N00181_001571
NORFOLK PORTS NSY
SSIC 5000-33a

FINAL RECORD OF DECISION SITE 10 NORFOLK NAVAL SHIPYARD PORTSMOUTH VA

09/01/2008

NAVFAC MID ATLANTIC

Approved for public release: distribution unlimited.

Final

Record of Decision
Site 10

Norfolk Naval Shipyard
Portsmouth, Virginia

Prepared by

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

September 2008

Contents

Tables

Figures

Appendix

Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIA	Controlled Industrial Area
COC	chemical of concern
CSF	carcinogenic slope factor
CSM	Conceptual Site Model
CTE	central tendency exposure
EPA	United States Environmental Protection Agency
FFA	Federal Facility Agreement
FFS	Focused Feasibility Study
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IEUBK	Integrated Exposure Uptake Biokinetic
IRP	Installation Restoration Program
LUC	Land Use Control
MCL	maximum contaminant level
Navy	United States Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NNSY	Norfolk Naval Shipyard
O&M	operation and maintenance
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RD	Remedial Design
RfD	reference dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SSI	Supplemental Site Investigation
SSP	Site Screening Process
SVOC	Semivolatile Organic Compound

µg/dL	micrograms per deciliter
UTL	upper tolerance limit
VDEQ	Virginia Department of Environmental Quality

SECTION 1

Declaration

1.1 Site Name and Location

Site 10

Norfolk Naval Shipyard (NNSY)

Portsmouth, Virginia

U.S. Environmental Protection Agency (EPA) ID No. VA1170024813

1.2 Statement of Basis and Purpose

This Record of Decision (ROD) presents the selected remedy for Site 10 at NNSY in Portsmouth, Virginia. The determination was made in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, and to the extent practicable, with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the information contained in the Administrative Record for the site.

The United States Department of the Navy (Navy) is the lead agency and provides funding for site cleanup at NNSY. The Navy and EPA Region III issue this ROD jointly. The Virginia Department of Environmental Quality (VDEQ) concurs with the selected remedy.

1.3 Assessment of the Site

Previous investigations have identified the presence of lead in soil at concentrations that pose a human health risk to potential future residents at Site 10. The response action selected in this ROD is necessary to protect the public health or welfare and the environment from exposure to actual or threatened releases of hazardous substances into the environment from the site.

1.4 Description of the Selected Remedy

Site 10 is one of several Installation Restoration Program (IRP) sites under CERCLA at NNSY. Information about the other IRP sites at NNSY can be found in the current version of the Site Management Plan, which is located in the Administrative Record.

Based on current land use, there are no unacceptable risks to human health or the environment. However, future residential land use may result in unacceptable risks because of exposure to lead in the soil. The selected remedy at Site 10 is land use controls (LUCs). This remedy is selected based on the evaluation of site conditions, site-related risks,

applicable or relevant and appropriate requirements (ARARs), and the Remedial Action Objective (RAO). LUCs provide the best alternative for eliminating exposure pathways to future residential receptors.

LUCs will be implemented within the boundaries of Site 10 to prohibit use of the site for residential housing, child care, elementary and secondary schools, or playground facilities. Within 90 days following the execution of this ROD, the Navy shall develop and submit to EPA and VDEQ, in accordance with the Federal Facility Agreement (FFA), a draft Remedial Design (RD) that defines the detailed implementation actions for LUCs. The Navy will implement, maintain, monitor, and enforce the LUCs according to the RD. LUCs will eliminate potential unacceptable exposure from lead-contaminated soil.

1.5 Statutory Determination

The LUC remedy is protective of human health and the environment, complies with federal and Commonwealth of Virginia statutes and regulations that are applicable or relevant and appropriate to the remedial action, and is cost-effective. While a LUC remedy does not use permanent solutions and alternative treatment technologies as a principal element, excavation of soil within the controlled industrial area (CIA) of NNSY does not provide the best balance of tradeoffs, including cost-effectiveness, given the current active industrial operations at the site and the continuation of industrial operations in the foreseeable future.

Soil with lead concentrations exceeding levels that allow for unlimited use and unrestricted exposure will remain in place. As a result, in accordance with CERCLA Section 121(c), 42 U.S.C. §9621(c), a review will be conducted no less often than each 5 years after commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

1.6 Record of Decision Data Certification Checklist

The following information is included in the Decision Summary (Section 2) of this ROD. Additional information for Site 10 can be found in the Administrative Record for NNSY.

- Chemicals of concern (COCs) and their respective concentrations (Section 2.7 and associated tables)
- Baseline risks associated with exposure to the COCs (Section 2.7)
- Remedial Action Objective (Section 2.8)
- Potential land and groundwater use that will be available at the site as a result of the selected remedy (Section 2.12)
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (Section 2.12)
- Key factors leading to the selection of the remedy (Section 2.13)

1.7 Authorizing Signatures

G. G. WOMACK
Captain, U.S. Navy
Chief of Staff

25 Sep 08
Date

James J. Burke, Director
Hazardous Site Cleanup Division
EPA (Region III)

10/14/08
Date

SECTION 2

Decision Summary

This ROD describes the selected remedial action for Site 10 at NNSY, Portsmouth, Virginia. The Navy and EPA jointly select the remedy. VDEQ concurs with the selected remedy. NNSY (EPA ID No. VA1170024813) was placed on the National Priorities List in July 1999.

2.1 Site Name, Location, and Description

Site 10 is located in the southern portion of the NNSY in a flat, heavily developed industrial area. The NNSY is located off Effingham Street in the city of Portsmouth, Virginia (**Figure 2-1**). Site 10 includes Buildings 260, 297, and 510, and is surrounded by paved roads and parking lots. The area includes that adjacent to Dry Dock 8; however, due to the excavation required to construct Dry Dock 8, it is not included within the Site 10 boundary. The area of the proposed Dry Dock 8 expansion is within the Site 10 boundary. Vegetation within the site consists of limited landscape features. There are no surface water features in the area, and stormwater is collected through storm drains and discharged to the southern branch of the Elizabeth River.

2.2 Site History and Enforcement Activities

2.2.1 Site History

The NNSY, one of the largest shipyards in the world that is devoted exclusively to ship repair and overhaul, is located on the southern branch of the Elizabeth River. It is the oldest continuously operated shipyard in the United States, with origins dating back to 1767 when it was a merchant shipyard under British rule. The NNSY is located in the Hampton Roads Region of southeastern Virginia, approximately 15 miles from the Chesapeake Bay.

Site 10, known as the 1927 Landfill in previous documents, was reportedly used from before 1927 to 1941. There is no specific design or information on materials used as fill. Basewide investigations and assessments have indicated that based on the activities at the NNSY, salvage waste, sandblast grit, flyash, and asbestos may be found at the site and no release controls such as clay liners, leachate collection systems, or compacted cover material are in place. However, results from debris delineation activities completed in 2001 and a historical photograph review indicate that the site consists primarily of dredge fill material and a small amount of construction debris rather than waste consistent with an industrial landfill (CH2M HILL, 2003). Therefore, the Navy, in partnership the EPA and VDEQ, agree that Site 10 is more likely to have been a filling operation to reclaim land than a landfill.

2.2.2 Previous Investigations Summary

Investigations basewide at NNSY and/or specifically at Site 10 include the Initial Assessment Study, dated 1983; Interim RCRA Facilities Assessment (RFA), dated 1986; Supplementation RFA (RFA-S), dated 1987; EPA Photographic Interpretation Center photo

review, dated 1994; Site Screening Assessment, dated 2000; Site Screening Process (SSP) investigation, dated 2003; and the Supplemental Site Investigation (SSI), dated 2004. These investigations determined that further investigations were warranted at Site 10.

