.5E+00	ug/L	N/A	N/A	N/A	N/A	N/A	2.9E-07	mg/kg/day	7.5E-05	mg/kg/day	3.9E-03
				Iron	8.8E+03	ug/L	N/A	N/A	N/A	N/A	N/A	3.6E-04	mg/kg/day	7.0E-01	mg/kg/day	5.2E-04
				Manganese	7.4E+02	ug/L	N/A	N/A	N/A	N/A	N/A	3.0E-05	mg/kg/day	8.0E-04	mg/kg/day	3.8E-02
				Vanadium	2.2E+00	ug/L	N/A	N/A	N/A	N/A	N/A	8.9E-08	mg/kg/day	2.6E-05	mg/kg/day	3.4E-03
			Exp. Route Total								N/A					4.7E-02
		Exposure Point Total									N/A					1.2E+00
	Exposure Medium Total										N/A					1.2E+00
Medium Total											N/A					1.2E+00
									Total of Receptor Risks Across All Media		N/A			Total of Receptor Hazards Across All Media		1.2E+00

Notes-

NA = Not applicable.

DAevent for exposure to groundwater while showering is calculated on Table 7.1.CTE Supplement A.

Table 7.1.RME Supplement A
Calculation of DAevent
Resident Adult Ground Water
Site 7, NAB Little Creek

Chemical of Potential Concern	Water Concentration (CW) (μg/L)	Permeability Coefficient[1] (Kp) (cm/hr)	B[1] (dimensionless)	Lag Time[1] (τ_{event}) (hr)	t*[1] (hr)	Fraction Absorbed Water[1] (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
Arsenic	1.0E+01	1.0E-03	NA	NA	NA	NA	0.25	2.5E-09	1
Chromium	3.5E+00	2.0E-03	NA	NA	NA	NA	0.25	1.8E-09	1
Iron	8.8E+03	1.0E-03	NA	NA	NA	NA	0.25	2.2E-06	1
Manganese	7.4E+02	1.0E-03	NA	NA	NA	NA	0.25	1.8E-07	1
Vanadium	2.2E+00	1.0E-03	NA	NA	NA	NA	0.25	5.4E-10	1

Inorganics: DAevent (mg/cm2-event) =
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (eq 1)

Organics: DAevent (mg/cm2-event) =
If $t_{event} < t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} > t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[\frac{t_{event}}{1+B} + 2 \times \tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
NA - not applicable.

TABLE 7.2.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Upper Aquifer Tap Water	Ingestion													
				Arsenic	1.0E+01	ug/L	N/A	N/A	N/A	N/A	N/A	4.3E-04	mg/kg/day	3.0E-04	mg/kg/day	1.4E+00
				Chromium	3.5E+00	ug/L	N/A	N/A	N/A	N/A	N/A	1.5E-04	mg/kg/day	3.0E-03	mg/kg/day	5.0E-02
				Iron	8.8E+03	ug/L	N/A	N/A	N/A	N/A	N/A	3.8E-01	mg/kg/day	7.0E-01	mg/kg/day	5.4E-01
				Manganese	7.4E+02	ug/L	N/A	N/A	N/A	N/A	N/A	3.1E-02	mg/kg/day	2.0E-02	mg/kg/day	1.6E+00
				Vanadium	2.2E+00	ug/L	N/A	N/A	N/A	N/A	N/A	9.3E-05	mg/kg/day	1.0E-03	mg/kg/day	9.3E-02
			Exp. Route Total								N/A					3.7E+00
			Dermal Absorption													
				Arsenic	1.0E+01	ug/L	N/A	N/A	N/A	N/A	N/A	9.3E-07	mg/kg/day	3.0E-04	mg/kg/day	3.1E-03
				Chromium	3.5E+00	ug/L	N/A	N/A	N/A	N/A	N/A	6.6E-07	mg/kg/day	7.5E-05	mg/kg/day	8.7E-03
				Iron	8.8E+03	ug/L	N/A	N/A	N/A	N/A	N/A	8.2E-04	mg/kg/day	7.0E-01	mg/kg/day	1.2E-03
				Manganese	7.4E+02	ug/L	N/A	N/A	N/A	N/A	N/A	6.8E-05	mg/kg/day	8.0E-04	mg/kg/day	8.6E-02
				Vanadium	2.2E+00	ug/L	N/A	N/A	N/A	N/A	N/A	2.0E-07	mg/kg/day	2.6E-05	mg/kg/day	7.8E-03
			Exp. Route Total								N/A					1.1E-01
		Exposure Point Total									N/A					3.8E+00
	Exposure Medium Total										N/A					3.8E+00
Medium Total											N/A					3.8E+00
									Total of Receptor Risks Across All Media		N/A			Total of Receptor Hazards Across All Media		3.8E+00

Notes-

NA = Not applicable.

DAevent for exposure to groundwater while bathing is calculated on Table 7.2.RME Supplement A.

Table 7.2.CTE Supplement A
Calculation of DAevent
Resident Child Ground Water
Site 7, NAB Little Creek

Chemical of Potential Concern	Water Concentration (CW) (μg/L)	Permeability Coefficient[1] (Kp) (cm/hr)	B[1] (dimensionless)	Lag Time[1] (τ_{event}) (hr)	t*[1] (hr)	Fraction Absorbed Water[1] (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
Arsenic	1.0E+01	1.0E-03	NA	NA	NA	NA	0.33	3.3E-09	1
Chromium	3.5E+00	2.0E-03	NA	NA	NA	NA	0.33	2.3E-09	1
Iron	8.8E+03	1.0E-03	NA	NA	NA	NA	0.33	2.9E-06	1
Manganese	7.4E+02	1.0E-03	NA	NA	NA	NA	0.33	2.4E-07	1
Vanadium	2.2E+00	1.0E-03	NA	NA	NA	NA	0.33	7.2E-10	1

Inorganics: DAevent (mg/cm2-event) =
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (eq 1)

Organics: DAevent (mg/cm2-event) =
If $t_{event} < t^*$ then

$$DA_{event} = 2 \times FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}} \qquad \text{(eq 2)}$$

If $t_{event} > t^*$ then

$$DA_{event} = FA \times K_p \times C_w \times 0.001 \quad mg/ug \times 0.001 \quad l/cm^3 \left[\frac{t_{event}}{1+B} + 2 \times \tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right] \qquad \text{(eq 3)}$$

Notes:
[1] Values from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
NA - not applicable.

TABLE 7.3.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Upper Aquifer Tap Water	Ingestion													
				Arsenic	1.0E+01	ug/L	5.3E-05	mg/kg/day	1.5E+00	mg/kg/day	8.0E-05	N/A	N/A	N/A	N/A	N/A
				Chromium	3.5E+00	ug/L	1.9E-05	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Iron	8.8E+03	ug/L	4.7E-02	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Manganese	7.4E+02	ug/L	3.9E-03	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Vanadium	2.2E+00	ug/L	1.2E-05	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
			Exp. Route Total								8.0E-05					0.0E+00
			Dermal Absorption													
				Arsenic	1.0E+01	ug/L	1.3E-07	mg/kg/day	1.5E+00	mg/kg/day	2.0E-07	N/A	N/A	N/A	N/A	N/A
				Chromium	3.5E+00	ug/L	4.1E-06	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Iron	8.8E+03	ug/L	5.2E-03	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Manganese	7.4E+02	ug/L	4.3E-04	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
				Vanadium	2.2E+00	ug/L	1.3E-06	mg/kg/day	N/A		N/A	N/A	N/A	N/A	N/A	N/A
			Exp. Route Total								2.0E-07					0.0E+00
		Exposure Point Total									8.0E-05					0.0E+00
	Exposure Medium Total										8.0E-05					0.0E+00
Medium Total											8.0E-05					0.0E+00
									Total of Receptor Risks Across All Media		8.0E-05			Total of Receptor Hazards Across All Media		0.0E+00

Notes-
NA = Not applicable.

TABLE 7.4.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Upper Aquifer Tap Water	Ingestion													
				Arsenic	1.0E+01	ug/L	6.1E-06	mg/kg/day	1.5E+00	mg/kg/day	9.2E-06	8.6E-05	mg/kg/day	3.0E-04	mg/kg/day	2.9E-01
				Chromium	3.5E+00	ug/L	2.2E-06	mg/kg/day	N/A		N/A	3.0E-05	mg/kg/day	3.0E-03	mg/kg/day	1.0E-02
				Iron	8.8E+03	ug/L	5.4E-03	mg/kg/day	N/A		N/A	7.5E-02	mg/kg/day	7.0E-01	mg/kg/day	1.1E-01
				Manganese	7.4E+02	ug/L	4.5E-04	mg/kg/day	N/A		N/A	6.3E-03	mg/kg/day	2.0E-02	mg/kg/day	3.2E-01
				Vanadium	2.2E+00	ug/L	1.3E-06	mg/kg/day	N/A		N/A	1.9E-05	mg/kg/day	1.0E-03	mg/kg/day	1.9E-02
			Exp. Route Total								9.2E-06					7.4E-01
		Exposure Point Total									9.2E-06					7.4E-01
	Exposure Medium Total										9.2E-06					7.4E-01
Medium Total											9.2E-06					7.4E-01
									Total of Receptor Risks Across All Media		9.2E-06			Total of Receptor Hazards Across All Media		7.4E-01

Notes-
NA = Not applicable.

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	N/A	N/A	N/A	0.0E+00	Skin, Vascular	2.6E+00	N/A	1.3E-02	2.6E+00
			Chromium	N/A	N/A	N/A	0.0E+00	Not identified	1.9E-01	N/A	7.8E-02	2.6E-01
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	4.6E-01	N/A	2.4E-03	4.6E-01
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	1.6E+00	N/A	2.0E-01	1.8E+00
			Vanadium	N/A	N/A	N/A	0.0E+00	Kidney	1.2E-01	N/A	2.4E-02	1.4E-01
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		4.9E+00	0.0E+00	3.2E-01	5.2E+00
		Exposure Point Total					0.0E+00					5.2E+00
	Exposure Medium Total						0.0E+00					5.2E+00
Medium Total							0.0E+00					5.2E+00
Receptor Total							0.0E+00				Receptor HI Total	5.2E+00

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	1.8E+00
Total Liver HI Across All Media =	4.6E-01
Total Gastrointestinal HI Across All Media =	4.6E-01
Total Blood HI Across All Media =	4.6E-01
Total Kidney HI Across All Media =	1.4E-01
Total Skin HI Across All Media =	2.6E+00
Total Vascular HI Across All Media =	2.6E+00

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	N/A	N/A	N/A	0.0E+00	Skin, Vascular	6.0E+00	N/A	4.0E-02	6.0E+00
			Chromium	N/A	N/A	N/A	0.0E+00	Not identified	4.4E-01	N/A	2.3E-01	6.6E-01
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	1.1E+00	N/A	7.0E-03	1.1E+00
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	3.6E+00	N/A	6.0E-01	4.2E+00
			Vanadium	N/A	N/A	N/A	0.0E+00	Kidney	2.7E-01	N/A	7.0E-02	3.4E-01
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		1.1E+01	0.0E+00	9.5E-01	1.2E+01
		Exposure Point Total					0.0E+00					1.2E+01
	Exposure Medium Total						0.0E+00					1.2E+01
Medium Total							0.0E+00					1.2E+01
Receptor Total							0.0E+00				Receptor HI Total	1.2E+01

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	4.2E+00
Total Liver HI Across All Media =	1.1E+00
Total Gastrointestinal HI Across All Media =	1.1E+00
Total Blood HI Across All Media =	1.1E+00
Total Kidney HI Across All Media =	3.4E-01
Total Skin HI Across All Media =	6.0E+00
Total Vascular HI Across All Media =	6.0E+00

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	6.3E-04	N/A	3.6E-06	6.3E-04	Skin, Vascular	N/A	N/A	N/A	0.0E+00
			Chromium	N/A	N/A	N/A	0.0E+00	Not identified	N/A	N/A	N/A	0.0E+00
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	N/A	N/A	N/A	0.0E+00
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	N/A	N/A	N/A	0.0E+00
			Vanadium	N/A	N/A	N/A	0.0E+00	Kidney	N/A	N/A	N/A	0.0E+00
			Chemical Total	6.3E-04	0.0E+00	3.6E-06	6.3E-04		0.0E+00	0.0E+00	0.0E+00	0.0E+00
		Exposure Point Total					6.3E-04					0.0E+00
	Exposure Medium Total						6.3E-04					0.0E+00
Medium Total							6.3E-04					0.0E+00
Receptor Total							6.3E-04				Receptor HI Total	0.0E+00

HI - Hazard Index
CNS = Central Nervous System

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	1.5E-04	N/A	N/A	1.5E-04	Skin, Vascular	9.2E-01	N/A	N/A	9.2E-01
			Chromium	N/A	N/A	N/A	0.0E+00	Not identified	6.7E-02	N/A	N/A	6.7E-02
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	1.6E-01	N/A	N/A	1.6E-01
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	5.6E-01	N/A	N/A	5.6E-01
			Vanadium	N/A	N/A	N/A	0.0E+00	Kidney	4.2E-02	N/A	N/A	4.2E-02
			Chemical Total	1.5E-04	0.0E+00	0.0E+00	1.5E-04		1.7E+00	0.0E+00	0.0E+00	1.7E+00
		Exposure Point Total					1.5E-04					1.7E+00
	Exposure Medium Total						1.5E-04					1.7E+00
Medium Total							1.5E-04					1.7E+00
Receptor Total							1.5E-04				Receptor HI Total	1.7E+00

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	5.6E-01
Total Liver HI Across All Media =	1.6E-01
Total Gastrointestinal HI Across All Media =	1.6E-01
Total Blood HI Across All Media =	1.6E-01
Total Kidney HI Across All Media =	4.2E-02
Total Skin HI Across All Media =	9.2E-01
Total Vascular HI Across All Media =	9.2E-01

TABLE 9.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Water in Excavation Pit	Arsenic	N/A	N/A	1.3E-07	1.3E-07	Skin, Vascular	N/A	N/A	2.1E-02	2.1E-02
			Chromium	N/A	N/A	N/A	0.0E+00	Not identified	N/A	N/A	1.8E-02	1.8E-02
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	N/A	N/A	3.7E-03	3.7E-03
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	N/A	N/A	3.2E-01	3.2E-01
			Vanadium	N/A	N/A	N/A	0.0E+00	Lifetime	N/A	N/A	5.3E-03	5.3E-03
			Chemical Total	0.0E+00	0.0E+00	1.3E-07	1.3E-07		0.0E+00	0.0E+00	3.6E-01	3.6E-01
		Exposure Point Total					1.3E-07					3.6E-01
	Exposure Medium Total						1.3E-07					3.6E-01
Medium Total							1.3E-07					3.6E-01
Receptor Total							1.3E-07	Receptor HI Total				3.6E-01

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	3.2E-01
Total Liver HI Across All Media =	3.7E-03
Total Gastrointestinal HI Across All Media =	3.7E-03
Total Blood HI Across All Media =	3.7E-03
Total Lifetime HI Across All Media =	5.3E-03
Total Skin HI Across All Media =	2.1E-02
Total Vascular HI Across All Media =	2.1E-02

TABLE 9.1.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	N/A	N/A	N/A	0.0E+00	Skin, Vascular	4.3E-01	N/A	1.4E-03	4.3E-01
			Chromium	N/A	N/A	N/A	0.0E+00	Not identified	1.5E-02	N/A	3.9E-03	1.9E-02
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	1.6E-01	N/A	5.2E-04	1.6E-01
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	4.7E-01	N/A	3.8E-02	5.1E-01
			Vanadium	N/A	N/A	N/A	0.0E+00	Kidney	2.8E-02	N/A	3.4E-03	3.1E-02
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		1.1E+00	0.0E+00	4.7E-02	1.2E+00
		Exposure Point Total					0.0E+00					1.2E+00
	Exposure Medium Total						0.0E+00					1.2E+00
Medium Total							0.0E+00					1.2E+00
Receptor Total							0.0E+00				Receptor HI Total	1.2E+00

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	5.1E-01
Total Liver HI Across All Media =	1.6E-01
Total Gastrointestinal HI Across All Media =	1.6E-01
Total Blood HI Across All Media =	1.6E-01
Total Kidney HI Across All Media =	3.1E-02
Total Skin HI Across All Media =	4.3E-01
Total Vascular HI Across All Media =	4.3E-01