The SSP investigation was conducted in 2001. The results of the SSP investigation indicated that no further action or investigations regarding impacts to ecological receptors at the site were warranted, but that additional soil and groundwater sampling were required to further define the nature and extent of contamination and to determine the potential risk to human health. The requirements and objectives of the SSI were scoped to develop an SSI Work Plan to collect additional soil and groundwater samples, which was implemented in 2004. In addition to the work to characterize the nature and extent of contamination at Site 10, soil analyses were performed at Site 10 in the area adjacent to Dry Dock 8 to determine if there were any potential risks or hazards to construction workers that may be exposed to deep soil as part of the expansion work likely to be conducted at Dry Dock 8 which is expected to include a small portion of Site 10. Preliminary analysis of the Human Health Risk Assessment (HHRA) data indicated that remedial action would be required at Site 10; therefore, the scope of the SSI was expanded to include remedial alternative analysis, with the end product being the Remedial Investigation/Human Health Risk Assessment/ Focused Feasibility Study Report (RI/HHRA/FFS), dated June 2006. A summary table of the investigations completed to date pertaining to Site 10 is provided in **Table 2-1**. No enforcement activities have been recorded to date at the site.

2.3 Community Participation

The Navy and EPA provide information regarding the cleanup of NNSY to the public through the Community Relations Program, which includes a NNSY Restoration Advisory Board (RAB) that was formed in 1994, public meetings, the Administrative Record file, the Information Repository, and announcements published in the local newspaper. The RAB provides a forum for the exchange of information among community members, the Navy, EPA, and VDEQ. During the course of investigations at Site 10, the RAB has been apprised of all environmental activities related to the site.

In accordance with Sections 113 and 117 of CERCLA, the Navy provided a public comment period from December 9, 2006 through January 9, 2007, for the Proposed Plan for Site 10. A public meeting to present the Proposed Plan was held on December 20, 2006, at the Portsmouth Main Branch Library, Portsmouth, Virginia. Public notice of the meeting and availability of documents was placed in *The Virginian-Pilot* newspaper on December 9, 2006. The Proposed Plan and previous investigation reports for Site 10 are available to the public in the Administrative Record maintained at:

NAVFAC Atlantic
Lafayette River Annex
6508 Hampton Boulevard
Norfolk, VA 23508

Or, in the Information Repository located at:

Portsmouth Main Branch Public Library
601 Court Street
Portsmouth, Virginia 23704
(757) 393-8501

2.4 Scope and Role of the Remedy

The selected remedy for Site 10 is based on the findings of site investigations, as documented in the Administrative Record. The Navy, EPA, and VDEQ entered into an FFA in 2005 for two purposes: (1) to ensure that the environmental impacts associated with past and present activities at NNSY are thoroughly investigated and appropriate remedial action is taken, as necessary, to protect public health and welfare and the environment; and (2) to establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions at NNSY in accordance with CERCLA, as amended, and the NCP. The NNSY FFA identifies and categorizes every area of the shipyard, including annexes, that have been identified as having, or is suspected to have had, a historical release of a hazardous substance.

Seven IRP sites were identified in the FFA for investigation under CERCLA, with ultimate closure performed pursuant to a ROD. A ROD is in place for two of these IRP sites. Site 2 (the Scott Center Landfill) was closed with a No-Action ROD in October 2005. An Action ROD for LUCs was issued for Site 17 (the Building 195 Plating Shop) in August 2006. The remaining five IRP sites are Sites 3 through 7 and are part of Operable Unit 2 at NNSY. These sites are still under investigation. The NNSY FFA also identified two SSP areas: IR Site 10 (the 1927 Landfill), which is the subject of this ROD, and IR Site 15 (the Past Pier-Side Industrial Operations), which was investigated following the SSP. A no action determination for Site 15 was completed in December 2006 following completion of a Preliminary Assessment and Action Determination Report (CH2M HILL, December 2006). Additionally, the NNSY FFA includes a listing of 154 sites for which no further action is required under CERCLA.

The selected remedy for Site 10 constitutes the final remedy for the site and addresses all potential risks posed by exposure to contaminated soil as documented in the RI/HHRA/FFS. Groundwater did not pose unacceptable risk in the RI/HHRA/FFS. The response action for Site 10 does not affect any other sites at NNSY. The selected remedy will eliminate the potential risk to human health associated with exposure to contaminated soil at Site 10 by preventing exposures to residential receptors through the implementation of LUCs. LUCs will be maintained within the boundaries of Site 10 (**Figure 2-2**) until such time that conditions at the site allow for unlimited use and unrestricted exposure. Within 90 days following the execution of this ROD, the Navy shall develop and submit to EPA and VDEQ, in accordance with the FFA, a draft RD that defines the detailed implementation actions for LUCs. LUC implementation actions will include periodic inspections and reporting to ensure that unacceptable exposure will not occur at the site.

2.5 Site Characteristics

NNSY is an industrial facility dedicated to ship repair and overhaul. The southern branch of the Elizabeth River forms the eastern boundary of NNSY, and the area surrounding NNSY is industrial, commercial, and residential. Site 10 is located in the industrial area of NNSY and covers approximately 36 acres. Site 10 consists of dredge fill material and small amounts of construction debris covered by buildings, asphalt roads, and concrete.

Site geology is based on lithologic descriptions from soil boring logs and monitoring well installation logs. Fill and debris material are present generally to 6 feet below ground surface (bgs) with some areas extending to 12 feet bgs. The debris is not restricted to specific areas and consists of concrete, wood, glass, ceramic fragments, brick, and slag. The geology across the site below the fill consists of sands and gravelly sands with some finer material to a depth of approximately 18 to 19 feet bgs, where the Yorktown Confining Unit was typically encountered within the site; however, at three monitoring-well locations, the Yorktown Confining Unit was only 13 to 16 feet bgs. Groundwater was characterized as part of the RI/HHRA/FFS. Surface water runoff flows into catch basins that connect to the NNSY stormwater system.

2.5.1 Conceptual Site Model

The Conceptual Site Model (CSM) for the HHRA is illustrated on **Figure 2-3**. The CSM integrates physical characteristics of the site, potentially exposed populations, sources of contamination, and contaminant mobility (fate and transport) to identify exposure routes and receptors evaluated in the risk assessment for soil. The potential source at Site 10 was buried debris from industrial activities, although only inert construction debris was evident. The debris materials associated with the fill were distributed across the site; no specific waste areas were identified. The primary mechanism for contaminant transport from Site 10 is leaching of contaminants from soil/fill as groundwater migrates through the site. Because most of the site is covered by asphalt paving and buildings, with the exception of landscaped areas, other mechanisms, such as precipitation infiltration and leaching through the debris/fill materials, erosion and deposition, and entrainment of contaminated media via wind erosion, do not play a major role in contaminant transport.

Current activities at the industrialized area of NNSY Site 10 are anticipated to continue for the foreseeable future. Therefore it is reasonable to assume that future human receptors potentially exposed to chemicals detected in surface soil, subsurface soil, and groundwater at Site 10 are likely to be current/future on-site and future construction workers. However, the hypothetical child and lifetime resident were included in the RI/HHRA/FFS to quantify risk if the site were designated for unlimited use and unrestricted exposure.

2.5.2 Sampling Strategy

Site 10 investigations involving sampling of environmental media during the SSP and the SSI provided the data for the RI/HHRA/FFS report. Field sampling activities included the collection of surface and subsurface soil samples from both hollow stem auger and direct push technology sampling methods. Groundwater samples were collected from monitoring wells using low-flow sampling methods. A summary of sampling and analyses conducted

at Site 10 for use in risk evaluation is provided in **Table 2-2.** Sample locations are shown in **Figure 2-4**.

2.5.3 Nature and Extent of Contamination

The nature and extent of contamination at Site 10 is based on the analysis of soil and groundwater samples and comparison of site chemical concentrations to background concentrations as determined by the upper tolerance limits (UTLs) for background data, and EPA risk-based screening criteria. Soil and groundwater samples were analyzed for volatile organic compounds, semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls, and metals. The metals antimony, arsenic, and cadmium were detected in site groundwater above the maximum contaminant levels (MCLs). Polycyclic aromatic hydrocarbons, a subset of SVOCs, and the metals arsenic and lead were detected above the background UTLs and risk-based screening criteria in Site 10 soil.

2.5.4 Current and Potential Future Surface and Subsurface Routes of Exposure and Receptors

Site 10 is primarily covered by concrete, gravel, asphalt paving, and includes buildings with few landscaped areas. The primary contaminant transport mechanism from Site 10 is leaching from soil/fill as groundwater migrates through the site. Potential exposure receptors include current/future on-site workers, future construction workers, and hypothetical future residents conducting intrusive activities in direct contact with soil or groundwater at the site.

2.5.5 Aquifer Characteristics

Site 10 is underlain by fill material(s) present to a depth of approximately 16 to 18 feet bgs, which comprises the unconfined Columbia Aquifer. The Yorktown Confining Unit is typically encountered at a depth of approximately 18 to 19 feet bgs, but was observed as shallow as 13 to 16 feet bgs. Groundwater, encountered at depths ranging from 3.22 to 6.85 bgs flows east and northeast toward Slip 5 and Dry Dock 8. The groundwater gradient is variable, with a range of 0.025 foot/feet to 0.0007 foot/feet across the site. The water quality of the Columbia Aquifer is variable and only suitable for limited uses, such as lawn watering. While site-specific hydraulic conductivity testing has not been performed at Site 10, hydraulic testing has been performed at nearby Site 17, where the estimated hydraulic conductivity is 2.8 feet/day.

2.6 Current and Potential Future Land and Resource Uses

Site 10 is located in the southern portion of NNSY in a flat, heavily developed industrial area. Site 10 includes Buildings 260, 297, and 510, and is surrounded by paved roads and parking lots (**Figure 2-2**). The area is bordered by Dry Dock 8 and Slip 5 to the east. NNSY is surrounded by roads and industrial areas. Site 10 is currently actively used to support the industrial operations of the shipyard. There are no other foreseeable future land uses, and the LUC remedy will remain in place unless other remedial actions under CERCLA are taken to ensure that site conditions are sufficiently protective to allow for unrestricted use and unlimited exposure.

Shallow groundwater is currently not used as a water supply at, or in the vicinity of, NNSY. The City of Portsmouth supplies water to NNSY and surrounding communities using a combination of surface water and deep groundwater (aquifers greater than 500 feet bgs). There are no surface water features in the area, and stormwater is collected through storm drains and discharged to the southern branch of the Elizabeth River.

2.7 Summary of Site Risks

The environmental media evaluated for human health and ecological risk include surface soil, subsurface soil and groundwater. A more detailed discussion of site risk assessment and the results is contained in the RI/HHRA/FFS. The potential human health risks associated with exposure to soil and groundwater within Site 10 were quantitatively evaluated for current/future on-site workers, future construction workers, and future residents as part of the RI/HHRA/FFS Report. Site 10 is an industrial site that provides no viable ecological habitat. Therefore, a quantitative ecological risk assessment for Site 10 was not conducted. However, potential ecological risks that may result from groundwater intrusion to surface water and sediment were evaluated.

A detailed discussion of potential risks are provided in the RI/HHRA/FFS (CH2M HILL, June 2006), and are summarized below.

2.7.1 Human Health Risk Assessment

The HHRA estimates risks posed by the site if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the HHRA for this site.

Identification of Chemicals of Potential Concern

The selection of chemicals of potential concern (COPCs) is a conservative screening process that identifies those chemicals that may be present at the site at concentrations that could result in risks to exposed receptors. The maximum detected concentration of each constituent in each medium (surface soil, subsurface soil, and groundwater) was compared to a conservative risk-based screening value to select the COPCs. If the maximum detected concentration of a constituent exceeded the screening value, the constituent was selected as a COPC and retained for further evaluation. The COPCs and the exposure-point concentrations (EPCs) used to estimate risks for COPCs are provided on **Tables 2-3** through **2-6**.

Soil data were compared to the EPA Region III risk-based concentrations (RBCs) for residential contact with soil. Lead concentrations in soil were compared to the EPA residential child soil-screening value of 400 mg/kg, as determined by the Integrated Exposure Uptake Biokinetic (IEUBK) Model. The COPCs for soil are provided on **Table 2-3 and 2-4**. Additionally, air concentrations associated with fugitive dust and volatile emissions from soil were modeled based on the soil data, following EPA's Soil Screening Guidance, and the calculated air concentrations were compared to EPA Region III ambient air RBCs. There were no COPCs retained for the soil-to-air pathway based on this screening.

Groundwater data were compared to the EPA Region III RBCs for tap water. The RBCs that are based on noncarcinogenic effects were divided by 10 to account for exposure to multiple constituents. Lead concentrations in groundwater were compared to the EPA Safe Drinking Water Act action level of 15 µg/L. Groundwater COPCs are provided on **Table 2-5**.

For the Dry Dock 8 expansion area, soil data were compared to the EPA Region III RBCs for residential contact with soil. The Dry Dock 8 soil COPCs are provided on **Table 2-6**. Air concentrations associated with fugitive dust and volatile emissions from soil were modeled based on the soil data, following EPA's Soil Screening Guidance Document, and compared to EPA Region III ambient air RBCs. There were no COPCs retained for the soil-to-air pathway based on this screening.

COCs are a subset of the COPCs posing potential unacceptable risk.

Exposure Assessment

The human health exposure assessment identifies and evaluates the contaminant sources, release mechanisms, exposure pathways, exposure routes, and receptors. The elements of the exposure assessment for Site 10 are identified in the CSM (**Figure 2-3**). A future construction worker, current/future on-site worker (industrial worker), and future lifetime (adult/child) resident were identified as potential receptors at Site 10. The construction worker could be exposed to soil via incidental ingestion and dermal contact and to groundwater via dermal contact and inhalation of groundwater vapors from an open excavation. The current/future on-site worker could be exposed to soil via incidental ingestion and dermal contact and to groundwater via ingestion. Future residents could be exposed to soil via incidental ingestion and dermal contact and to groundwater, if groundwater were used as a potable water supply, via ingestion, dermal contact, and inhalation of vapors. The future resident risk evaluation included evaluation of a child resident for noncarcinogenic hazards and a lifetime resident for carcinogenic risks. It was assumed that if the child resident scenario (a scenario more conservative than an adult resident scenario) showed no risk, the adult resident would also have no risk.