TABLE 9.2.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	N/A	N/A	N/A	0.0E+00	Skin, Vascular	1.4E+00	N/A	3.1E-03	1.4E+00
			Chromium	N/A	N/A	N/A	0.0E+00	Not identified	5.0E-02	N/A	8.7E-03	5.9E-02
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	5.4E-01	N/A	1.2E-03	5.4E-01
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	1.6E+00	N/A	8.6E-02	1.7E+00
			Vanadium	N/A	N/A	N/A	0.0E+00	Kidney	9.3E-02	N/A	7.8E-03	1.0E-01
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		3.7E+00	0.0E+00	1.1E-01	3.8E+00
		Exposure Point Total					0.0E+00					3.8E+00
	Exposure Medium Total						0.0E+00					3.8E+00
Medium Total							0.0E+00					3.8E+00
Receptor Total							0.0E+00				Receptor HI Total	3.8E+00

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	1.7E+00
Total Liver HI Across All Media =	5.4E-01
Total Gastrointestinal HI Across All Media =	5.4E-01
Total Blood HI Across All Media =	5.4E-01
Total Kidney HI Across All Media =	1.0E-01
Total Skin HI Across All Media =	1.4E+00
Total Vascular HI Across All Media =	1.4E+00

TABLE 9.3.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	8.0E-05	N/A	2.0E-07	8.0E-05	Skin, Vascular	N/A	N/A	N/A	0.0E+00
			Chromium	N/A	N/A	N/A	0.0E+00	Not identified	N/A	N/A	N/A	0.0E+00
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	N/A	N/A	N/A	0.0E+00
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	N/A	N/A	N/A	0.0E+00
			Vanadium	N/A	N/A	N/A	0.0E+00	Kidney	N/A	N/A	N/A	0.0E+00
			Chemical Total	8.0E-05	0.0E+00	2.0E-07	8.0E-05		0.0E+00	0.0E+00	0.0E+00	0.0E+00
		Exposure Point Total					8.0E-05					0.0E+00
	Exposure Medium Total						8.0E-05					0.0E+00
Medium Total							8.0E-05					0.0E+00
Receptor Total							8.0E-05				Receptor HI Total	0.0E+00

HI - Hazard Index
CNS = Central Nervous System

TABLE 9.4.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	9.2E-06	N/A	N/A	9.2E-06	Skin, Vascular	2.9E-01	N/A	N/A	2.9E-01
			Chromium	N/A	N/A	N/A	0.0E+00	Not identified	1.0E-02	N/A	N/A	1.0E-02
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	1.1E-01	N/A	N/A	1.1E-01
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	3.2E-01	N/A	N/A	3.2E-01
			Vanadium	N/A	N/A	N/A	0.0E+00	Kidney	1.9E-02	N/A	N/A	1.9E-02
			Chemical Total	9.2E-06	0.0E+00	0.0E+00	9.2E-06		7.4E-01	0.0E+00	0.0E+00	7.4E-01
		Exposure Point Total					9.2E-06					7.4E-01
	Exposure Medium Total						9.2E-06					7.4E-01
Medium Total							9.2E-06					7.4E-01
Receptor Total							9.2E-06				Receptor HI Total	7.4E-01

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	3.2E-01
Total Liver HI Across All Media =	1.1E-01
Total Gastrointestinal HI Across All Media =	1.1E-01
Total Blood HI Across All Media =	1.1E-01
Total Kidney HI Across All Media =	1.9E-02
Total Skin HI Across All Media =	2.9E-01
Total Vascular HI Across All Media =	2.9E-01

TABLE 10.1.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	N/A	N/A	N/A	0.0E+00	Skin, Vascular	2.6E+00	N/A	1.3E-02	2.6E+00
			Chromium	N/A	N/A	N/A	0.0E+00	Not identified	1.9E-01	N/A	7.8E-02	2.6E-01
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	4.6E-01	N/A	2.4E-03	4.6E-01
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	1.6E+00	N/A	2.0E-01	1.8E+00
			Vanadium	N/A	N/A	N/A	0.0E+00	Kidney	1.2E-01	N/A	2.4E-02	1.4E-01
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		4.9E+00	0.0E+00	3.2E-01	5.2E+00
		Exposure Point Total					0.0E+00					5.2E+00
	Exposure Medium Total						0.0E+00					5.2E+00
Medium Total							0.0E+00					5.2E+00
Receptor Total							0.0E+00				Receptor HI Total	5.2E+00

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	1.8E+00
Total Liver HI Across All Media =	4.6E-01
Total Gastrointestinal HI Across All Media =	4.6E-01
Total Blood HI Across All Media =	4.6E-01
Total Kidney HI Across All Media =	1.4E-01
Total Skin HI Across All Media =	2.6E+00
Total Vascular HI Across All Media =	2.6E+00

TABLE 10.2.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	N/A	N/A	N/A	0.0E+00	Skin, Vascular	6.0E+00	N/A	4.0E-02	6.0E+00
			Chromium	N/A	N/A	N/A	0.0E+00	Not identified	4.4E-01	N/A	2.3E-01	6.6E-01
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	1.1E+00	N/A	7.0E-03	1.1E+00
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	3.6E+00	N/A	6.0E-01	4.2E+00
			Vanadium	N/A	N/A	N/A	0.0E+00	Kidney	2.7E-01	N/A	7.0E-02	3.4E-01
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		1.1E+01	0.0E+00	9.5E-01	1.2E+01
		Exposure Point Total					0.0E+00					1.2E+01
	Exposure Medium Total						0.0E+00					1.2E+01
Medium Total							0.0E+00					1.2E+01
Receptor Total							0.0E+00				Receptor HI Total	1.2E+01

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	4.2E+00
Total Liver HI Across All Media =	1.1E+00
Total Gastrointestinal HI Across All Media =	1.1E+00
Total Blood HI Across All Media =	1.1E+00
Total Kidney HI Across All Media =	3.4E-01
Total Skin HI Across All Media =	6.0E+00

TABLE 10.3.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	6.3E-04	N/A	3.6E-06	6.3E-04	Skin, Vascular	N/A	N/A	N/A	0.0E+00
			Chemical Total	6.3E-04	0.0E+00	3.6E-06	6.3E-04		0.0E+00	0.0E+00	0.0E+00	0.0E+00
		Exposure Point Total					6.3E-04					0.0E+00
	Exposure Medium Total						6.3E-04					0.0E+00
Medium Total							6.3E-04					0.0E+00
Receptor Total							6.3E-04				Receptor HI Total	0.0E+00

HI - Hazard Index
CNS = Central Nervous System

TABLE 10.4.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	1.5E-04	N/A	N/A	1.5E-04	Skin, Vascular	9.2E-01	N/A	N/A	9.2E-01
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	1.6E-01	N/A	N/A	1.6E-01
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	5.6E-01	N/A	N/A	5.6E-01
			Chemical Total	1.5E-04	0.0E+00	0.0E+00	1.5E-04		1.6E+00	0.0E+00	0.0E+00	1.6E+00
		Exposure Point Total					1.5E-04					1.6E+00
	Exposure Medium Total						1.5E-04					1.6E+00
Medium Total							1.5E-04					1.6E+00
Receptor Total							1.5E-04	Receptor HI Total				1.6E+00

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	5.6E-01
Total Liver HI Across All Media =	1.6E-01
Total Gastrointestinal HI Across All Media =	1.6E-01
Total Blood HI Across All Media =	1.6E-01
Total Skin HI Across All Media =	9.2E-01
Total Vascular HI Across All Media =	9.2E-01

TABLE 10.1.CTE
RISK SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	N/A	N/A	N/A	0.0E+00	Skin, Vascular	4.3E-01	N/A	1.4E-03	4.3E-01
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	1.6E-01	N/A	5.2E-04	1.6E-01
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	4.7E-01	N/A	3.8E-02	5.1E-01
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		1.1E+00	0.0E+00	4.0E-02	1.1E+00
		Exposure Point Total					0.0E+00					1.1E+00
	Exposure Medium Total						0.0E+00					1.1E+00
Medium Total							0.0E+00					1.1E+00
Receptor Total							0.0E+00				Receptor HI Total	1.1E+00

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	5.1E-01
Total Liver HI Across All Media =	1.6E-01
Total Gastrointestinal HI Across All Media =	1.6E-01
Total Blood HI Across All Media =	1.6E-01
Total Skin HI Across All Media =	4.3E-01
Total Vascular HI Across All Media =	4.3E-01

TABLE 10.2.CTE
RISK SUMMARY
CENTRAL TENDENCY EXPOSURE
Site 7, NAB Little Creek

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Upper Aquifer - Tap Water	Arsenic	N/A	N/A	N/A	0.0E+00	Skin, Vascular	1.4E+00	N/A	3.1E-03	1.4E+00
			Iron	N/A	N/A	N/A	0.0E+00	Gastrointestinal, Blood, Liver	5.4E-01	N/A	1.2E-03	5.4E-01
			Manganese	N/A	N/A	N/A	0.0E+00	CNS	1.6E+00	N/A	8.6E-02	1.7E+00
			Vanadium	N/A	N/A	N/A	0.0E+00	Kidney	9.3E-02	N/A	7.8E-03	1.0E-01
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		3.6E+00	0.0E+00	9.8E-02	3.7E+00
		Exposure Point Total					0.0E+00					3.7E+00
	Exposure Medium Total						0.0E+00					3.7E+00
Medium Total							0.0E+00					3.7E+00
Receptor Total							0.0E+00				Receptor HI Total	3.7E+00

HI - Hazard Index
CNS = Central Nervous System

Total Nervous System/CNS Across All Media =	1.7E+00
Total Liver HI Across All Media =	5.4E-01
Total Gastrointestinal HI Across All Media =	5.4E-01
Total Blood HI Across All Media =	5.4E-01
Total Kidney HI Across All Media =	1.0E-01
Total Skin HI Across All Media =	1.4E+00
Total Vascular HI Across All Media =	1.4E+00

Appendix B
Groundwater Risk Management Supporting Information

Statement to Tier 1 Teams December 6, 2004

In cases where teams may be working to assess beneficial use, groundwater potability and/or cleanup goals, there are flexibilities in the process that can be used by each team to develop a strategy in accordance with CERCLA, the NCP and site specific conditions to reach a mutually agreeable solution. It is our expectation that the appropriate technical experts will be brought in to participate in discussions early on to help identify which flexibilities may be appropriate to explore. These flexibilities can be used as part of the overall site assessment process to create lines of evidence that serve as documentation for beneficial use, ground water potability, and/or cleanup goals. The teams will determine the specific site appropriate flexibilities that should be used (number and type) that form the lines of evidence.

Flexibilities may include but are not limited to:

- Background: In many cases, inorganics may be attributable to background conditions. A background assessment can prove to be invaluable to determining whether or not a contaminant is site-related.

- Risk-Range: There is flexibility in determining whether an action needs to be taken as long as the site-related cancer risk falls within EPA's acceptable risk-range (1×10^{-6} to 1×10^{-4} and Hazard Index of 1).

- Source removal/containment & monitoring: Another option to explore if there is not a current user. If the contamination in the groundwater is representative of what is being found in the soils, soil removal and monitoring may be warranted to determine if source removal alone will result in a reduction of contaminant levels in the groundwater.

- Timeframes: Depending on the current use of the groundwater the amount of time needed to reach cleanup goals may be flexible. For example, if groundwater is not currently being used as a drinking water source, and it is not expected to be used as such in the near future, cleanup technologies that may take longer to achieve cleanup goals could be considered. Monitored Natural Attenuation (MNA) is an example. MNA may be used in certain situations when: the processes will allow ARARs to be met in a timeframe comparable to a more active remedy. (NCP Preamble, 55 Fed. Reg. 8734). Additional EPA Guidance is available: *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, 1999. This guidance clarifies that MNA may be used when there is a low potential for plume migration, and when sources have been controlled.

  When evaluating remedial actions that require extended timeframes, additional factors may be considered that lend support to the Timeframe flexibility. For example, existing ground water controls, regulations, ordinances, etc., can be used to demonstrate that current restrictions are in place to manage water usage until the remedial action is complete.

- Is it a Plume? (Consistent/Contiguous): There may be instances where data from one well is driving the site-related risk. A close review of data will help determine whether there truly is a plume or not.

- Sample representativeness: It may be beneficial to review historical data to determine if proper well installation and sampling methodology occurred and verify the current conditions of the wells to ensure that sampling of the wells will generate representative samples.

- Classification: Guidance for assessing groundwater uses is provided in the Preamble to the 1990 NCP Revision (55 Fed Reg. 8666 et seq. (March 1990); recommending that EPA's 1984 "Ground-Water Protection Strategy" and 1986 "Guidelines for Ground-Water Classification" be used to assess future use of ground waters at a particular site.

- Alternate Concentration Limits (ACLs): (only when active restoration to ARARs is not practicable (from the nine criteria analysis). This is not the engineering practicability as used for TI determination.

  CERCLA Section 121(d)(2)(B)(ii) and NCP Section 300.430(e)(2)(i)(F) also allow for the use of Alternate Concentration Limits (ACLS):
  - there are known and projected points of groundwater entry into surface water
  - there are no statistically significant increases in contaminant levels downstream or at any place where contamination is expected to accumulate; and
  - enforceable measures can be taken to prevent human exposure between site and the entry points in surface water

- Technical Impracticability (TI): If from an engineering perspective, it is technically impracticable to comply with an applicable, relevant and/or appropriate requirement (ARAR) (such as meeting MCLs), a TI Waiver may be prepared. EPA's "Guidance for Evaluating the Technical Impracticability of Groundwater Restoration" can be utilized to prepare the supporting TI Waiver documentation.