Toxicity Assessment

The toxicity assessment provides a numerical estimate of the relationship between the extent of exposure and possible severity of adverse effects; it consists of two steps: hazard identification and dose-response assessment. Toxicity data used in the HHRA are EPA-published toxicity values (noncarcinogenic reference doses [RfDs] and carcinogenic slope factors [CSFs]) in the Integrated Risk Information System and Health Effects Assessment Summary Tables databases. If data were not available from either of these sources, EPA's National Center for Environmental Assessment data was used. Toxicity data used in risk evaluations for the COPCs are provided on **Table 2-7** (non-cancer) and **Table 2-8** (cancer).

Lead does not have available published toxicity factors and therefore is assessed by using the IEUBK Model (EPA, May 2002). The principal assumption associated with the use of IEUBK is that a child resident under age 7 is the receptor for potential exposure to lead in soil. The Site 10 toxicity assessment also evaluates exposure to lead by a female current/future on-site worker of a child-bearing age (EPA, December 1996). The average lead concentration in soil (741 mg/kg) was used as the exposure concentration in both models.

Risk Characterization

The results of the exposure and toxicity assessments were used to develop numerical estimates and characterize the potential health risks associated with COPCs. For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated using the following equation:

Risk = CDI x CSF

where:

Risk = a unitless probability (i.e., 2×10^{-5}) of an individual's developing cancer
CDI = chronic daily intake averaged over 70 years (mg/kg-day)
CSF = carcinogenic slope factor, expressed as $(mg/kg\text{-}day)^{-1}$

These risks are probabilities, which usually are expressed in scientific notation (for example, 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure (RME) estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This risk is referred to as "excess lifetime cancer risk" because the risk being estimated would be in addition to the risks of cancer individuals face from other causes such as smoking or excess sun exposure. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. The NCP at 40 CFR Section 300.430(e)(2)(i)(A)(2) indicates that a generally acceptable risk range for site-related exposures is 1×10^{-4} to 1×10^{-6}.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with an RfD derived for a similar exposure period. An RfD represents a level to which an individual may be exposed that is not expected to cause any harmful effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ of less than 1 indicates that a receptor's dose of a single contaminant is less than the RfD and that toxic noncarcinogenic effects from that chemical are unlikely, even in sensitive subpopulations. The hazard index (HI) is generated by adding the HQs for all chemicals of potential concern that affect the same target organ (for example, the liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI of less than 1 indicates that, based on the sum of all HQs from different COPCs and exposure routes, toxic noncarcingenic cumulative effects are unlikely. An HI of greater than 1 indicates that site-related exposures may present a risk to human health. The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

Future Construction Workers

Future construction worker exposure to combined surface and subsurface soil across NNSY Site 10 would not result in any noncarcinogenic hazards or carcinogenic risks greater than EPA target levels (Table 2-9). Although the RME noncarcinogenic hazard is 2, there are no individual target organs/effects with HIs greater than 1, and the central tendency exposure

(CTE) hazard is below 1 (HI=0.83). Additionally, the RME cancer risk is within EPA's acceptable risk range ($5.5x10^{-6}$). The future construction worker exposure to surface soil and subsurface soil during the Dry Dock 8 expansion project will not result in any noncancer hazards (HI=0.65) or cancer risks ($8.5x10^{-7}$) greater than EPA's target levels. Exposure to lead in soil is not considered a health concern for the fetuses of adult construction workers.

Future construction worker exposure to groundwater across NNSY Site 10 would not result in any noncarcinogenic hazards or carcinogenic risks greater than EPA target levels. The RME hazard for groundwater is below the target HI of 1 (HI=0.38), and the RME cancer risk is less than EPA's acceptable risk range ($3.3x10^{-7}$). As a result, no COCs were retained for the future construction worker.

Current/Future On-Site Workers

Current/future on-site worker exposure to surface soil or combined surface and subsurface soil across NNSY Site 10 would not result in any noncarcinogenic hazards or carcinogenic risks greater than EPA target levels (**Table 2-10 and 2-11**). The cancer risks associated with exposure to surface soil ($3.4x10^{-5}$) and combined surface/subsurface soil ($3.7x10^{-5}$) are within EPA's target carcinogenic risk range. The noncarcinogenic hazards associated with exposure to surface soil (HI=0.64) and combined surface/subsurface soil (HI=0.53) are less than EPA's target HI. However, exposure to lead in surface soil may result in a slight risk to fetuses of female on-site workers, according to the Adult Lead Model (**Figure 2-5**). The calculated results of the lead model indicated that 5.2 percent of the population has a blood lead level greater than 10 micrograms per deciliter (µg/dl), which is 0.2 percent greater than acceptable EPA blood lead population level of 5 percent. However, the site-wide average lead concentration in surface soil is 741 mg/kg, which is below EPA's industrial action level guidance criteria of 1,000 mg/kg. For these reasons, the Navy, EPA, and VDEQ, agree the potential risk associated with exposure to lead is acceptable.

Current/future on-site worker exposure to shallow groundwater could result in a carcinogenic risk of $1.2x10^{-4}$, which is greater than EPA's target carcinogenic risk range. The risk is primarily driven by arsenic. Because the carcinogenic risk was greater than $1x10^{-4}$, a CTE evaluation for a current/future on-site worker in contact with shallow groundwater was performed. The CTE carcinogenic risk ($2.5x10^{-5}$) is within the EPA's target carcinogenic risk range of $1x10^{-4}$ to $1x10^{-6}$. The noncarcinogenic HI (2.6) associated with exposure to shallow groundwater by on-site workers exceeds EPA's target HI. The hazard is primarily driven by ingestion of iron (1.3). Because the noncarcinogenic HI was greater than 1, a CTE evaluation for a current/future on-site worker in contact with shallow groundwater was performed. The CTE HI of 1.3 associated with exposure to shallow groundwater exceeds EPA's target HI; however, none of the individual target organs/effects have HIs greater than 1, and therefore the noncarcinogenic hazard is acceptable.

Future Residential Receptors

Residential use of the site would result in RME noncarcinogenic hazard (HI=5.6) and carcinogenic risk ($1.4x10^{-4}$) greater than EPA's target levels for exposure to soil (**Table 2-12**). The primary risk driver was arsenic in soil (HQ=1.1). The CTE noncarcinogenic hazard (HI=0.91) and carcinogenic risk ($1.5x10^{-5}$) for exposure to combined surface and subsurface soil are less than or within EPA's target levels. The IEUBK lead model results indicated

potential risks to future residents because of exposure to lead in soil. The calculated results of the lead model indicated that 12 percent of the population has a blood lead level greater than 10 µg/dl, which is 7 percent greater than the acceptable EPA blood lead population level of 5 percent (**Figure 2-6**).

Future residential use of Site 10 groundwater may pose a carcinogenic risk and noncarcinogenic hazard greater than EPA target levels. The RME noncarcinogenic hazard (HI=39) is primarily because of ingestion of arsenic (HQ=4.5), iron (HQ=8.5), and manganese (HQ=1.7) and dermal contact with manganese (HQ=21). The CTE risk is also greater than the EPA acceptable target HI of 1 (HI=6.5) because of ingestion of arsenic (HQ=2) and iron (HQ=2.9).The RME cancer risk is $5.5x10^{-4}$ with arsenic as the primary risk driver ($4.7x10^{-4}$). The CTE cancer risk is also greater than EPA's acceptable risk range ($1.2x10^{-4}$) because of arsenic in groundwater ($1.1x10^{-4}$).

Exposure to iron in groundwater is not expected to be a health concern for the future resident because iron is an essential human nutrient. The estimated RME intake of iron via ingestion of groundwater (2.6 mg/kg-day) is only slightly above the recommended daily allowance range for children ages 6 months to 10 years (0.36 to 1.11 mg/kg-day) (EPA, January 1999). Additionally, the intake is below the maximum daily intake that is likely to pose risk for adverse effects (the Dietary Reference Intake Tolerable Upper Intake Level of 40 mg/day, equivalent to an intake of 2.7 mg/kg-day calculated by dividing 40 mg/day by the child body weight of 15 kg, USDA, 2006).

Exposure to manganese in the groundwater is not expected to be a health concern for the future resident. Although the oral RfD for manganese is not provisional, the derivation of toxicity factors for essential nutrients is complicated because manganese is an essential human nutrient responsible for activating several enzymes (EPA, 2006). The IRIS profile for manganese states the following:

> The reference dose is estimated to be an intake for the general population that is not associated with adverse health effects; this is not meant to imply that intakes above the reference dose are necessarily associated with toxicity. Some individuals may, in fact, consume a diet that contributes more than 10 mg Mn/day without any cause for concern *(EPA, 2006).*

The combined intake from ingestion (0.034 mg/kg-day) and dermal contact (0.017 mg/kg-day) of manganese for a future child resident is much lower than the Dietary Reference Intake Tolerable Upper Intake Level of 2 mg/day for a child 1 to 3 years of age (USDA, 2006), which is equivalent to an intake of 0.13 mg/kg-day calculated by dividing 2 mg/day by the child body weight of 15 kg.

A technical memorandum summarizing the potential groundwater risks associated with arsenic, and rationale for risk management consideration, was completed for Site 10 and is included as Appendix A of the RI/HHRA/FFS (CH2M HILL, 2006). A statistical analysis of the data demonstrated that there is no significant statistical difference between data collected in the 2001 and 2004 sampling rounds. There are also no statistical differences between concentrations detected upgradient, downgradient, and around the locations of elevated soil arsenic concentrations, which indicates that there is no source of arsenic contamination and that the groundwater concentrations are due to background. The

statistical analysis was reviewed and confirmed by the Technical Support Center of EPA's National Exposure Research Laboratory (EPA NERL, 2006). Moreover, the data indicate that the arsenic in groundwater is not spatially consistent with the elevated soil concentrations of arsenic and, therefore, is not likely to be related to arsenic in soil. Thus, excavation of arsenic in soil is unlikely to affect arsenic in groundwater. According to CERCLA Section 104(a)(3)(A), releases or threats of release of a naturally occurring substance is exempt from action under CERCLA. Consequently, arsenic was not retained as a COC.

Antimony and cadmium were detected above the MCL in site groundwater but were not retained as COCs in the HHRA because they did not individually pose risk to any future receptor. The exceedances were inconsistent (not detected in 2001 but detected in 2004) and isolated. (Dissolved antimony was detected above the MCL in two of 15 monitoring wells, and total and dissolved cadmium was detected above the MCL in one of 15 monitoring wells.) Lead in site soil is the only chemical retained as a COC requiring remedial action at Site 10.

Uncertainty

The risk measures used in site risk assessments are not fully probabilistic estimates of risk but are conditional estimates given that a set of assumptions about exposure and toxicity are realized. Thus, it is important to specify the assumptions and uncertainties inherent in the risk assessment to place the risk estimates in proper perspective (EPA, December 1989). A detailed discussion of the uncertainties associated with the risk assessment is included in the RI/HHRA/FFS (CH2M HILL, 2006).

2.7.2 Summary of Ecological Risks

The Navy evaluated potential risks at Site 10 that may result from groundwater intrusion to surface water and sediment. There were slight exceedances of the very conservative benchmarks established by the EPA's Biological Technical Assistance Group and the background UTLs for iron and manganese in surface water and sediment. These constituents are common in Virginia coastal plain groundwater, and their concentrations are expected to be diluted when groundwater discharges to the southern branch of the Elizabeth River. Additionally, there is no evidence indicating that a CERCLA release to groundwater occurred at Site 10. Therefore, without potential risk resulting from groundwater to surface water discharge, and considering the minimal habitat for ecological receptors at Site 10, there is not unacceptable ecological risk, and no further action regarding impacts to ecological receptors is warranted.

2.8 Remedial Action Objective

The RAOs are established based on the nature and extent of contamination, the resources that are currently and/or potentially threatened, the potential for human and environmental exposure, and the reasonably anticipated future land use. RAOs may specify acceptable threshold contaminant levels, where applicable, for various exposure pathways. Based on the results of the HHRA, lead is the only COC for residential soil exposures and has been retained as a COC at Site 10.

The RAO for Site 10 is to prevent residential or childcare use until site conditions allow for unlimited use and unrestricted exposure to surface and subsurface soil without unacceptable levels.

2.9 Description of Alternatives

2.9.1 Alternative 1: No-Action

Description. Evaluation of the No-Action Alternative is required by the NCP to provide a baseline comparison for other remediation alternatives. Under the No-Action Alternative, no additional controls or remedial technologies would be implemented and no further site-related monitoring or maintenance would be conducted. Under this alternative, the remediation goals would not be met.

Cost. There are no capital or O&M costs related to this alternative.

2.9.2 Alternative 2: LUCs

Description. The LUCs will be implemented by the Navy to prohibit the development and use of the property for residential housing, elementary and secondary schools, child care facilities, or a playground. LUCs will be maintained within the boundaries of Site 10 (**Figure 2-1**) until such time that additional actions are completed that allow for unlimited use and unrestricted exposure. Within 90 days following the execution of this ROD, the Navy shall develop and submit to EPA and VDEQ, in accordance with the FFA, a draft RD that defines the detailed implementation actions for LUCs. LUC implementation actions will include periodic inspections and reporting to ensure that unacceptable exposure will not occur on the site. The Navy will implement, maintain and report on, and enforce the LUCs according to the RD. These actions will reduce unacceptable risks to receptors by eliminating direct exposure to contaminated soil.

Cost: Present worth costs were calculated over a 30-year period, using a 2005 discount rate of 3.1 percent per OMB Circular A-94, Appendix C, updated January 2005 (CH2M HILL, 2006). The estimated costs of Alternative 2 are as follows:

- Capital cost: $10,000
- Annual O&M: $1,272
- 5-year statutory reviews: $7,632 (per event)
- Net present worth (30-year): $58,000

2.9.3 Alternative 3: Soil Excavation, Backfill, and Site Restoration

Description. Alternative 3 will include excavation of Site 10 soil and backfill with clean material. During the remedy construction, all shipyard activities occurring within and adjacent to the site will have to be temporarily relocated. Buildings, structures, and paving will be demolished and properly disposed. Utilities located within the proposed excavation will need to be marked, temporarily secured and braced, or temporarily re-routed during excavation activities within the approximate 40-acre area. After the excavation and disposal of the soil is complete, clean fill material will be used to restore the area, including replacing utilities as required. Because of the intrusive nature of this alternative, compliance with

ARARs will require increased controls related to the handling of excavated soils and dealing with nuisance water within the excavation. Disruption to the mission of NNSY is not possible to estimate; however, implementation of this alternative would adversely affect the operations of NNSY as a portion of the facility would have to be temporarily inaccessible, underground utilities would need to be relocated, and substantial amount of construction traffic into the CIA would be required. After the completion of this alternative, the surface and subsurface hazards associated with site contaminations will be eliminated. Following site restoration, this alternative will be protective of human health and the environment.