Table B-1
Historical Groundwater Results
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Station ID	MCL-Groundwater	LC-Background UTL-Groundwater	LS07-MW01															
Sample ID			07-GW-101-93C	LS07-MW01-98B	LS07-MW01P-98B	LS07-MW01-98D	LS07-MW01-99B	LS07-MW01P-99B	LS07-MW01-00A	LS07-MW01-01A	LS07-MW01-01C	LS07-MW01P-01C	LS07-MW01-02A	LS07-MW01P-02A	LS07-MW01-02D	LS07-MW01-03A	LS07-MW01P-03A	LS07-MW01-03C
Sample Date			07/01/93	06/03/98	06/03/98	11/16/98	06/11/99	06/11/99	01/12/00	02/26/01	09/13/01	09/13/01	03/05/02	03/05/02	11/07/02	03/18/03	03/18/03	09/02/03
Chemical Name																		
Total Metals (UG_L)																		
Aluminum	--	713	18,000 J	308 B	174 B	1,080 J	2,120	1,970	3,960	88.6 B	124 J	137 J	1,340	932	NA	NA	NA	NA
Antimony	6	--	41 U	2.3 U	2.3 U	2.6 U	4.9 U	5.4 B	4.9 UL	2.5 U	3.6 U	3.6 U	1.5 U	1.5 U	3.7 U	3.8 U	3.8 U	4.7 U
Arsenic	10	4	8 J	3.4 B	5.5 B	7.2 J	3.8 UL	3.8 UL	6.8 J	4.2 U	3.9 U	3.9 U	1.7 U	1.7 U	2.5 U	4.5 U	4.5 U	2.8 U
Barium	2,000	55,000	52.7	9 B	9.3 B	9.1 B	11.2 B	11.1 B	14.7 B	3.5 J	6.3 J	6 J	6.6 B	5.7 B	5.8 J	9.9 U	9.9 U	8.2 J
Beryllium	4	0.5	1 U	0.61 U	0.61 U	1 U	0.4 U	0.4 U	0.4 U	0.1 U	0.2 U	0.2 U	0.3 U	0.3 U	0.19 J	0.1 U	0.1 U	0.1 U
Cadmium	5	2.1	4 U	0.27 U	0.27 U	0.4 U	0.5 U	0.5 U	0.5 U	0.6 U	0.3 U	0.3 U	0.3 U	0.3 U	0.4 U	0.8 U	0.8 U	0.4 U
Calcium	--	129,000	7,960	12,500	12,600	7,720	8,730	8,470	9,120 B	8,180	16,300	15,300	7,580	7,770	NA	NA	NA	NA
Chromium	100	4.1	13.8 J	6.6 U	6.6 U	7.3 U	5.3 B	5 B	8.6 J	0.5 U	1.6 J	0.73 J	0.9 UL	0.9 UL	2 J	1.4 U	1.4 U	2.4 J
Cobalt	--	2.6	4.8	5.7 U	5.7 U	5.4 U	1.6 B	1.9 J	2.1 J	0.7 U	0.7 U	0.7 U	2 U	2 U	0.6 U	0.76 B	0.7 U	0.6 U
Copper	1,300	--	7.3	5.5 U	5.5 U	10.5 U	4.6 J	4.8 B	7.2 B	2.6 B	0.6 U	1.3 J	3.1 B	3 B	1.4 UL	3.6 U	3.6 U	2.2 J
Cyanide	200	--	NA	5 U	5 U	5 U	2 U	2 U	2 U	0.65 U	5 U	5 U	0.8 U	0.8 U	NA	NA	NA	NA
Iron	--	17,100	17,600 J	6,370	6,370	4,370	4,170	3,990	5,870	3,450 K	3,450	3,370	2,950	2,460	NA	NA	NA	NA
Lead	15	2.4	9.9 J	2.2 B	2.5 B	1.5 U	2.4 U	2.4 U	2.4 U	1.7 UL	1.4 U	1.4 U	1.6 U	1.6 U	2.3 U	3.6 U	3.6 U	2.1 U
Magnesium	--	45,600	16,500	18,100	18,400	12,500	14,000	13,100	20,800	14,500	36,900	34,400	19,300	20,000	NA	NA	NA	NA
Manganese	--	1,500	132	84.2	85.2	64.2	55.5	53.4	50.4	51.8	62.8	60.1	33	31.9	NA	NA	NA	NA
Mercury	2	0.3	0.14 U	0.12 U	0.13 U	0.13 U	0.2 U	0.2 U	0.2 U	0.08 J	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA	NA	NA
Nickel	--	14	10 U	6.8 U	6.8 U	10 U	3 U	3.3 J	5.8 J	1.4 J	1 U	1 U	1 U	1 U	1 U	2 U	2 U	4.1 J
Potassium	--	16,600	13,300	14,400	14,600	10,300	11,600	10,900	14,000 B	11,600 J	25,300	23,900	17,400 J	17,800 J	NA	NA	NA	NA
Selenium	50	8	2 U	3.6 U	3.6 U	3.2 U	4.5 U	4.5 U	6 K	4.8 U	4.2 U	4.2 U	1.9 U	1.9 U	3.3 UL	1.6 B	1.3 U	3.6 J
Silver	--	2	3 U	3.8 B	6.6 B	6.4 B	1.2 U	1.2 U	1.2 U	0.63 B	1 U	1 U	0.5 U	0.5 U	NA	3.7 U	3.7 U	1.7 J
Sodium	--	65,000	142,000	189,000	191,000	121,000	164,000 B	152,000 B	213,000 L	138,000	400,000	374,000	189,000	196,000	NA	NA	NA	NA
Thallium	2	2.5	3 R	1.7 U	2.2 B	2 U	2.5 U	2.5 U	2.5 U	6.2 U	5.3 U	5.3 U	3 U	3 U	5.1 U	5.3 U	5.3 U	5.4 U
Vanadium	--	5	30.5	5.8 U	5.8 U	10.1 J	5 J	4.7 J	8.9 J	2 B	1.9 J	2 J	4.3 J	3.4 J	2.2 J	2.2 B	2.1 B	2.9 J
Zinc	--	59	42.9	17.3 B	16.4 B	7.5 U	16.5 B	18.4 B	28 B	19 J	0.87 J	0.6 U	4.6 UL	4.6 UL	2.8 B	16.5 B	13.6 B	39.2
Dissolved Metals (UG_L)																		
Aluminum	--	713	NA	45.5 B	101 B	64.1 B	12.5 U	12.5 U	27.9 B	70.7 B	11.7 U	11.7 U	65.6 U	65.6 U	NA	NA	NA	NA
Antimony	6	--	41 U	2.3 U	2.3 U	2.6 U	4.9 U	4.9 U	4.9 U	2.5 U	3.6 U	3.6 U	4 U	4 U	NA	NA	NA	NA
Arsenic	10	4	3.2	5 J	5.4 J	5.7 J	4.2 L	3.8 UL	13.8	4.2 U	3.9 U	3.9 U	2.4 U	2.4 U	NA	NA	NA	NA
Barium	2,000	55,000	8.1	6.6 B	7 B	5.5 B	4.9 J	5.1 B	3.1 B	3.4 J	5.3 J	5.6 J	2.9 B	2.4 B	NA	NA	NA	NA
Beryllium	4	0.5	1 U	0.61 U	0.61 U	1 U	0.4 U	0.4 U	0.4 U	0.1 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	NA	NA	NA
Cadmium	5	2.1	4 U	0.27 U	0.27 U	0.4 U	0.5 U	0.5 U	0.5 U	0.6 U	0.3 U	0.3 U	0.3 U	0.3 U	NA	NA	NA	NA
Calcium	--	129,000	6,250	11,500	10,800	6,200	7,140	7,430	3,830 B	8,000	14,100	15,100	7,610	6,540	NA	NA	NA	NA
Chromium	100	4.1	5 UJ	6.6 U	6.6 U	7.3 UL	5.8 J	2.8 B	1.2 J	0.9 J	0.7 U	0.7 U	0.6 U	0.6 U	NA	NA	NA	NA
Cobalt	--	2.6	3.5	5.7 U	5.7 U	5.4 U	2.7 J	7.1 B	0.9 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	NA	NA	NA	NA
Copper	1,300	--	2.1	5.5 U	5.5 U	10.5 U	2.4 B	2.4 B	4.5 B	11.3 J	0.6 U	0.6 U	4.3 U	4.3 U	NA	NA	NA	NA
Iron	--	17,100	1,070 J	6,410	5,570	3,370	2,600	2,690	1,800	3,660 L	3,130	3,260	1,320	1,390	NA	NA	NA	NA
Lead	15	2.4	2 UJ	1.7 U	2.7 J	1.7 J	2.4 U	2.4 U	2.4 UL	1.7 UL	1.4 U	1.4 U	1.8 U	1.8 U	NA	NA	NA	NA
Magnesium	--	45,600	11,300	15,100	15,500	6,220 J	10,500	11,000	3,700 B	13,300	31,400	33,800	17,400	14,500	NA	NA	NA	NA
Manganese	--	1,500	46.2	77.1	71.3	53.5	45	45.5	27	53	56.7	60	29.8	28.7	NA	NA	NA	NA
Mercury	2	0.3	0.15	0.12 U	0.13 U	0.13 U	0.2 U	0.2 U	0.2 U	0.06 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA	NA	NA
Nickel	--	14	10 U	6.8 U	6.8 U	10 U	4.2 J	5.2 J	3 U	2.8 J	1 U	1 U	1.3 U	1.3 U	NA	NA	NA	NA
Potassium	--	16,600	9,730	12,500	12,100	7,160	10,000	10,900	4,390 B	11,100 J	22,500	23,600	17,200 J	14,900 J	NA	NA	NA	NA
Selenium	50	8	2 U	3.6 U	3.6 U	3.2 U	4.5 U	4.5 U	4.5 U	4.8 U	4.2 U	4.2 U	4.6 U	4.6 U	NA	NA	NA	NA
Sodium	--	65,000	123,000	157,000 J	159,000 J	57,800 J	120,000	127,000	26,400 J	128,000	344,000	365,000	188,000 J	150,000 J	NA	NA	NA	NA
Thallium	2	2.5	3 R	1.7 U	3.7 J	2 U	2.8 J	2.5 U	2.5 U	6.2 U	5.3 U	5.3 U	6 U	6 U	NA	NA	NA	NA
Vanadium	--	5	9 U	5.8 U	5.8 U	8.2 U	1.1 J	1 J	1.6 J	1.7 B	1.1 U	1.5 J	0.94 J	1.4 J	NA	NA	NA	NA
Zinc	--	59	NA	18.1 B	15.7 B	7.5 U	15.1 B	19.5 B	12.3 B	182 J	1.3 J	0.72 J	2.2 B	2 U	NA	NA	NA	NA

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected quantitation limit is probably higher
Exceeds one or more criteria
-- No criteria established

Table B-1
Historical Groundwater Results
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Station ID	MCL-Groundwater	LC-Background UTL-Groundwater	LS07-MW01		LS07-MW02	LS07-MW03														
Sample ID			LS07-MW01P-03C	LS07-MW01-04A	07-GW-102-93C	07-GW-103-93C	LS07-MW03-98B	LS07-MW03-98D	LS07-MW03P-98D	LS07-MW03-99B	LS07-MW03-00A	LS07-MW03-01A	LS07-MW03-01B	LS07-MW03-01C	LS07-MW03-02A	LS07-MW03-02D	LS07-MW03P-02D	LS07-MW03-03A	LS07-MW03-03C	LS07-MW03-04A
Sample Date			09/03/03	02/24/04	07/01/93	07/01/93	06/03/98	11/16/98	11/16/98	06/10/99	01/12/00	02/26/01	06/26/01	09/20/01	03/05/02	11/07/02	11/07/02	03/18/03	09/02/03	02/24/04
Chemical Name																				
Total Metals (UG_L)																				
Aluminum	--	713	NA	NA	23,300 J	330,000 J	14,500	8,170 J	12,800 J	11,700	13,500	156 B	538 J	135 J	94.9 J	NA	NA	NA	NA	NA
Antimony	6	--	4.7 U	4 J	41 U	41 U	2.3 U	2.6 U	2.6 U	7.8 B	10.7 B	2.5 U	1.6 U	3.6 U	1.5 U	3.7 U	3.7 U	3.8 U	16.2 J	3.4 J
Arsenic	10	4	2.8 U	2.1 U	50.6	20.5	15.6	12.9	14.1	12.7 L	19.9	4.2 U	2.1 U	3.9 U	2.2 J	2.5 U	2.5 U	4.5 U	12.2	7.3 J
Barium	2,000	55,000	8.1 J	13.5 J	80.1	754	55.4 J	51 J	58.8 J	47.4 B	55.1 B	28.6 J	29.7 J	29.8 J	39.9 B	37.6	38.7	30.2 J	30.4 J	27.2 J
Beryllium	4	0.5	0.1 U	0.2 U	2.7	11	1.4 J	1.2 J	1.2 J	0.82 J	0.89 J	0.1 U	0.58 J	0.3 J	0.3 U	0.32 J	0.37 J	0.23 J	0.9 U	0.2 U
Cadmium	5	2.1	0.4 U	0.2 U	8.3	37.6	0.27 U	0.4 U	0.4 U	2 J	4.2 J	0.6 U	0.53 J	0.3 U	0.3 U	0.4 U	0.4 U	0.8 U	1.8 J	0.2 U
Calcium	--	129,000	NA	NA	42,400	50,300	39,100	36,000	37,500	27,800	32,200 B	25,000	29,500	22,900	34,900	NA	NA	NA	NA	NA
Chromium	100	4.1	2 J	1.3 J	29.7 J	360	17.8	14.4	16.7	14.7	18.9	23.4	1.1 B	1.1 J	0.9 UL	1.1 J	1.2 J	1.4 U	2.3 J	0.96 J
Cobalt	--	2.6	0.6 U	0.6 U	20.2	121	18.8 J	23.8 J	21.1 J	14.6 J	21.5 J	9.2 J	10.7 J	8.7 J	13 J	12.1	12.6	11.3 B	14.8 J	9.7
Copper	1,300	--	2.7 J	1.5 J	32.7	226	12.6 J	10.5 U	10.5 U	11.8 B	14.1 B	2 B	1.3 B	1.2 B	1.8 U	1.4 UL	1.4 UL	3.6 U	3.1 J	0.8 U
Cyanide	200	--	NA	NA	NA	NA	5 U	5 U	5 U	2 U	2 U	0.65 U	1.3 B	5 U	0.8 U	NA	NA	NA	NA	NA
Iron	--	17,100	NA	NA	98,300 J	224,000 J	27,700	21,500	27,100	15,300	22,800	8,260 K	9,370	9,420	11,100	NA	NA	NA	NA	NA
Lead	15	2.4	2.5 J	1.3 U	15.6 J	177 J	11.2 B	4.5	8.4 B	7.4	6.2	1.7 UL	2 J	1.4 U	1.6 U	2.3 U	2.3 U	3.6 U	3 U	1.3 U
Magnesium	--	45,600	NA	NA	8,340	39,400	18,400	17,300	18,200	13,000	15,600	10,600	13,600	9,430	16,400	NA	NA	NA	NA	NA
Manganese	--	1,500	NA	NA	225	1,930	852	855	900	633	792	565	638	558	785	NA	NA	NA	NA	NA
Mercury	2	0.3	NA	NA	0.18	0.27	0.12 U	0.13 U	0.13 U	0.2 U	0.2 U	0.08 J	0.15 J	0.1 U	0.1 U	NA	NA	NA	NA	NA
Nickel	--	14	2 J	1.3 J	10 U	176	13.7 J	20.3 J	25.4 J	16.4 J	22.4 J	7.9 J	7.6 J	5.1 J	4.1 J	7.2	7.5	8.5 J	11 B	5.8 J
Potassium	--	16,600	NA	NA	7,810 J	29,500 J	12,300	12,000	12,900	10,900	12,700 B	9,040 J	12,400 J	9,330	12,600 J	NA	NA	NA	NA	NA
Selenium	50	8	3 U	2 U	2 U	20 U	3.6 U	3.2 U	3.2 U	4.5 U	4.5 U	4.8 U	2.3 U	4.2 U	1.9 U	3.3 UL	3.3 UL	1.3 U	1.3 U	2 U
Silver	--	2	1.7 J	0.5 U	3 U	3 U	4.8 B	8.1 B	9.2 B	1.2 U	1.2 U	0.5 U	0.7 U	1 U	0.5 U	NA	NA	3.7 U	3.7 U	0.5 U
Sodium	--	65,000	NA	NA	50,000	56,900	66,100	65,100	66,400	48,600 B	58,200 L	47,700 B	63,600	41,100	78,600	NA	NA	NA	NA	NA
Thallium	2	2.5	5.4 U	3.2 U	3 R	3 R	1.7 U	2 U	2 U	2.5 U	2.5 U	6.2 U	3.5 U	5.3 U	3 U	5.1 U	5.1 U	5.3 U	7.2 J	3.2 U
Vanadium	--	5	2.1 J	1.8 J	43.2	634	32 J	17.8 J	29.8 J	23 J	26.3 J	1.1 B	1.4 J	1.1 U	1.7 U	0.95 J	0.7 U	2 B	2.5 U	1.8 J
Zinc	--	59	48.6	16.2 J	77.4	1,620	283	333	375	230	397	162	127	89.6	107	125	121	128 L	139	114 J
Dissolved Metals (UG_L)																				
Aluminum	--	713	NA	NA	NA	272	107 B	58.3 U	90.6 B	56.1 J	88.5 J	158 B	61 B	104 J	82.2 J	NA	NA	NA	NA	NA
Antimony	6	--	NA	NA	41 U	41 U	2.3 U	8.5 J	2.8 J	4.9 U	13.3 B	2.5 U	1.6 U	3.6 U	4 U	NA	NA	NA	NA	NA
Arsenic	10	4	NA	NA	2 U	3.4 J	2.3 U	5.4 J	5.6 J	4.1 L	3.8 U	4.2 U	2.1 U	3.9 U	2.4 U	NA	NA	NA	NA	NA
Barium	2,000	55,000	NA	NA	16.8 J	101 J	24.9 B	35.1 J	33.2 J	20.7 J	27.9 B	29.3 J	29.7 J	29.7 J	35.8 B	NA	NA	NA	NA	NA
Beryllium	4	0.5	NA	NA	1 U	1 U	0.61 U	1 U	1 U	0.4 U	0.4 U	0.1 U	0.55 J	0.29 J	0.2 U	NA	NA	NA	NA	NA
Cadmium	5	2.1	NA	NA	4 U	4 U	0.27 U	0.4 U	0.4 U	0.5 U	0.5 U	0.6 U	0.4 B	0.3 U	0.3 U	NA	NA	NA	NA	NA
Calcium	--	129,000	NA	NA	44,300	36,200	41,800	37,700	41,300	25,800	34,300 B	27,300	29,500	23,900	35,900	NA	NA	NA	NA	NA
Chromium	100	4.1	NA	NA	5 U	5 U	6.6 U	7.3 U	7.3 U	2.3 J	1.3 J	0.5 U	1 B	0.7 U	0.6 U	NA	NA	NA	NA	NA
Cobalt	--	2.6	NA	NA	6.6 J	24.6 J	9.8 J	10 J	12.3 J	10.4 J	12.2 J	9.2 J	10.5 J	8.2 J	12 J	NA	NA	NA	NA	NA
Copper	1,300	--	NA	NA	3.1 J	3.1 J	12.2 B	10.5 U	10.5 U	2.3 B	3 B	5.1 B	0.9 U	0.6 U	4.3 U	NA	NA	NA	NA	NA
Iron	--	17,100	NA	NA	605	8,380	6,710	7,280	7,120	5,240	6,980	7,940 L	8,260	9,400	10,800	NA	NA	NA	NA	NA
Lead	15	2.4	NA	NA	2 U	2 U	1.7 U	1.5 U	1.5 U	2.4 R	2.4 UL	1.7 UL	0.9 U	1.4 U	1.8 U	NA	NA	NA	NA	NA
Magnesium	--	45,600	NA	NA	7,100	15,000	19,100	16,800 J	18,200 J	11,500	15,900	11,700	13,500	9,990	16,000	NA	NA	NA	NA	NA
Manganese	--	1,500	NA	NA	129	955	863	831	893	571	820	603	646	581	773	NA	NA	NA	NA	NA
Mercury	2	0.3	NA	NA	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.2 U	0.2 U	0.09 J	0.1 U	0.1 U	0.1 U	NA	NA	NA	NA	NA
Nickel	--	14	NA	NA	10 U	10 U	6.8 U	11.5 J	22.6 J	8 J	9 J	8 J	11.5 J	4.6 J	7.8 B	NA	NA	NA	NA	NA
Potassium	--	16,600	NA	NA	6,770	11,800	11,600	11,600	12,500	9,490	10,500 B	9,750 J	12,400	9,750	13,700 J	NA	NA	NA	NA	NA
Selenium	50	8	NA	NA	2 U	2 U	3.6 U	3.2 U	3.2 U	6	4.5 U	4.8 U	2.3 U	4.2 U	4.6 U	NA	NA	NA	NA	NA
Sodium	--	65,000	NA	NA	60,000	54,700	72,700 J	66,200 J	72,000 J	45,600	64,400 J	57,700	62,700	45,100	75,300 J	NA	NA	NA	NA	NA
Thallium	2	2.5	NA	NA	NA	NA	1.7 U	2.3 J	2 U	3 J	2.5 U	6.2 U	3.8 J	5.3 U	6 U	NA	NA	NA	NA	NA
Vanadium	--	5	NA	NA	9 U	9 U	5.8 U	8.2 U	8.2 U	0.9 U	0.9 U	0.73 B	0.63 J	1.1 U	0.88 J	NA	NA	NA	NA	NA
Zinc	--	59	NA	NA	NA	307	159	190	197	133	157	220 J	110	87.7	109 B	NA	NA	NA	NA	NA