Cost. Initial cost calculations for Alternative 3 include only the excavation and removal of Site 10 soil. The initial capital cost for excavation, transportation, and disposal alone (assuming non-hazardous classification for disposal) is in exceedance of $35 million, without applying markups to the cost estimate in accordance with Feasibility Study guidance. Numerous other costs also would be incurred, such as the disruption of the NNSY activities and costs associated with utilities; however, since this alternative is not practicable, no further detailed costs were calculated.

2.9.4 Common Elements and Distinguishing Features

Neither Alternative 1 nor 2 address remediation of the site soil; however, Alternative 2 protects against exposure to soil contaminants by restricting residential development of the site, while Alternative 1 provides no protection to receptors. Alternative 3 will eliminate potential risk from Site 10 and completely reduce the surface and subsurface soil toxicity, mobility, and volume of lead in soil. A description of the alternatives is presented in **Table 2-8**. By comparison, remedial alternatives intended to treat or remove contamination would be more costly and unnecessary because the current and reasonably anticipated future land use for the site is industrial.

2.10 Comparative Analysis of Alternatives

Each remedial alternative for Site 10 was evaluated against the nine criteria listed below, as required by the NCP at 40 CFR 300.430 (e)(9)(iii). The Site 10 FFS provides a more detailed comparative analysis of alternatives than is presented in this ROD. A comparison of the alternatives is presented in **Table 2-9** and described in Section 2.10.1, below**.**

- **Protection of Human Health and the Environment**—addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.
- **Compliance with ARARs**—Section 121(d) of CERCLA and the NCP at 40 CFR Section 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations, which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA Section 121(d)(4).
- **Long-Term Effectiveness and Permanence**—refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration

of residual risk that will remain on-site following remediation and the adequacy and reliability of controls.

- **Reduction of Toxicity, Mobility, or Volume Through Treatment**—refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.
- **Short-Term Effectiveness**—addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.
- **Implementability**—addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.
- **Cost**—refers to the estimated capital and annual operations and maintenance costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.
- **State Acceptance**—considers whether the state agrees with the analyses and recommendations.
- **Community Acceptance**—considers whether the local community agrees with the analyses and preferred alternative.

2.10.1 Threshold Criteria

Overall Protection of Human Health and the Environment

All of the alternatives, except the No-Action alternative, are protective of human health and the environment by eliminating, reducing, or controlling risks posed by the site through engineering or institutional controls. The LUCs provided in Alternative 2 would result in a high degree of overall protection by preventing unrestricted exposure to soil and ensuring that future land use remains consistent with the LUC objectives. Alternative 3, Soil Excavation, Backfill, and Restoration, completely eliminates the potential risk to human health by removing contaminated surface and subsurface soil.

Compliance with ARARs

Alternative 1, No-Action, does not meet ARARs. Alternative 2, LUCs, will comply with all state and federal ARARs because measures will be instituted to prevent exposure scenarios presenting unacceptable risk and the site use can continue as an industrial site. Alternative 3, Soil Excavation, Backfill, and Restoration, will require substantial controls during implementation to comply with all state and federal ARARs related to waste characterization, transportation and disposal, and stormwater/nuisance water management during excavation activities. This ROD does not waive any ARARs.

2.10.2 Primary Balancing Criteria

Long-Term Effectiveness and Permanence

Alternative 1 provides no long-term effectiveness or permanence and does not meet the RAO for the site. Alternative 2 would allow for continued land use as an industrial site, and the RD would include monitoring and maintenance to ensure protectiveness and permanence over time. Although Alternative 2 will not remediate the site and will result in a residual risk remaining at the site, it does effectively eliminate unrestricted exposure to soil, which will achieve the RAO. Alternative 3, Soil Excavation, Backfill, and Restoration, will have long-term effectiveness and permanence by removing the contaminated soil.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Neither Alternative 1, No–Action, nor Alternative 2, LUCs, will reduce toxicity, mobility or volume of the contaminants at Site 10. Alternative 3, Soil Excavation, Backfill, and Restoration, completely eliminates toxicity, mobility, and volume.

Short-Term Effectiveness

Both Alternatives 1 and 2 will be effective in the short term because Site 10 is currently an industrial operations area and is located within the CIA, access to which is extremely restricted. Under current land use scenarios, there are no unacceptable risks; therefore, there is no short-term risk. Alternative 3 (Soil Excavation, Backfill, and Site Restoration) would be less effective in the short term because of the risk involved during the construction effort to remove the soils, transportation, and disposal of excavated soils.

Implementability

No action would be implemented under Alternative 1. For Alternative 2, the Navy has proven capability to restrict access to specific areas within the installation and to conduct periodic monitoring of the facility. Alternative 3, Soil Excavation, Backfill, and Restoration, would be the most difficult to implement based on the excavation and disposal volume, clean fill volume, and the amount of time required to move this quantity of material. The impact to shipyard activities because of the demolition of buildings, utility relocation, and disruption to the mission of NNSY would be significant.

Cost

In terms of net present worth, the No-Action alternative has no cost. There would be minimal costs, approximately $58,000 over a 30-year assumed time frame, to implement Alternative 2, LUCs. However, LUCs would be implemented indefinitely. The costs associated with Alternative 3 exceed $35 million and are orders of magnitude higher than the cost anticipated to establish and maintain LUCs. This cost is unacceptable for purposes of a cost-benefit analysis and impractical in practice.

State Acceptance

The Commonwealth of Virginia was involved throughout the CERCLA process and in the selection of the remedy for Site 10. The VDEQ, as the designated state support agency in Virginia, has reviewed this ROD and has given concurrence on the selected remedy.

Community Acceptance

No written comments, concerns, or questions were received by the Navy, EPA, or Commonwealth of Virginia during the public comment period from December 9, 2006 through January 9, 2006. A public meeting was held on December 20, 2006, to present the Proposed Plan for Site 10 and answer questions on the Proposed Plan and documents in the Administrative Record. There was no public attendance at the public meeting.

2.11 Principal Threat Wastes

The NCP establishes an expectation that EPA will use treatment to minimize the principal threats posed by a site whenever practicable. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. There are no principal threat wastes present at Site 10.

2.12 Selected Remedy

The selected remedy for contaminated soil at Site 10 is LUCs.

2.12.1 Summary of the Rationale for the Selected Remedy

LUCs are the selected remedy for Site 10 to protect humans from exposure to soil in a future residential scenario. For over 200 years the site area has been industrial, and the Navy has no plans to use the property for anything other than industrial use. The area is mostly covered by concrete, asphalt, or buildings, and all surface water is directed to the NNSY stormwater system. There are no unacceptable risks to current or future on-site or construction workers. Because the area is currently industrial and is intended to remain industrial use only, LUCs can be reasonably relied upon to protect human health, and are warranted for Site 10; therefore, no remediation goals are established for the LUC remedy. The Navy and EPA, in partnership and VDEQ, select LUCs as the remedial alternative, based on a detailed evaluation of alternatives using the criteria of protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, reduction of toxicity, mobility and volume of contamination through treatment, short-term effectiveness, implementability, and cost.

2.12.2 Description of the Selected Remedy

The selected LUC remedy will be implemented by the Navy to prohibit the development and use of the property for residential housing, elementary and secondary schools, child care facilities, or a playground. LUCs will be maintained within the boundaries of Site 10 (**Figure 2-2**) until such time that additional actions are completed that allow for unlimited use and unrestricted exposure. Within 90 days following the execution of this ROD, the Navy shall develop and submit to EPA and VDEQ, in accordance with the FFA, a draft RD that defines the detailed implementation actions for LUCs. The Navy will delineate Site 10 on a map of the installation with a notation regarding the soil contamination and the LUCs required by this ROD. This interactive, electronic map will be included in the facility's site approval process such that the restrictions on site use will be clearly noted. LUC implementation actions will include periodic inspections and reporting to EPA and VDEQ to ensure that conditions do not allow for unacceptable exposure to occur at the site. The

Navy will implement, maintain and report on, and enforce the LUCs according to the RD. These actions will reduce unacceptable risks to receptors by eliminating direct exposure to contaminated soil.

The estimated costs of LUCs are:

- Annual O&M: $1,272
- 5-year statutory reviews: $7,632 (per event)
- Net present worth (30-year): $58,000

2.12.3 Expected Outcome of the Selected Remedy

Current industrial land uses are expected to continue at Site 10, and there is no other planned land use in the foreseeable future. Once LUCs are implemented, exposure will be controlled until such time that additional actions are completed that allow for unlimited use and unrestricted exposure. The effectiveness of LUCs will be monitored through implementation of maintenance actions, including periodic inspections and reporting, which will be documented in accordance with the RD.

2.13 Statutory Determinations

The selected remedy must satisfy the statutory requirements of CERCLA Section 121, which include:

- Protection of human health and the environment
- Compliance with ARARs (or justification of a waiver)
- Cost-effectiveness
- Utilization of permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable
- Preference for treatment as a principal element of the remedy to the extent practicable

The evaluation of how the selected remedy for Site 10 satisfies these requirements is presented below.

2.13.1 Protection of Human Health and the Environment

The selected remedy will protect human health and the environment by preventing exposure to contaminated soil at Site 10. The LUCs will prevent exposure in both the short- and long–terms, and will afford an effective level of protection.

2.13.2 Compliance with ARARs

The selected remedy will meet all identified ARARs, as described in Appendix A.

2.13.3 Cost-Effectiveness

The selected remedy is cost-effective and represents a reasonable value for maintaining LUCs. The remedy is cost-effective because its costs are proportional to its overall

effectiveness. Overall effectiveness was evaluated by assessing balancing criteria in combination. The total present worth cost of the selected remedy in this ROD is $58,000.

2.13.4 Use of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The Navy, EPA, and VDEQ determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner at Site 10, and that the selected remedy provides the best balance of tradeoffs in terms of the balancing criteria while also considering the statutory preference for treatment as a principal element and bias against offsite treatment and disposal, and state and community acceptance.

2.13.5 Preference for Treatment as a Principal Element

The use of a treatment or disposal alternative for soil is not cost-effective or practicable for this site.

2.13.6 Five-Year Review Requirement

The Navy will maintain LUCs and conduct a statutory remedy review within 5 years after initiating remedial action, and every five years thereafter, to ensure LUCs continue to provide adequate protection of human health and the environment.

2.14 Documentation of Significant Changes

No significant changes to the remedy have been made since the time it was presented as the Preferred Alternative in the Proposed Plan.

SECTION 3

Responsiveness Summary

Public input is a key element in the decisionmaking process. The Proposed Plan was made available on December 9, 2006. In accordance with Sections 113 and 117 of CERCLA, the Navy provided a public comment period, from December 9, 2006 through January 9, 2007, for the proposed remedial action described in the Proposed Plan for Site 10. The Proposed Plan was available to the public in the Administrative Record and the Information Repository for NNSY.

A public meeting was held on December 20, 2006, at the Portsmouth Main Branch Library, Portsmouth, Virginia, to formally present the Proposed Plan for Site 10. Public notice of the meeting and availability of documents was placed in *The Virginian-Pilot* newspaper on December 9, 2006. Navy representatives were available to present the Proposed Plan for Site 10 and to answer any questions on the Proposed Plan and on the documents in the Information Repository. No one from the public attended the public meeting, and no comments were received from the public during the public comment period.

SECTION 4

References

A.T. Kearney, Inc., March 1987. *Supplement to Interim Final RCRA Facility Assessment Report (RFA)*.

Baker Environmental. January 2000. *Site Screening Assessment for Norfolk Naval Shipyard, Portsmouth, Virginia*. Final.

CH2M HILL, Inc., July 2003. *Final Site Screening Process Investigation and Action Determination Report Building 236, Building 369, and the 1927 Landfill and Vicinity, Norfolk Naval Shipyard*.

CH2M HILL, Inc., December 2003. *Supplemental Site Investigation Work Plan: Site 10 Disposal Area, Norfolk Naval Shipyard, Portsmouth, Virginia.*

CH2M HILL, Inc., April 2006. *Remedial Investigation, Human Health Risk Assessment, and Focused Feasibility Study Report for Site 10, Norfolk Naval Shipyard, Portsmouth, Virginia.*

CH2M HILL, Inc. December 2006. *Preliminary Assessment and Action Determination Report for Site 15, Norfolk Naval Shipyard, Portsmouth, Virginia.*

EPA Water and Air Research, 1983. *Initial Assessment Study, Norfolk Naval Shipyard (IAS)*.

EPA, December 1989. *Risk Assessment Guidance for Superfund, Vol. I, Human Health Evaluation Manual (Part A). Interim Fina*l. EPA/540/1-89/002. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

EPA, Photographic Interpretation Center (EPIC), October 1994, *Aerial Photographic Site Analysis for Norfolk Naval Shipyard*.

EPA, December 1996. *Recommendations of the Technical Review Workgroup for Lead for an interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil*.

EPA, May 2002. *User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK)*.

USDA, 2006. *Dietary Reference Intakes (DRIs) for Elements*. Food and Nutrition Board. http://www.iom.edu/Object.File/Master/21/372/0.pdf.

Tables

Table 2-1
History of Environmental Investigations
Site 10 Record of Decision
Norfolk Naval Shipyard, Portsmouth, Virginia

Date of Report/Investigation	Author	Report/Investigation	Summary
March 1983	EPA Water and Air Research	Initial Assessment Study	Identified and assessed sites at NNSY posing potential human health and ecological risks due to contamination resulting from prior hazardous waste management activities. The study concluded that nine sites, including Site 10 warranted further investigation under the Navy Assessment and Control of Installation Pollutants (NACIP) program, to assess potential long-term impacts.
October 1986 and March 1987	NUS Corporation	Interim and Supplemental RCRA Facilities Assessment (RFA)	Reviewed EPA files and data from DEQ regarding potential releases at the facility. Because there was no sampling conducted at Site 10 at the time of the assessment, there was no direct evidence of a release. The report concluded that there was a potential for a release and recommended a confirmation study to assess the potential degradation of groundwater and the underlying soils at the Site.
October 1994	EPA Photographic Interpretation Center	Aerial Photographic Site Analysis for the Norfolk Naval Shipyard (EPIC Review)	The EPIC study review indicated that Site 10 was a tidal tributary (Back Creek) to the Southern Branch of the Elizabeth River in 1937, and by 1949, filling operations had established a shoreline at Site 10 similar to what exists today.
January 2000	Baker Environmental	Site Screening Assessment (SSA)	Reviewed sites identified in the RFA and EPIC review. 105 Sites, including Site 10 were identified for site verification.
July 2003	CH2M HILL	Site Screening Process (SSP)	Delineated the boundary of the site, characterized the nature and extent of soil and groundwater contamination, and qualitatively evaluated potential human health and ecological risk. The report concluded that there were no unacceptable ecological risks due to the limited exposure pathways and highly industrialized nature of the site. Debris delineation results concluded that the site lacked evidence of an industrial landfill and was composed of generally dredge fill with some construction debris. Further soil and groundwater investigations were recommended to assess potential human health risk
2005	CH2M HILL	Supplemental Site Investigation (SSI)	Soil and groundwater samples were collected to further characterize the nature and extent of contamination (primarily arsenic in groundwater). Additionally, soil samples were collected in the vicinity of dry dock 8 to evaluate potential risks to construction workers. The Navy , EPA and DEQ agreed that the results from this study should be incorporated into a Remedial Investigation for the Site to quantify potential human health risks in soil and groundwater.
June 2006	CH2M HILL	Remedial Investigation/Human Health Risk Assessment/Focused Feasibility Study	The data collected during the SSI and SSP were used as the basis for this report. The report characterized the nature and extent of contamination at Site 10, quantitatively assessed human health risks, and evaluated remedial alternatives to address unacceptable risks. The report concluded that lead in site soil may pose unacceptable risk, and evaluated no action, land use controls, and soil excavation/backfill/restoration as potential alternatives to address the risk.
July 2006	CH2M HILL	Proposed Plan	Presented the preferred alternative (Land Use Controls to prevent residential development) to address potential unacceptable risk in Site 10 soil. The Proposed Plan was made available to the public in December 2006.