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected quantitation limit is probably higher
Exceeds one or more criteria
-- No criteria established

Station ID	MCL-Groundwater	LC-Background UTL-Groundwater	LS07-MW04	LS07-MW05	LS07-MW06													LS07-MW07	
Sample ID			07-GW-104-93C	07-GW-105-93C	07-GW-106-93C	LS07-MW06-98B	LS07-MW06-98D	LS07-MW06-99B	LS07-MW06-00A	LS07-MW06-01A	LS07-MW06P-01A	LS07-MW06-01C	LS07-MW06-02A	LS07-MW06-02D	LS07-MW06-03C	LS07-MW06-04A	LS07-MW06P-04A	07-GW-107-93C	LS07-MW07-98B
Sample Date			07/01/93	07/29/93	07/01/93	06/04/98	11/21/98	06/10/99	01/12/00	02/26/01	02/26/01	09/13/01	03/05/02	11/07/02	09/02/03	02/24/04	02/24/04	07/01/93	06/04/98
Chemical Name																			
Total Metals (UG_L)																			
Aluminum	--	713	117 J	4,590 J	7,740 J	1,000	12,400	2,120	17,100	54.5 B	65.2 B	11.7 U	233	NA	NA	NA	NA	225 J	752
Antimony	6	--	41 U	41 U	41 U	2.3 U	2.6 U	11 B	53.9 B	2.5 U	2.5 U	3.6 U	1.5 U	3.7 U	2 U	2.7 J	3.5 J	41 U	2.3 U
Arsenic	10	4	2 U	7.8 J	30.2	25.2	57.7	39.4 L	66.5	18.8	17.6	27.5	30.6	21.8	23.1	42.3	35.2	2 U	3.7 B
Barium	2,000	55,000	41.9	36.2	33.7	35.8 J	32 J	29.5 B	51.5 B	16 J	16.2 J	17.6 J	21.1 B	20.6	14.3 J	20.7 J	21.5 J	47.6	64.7 J
Beryllium	4	0.5	1 U	1.9	1 U	1 J	1.2 J	0.4 U	0.96 J	0.1 U	0.1 U	0.2 U	0.3 U	0.16 J	0.1 U	0.2 U	0.2 U	1 U	0.61 U
Cadmium	5	2.1	4 U	4 U	4 U	0.27 U	0.4 U	0.5 U	0.98 J	0.6 U	0.6 U	0.3 U	0.3 U	0.4 U	0.8 U	0.2 U	0.2 U	4 U	0.27 U
Calcium	--	129,000	109,000	125,000	120,000	164,000	167,000	161,000	145,000	133,000	133,000	148,000	143,000	NA	NA	NA	NA	257,000	345,000
Chromium	100	4.1	5 UJ	5.9 J	5 UJ	6.6 U	16.8	5.8 J	26.6	0.5 U	0.5 U	0.93 J	0.9 UL	1.5 J	1.4 U	1 J	1.2 J	5 UJ	6.6 U
Cobalt	--	2.6	3 U	3 U	28.3	5.7 U	8.2 J	9.9 J	46.5 J	2 J	1.9 J	1.6 J	3 J	1.8 J	1.7 J	2.8 J	2.9 J	3 U	5.7 U
Copper	1,300	--	2 U	38.3	4.7 J	5.5 U	10.5 U	19 J	6.7 B	0.95 B	1.5 B	0.6 U	2.6 B	1.4 UL	3.6 U	1.5 J	0.92 J	2 U	5.5 U
Cyanide	200	--	NA	10 U	NA	5 U	5 U	2 U	2 U	0.65 U	0.65 U	5 U	0.8 U	NA	NA	NA	NA	NA	5 U
Iron	--	17,100	4,800 J	63,000 J	22,300 J	18,900	35,000	19,900	31,800	11,500 K	11,400 K	13,500	15,500	NA	NA	NA	NA	1,830 J	1,070
Lead	15	2.4	2 UJ	20.7 J	4.3	1.7 U	6.4	2.4 R	2.4 U	1.7 UL	1.7 UL	1.4 U	1.6 U	2.3 U	3 U	1.3 U	1.3 U	2 UJ	1.7 U
Magnesium	--	45,600	16,200	108,000	108,000	138,000	141,000	137,000	122,000	113,000	113,000	125,000	125,000	NA	NA	NA	NA	380,000	685,000
Manganese	--	1,500	697	1,300	1,170	1,600	1,720	1,810	1,610	1,410	1,420	1,560	1,590	NA	NA	NA	NA	268	290
Mercury	2	0.3	0.13 U	0.29 U	0.13 U	0.13 U	0.13 U	0.2 U	0.2 U	0.06 U	0.08 J	0.1 U	0.1 U	NA	NA	NA	NA	0.14 U	0.13 U
Nickel	--	14	10 U	10 U	35.7	6.8 U	12.6 J	8.4 J	64.9	1.3 U	1.3 U	1 U	1 U	1 U	2 U	2.3 J	1.9 J	10 U	6.8 U
Potassium	--	16,600	15,100 J	10,700	20,000 J	24,500	21,600	21,700 J	23,600	25,600 J	25,600 J	22,200	29,400 J	NA	NA	NA	NA	153,000 J	188,000
Selenium	50	8	2 U	2 UJ	2 UJ	3.6 U	3.2 U	4.5 U	4.5 U	4.8 U	4.8 U	4.2 U	2.3 J	3.3 UL	1.3 U	2 U	2 U	20 U	3.6 U
Silver	--	2	3 U	3 U	3 U	7.5 B	1.5 B	1.2 U	1.2 U	0.5 U	0.5 U	1 U	0.5 U	NA	3.7 U	0.5 U	0.5 U	3 U	9.5 B
Sodium	--	65,000	86,600	208,000	428,000	460,000	429,000	393,000	269,000 L	306,000	309,000	389,000	326,000	NA	NA	NA	NA	3,570,000	5,930,000
Thallium	2	2.5	3 R	3.8 R	3 R	1.7 U	2 U	5.9 J	2.5 U	6.2 U	6.2 U	5.3 U	3 U	5.1 U	6.6 J	3.2 U	3.2 U	30 R	3.3 B
Vanadium	--	5	9 U	16	9 U	5.8 U	23.3 J	4.7 J	35.7 J	0.81 B	0.72 B	1.1 U	1.7 U	0.7 U	1.4 U	1.2 J	1.6 J	9 U	11.6 J
Zinc	--	59	NA	61.3 U	37.7	38 B	48.7	5.7 B	116	12.4 J	31.6 L	4.3 J	4.6 UL	6.2 J	33	22.3 J	7.6 J	NA	29.9 B
Dissolved Metals (UG_L)																			
Aluminum	--	713	NA	19.2 J	NA	56.9 J	1,980	42.3 J	12.5 U	49.3 B	59.4 B	12.6 J	65.6 U	NA	NA	NA	NA	225 J	57.6 B
Antimony	6	--	41 U	41 U	41 U	3.7 J	2.6 U	5.6 B	47.7 B	2.5 U	2.5 U	3.6 U	4 U	NA	NA	NA	NA	41 U	2.3 U
Arsenic	10	4	2 U	2.5	16.1	19.3	36.6	22.7 L	25.2	17.3	16.1	22.5	18.7	NA	NA	NA	NA	2 U	2.3 U
Barium	2,000	55,000	32 J	17.2	24 J	36.8 B	12.9 J	24.3 J	26.3 B	16 J	14 J	17.6 J	19.6 B	NA	NA	NA	NA	47.6 J	63.4 J
Beryllium	4	0.5	1 U	1.1	1 U	0.81 B	1 U	0.4 U	0.4 U	0.1 U	0.1 U	0.2 U	0.2 U	NA	NA	NA	NA	1 U	0.61 U
Cadmium	5	2.1	4 U	4 U	4 U	0.27 U	0.4 U	0.5 U	0.84 J	0.6 U	0.6 U	0.3 U	0.3 U	NA	NA	NA	NA	4 U	0.27 U
Calcium	--	129,000	106,000	124,000	110,000	173,000	135,000	159,000	167,000	132,000	116,000	147,000	144,000	NA	NA	NA	NA	257,000	350,000
Chromium	100	4.1	5 U	5 UJ	5 U	6.6 U	7.3 U	2.9 J	1.9 J	0.56 J	0.5 U	0.7 U	0.6 U	NA	NA	NA	NA	5 U	6.6 U
Cobalt	--	2.6	3 U	3 U	3 U	5.7 U	5.4 U	3.3 J	2.7 J	1.5 J	1.3 J	1.8 J	2.5 J	NA	NA	NA	NA	3 U	5.7 U
Copper	1,300	--	2 U	2 U	2 U	5.5 U	10.5 U	3.4 B	15.5 B	1.7 B	5.4 B	0.6 U	4.3 U	NA	NA	NA	NA	2 U	5.5 U
Iron	--	17,100	NA	38,300 UJ	13,400	17,500	18,800	15,700	14,100	11,500 L	10,100 L	12,900	13,900	NA	NA	NA	NA	NA	91.4 B
Lead	15	2.4	2 U	2 UJ	2 U	1.7 U	6.2	2.4 R	2.4 UL	1.7 UL	1.7 UL	1.4 U	1.8 U	NA	NA	NA	NA	2 U	1.7 U
Magnesium	--	45,600	18,800	111,000	98,900	145,000	113,000	135,000	185,000	111,000	96,900	124,000	123,000	NA	NA	NA	NA	380,000	687,000
Manganese	--	1,500	621	1,270	1,070	1,700	1,360	1,800	1,500	1,400	1,230	1,550	1,570	NA	NA	NA	NA	268	295
Mercury	2	0.3	0.13 U	0.37 U	0.15 J	0.12 U	0.31	0.2 U	0.2 U	0.07 U	0.06 U	0.1 U	0.1 U	NA	NA	NA	NA	0.13 U	0.13 U
Nickel	--	14	10 U	10 U	10 U	6.8 U	10 U	3 U	3 U	2.2 J	2 J	1 U	1.7 B	NA	NA	NA	NA	10 U	6.8 U
Potassium	--	16,600	16,400	10,200	18,000	24,900	16,600	21,600 J	41,400	24,800 J	20,900 J	21,800	30,500 J	NA	NA	NA	NA	153,000	189,000
Selenium	50	8	2 U	2 UJ	2 U	3.6 U	3.2 U	4.5 U	6.4 L	4.8 U	4.8 U	4.2 U	4.6 U	NA	NA	NA	NA	2 U	3.6 U
Sodium	--	65,000	115,000	237,000	403,000	473,000 J	356,000	390,000	276,000 J	299,000	265,000	380,000	387,000 J	NA	NA	NA	NA	3,570,000	5,950,000 J
Thallium	2	2.5	NA	3 R	NA	2.5 B	2 U	7.2 J	4.2 J	6.2 U	6.2 U	5.3 U	6 U	NA	NA	NA	NA	NA	3.9 B
Vanadium	--	5	9 U	9 U	9 U	5.8 U	8.2 U	0.9 U	0.9 U	0.7 U	0.7 U	1.1 U	0.8 U	NA	NA	NA	NA	9 U	5.8 U
Zinc	--	59	NA	23.3 U	NA	15.9 J	44.2	1.4 U	13.4 B	54.6 J	144 J	6 J	7.4 B	NA	NA	NA	NA	NA	18 J

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected quantitation limit is probably higher
Exceeds one or more criteria
-- No criteria established

Table B-1
Historical Groundwater Results
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Station ID	MCL-Groundwater	LC-Background UTL-Groundwater	LS07-MW07										LS07-MW08							
Sample ID			LS07-MW07-98D	LS07-MW07-99B	LS07-MW07-00A	LS07-MW07-01A	LS07-MW07-01C	LS07-MW07-02A	LS07-MW07-02D	LS07-MW07-03A	LS07-MW07-03C	LS07-MW07-04A	07-GW-108-93C	LS07-MW08-98B	LS07-MW08-98D	LS07-MW08-99B	LS07-MW08-00A	LS07-MW08-01A	LS07-MW08-01C	LS07-MW08-02A
Sample Date			11/18/98	06/11/99	01/13/00	02/27/01	09/10/01	03/04/02	11/08/02	03/18/03	09/02/03	02/24/04	07/01/93	06/04/98	11/18/98	06/11/99	01/13/00	02/27/01	09/10/01	03/04/02
Chemical Name																				
Total Metals (UG_L)																				
Aluminum	--	713	58.3 U	12.5 U	12.5 U	64.6 B	25.5 B	44 U	NA	NA	NA	NA	929 J	753	1,250	12.5 U	12.5 U	19.4 B	30.3 B	44 U
Antimony	6	--	2.6 U	25.3 J	19.4 B	2.5 U	3.6 U	1.5 U	3.7 U	3.8 U	17.1 B	2.1 U	41 U	2.3 U	2.6 U	26.1 B	16.6 J	2.5 U	3.6 U	1.5 U
Arsenic	10	4	3.1 U	3.8 UL	7.1 J	4.2 U	3.9 U	1.7 U	2.5 U	4.5 U	4.5 U	3.3 J	2 U	8.3 B	3.1 U	5.3 L	6 J	4.2 U	3.9 U	1.7 U
Barium	2,000	55,000	60.9 J	56.3 B	49.7 J	53.4 J	58.8 J	65.9 J	61.1	49.9 J	28.5 J	59.6 J	42.2	61.4 J	65 J	50.3 B	42.1 J	34.1 J	41.6 J	58.4 B
Beryllium	4	0.5	1 U	0.4 U	0.4 U	0.1 U	0.2 U	0.3 U	0.31 J	0.1 U	0.9 U	0.2 U	1 U	0.81 B	1 U	0.4 U	0.4 U	0.1 U	0.2 U	0.3 U
Cadmium	5	2.1	0.4 U	0.5 U	0.5 U	0.6 U	0.3 U	0.3 U	0.4 U	0.8 U	0.8 U	0.2 U	4 U	0.27 U	0.4 U	0.74 J	0.5 U	0.66 J	0.3 U	0.3 U
Calcium	--	129,000	265,000	295,000	245,000	296,000	283,000	344,000	NA	NA	NA	NA	272,000	428,000	336,000	320,000	277,000	266,000	276,000	354,000
Chromium	100	4.1	26.6	1 U	1 U	2.4 J	2.2 B	4.1 B	2.8 J	1.7 J	4.7 B	3.2 J	5 UJ	6.6 U	18.4	1 U	1 U	0.78 J	89.8 L	1.1 B
Cobalt	--	2.6	5.4 U	0.9 U	1.8 J	1.3 J	0.7 U	2 U	0.6 U	0.86 B	6 B	0.63 J	3 U	5.7 U	5.4 U	1 J	1.5 J	0.7 U	0.88 J	2 U
Copper	1,300	--	10.5 U	4.4 B	8.4 J	0.86 B	1.7 B	2.3 B	1.4 UL	3.6 U	2 U	0.8 U	5.9	5.5 U	10.5 U	4.4 B	10.8 J	1.5 B	3.7 B	2.6 B
Cyanide	200	--	5 U	2 U	2 U	0.65 U	5 U	19	NA	NA	NA	NA	NA	5 U	5 U	2 U	2 U	0.65 U	5 U	0.8 U
Iron	--	17,100	526	31.5 B	87.3 J	88.4 B	14.1 UL	32.1 J	NA	NA	NA	NA	1,720 J	1,330	2,040	15.7 J	7.4 U	30.9 B	2,010 L	25.1 J
Lead	15	2.4	1.5 U	2.4 U	2.4 UL	1.7 UL	1.4 U	1.6 U	2.3 U	4	3 U	1.3 U	103 J	1.7 U	1.5 U	2.4 U	2.4 UL	1.7 UL	1.4 U	1.6 U
Magnesium	--	45,600	563,000	687,000	625,000	625,000	594,000	731,000	NA	NA	NA	NA	393,000	787,000	644,000	668,000	637,000	583,000	576,000	697,000
Manganese	--	1,500	101	142	149	189	170	242	NA	NA	NA	NA	114	310	299	209	148	120	177	295
Mercury	2	0.3	0.13 U	0.2 U	0.2 U	0.06 U	0.1 U	0.1 U	NA	NA	NA	NA	0.14 U	0.13 U	0.13 U	0.2 U	0.2 U	0.07 U	0.1 U	0.1 U
Nickel	--	14	10 U	3 U	3 U	1.8 J	1 U	1.5 J	1 U	3.1 J	2 U	1.7 J	10 U	6.8 U	10.5 J	3 U	3 U	1.5 J	12.5 J	1 U
Potassium	--	16,600	161,000	351,000	187,000	282,000 J	195,000	316,000 J	NA	NA	NA	NA	143,000 J	211,000	173,000	331,000	222,000	272,000 J	201,000	320,000 J
Selenium	50	8	3.2 U	4.5 U	24.4 K	4.8 U	4.2 U	1.9 U	3.3 UL	8.1	1.3 U	2 U	20 UJ	3.6 U	3.2 U	4.5 U	32.4 K	4.8 U	4.2 U	1.9 U
Silver	--	2	0.8 U	1.2 U	1.2 U	1.5 B	1 U	0.5 U	NA	13.2	3.7 U	0.5 U	3 U	7.4 B	0.8 U	1.2 U	1.2 U	0.5 U	1 U	0.5 U
Sodium	--	65,000	4,790,000	5,660,000	4,760,000 L	4,380,000	4,750,000	4,980,000	NA	NA	NA	NA	3,520,000	6,980,000	5,660,000	5,510,000	5,020,000 L	4,110,000	4,750,000	4,910,000
Thallium	2	2.5	2 U	26.4	18.3	6.2 U	5.3 U	3 U	5.1 U	5.3 U	4.2 U	3.2 U	30 R	3.4 B	2 U	30.8	19.3	6.2 U	5.3 U	3 U
Vanadium	--	5	8.2 U	1.2 J	0.9 U	2 B	3.4 J	1.7 U	2.3 J	4.6 B	2.5 U	2.6 J	9 U	8.1 J	9 J	1.2 J	0.93 J	0.87 B	8.9 J	1.7 U
Zinc	--	59	12.4 J	1.4 U	1.4 U	1.1 UL	4.4 B	4.6 UL	2.3 B	18.5 B	15.8 J	5 J	NA	32.5 B	24.6	1.4 U	1.4 U	1.1 UL	6.3 B	4.6 UL
Dissolved Metals (UG_L)																				
Aluminum	--	713	58.3 U	12.5 U	12.5 U	15.1 U	11.7 U	65.6 U	NA	NA	NA	NA	929 J	56.2 B	58.3 U	12.5 U	12.5 U	19.1 B	22.3 B	65.6 U
Antimony	6	--	2.6 U	20.8 B	20.5 B	2.5 U	3.6 U	4 U	NA	NA	NA	NA	41 U	2.3 U	2.6 U	24.7 B	23.6 B	2.5 U	3.6 U	4 U
Arsenic	10	4	3.1 U	3.8 UL	7.5 J	4.2 U	3.9 U	2.4 U	NA	NA	NA	NA	2 U	4.5 J	3.1 U	3.8 UL	3.8 U	4.2 U	3.9 U	2.4 U
Barium	2,000	55,000	51.1 J	56.4 J	49.3 J	54.2 J	59.8 J	60 J	NA	NA	NA	NA	42.2 J	52.4 J	71.2 J	51 J	42.4 J	37.9 J	42.3 J	52.5 J
Beryllium	4	0.5	1 U	0.4 U	0.4 U	0.1 U	0.2 U	0.2 U	NA	NA	NA	NA	1 U	0.81 B	1 U	0.4 U	0.4 U	0.1 U	0.2 U	0.2 U
Cadmium	5	2.1	0.4 U	0.5 U	0.5 U	0.6 U	0.3 U	0.3 U	NA	NA	NA	NA	4 U	0.27 U	0.4 U	0.5 U	0.56 J	0.6 U	0.3 U	0.3 U
Calcium	--	129,000	298,000	284,000	242,000	298,000	292,000	328,000	NA	NA	NA	NA	272,000	376,000	380,000	314,000	277,000	301,000	273,000	328,000
Chromium	100	4.1	7.3 U	1 U	1 U	1.3 J	2 B	0.76 J	NA	NA	NA	NA	5 U	6.6 U	7.3 U	1 U	1 U	1.7 J	3.7 B	1.6 J
Cobalt	--	2.6	5.4 U	1.3 J	2.3 J	0.7 U	0.7 U	0.7 U	NA	NA	NA	NA	3 U	5.7 U	5.4 U	0.9 U	2.3 J	0.7 U	0.7 U	0.7 U
Copper	1,300	--	10.5 U	7.7 B	7.8 B	1.1 B	1.9 B	4.3 U	NA	NA	NA	NA	5.9 J	5.5 U	10.5 U	6.6 B	8.9 B	2 B	2.9 B	4.3 U
Iron	--	17,100	149	7.4 U	7.4 U	21.7 B	14.1 U	56.4 B	NA	NA	NA	NA	1,720 J	128 B	175	7.4 U	7.4 U	36.2 B	14.1 U	44.8 B
Lead	15	2.4	1.5 U	2.4 U	2.4 UL	1.7 UL	1.5 J	1.8 UL	NA	NA	NA	NA	103 J	1.7 U	1.5 U	2.4 U	2.4 UL	1.7 UL	1.4 U	1.8 UL
Magnesium	--	45,600	626,000	662,000	633,000	633,000	617,000	745,000	NA	NA	NA	NA	393,000	680,000	715,000	636,000	595,000	624,000	571,000	711,000
Manganese	--	1,500	143	178	144	197	171	260	NA	NA	NA	NA	114	263	337	222	143	145	174	304
Mercury	2	0.3	0.13 U	0.27	0.2 U	0.06 U	0.1 U	0.1 U	NA	NA	NA	NA	0.13 U	0.12 U	0.14 U	0.2 U	0.2 U	0.07 J	0.1 U	0.1 U
Nickel	--	14	10 U	3 U	3 U	1.3 U	1.4 J	1.3 U	NA	NA	NA	NA	10 U	6.8 U	10 U	3 U	3 U	2.3 J	1.3 J	2.2 J
Potassium	--	16,600	179,000	323,000	184,000 L	282,000 J	208,000	313,000 J	NA	NA	NA	NA	143,000	179,000	191,000	310,000	196,000 L	298,000 J	203,000	308,000 J
Selenium	50	8	3.2 U	4.5 U	23.4 L	4.8 U	4.2 U	4.6 UL	NA	NA	NA	NA	2 U	3.6 U	3.2 U	4.5 U	29.4 L	4.8 U	4.2 U	4.6 UL
Sodium	--	65,000	5,510,000	5,390,000	4,870,000 J	4,460,000	5,020,000	5,980,000 J	NA	NA	NA	NA	3,520,000	5,780,000 J	5,980,000	5,190,000	4,630,000 J	4,470,000	4,780,000	5,750,000 J
Thallium	2	2.5	2 U	27.9	18.1	6.2 U	5.3 U	6 U	NA	NA	NA	NA	NA	3.6 B	2 U	29.4	24.2	6.2 U	5.3 U	6 U
Vanadium	--	5	8.2 U	0.9 U	0.9 U	0.75 B	2.7 J	2 J	NA	NA	NA	NA	9 U	5.8 U	10.5 J	0.9 J	1 J	0.7 U	3 J	1.8 J
Zinc	--	59	14.1 J	1.4 U	1.4 U	2.4 B	2.4 B	2.2 B	NA	NA	NA	NA	NA	31.8 B	14.9 J	1.4 U	1.4 U	57.9 B	3.6 B	2 U

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected quantitation limit is probably higher
Exceeds one or more criteria
-- No criteria established

Table B-1
Historical Groundwater Results
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Station ID	MCL-Groundwater	LC-Background UTL-Groundwater	LS07-MW08				LS07-MW09											
Sample ID			LS07-MW08-02D	LS07-MW08-03A	LS07-MW08-03C	LS07-MW08-04A	07-GW-109-93C	LS07-MW09-98B	LS07-MW09-98D	LS07-MW09-99B	LS07-MW09-00A	LS07-MW09-01A	LS07-MW09-01C	LS07-MW09-02A	LS07-MW09-02D	LS07-MW09-03A	LS07-MW09-03C	LS07-MW09-04A
Sample Date			11/08/02	03/18/03	09/02/03	02/24/04	07/01/93	06/04/98	11/18/98	06/11/99	01/13/00	02/27/01	09/10/01	03/04/02	11/08/02	03/18/03	09/02/03	02/24/04
Chemical Name																		
Total Metals (UG_L)																		
Aluminum	--	713	NA	NA	NA	NA	1,060 J	778	119 B	12.5 U	12.5 U	15.1 U	15.8 B	44 U	NA	NA	NA	NA
Antimony	6	--	3.7 U	3.8 U	41 J	2.1 U	41 U	2.3 U	2.6 U	26 B	56.5 B	2.5 U	3.6 U	1.5 U	3.7 U	3.8 U	35 J	3.4 J
Arsenic	10	4	2.5 U	4.5 U	4.5 U	2.1 U	2 U	2.3 U	3.1 U	10.1 L	8.9 J	4.2 U	3.9 U	2.2 J	2.5 U	4.5 U	4.5 U	2.1 U
Barium	2,000	55,000	52.8	53.3 J	37.2 J	46.5 J	75.9	174 J	70.2 J	97.3 B	71 J	71.4 J	87.5 J	83.3 J	77.7	81.2 J	42.3 J	79.9 J
Beryllium	4	0.5	0.31 J	0.1 U	0.9 U	0.2 U	1 U	0.61 U	1 U	0.4 U	0.4 U	0.1 U	0.2 U	0.3 U	0.33 J	0.1 U	0.9 U	0.2 U
Cadmium	5	2.1	0.4 U	0.8 U	0.8 U	0.2 U	4.4	0.27 U	0.4 U	1 J	2.1 J	0.6 U	0.54 J	1.4 B	0.64 B	0.8 U	0.8 U	0.64 J
Calcium	--	129,000	NA	NA	NA	NA	283,000	346,000	292,000	296,000	235,000	271,000	277,000	290,000	NA	NA	NA	NA
Chromium	100	4.1	2.2 J	12.6	15.8	7	5 UJ	6.6 U	7.3 U	1 U	1 U	0.5 U	0.7 UL	1 B	0.85 J	2.6 J	7.8 J	0.68 J
Cobalt	--	2.6	0.6 U	4.7 B	11.9 J	0.69 J	3.8	5.7 U	5.4 U	2.2 J	2.2 J	0.7 U	0.7 U	2 U	0.6 U	3.8 B	9 B	0.6 U
Copper	1,300	--	1.4 UL	4.4 B	2 U	0.8 U	17.7	14.5 J	10.5 U	6.5 J	1.7 U	0.7 U	2.7 B	2.8 B	1.4 UL	3.6 U	2 U	0.8 U
Cyanide	200	--	NA	NA	NA	NA	NA	5 U	5 U	2 U	2 U	0.65 U	5 U	0.93 B	NA	NA	NA	NA
Iron	--	17,100	NA	NA	NA	NA	24,400 J	102,000	28,300	57,200	51,800	39,800 K	29,800 L	42,700	NA	NA	NA	NA
Lead	15	2.4	2.3 U	6 B	3 U	1.3 U	2 UJ	1.7 U	1.5 U	2.4 U	2.4 UL	1.7 UL	1.4 U	1.6 U	2.3 U	3.6 U	3.3	1.3 U
Magnesium	--	45,600	NA	NA	NA	NA	596,000	919,000	766,000	853,000	816,000	777,000	768,000	804,000	NA	NA	NA	NA
Manganese	--	1,500	NA	NA	NA	NA	754	1,140	871	1,020	798	799	784	843	NA	NA	NA	NA
Mercury	2	0.3	NA	NA	NA	NA	0.15 U	0.13 U	0.13 U	0.2 U	0.2 U	0.08 J	0.1 U	0.1 U	NA	NA	NA	NA
Nickel	--	14	1 U	8.4 J	2 U	4.4 J	10 U	6.8 U	12.6 J	3 U	3.7 J	1.3 U	1 U	1 U	1 U	3.4 J	2 U	1.1 J
Potassium	--	16,600	NA	NA	NA	NA	220,000 J	229,000	210,000	422,000	256,000	346,000 J	258,000	364,000 J	NA	NA	NA	NA
Selenium	50	8	3.3 UL	10.6 B	1.3 U	3.3 J	20 UJ	7.2 U	3.2 U	4.5 U	4.5 U	4.8 U	4.2 U	1.9 U	3.3 UL	1.8 B	1.3 U	2 U
Silver	--	2	NA	17.7	3.7 U	0.5 U	3 U	9.2 B	0.8 U	1.2 U	1.2 U	0.5 U	1 U	0.57 J	NA	10.3	3.7 U	0.5 U
Sodium	--	65,000	NA	NA	NA	NA	5,430,000	7,220,000	10,400,000	6,990,000	6,500,000 L	5,790,000	6,520,000	6,310,000	NA	NA	NA	NA
Thallium	2	2.5	5.1 U	5.3 U	4.2 U	3.2 U	30 R	1.7 U	2 U	12.6	8.1 J	6.2 U	5.3 U	6 J	5.1 U	5.3 U	28.2	6.2 J
Vanadium	--	5	2.2 J	9 B	2.5 U	2.4 J	9 U	12.8 J	8.2 U	2.8 J	1.9 J	0.7 U	1.5 J	1.7 U	0.78 J	6.4 B	2.5 U	1.8 J
Zinc	--	59	3.1 B	17.6 B	14.9 J	2.9 J	NA	34.7 B	7.5 U	1.4 U	1.4 U	1.1 UL	3.8 B	4.6 UL	4.5 B	16.4 B	24.6	10.2 J
Dissolved Metals (UG_L)																		
Aluminum	--	713	NA	NA	NA	NA	1,060 J	36.7 U	58.3 U	12.5 U	12.5 U	65.8 B	16.8 B	65.6 U	NA	NA	NA	NA
Antimony	6	--	NA	NA	NA	NA	41 U	2.3 U	2.6 U	22.5 B	55.3 B	2.5 U	3.6 U	4 U	NA	NA	NA	NA
Arsenic	10	4	NA	NA	NA	NA	2 U	2.3 U	3.1 U	8.9 L	9.9 J	4.2 U	3.9 U	2.4 U	NA	NA	NA	NA
Barium	2,000	55,000	NA	NA	NA	NA	75.9 J	71.6 J	67.1 J	77.4 J	73.1 J	69.4 J	84.1 J	73.7 J	NA	NA	NA	NA
Beryllium	4	0.5	NA	NA	NA	NA	1 U	0.81 B	1 U	0.4 U	0.4 U	0.1 U	0.2 U	0.2 U	NA	NA	NA	NA
Cadmium	5	2.1	NA	NA	NA	NA	4.4 J	0.27 U	0.4 U	0.78 J	2.4 J	0.73 J	0.5 J	0.48 J	NA	NA	NA	NA
Calcium	--	129,000	NA	NA	NA	NA	263,000	330,000	300,000	285,000	276,000	262,000	272,000	285,000	NA	NA	NA	NA
Chromium	100	4.1	NA	NA	NA	NA	5 U	6.6 U	7.3 U	1 U	1 U	0.5 U	0.7 U	0.6 U	NA	NA	NA	NA
Cobalt	--	2.6	NA	NA	NA	NA	3.8 J	5.7 U	5.4 U	5.9 J	3.1 J	0.7 U	0.7 U	0.7 U	NA	NA	NA	NA
Copper	1,300	--	NA	NA	NA	NA	17.7 J	17.7 B	10.5 U	26.5	1.7 U	2.3 B	1.5 B	4.3 U	NA	NA	NA	NA
Iron	--	17,100	NA	NA	NA	NA	24,400 J	37,600	24,800	39,300	39,300	39,300 L	27,700	38,600	NA	NA	NA	NA
Lead	15	2.4	NA	NA	NA	NA	2 U	1.7 U	1.5 U	3.1	2.4 UL	1.7 UL	1.4 U	1.8 UL	NA	NA	NA	NA
Magnesium	--	45,600	NA	NA	NA	NA	596,000	696,000	786,000	868,000	815,000	732,000	751,000	887,000	NA	NA	NA	NA
Manganese	--	1,500	NA	NA	NA	NA	754	1,040	899	979	924	767	774	863	NA	NA	NA	NA
Mercury	2	0.3	NA	NA	NA	NA	0.13 U	0.13 U	0.13 U	0.2 U	0.2 U	0.07 J	0.1 U	0.1 U	NA	NA	NA	NA
Nickel	--	14	NA	NA	NA	NA	10 U	6.8 U	10 U	3 U	3 U	1.7 J	1 U	2.6 J	NA	NA	NA	NA
Potassium	--	16,600	NA	NA	NA	NA	220,000	221,000	216,000	410,000	249,000 L	329,000 J	250,000	373,000 J	NA	NA	NA	NA
Selenium	50	8	NA	NA	NA	NA	2 U	3.6 U	3.2 U	14.2	10.1 L	4.8 U	4.2 U	4.6 UL	NA	NA	NA	NA
Sodium	--	65,000	NA	NA	NA	NA	5,430,000	5,480,000 J	6,550,000	7,030,000	6,520,000 J	5,420,000	6,380,000	6,640,000 J	NA	NA	NA	NA
Thallium	2	2.5	NA	NA	NA	NA	NA	1.7 U	2 U	11.3	13.4	6.2 U	5.3 U	6 U	NA	NA	NA	NA
Vanadium	--	5	NA	NA	NA	NA	9 U	5.8 U	8.2 U	0.98 J	0.9 U	0.71 B	2.1 J	0.8 U	NA	NA	NA	NA
Zinc	--	59	NA	NA	NA	NA	NA	28.8 B	17.7 J	1.4 U	1.4 U	33.2 B	3.3 B	3.6 B	NA	NA	NA	NA

Notes:
NA - Not analyzed
U - Analyte not detected
J - Result may be estimated
B - Possible blank contamination
R - Unreliable result
K - Reported value may be biased high
L - Reported value may be biased low
UJ - Analyte not detected, result may be estimated
UL - Analyte not detected quantitation limit is probably higher
Exceeds one or more criteria
-- No criteria established

Table B-2
ORP and DO Results
LS07-MW06
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Station ID	LS07-MW06	LS07-MW06	LS07-MW06	LS07-MW06	LS07-MW06	LS07-MW06	LS07-MW06	LS07-MW06
Sample ID	LS07-MW06-01A	LS07-MW06P-01A	LS07-MW06-01C	LS07-MW06-02A	LS07-MW06-02D	LS07-MW06-03A	LS07-MW06-03C	LS07-MW06-04A
Sample Date	2/26/01	2/26/01	9/13/01	3/5/02	11/7/02	3/18/03	9/2/03	2/24/04
Field Parameters								
Dissolved Oxygen (MG_L)	0	0	0.6	0.7	0.46	0	1.4	1.71
Oxidation Reduction Potential (MV)	261	261	NA	-76	-71	-52	-135	-71

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas. The community map repository should be consulted for possible updated flood hazard information prior to use of this map for property purchase or construction purposes.

Coastal base flood elevations apply only landward of 0.0' National Geodetic Vertical Datum of 1929 (NGVD), and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Areas of special flood hazard (100-year flood) include Zones A, AE, AH, AO, A99, V, and VE.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

For adjoining map panels see separately printed Map Index.

DIGITAL DATA AVAILABILITY: Digital files containing the thematic floodplain information shown on these maps are published by the Federal Emergency Management Agency in DLG-3 Optional format on CD-ROM. Requests for data should include the full name of the community or county and the Flood Insurance Rate Map panel numbers covered by the request. Contact the Federal Emergency Management Agency, Map Service Center, 6730 Santa Barbara Court, Baltimore, Maryland 21227-5832, Telephone 1-800-358-9616.

NOTE: The coordinate system used for the production of this Flood Insurance Rate Map (FIRM) is Universal Transverse Mercator (UTM), North American Datum of 1927 (NAD27), Clarke 1866 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the Transverse Mercator projection, NAD27. Differences in the datum and spheroid used in the production of FIRMs for adjacent communities may result in slight positional differences in map features at the community boundaries. These differences do not affect the accuracy of the information shown on the FIRM.

ATTENTION: Flood elevations on this map are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, contact the National Geodetic Survey at the following address:

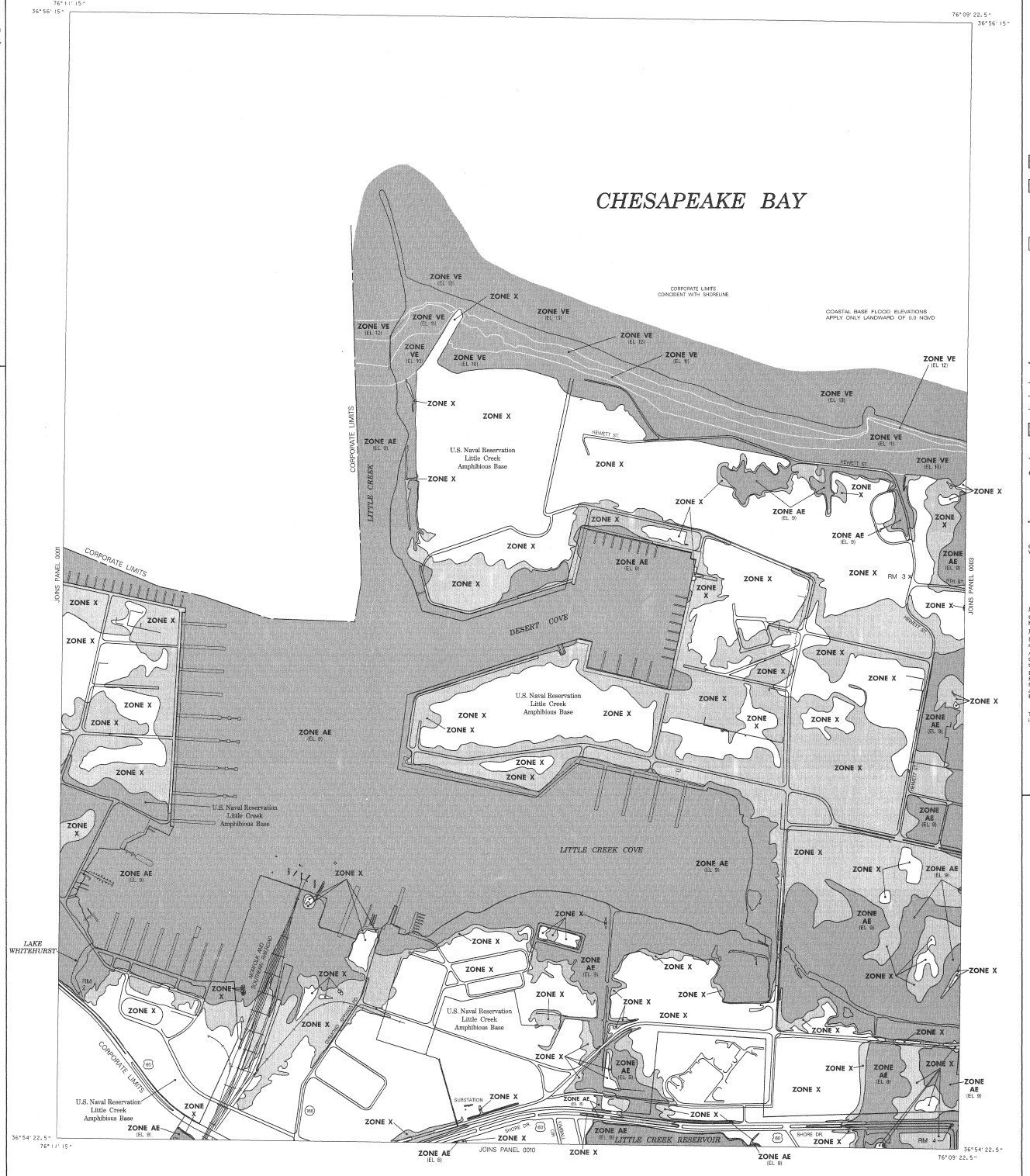
Vertical Network Branch, N/CG13
National Geodetic Survey, NOAA
Silver Spring Metro Center 3
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

BASE MAP SOURCE: Base map information was provided by the City of Virginia Beach. This information was compiled from aerial photography dated Spring 1986. Roads shown on this map represent edge of pavement.

ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION IN FT. (NGVD)[1]	DESCRIPTION OF LOCATION
RM 2	12.791	USC&GS disk approximately 2.85 miles west along Shore Drive (S.R. Route 60) from its intersection with North Hampton Boulevard approximately 0.3 mile west of overpass over Norfolk and Southern Railroad, set in top northeast end of northeast abutment of bridge over Lake Whitehurst, approximately 27 feet northeast of centerline of highway and approximately 1.0 feet above highway.
RM 3	18.520	USC&GS brass disk located on Little Creek Amphibious Base on western side of Hewitt Drive, north of its intersection with 11th Street, set vertically in northeast face of southeast corner of building no. 3113 and approximately 3.5 feet above ground.
RM 4	9.783	Brass disk located on Shore Drive, approximately 0.73 mile west of intersection of Shore Drive and Independence Boulevard, located in front of house no. 3269, approximately 29.3 feet north of centerline of eastbound lane and approximately 1.8 feet west of edge of pavement.

[1] National Geodetic Vertical Datum of 1929



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

- **ZONE A** No base flood elevations determined.
- **ZONE AE** Base flood elevations determined.
- **ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
- **ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- **ZONE A99** To be protected from 100-year flood by Federal flood protection system under construction; no base flood elevations determined.
- **ZONE V** Coastal flood with velocity hazard (wave action); no base flood elevations determined.
- **ZONE VE** Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

- **ZONE X** Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

- **ZONE X** Areas determined to be outside 500-year floodplain.
- **ZONE D** Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS*

Identified 1983 | Identified 1990 or Later | Otherwise Protected Areas Identified 1991 or Later

*Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain Boundary
- Floodway Boundary
- Zone D Boundary
- Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.
- 513 — Base Flood Elevation Line; Elevation in Feet**
- A — A — Cross Section Line
- (EL. 987) — Base Flood Elevation in Feet Where Uniform Within Zone**
- RM7 X — Elevation Reference Mark
- ● M1.5 — River Mile

**Referenced to the National Geodetic Vertical Datum of 1929

MAP REPOSITORY
Office of the City Engineer, Operations Building, Municipal Center, Virginia Beach, Virginia 23456 (Maps available for reference only, not for distribution.)

INITIAL IDENTIFICATION:
OCTOBER 3, 1970
FLOOD HAZARD BOUNDARY MAP REVISIONS:
NONE
FLOOD INSURANCE RATE MAP EFFECTIVE:
OCTOBER 3, 1970
FLOOD INSURANCE RATE MAP REVISIONS:

July 1, 1974 – to change zone designations.

October 8, 1976 – to reflect curvilinear flood boundary and to add special flood hazard areas.

January 17, 1985 – to add detailed riverine and wave height analysis.

December 5, 1990 – to change special flood hazard areas, to add roads and road names, and to reflect updated topographic information.

August 18, 1992 – to add otherwise protected areas, to decrease base flood elevations, to change special flood hazard areas, to add roads and road names, and to reflect updated topographic information.

December 5, 1996 – to update corporate limits and map format; to change base flood elevations, special flood hazard areas, and zone designations; to add base flood elevations and special flood hazard areas; to delete special flood hazard areas; to reflect updated topographic information; and to modify Coastal Barrier Resources System units.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at (800) 638-6620.

APPROXIMATE SCALE
500 0 500 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

CITY OF
VIRGINIA BEACH,
VIRGINIA
INDEPENDENT CITY

PANEL 2 OF 109

(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY - PANEL NUMBER
515531 0002 E

MAP REVISED:
DECEMBER 5, 1996

Federal Emergency Management Agency

Appendix C
ARARs

Table C-1
Federal Chemical-Specific ARARs
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Media	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Clean Air Act					
Air	NAAQS specify the maximum concentration of each criteria pollutant (carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, sulfur dioxide) which is to be permitted in the ambient air, as averaged over a period of time. Requirements differ for new sources of air pollutant emissions and existing sources. Requirements also differ based on the air quality designation of the site's location (i.e., attainment, non-attainment, unclassified, or transport) (*see Federal Location-Specific ARARs*).	Emissions of criteria pollutants during the response action, or during the operation and maintenance of the response action. NAAQSs are not enforceable in and of themselves. Any substantive standards contained within the State Implementation Plan are, however, federally enforceable.	40 CFR 50.4 to 50.12	TBC	Construction of the soil cover is complete. No discharges to air are anticipated other than fugitive dust during soil cover maintenance activities.
Safe Drinking Water Act					
Groundwater	SDWA standards serve to protect public water systems. Primary drinking water standards consist of federally enforceable MCLs. MCLs are the highest level of a contaminant that is allowed in drinking water.	Impact to public water systems that have at least 15 service connections or serve at least 25 year-round residents. May also be cleanup standards for on-site ground or surface waters that are current or potential sources of drinking water.	40 CFR 141.11 to 141.16 and 141.61 to 141.66	Relvant and Appropriate	Groundwater at the point of compliance (limits of waste in place and soil cover) will be addressed under state regulations for rgroundwater quality standards.
Groundwater	SDWA standards serve to protect public water systems. The MCLG is the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.	Impact to public water systems that have at least 15 service connections or serve at least 25 year-round residents. May also be cleanup standards for on-site ground or surface waters that are current or potential sources of drinking water.	40 CFR 141.50 to 141.55	TBC	The MCGLs are non-enforcable goals. No preliminary remediation goals have been established for the site because there are no unnaceptable human health risks. Groundwater quality will be monitored through LTM to ensure a release has not occured. The aquifer is not currently, nor reasonably anticipated in the future to be used as a potable water supply.
USEPA Region III RBC Tables					
Water, air, fish tissue, soil	Chemical concentrations corresponding to fixed levels of human health risk (i.e., a hazard quotient of 1, or lifetime cancer risk of 10^{-4} to 10^{-6}, whichever occurs at a lower concentration).	Assessment of potential human health risks.	USEPA Region III RBC Tables	TBC	A human health risk assessment was conducted and determined that the current site conditions are protective of human health. The human health risk assessment and exposure point concentrations will be reassessed during the five year review to evaluate potential toxicity associated with RBC changes.
USEPA Region III BTAG Screening Values					
Soil, sediment, surface water	Chemical concentrations corresponding to fixed levels of risks to ecological receptors (flora and/or fauna).	Assessment of potential ecological risks.	USEPA Region III BTAG Screening Values	TBC	An ecological risk assessment was conducted followed by implementation of an Interim Remedial Action resulting in current site conditions that are protective of the human health and the environment. The ecological risk assessment conclusions will be reassessed during the five year review based on current site conditions.

Table C-2
Virginia Chemical-Specific ARARs
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Media	Requirement	Prerequisite	Citation	ARAR Determination	Comment
State Water Control Law **[VA Code Ann. §§ 62.1-44.2 to 62.1-44.34:28 (2003)]**					
Groundwater	Establishes groundwater quality standards to protect the public health or welfare.	Establishes criteria for drinking water supplies.	*Groundwater Quality Standards* , 9 VAC 25-280	Applicable	The aquifer is not currently, or reasonably anticipated to be used as a potable water supply. A groundwater LTM program will be implemented to monitor groundwater quality.
Surface Water	The Code of Virginia directs DEQ to develop a list of impaired waters, develop TMDLs for these waters, and develop Implementation Plans for the TMDLs. DEQ administers the TMDL process including the public participation component and formally submits the TMDLs to EPA and the State Water Control Board for approval.	Development of implementation plan and sets numeric limits for specific physical, chemical, biological or radiological characteristics of water. These statements and numeric limits describe water quality necessary to meet and maintain uses such as swimming and other water-based recreation, public water supply, and the propagation and growth of aquatic life.	*Water Quality Management Planning Regulation, 90 VAC 25-720*	Relevant and Appropriate	Little Creek and Little Creek Harbor are on the 2006 list of impaired waters for PCBs in fish tissue.
Virginia Waste Management Act **[VA Code Ann. §§ 10.1-1400 to 1457 (2004)]**					
Waste/Soil/Water	Wastes to be managed must be sampled for TCLP analyses to determine the appropriate waste characterization. TCLP regulatory levels and definition of RCRA hazardous waste.	Management of wastes.	Hazardous Waste Regulations 9 VAC 20-60-261.3	Applicable	This remedy will generate water and potentially soil IDW which will be characterized for off-site disposal. Based on site history, it is not anticiapted that IDW will be characterized as hazardous waste.
Waste/Soil/Water	Hazardous wastes shall not be disposed or managed in solid waste disposal facilities.	Management of solid waste.	Solid Waste Management Regulations 9VAC20-80-240 (c)	Relevant and Appropriate	This remedy will generate water and potentially soil IDW which will be characterized for off-site disposal.
Air Pollution Control Board **[VA Code Ann. §§ 10.1-1300 to 1326 (1998)]**					
Air	Assures that ambient concentrations of air pollutants are consistent with established criteria and serves as the basis for effective and reasonable management of the air resources of the Commonwealth. Primary ambient air quality standards define levels of air quality which, allowing an adequate margin of safety, are necessary to protect the public health. Secondary ambient air quality standards define more stringent levels of air quality which are necessary to protect the public welfare from any known or anticipated adverse effects associated with the presence of air pollutants in the ambient air.	Air emission from disturbance of soil, treatment of soil or water, or other pollutant management activities.	*Ambient Air Quality Standards* , 9 VAC 5-30-10 to 80	Relevant and Appropriate	No discharges to air are anticipated other than fugitive dust during maintenance activities.

Table C-3
Federal Location-Specific ARARs
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Location	Requirement	Prerequisite	Citation	ARAR Determiantion	Comment
Clean Water Act					
Wetlands	Avoid adverse effects, minimize potential harm, and preserve and enhance wetlands, to the extent possible.	Action involving construction of facilities or management of property in wetlands. Wetland as defined by Executive Order 11990 Section 7 (protection of Wetlands).	*Clean Water Act,* §404; Executive Order 11990; 40 CFR 6, Appendix A	Relevant and Appropriate	Wetlands are present at Site 7. Any O&M maintenance activities conducted in wetland areas will involve restoration to natural conditions. Activities undertaken entirely on a CERCLA site by authority of CERCLA as approved or required by EPA, are not required to obtain permits under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act.
Endangered Species Act					
Critical habitat of/or presence of an endangered or threatened species	Identify activities that may affect listed species. Actions must not threaten the continued existence of a listed species. Actions must not destroy critical habitat.	Presence of species or habitat listed as endangered or threatened.	*Endangered Species Act* , 16 USC 1531 et. seq.; 50 CFR 200; 50 CFR 402; *Fish and Wildlife Coordination Act* (16 USC 661 et seq.); 33 CFR 320 to 330	Relevant and Appropriate	No endangered or threatened species have been indentifed at Site 7.
Coastal Zone Management Act					
Coastal zone or area that will affect the coastal zone	Federal activities must be consistent with, to the area that will affect maximum extent practicable, State coastal zone management programs. Federal agencies must supply the State with a consistency determination.	Wetland, flood plain, estuary, beach, dune, barrier island, coral reef, and fish and wildlife and their habitat within the coastal zone.	*Coastal Zone Management Act* , 16 USC 1451 et. seq.; 15 CFR 930.30; 15 CFR 930.34	Relevant and Appropriate	Site 7 and surrounding vicinity is located within the coastal zone. If applicable, maintenance activities will be conducted in accordance with an approved state management program.
Fish and Wildlife Coordination Act					
Floodplain	Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain, i.e., lowlands, and relatively flat areas adjoining inland and coastal water and other flood prone areas.	*Fish and Wildlife Coordination Act* , 16 USC 661 et. seq.; Executive Order 11988; 40 CFR 6, Appendix A; 40 CFR 6.302	Relevant and Appropriate	The landfill is within the floodplain, however it is not anticipated that soil cover O&M activities and groundwater LTM will have any adverse effects on the floodplain environment.
Area affecting stream or river	Requires that activities avoid, minimize, or compensate for impacts to fish and wildlife and their habitats.	Diversion, channeling or other activity that modifies a stream or river and affects fish or wildlife and their habitat.	*Fish and Wildlife Coordination Act,* 16 USC 661 et. seq.; 40 CFR 6.302	Relevant and Appropriate	Site 7 is located adjacent to but does not impact a river or stream.
Migratory Bird Treaty Act					
Migratory bird area	Protects almost all species of native birds in the United States from unregulated taking which can include poisoning at hazardous waste sites.	Presence of migratory birds.	*Migratory Bird Treaty Act* , 16 USC 703	Applicable	NAB Little Creek is located in the Atlantic Migratory Flyway.
Federal Executive Order 11900 (Floodplain Mgmt and Wetlands Mgmt)					
Federal Executive Order 11900 (Floodplain Mgmt and Wetlands Mgmt	Protects wetlands and floodplains to avoid long and short term adverse impacts.	Applies to actions that are conducted in wetland and floodplain areas.	Federal Executive Order 11900 (Floodplain Mgmt and Wetlands Mgmt, 40 CFR Part 6 Appendix A	Applicable	Wetlands are present at Site 7. Any O&M maintenance activities conducted in wetland areas will involve restoration to natural conditions.

Table C-4
Virginia Location-Specific ARARs
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Location	Requirement	Prerequisite	Citation	ARAR Dtermination	Comment
General Provisions Relating to Marine Resources Commission **[VA Code Ann. §§ 28.2-1300 to 1320 (1998)]**					
Wetlands	Mitigate or minimize the loss of wetlands and the adverse ecological effects of all permitted activities. To preserve the wetlands as much as possible in their natural state and to consider appropriate requirements for compensation only after it has been proven that the loss of the natural resource is unavoidable and that the project will have the highest public and private benefit. The determination as to whether compensation is warranted and permissible is conducted on a case-by-case basis. Commitments to preserve other existing wetlands shall not ordinarily be an acceptable form of compensation.	If a wetlands zoning ordinance has been adopted by local government, in accordance with the *General Provisions Relating to Marine Resources Commission*, and the response action is not exempt from its provisions, the project must comply with the requirements of the ordinance. In the case of absence of an ordinance, or of an exemption to it, VMRC can exercise jurisdiction over tidal wetlands.	*Wetlands Mitigation Compensation Policy*, 4 VAC 20-390-10 to 50	Relevant and Appropriate	Wetlands are present at Site 7. Any O&M maintenance activities conducted in wetland areas will involve restoration to natural conditions. Virginia's draft regulation, Virginia Administrative Code, 9 VAC 25-210 et seq establishes excavation and related activities as regulated. Although CERCLA actions do not require permits in wetlands, the VDEQ (along with the USACE as the lead agency in CWA Section 404 actions) work with project proponents to meet the intent of the law, including compensatory mitigation.
Chesapeake Bay Preservation Act **[VA Code Ann. §§ 10.1-2100 to 2116]**					
Chesapeake Bay and its tributaries	Criteria that provide for the protection of water quality of the Chesapeake Bay and its tributaries, that will also accommodate economic development in Tidewater Virginia. Under these requirements, certain locally designated tidal and nontidal wetlands, as well as other sensitive land areas, may be subject to limitations regarding land-disturbing activities, removal of vegetation, use of impervious cover, erosion and sediment control, stormwater management, and other aspects of land use that may have effects on water quality.	Location is within a Chesapeake Bay Preservation Area.	*Chesapeake Bay Preservation Area Designation and Management Regulations*, 9 VAC 10-20-10 to 260	Relevant and Appropriate	Site 7 is located within the Chesapeake Bay watershed. O&M activities and periodic soil cover inspections will be ongoing to ensure continued remedy protectiveness.

Table C-4
Virginia Location-Specific ARARs
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Location	Requirement	Prerequisite	Citation	ARAR Dtermination	Comment
State Water Control Law **[VA Code Ann. §§ 62.1-44.2 to 62.1-44.34:28 (2003)]**					
Surface Water	The Code of Virginia directs DEQ to develop a list of impaired waters, develop TMDLs for these waters, and develop Implementation Plans for the TMDLs. DEQ administers the TMDL process including the public participation component and formally submits the TMDLs to EPA and the State Water Control Board for approval.	Development of implementation plan and sets numeric limits for specific physical, chemical, biological or radiological characteristics of water. These statements and numeric limits describe water quality necessary to meet and maintain uses such as swimming and other water-based recreation, public water supply, and the propagation and growth of aquatic life.	*Water Quality Management Planning Regulation, 90 VAC 25-720*	Relevant and Appropriate	Little Creek and Little Creek Harbor are on the 2006 list of impaired waters for PCBs in fish tissue.
Department of Game and Inland Fisheries					
Department of Game and Inland Fisheries	Protects fish, fishing, and wildlife diversity.	Presence of and activities involving wildlife and inland fisheries.	*Department of Game and Inland Fisheries, VA Code § 15-20-130 to 140*	Relevant and Appropriate	The remedy does not impact any wildlife o inland fisheries.

Table C-5
Federal Action-Specific ARARs
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Clean Air Act					
Air emissions	Ensure compliance with the Clean Air Act which regulates the various types of air emissions: mobile sources, hazardous air pollutants, acid deposition and electrical utility emissions, stationary sources, and stratospheric ozone. Requirements are based on the air quality designation of the site's location (i.e., attainment, non-attainment, unclassified, or transport) (see Federal Location-Specific ARARs) for each NAAQS, the classification of each area, the required control measures, and baseline emission estimates. Must meet specific NSPS standards for incineration, use of statutory gas turbines, and storage of petroleum liquids.	Air pollutant emissions during the response action, or during the operation and maintenance of the response action.	40 CFR 50.4 to 50.12 40 CFR 60.112 to 60.52	TBC	Federal NAAQS are non-enforceable standards. No discharges to air are anticipated other than fugitive dust durin maintenance activities.
Discharge of dredge-and-fill	No discharge of dredged or fill material will be allowed unless appropriate and practicable steps are taken that minimize potential adverse impacts of the discharge on the aquatic ecosystem.	Discharges of dredged or fill material to surface waters, including wetlands.	*Clean Water Act,* §404; 40 CFR 230; 33 CFR 320 to 330	Relevant and Appropriate	Contruction of the soil cover is complete O&M activities and periodic inspections of the soil cover will be ongoing to ensure erosion of the soil cover to adjacent waterbodies is not occuring.
Toxic Substances Control Act					
Use/presence of chemicals	Chemical control measures including information gathering, chemical testing, labeling, inspection, use, storage, and disposa requirements.	Use/presence of asbestos, CFCs used as aerosol propellants, hexavalent chromium, and PCBs.	*Toxic Substances Control Act* , §6; 40 CFR 700 to 766	TBC	The contents of the landfill are unknown. Nature and extent of contamination indicates a release of these substances has not occurred. Groundwater LTM will be conducted to ensure protectiveness.
PCB management	Governs many aspects of PCB management, including cleanup of spills, storage, and disposal. USEPA has also proposed PCB spill response regulations which utilize self-implementing, performance-based, and risk-based cleanup standards to address various types of PCB releases.	Presence of PCBs. PCB contamination below 50 ppm is not regulated by TSCA, except under special circumstances.	*Toxic Substances Control Act, §6;* 40 CFR 761	TBC	The contents of the landfill are unknown. Nature and extent of contamination indicates a release of these substances has not occurred. Groundwater LTM will be conducted to ensure protectiveness.

Table C-6
Virginia Action-Specific ARARs
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comment
State Water Control Law **[VA Code Ann. §§ 62.1-44.2 to 62.1-44.34:28 (2003)]**					
Discharge of stormwater from construction activities to a surface water or through a municipal or non-municipal separate storm sewer system to surface waters	This general permit regulation governs stormwater discharges from construction activities.	Discharges are defined as storm water discharges associated with industrial activity, and storm water discharges associated with small construction activity. Storm water discharges associated with other types of industrial activity shall not have coverage under this general permit. This general permit covers only discharges through a point source to a surface water or through a municipal or non-municipal separate storm sewer system to surface waters. Storm water discharges associated with industrial activity that originate from the site after construction activities have been completed and the site has undergone final stabilization are not authorized by this permit.	*VPDES General Permit Regulation for Discharges of Storm Water from Construction Activities* , 9 VAC 25-180-10 to 70	Relevant and Appropriate	If construction activities are necessary for O&M, sediment erosion control measures will be implemented. Activities undertaken entirely on a CERCLA site by authority of CERCLA as approved or required by EPA, are not required to obtain permits.
Erosion and Sediment Control Law **[VA Code Ann. §§ 10.1-562 - 573 (2005)]**					
Erosion and deposits of soil/sediment caused by land disturbing activities	Regulations for the effective control of soil erosion, sediment deposition and nonagricultural runoff which must be met in any control program to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources.	If a local soil and erosion control program has been adopted in accordance with the *Erosion and Sediment Control Law*, and the *Erosion and Sediment Control Regulations*, and the response action is not exempt under the local program, the project must comply with the program. In the case of absence of a local program, or of an exemption to it, the standards and regulations should be followed.	*Erosion and Sediment Control Regulations* , 4 VAC 50-30-10 to 110	Applicable	Construction of the soil cover is compelete. An O&M plan will be established to monitor and prevent erosion of the soil cover to adjacent waterbodies.
Air Pollution Control Board **[VA Code Ann. §§ 10.1-1300 to 1326 (1998)]**					
Air emissions from disturbance of soil, treatment of soil or water, or other pollutant management activities	Standards for visible emissions, fugitive dust/emissions, hazardous air pollutants, and toxic pollutants from new and modified sources.	Source of visible emissions, fugitive dust/emissions, and/or a stationary source that emits or may emit any toxic pollutant.	*Standards of Performance for Visible Emissions and Fugitive Dust/Emissions [Rule 5-1]* , 9 VAC 5-50-60 to 120; US*EPA National Emission Standards for Hazardous Air Pollutants [Rule 6-1]*, 9 VAC 5-60-60 to 80; *Emission Standards for Toxic Pollutants from New and*	Relevant and Appropriate	Contrustion of the soil cover is complete. No discharges to air are anticipated other than fugitive dust during maintenance activities.
Stormwater Management Act **[VA Code Ann. §§ 10.1-603.1 to 603.2:1 (2005)]**					
Stormwater runoff caused by development of land that contributes to water pollution, erosion, and localized flooding	Procedures and requirements to be followed in connection with establishment of surface water management areas, the issuance of surface water withdrawal permits and the issuance of surface water withdrawal certificates to provide for the protection of beneficial uses during periods of low streamflow.	Every locality that establishes a local stormwater management program; and every state project. If a local stormwater management program has been adopted in accordance with the *Stormwater Management Act*, and the *Stormwater Management Regulations*, and the response action is not exempt under the local program, the project must comply with the program. In the case of absence of a local program, or of an exemption to it, the standards and regulations should be followed.	*Stormwater Management Regulations* , 4 VAC 50-60-10, 50-80, 320, 380 B&C, 420 and 430	Relevant and Appropriate	A site specific stormwater management plan will be developed if warranted by O&M activities.

Table C-6
Virginia Action-Specific ARARs
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Virginia Waste Management Act **[VA Code Ann. §§ 10.1-1400 to 1457 (2004)]**					
Handling, storage, treatment, disposal, and/or transportation of hazardous waste IDW	Provides for the control of all hazardous wastes that are generated within, or transported to, the Commonwealth for the purposes of storage, treatment, or disposal or for the purposes of resource conservation or recovery. Any disposal facility must be properly permitted and in compliance with all operational and monitoring requirements of the permit and regulations.	Management of wastes that meet the definition of hazardous waste.	*Hazardous Waste Regulations*, 9 VAC 20-60-261.3	Applicable	This remedy will generate water and potentially soil IDW which will be characterized for off site disposal.
Handling, storage, treatment, disposal, and/or transportation of hazardous waste IDW	Provides for the control of all hazardous wastes that are generated within, or transported to, the Commonwealth for the purposes of storage, treatment, or disposal or for the purposes of resource conservation or recovery. Any disposal facility must be properly permitted and in compliance with all operational and monitoring requirements of the permit and regulations.	Management of wastes that meet the definition of hazardous waste.	*Hazardous Waste Regulations*, 9 VAC 20-60-,262,263 *Regulations Governing the Transportation of Hazardous Materials*, 9 VAC 20-110-10 to 130	Relevant and Appropriate	This remedy will generate water and potentially soil IDW which will be characterized for off site disposal. Based on site history, it is not anticipated that IDW will be characterized as hazardous waste. If characterization results indicate this material is hazardous, it will be disposed of accordingly.
Handling, storage, treatment, disposal, and/or transportation of solid waste IDW	Establishes standards and procedures pertaining to the management of solid wastes, and siting, design, construction, operation, maintenance, closure, and pos closure care of solid waste management facilities in this Commonwealth in order to protect the public health, public safety, the environment, and natural resources. Provides the means for identification of open dumping of solid waste and provides the means for prevention or elimination of open dumping of solid waste to protect the public health and safety and enhance the environment. Sets forth the requirements for undertaking corrective actions at solid waste management facilities. Any disposal facility must be properly permitted and in compliance with all operational and monitoring requirements of the permit and regulations.	Management of wastes that meet the definition of solid waste.	*Solid Waste Management Regulations*, 9 VAC 20-80-140 to 170	Relevant and Appropriate	This remedy will generate water and potentially soil IDW which will be characterized for off site disposal. Based on site history, it is not anticipated that IDW will be characterized as hazardous waste. If characterization results indicate this material is hazardous, it will be disposed of accordingly.

Table C-7
Acronyms and Abbreviations
Site 7 Focused Feasibility Study
NAB Little Creek
Virginia Beach, Virginia

ARAR	Applicable or relevant and appropriate requirement
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
DCR	Virginia Department of Conservation and Recreation
DNH	Division of Natural Heritage
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NAAQS	National Ambient Air Quality Standards
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NSDWRs	National Secondary Drinking Water Regulations
NSPS	New Source Performance Standards
OSWER	Office of Solid Waste and Emergency Response
PCB	Polychlorinated biphenyls
PMCL	Primary Maximum Contaminant Level
POTW	Publicly Owned Treatment Works
ppm	Parts per Million
RBC	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contaminant Level
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substance Control Act
UIC	Underground Injection Control
USACE	US Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
VAC	Virginia Administrative Code
VMRC	Virginia Marine Resource Commission
VPA	Virginia Pollutant Abatement
VPDES	Virginia Pollutant Discharge Elimination System

Notes:

Listing the statutes, policies, and citations for the ARARs does not indicate that the Navy accepts the entire statues or policies as potential ARARs; only substantive requirements of the specific citations are considered potential ARARs .

References

Commonwealth of Virginia, 2004. Preliminary Identification, Applicable or Relevant and Appropriate Requirements.

USEPA, 1998. *CERCLA Compliance with Other Laws Manual: Interim Final* . Office of Emergency and Remedial Response. EPA/540/G-89/006.

USEPA, 1998. *CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes.* Office of Emergency and Remedial Response. EPA/540/G-89/009.

USEPA, 1998. RCRA, Superfund & EPCRA Hotline Training Manual. Introduction to Applicable or Relevant and Appropriate Requirements. EPA540-R-98-020.

Appendix D
Alternative Cost Estimates

Table D-1a
Alternative 1 - No Action

Site: Site 7 **Description:** No Action
Location: Little Creek NAB, Amphibious Base Landfill
Phase: Focused Feasibility Study
Date: August 17, 2007

ASSUMPTIONS

CAPITAL COSTS

Description	Qty	Unit	Unit Cost	Total Cost	Notes
None					
SUBTOTAL				$0	
TOTAL CAPITAL COST				**$0**	

OPERATION AND MAINTENANCE COSTS (Years 1-30)

None

SUBTOTAL	$0
TOTAL ANNUAL OPERATION AND MAINTENANCE COST (Years 1-30)	$0
TOTAL PRESENT WORTH (30 Years)	**$0**

Table D-1b
Alternative 1 - No Action
Present Value Calcualation for Future Costs

3.0% Discount Rate

Year		Cost if Performed Today	Yearly Cost at 4% Inflation	Discount Factor at 3%	Total PV Costs at 3% ($)
0	2007	$ -	$ -	1.000	$ -
1	2008	$ -	$ -	0.971	$ -
2	2009	$ -	$ -	0.943	$ -
3	2010	$ -	$ -	0.915	$ -
4	2011	$ -	$ -	0.888	$ -
5	2012	$ -	$ -	0.863	$ -
6	2013	$ -	$ -	0.837	$ -
7	2014	$ -	$ -	0.813	$ -
8	2015	$ -	$ -	0.789	$ -
9	2016	$ -	$ -	0.766	$ -
10	2017	$ -	$ -	0.744	$ -
11	2018	$ -	$ -	0.722	$ -
12	2019	$ -	$ -	0.701	$ -
13	2020	$ -	$ -	0.681	$ -
14	2021	$ -	$ -	0.661	$ -
15	2022	$ -	$ -	0.642	$ -
16	2023	$ -	$ -	0.623	$ -
17	2024	$ -	$ -	0.605	$ -
18	2025	$ -	$ -	0.587	$ -
19	2026	$ -	$ -	0.570	$ -
20	2027	$ -	$ -	0.554	$ -
21	2028	$ -	$ -	0.538	$ -
22	2029	$ -	$ -	0.522	$ -
23	2030	$ -	$ -	0.507	$ -
24	2031	$ -	$ -	0.492	$ -
25	2032	$ -	$ -	0.478	$ -
26	2033	$ -	$ -	0.464	$ -
27	2034	$ -	$ -	0.450	$ -
28	2035	$ -	$ -	0.437	$ -
29	2036	$ -	$ -	0.424	$ -
30	2037	$ -	$ -	0.412	$ -
Total	**Alternate 2 30 years**				**$ -**

*Discount factor established per OMB Circular A-94, Revised January 2007, "Discount Rates for Cost Effectiveness, Lease Purchase, and Related Analysis".
//www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

Table D-2a
Alternative 2 - Land Use Controls, Long Term Monitoring, and Operation and Maintenance

Site:	Site 7	**Description:**	
Location:	Little Creek NAB, Amphibious Base Landfill	Land Use Controls, Long Term Monitoring, and Landfill Operation and Maintenance	
Phase:	Focused Feasibility Study		
Date:	August 17, 2007		

ASSUMPTIONS

1) Survey and Recording Deed Restriction
* Survey of approximately 40 acres
* Preparation and registration of deed restriction for the City of Virginia Beach

2) Long Term Monitoring
* Quarterly inspections of the landfill
  -option to reduce inspection frequency from quarterly to semi-annual after 5 year review
* Annual groundwater sampling of 7 MWs for TCL VOCs, TCL SVOCs, TCL PCBs, and TAL Metals (total and dissolved).
* 5 Year review due to waste left in place

3) Landfill Operation and Maintenance
* Semi-annual mowing
* Gate, fence, and sign repair
* Access road repair
* Landfill maintenance (vegetation, soil cover, and drainage features)

CAPITAL COSTS

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Survey and Recording Deed Restriction	1	EA	$26,550	$26,550	Recent quote
SUBTOTAL				$26,550	
Contingency	20%			$5,310	
SUBTOTAL				$31,860	
TOTAL CAPITAL COST OF SURVEY AND RECORDING DEED RESTRICTION				**$31,860**	

OPERATION AND MAINTENANCE COSTS (Years 1 - 30)

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Long Term Monitoring					
Quarterly site inspection and report	4	UNIT	$4,700.00	$18,800	Engineer's Estimate
Quarterly Groundwater Monitoring	1	UNIT	$22,322.82	$22,323	BOA
SUBTOTAL				$41,123	
Landfill Operation and Maintenance	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Semi-annual mowing	2	EA	$ 250.00	$ 500.00	
Feature repairs (fence, gate, access road)	1	LS	$ 2,500.00	$ 2,500.00	Repairs may be dependent upon extreme
Soil cover maintenance (vegetation, soil cover, drainage)	1	LS	$ 5,000.00	$ 5,000.00	weather or other factors and may vary
SUBTOTAL				$ 8,000.00	considerably.
Contingency	20%			$ 9,825	
SUBTOTAL				$ 58,947	
Project Management	15%			$ 8,842	
TOTAL ANNUAL O&M COST if performed today (Years 1-4, 6-9, 11-14, 16-19, 21-24, 26-29)				**$ 67,789**	

Table D-2a
Alternative 2 - Land Use Controls, Long Term Monitoring, and Operation and Maintenance

Site:	Site 7	**Description:**	
Location:	Little Creek NAB, Amphibious Base Landfill	Land Use Controls, Long Term Monitoring, and Landfill Operation and Maintenance	
Phase:	Focused Feasibility Study		
Date:	August 17, 2007		

OPERATION AND MAINTENANCE COSTS (Years 5, 10, 15, 20, 25, 30)

Site Inspection	**Qty**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
5-yr Review	1	UNIT	$45,000.00	45,000.00	Recent contract award
SUBTOTAL				45,000.00	
Contingency	20%			9,000.00	
SUBTOTAL				54,000.00	
Project Management	15%			8,100.00	
SUBTOTAL ANNUAL OPERATION AND MAINTENANCE COST (Years 5, 10, 15, 20, 25, 30)				62,100.00	
TOTAL ANNUAL O&M COST if performed today (Years 1-4, 6-9, 11-14, 16-19, 21-24, 26-29)				**67,789.50**	
TOTAL ANNUAL O&M COST if performed today (Years 5, 10, 15, 20, 25, 30)				**129,889.50**	
TOTAL PRESENT WORTH (30 Years)				**2,728,124.98**	

NOTE: ESTIMATES ARE BASED ON EXPERIENCE AT SIMILAR SITES. ACTUAL COSTS MAY VARY

Table D-2b
Alternative 2 - Land Use Controls, Long Term Monitoring, and Operation and Maintenance
Present Value Calcualation for Future Costs

3.0% Discount Rate

Year		Cost if Performed Today	Yearly Cost at 4% Inflation	Discount Factor at 3%	Total PV Costs at 3% ($)
0	2007	$ 31,860	$ 31,860	1.000	$ 31,860
1	2008	$ 67,789	$ 70,501	0.971	$ 68,448
2	2009	$ 67,789	$ 73,321	0.943	$ 69,112
3	2010	$ 67,789	$ 76,254	0.915	$ 69,783
4	2011	$ 67,789	$ 79,304	0.888	$ 70,461
5	2012	$ 129,889	$ 158,030	0.863	$ 136,318
6	2013	$ 62,862	$ 79,540	0.837	$ 66,614
7	2014	$ 62,862	$ 82,722	0.813	$ 67,261
8	2015	$ 62,862	$ 86,031	0.789	$ 67,914
9	2016	$ 62,862	$ 89,472	0.766	$ 68,573
10	2017	$ 129,889	$ 192,268	0.744	$ 143,066
11	2018	$ 62,862	$ 96,773	0.722	$ 69,911
12	2019	$ 62,862	$ 100,644	0.701	$ 70,590
13	2020	$ 62,862	$ 104,670	0.681	$ 71,275
14	2021	$ 62,862	$ 108,857	0.661	$ 71,967
15	2022	$ 129,889	$ 233,924	0.642	$ 150,147
16	2023	$ 62,862	$ 117,739	0.623	$ 73,371
17	2024	$ 62,862	$ 122,449	0.605	$ 74,084
18	2025	$ 62,862	$ 127,347	0.587	$ 74,803
19	2026	$ 62,862	$ 132,441	0.570	$ 75,529
20	2027	$ 129,889	$ 284,604	0.554	$ 157,578
21	2028	$ 62,862	$ 143,248	0.538	$ 77,003
22	2029	$ 62,862	$ 148,978	0.522	$ 77,750
23	2030	$ 62,862	$ 154,937	0.507	$ 78,505
24	2031	$ 62,862	$ 161,134	0.492	$ 79,267
25	2032	$ 129,889	$ 346,264	0.478	$ 165,378
26	2033	$ 62,862	$ 174,283	0.464	$ 80,814
27	2034	$ 62,862	$ 181,254	0.450	$ 81,599
28	2035	$ 62,862	$ 188,504	0.437	$ 82,391
29	2036	$ 62,862	$ 196,045	0.424	$ 83,191
30	2037	$ 129,889	$ 421,283	0.412	$ 173,563
Total	**Alternate 2 - 30 years**				**$ 2,728,125**

*Discount factor established per OMB Circular A-94, Revised January 2007, "Discount Rates for Cost Effectiveness, Lease Purchase, and Related Analysis".
//www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

Table D-2c
Alternative 2 - Land Use Controls, Long Term Monitoring, and Operation and Maintenance
Cost Estimate Backup

Surveyor

Item	Description	Units	Tidewater VA Rate	Quantity	Cost
1	Mobilization/Demobilization	lump sum	$ 350.00	1	$ 350.00
2	Field Surveying (2-person crew)[1]	per day	$ 700.00	20	$ 14,000.00
3	Surveying Data Evaluation and Report Preparation	per hour	$ 90.00	80	$ 7,200.00
4	Filing Survey Maps w/ City of Virginia Beach[2]	each	$ 5,000.00	1	$ 5,000.00
	TOTAL				**$ 26,550.00**
	[1] Quantity based upon recent quote for similar site with additional days added for dense vegetation				
	[2] Cost estimate derived from recent experence on similar site				

Quarterly Inspection

Labor and ODCs

Item	Description	Units	Average Rate	Quantity	Cost
1	Labor[1]	hour	$ 75.00	16	$ 1,200.00
3	Letter Report[2]	each	$ 3,500.00	1	$ 3,500.00
	TOTAL				**$ 4,700.00**
	[1] Assumes two field technicians for one 8 hour day				
	[2] Cost based upon recent development fee proposal for similar letter report				

Annual GW Monitoring

Labor and ODCs

Item	Description	Units	Average Rate	Quantity	Cost
1	Labor[1]	hour	$ 75.00	40	$ 3,000.00
2	Shipping/Equipment/Travel	each	$ 1,000.00	1	$ 1,000.00
3	Annual LTM Report[2]	each	$ 9,800.00	1	$ 9,800.00
	SUBTOTAL				**$ 13,800.00**
	[1] Assumes two field technicians for two 10 hour days of field work				
	[2] Cost based upon recent development fee proposal for similar LTM report				

Laboratory (1 Round)

Item	Description	Units	Average BOA Rate	Quantity[1]	Cost
1	TCL Volatiles by CLP (OLC03)	each	$ 109.45	12	$ 1,313.40
2	TCL Semivolatiles by CLP (OLC03)	each	$ 206.40	11	$ 2,270.40
3	TCL Pesticides/PCBs by CLP (OLM04)	each	$ 125.67	11	$ 1,382.33
4	TAL Metals by CLP (ILM05)	each	$ 114.27	11	$ 1,257.00
5	TAL Dissolved Metals by CLP (ILM05)	each	$ 114.27	11	$ 1,257.00
	SUBTOTAL				**$ 7,480.13**
	[1] Includes samples from MW1, MW3, MW5 - MW9 and QA/QC Samples (FD, TB, FB/EB, MS/MSD)				

Data Validation (1 Round)

Item	Description	Units	Average BOA Rate	Quantity[1]	Cost
1	TCL Volatiles by CLP (OLC03)	each	$ 19.25	12	$ 231.00
2	TCL Semivolatiles by CLP (OLC03)	each	$ 21.82	11	$ 240.02
3	TCL Pesticides/PCBs by CLP (OLM04)	each	$ 17.63	11	$ 193.93
4	TAL Metals by CLP (ILM05)	each	$ 17.17	11	$ 188.87
5	TAL Dissolved Metals by CLP (ILM05)	each	$ 17.17	11	$ 188.87
	SUBTOTAL				**$ 1,042.69**
	[1] Quantity includes QA/QC samples (FD, MS/MSD, TB, FB/EB)				
	TOTAL				**$ 22,322.82**

Table D-3
Summary of Cost Estimates
NAB Little Creek Site 7 FFS

Alternative	Capital Cost	Annual O&M Cost (Year 1)	Total Cost Through Year 1	Range of Estimate	
				-30%	+50%
1 - No Action	$0	$0	$0	$0	$0
2 - Land Use Controls, Long Term Monitoring, and Landfill O&M	$31,860	$70,501	$102,361	$71,653	$153,542