Table 2-2
Sample Analysis Summary
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

	Analytical Suite					
	TCL VOCs	TCL SVOCs	TCL Pesticides/ PCBs	TDS	TAL Total Metals & Cyanide	TAL Dissolved Metals
Site Screening Process (2001)						
Surface Soil (October 2001)	8	8	8	--	8	--
Subsurface Soil (October 2001)	11	11	11	--	11	--
Groundwater (October 2001)	11	11	11	NA	11	11
Supplementation Site Investigations (2004)						
Surface Soil (April 2004)	6	16	6	--	16	--
Subsurface Soil (April 2004)	8	17	8	--	17	--
Groundwater (April 2004)	15	4	4	15	15	15

Notes:
NA - Analytical suite not analyzed
PCBs - Polychlorinated Biphenyls
SVOCs - Semi-volatile Organic Compounds
VOCs - Volatile Organic Compounds
TAL - Target Analyte List
TCL - Target Compound List
TDS - Total dissoloved solids

Table 2-3
Surface Soil Contaminants of Potential Concern and Exposure Point Concentrations
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

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	Screening [4] Toxicity Value	Rationale for [5] Contaminant Selection	Arithmetic Mean	95% UCL of (N/T/G/NP)		Reasonable Maximum Exposure Exposure Point Concentration Calculation RME EPC	Units	Statistic	Rationale	Central Tendancy Exposure Exposure Point Concentration Calculation CTE EPC	Units	Statistic	Rationale
Benzo(a)anthracene	0.039 J	1.8	MG/KG	10-SO08-00	13/22	0.34 - 17	1.8	0.875 C	ASL	0.803	1.46	(T)	1.46	MG/KG	95% Cheb	(1)	0.62	MG/KG	Mean-T	(a)
Benzo(a)pyrene	0.041 J	1.6	MG/KG	10-SO08-00	13/22	0.34 - 17	1.6	0.0875 C	ASL	0.806	4.59	(NP)	1.60	MG/KG	Max	(2, 6)	0.81	MG/KG	Mean-N	(d)
Benzo(b)fluoranthene	0.055 J	3.1	MG/KG	10-SO08-00	14/22	0.34 - 17	3.1	0.875 C	ASL	0.904	4.82	(NP)	3.10	MG/KG	Max	(2, 6)	0.90	MG/KG	Mean-N	(d)
Dibenz(a,h)anthracene	0.039 J	0.54	MG/KG	10-SO07-00-P	7/22	0.34 - 17	0.54	0.0875 C	ASL	0.612	4.37	(NP)	0.54	MG/KG	Max	(2, 6)	0.54	MG/KG	Max	(d)
Indeno(1,2,3-cd)pyrene	0.04 J	1 J	MG/KG	10-SO07-00-P	13/22	0.34 - 17	1	0.875 C	ASL	0.677	4.43	(NP)	1.00	MG/KG	Max	(2, 6)	0.68	MG/KG	Mean-N	(d)
Heptachlor epoxide	0.13 D	0.13 D	MG/KG	SSP-LDFL1927-SS01-00	1/12	0.0018 - 0.018	0.13	0.0702 C	ASL	0.0117	0.12	(NP)	0.12	MG/KG	99% Cheb-m	(6)	0.01	MG/KG	Mean-N	(d)
Aluminum	2,960	9,130	MG/KG	10-SO14-00	22/22	6.1 - 48.53	9130	7,821 N	ASL	5,633	6,324	(N)	6,324	MG/KG	95% UCL-N	(3)	5632.73	MG/KG	Mean-N	(b)
Antimony	0.43 L	36.2	MG/KG	10-SO10-00	9/22	0.38 - 14.56	36.2	3.13 N	ASL	2.34	18.5	(NP)	18.5	MG/KG	99% Cheb-m	(6)	2.34	MG/KG	Mean-N	(d)
Arsenic	1.1 J	124 J	MG/KG	10-SO07-00	22/22	0.72 - 2.42	124	0.426 C	ASL	20.7	33.6	(G)	33.6	MG/KG	95% Gamma	(1,4,5)	20.74	MG/KG	Mean-N	(c)
Cadmium	0.21 J	10	MG/KG	10-SO11-00	17/22	0.052 - 1.21	10	7.82 N	ASL	1.89	3.27	(G)	3.3	MG/KG	95% Gamma	(4,5)	1.89	MG/KG	Mean-N	(c)
Chromium	7.1	85.6	MG/KG	10-SO04-00	22/22	0.15 - 2.42	85.6	23.5 N	ASL	27.2	36.8	(G)	36.8	MG/KG	95% Gamma	(1,4,5)	27.20	MG/KG	Mean-N	(c)
Copper	4.1	14,000	MG/KG	10-SO06-00	22/22	0.69 - 6.06	14000	313 N	ASL	925	2,776	(T)	2,776	MG/KG	95% Cheb	(1)	0.84	MG/KG	Mean-T	(a)
Iron	3,720	54,700	MG/KG	10-SO11-00	22/22	3.3 - 24.26	54700	2,346 N	ASL	19,501	25,746	(G)	25,746	MG/KG	95% Gamma	(1,4,5)	19,501	MG/KG	Mean-N	(c)
Lead	6.1	3,260	MG/KG	10-SO11-00	22/22	0.54 - 0.72	3260	400	ASL	741	1,445	(G)	741	MG/KG	Mean	(7)	741	MG/KG	Mean-N	(c)
Manganese	15.3	718	MG/KG	10-SO11-00	22/22	0.087 - 3.64	718	156 N	ASL	195	276	(G)	276	MG/KG	95% Gamma	(1,4,5)	195	MG/KG	Mean-N	(c)
Mercury	0.05 J	40.5	MG/KG	SSP-LDFL1927-SS15-00	19/22	0.018 - 1.04	40.5	2.3 N	ASL	4.72	10.8	(G)	10.8	MG/KG	95% Adj Gamma	(1,4,5)	5	MG/KG	Mean-N	(c)
Nickel	3.2 J	184	MG/KG	10-SO11-00	21/22	0.27 - 9.7	184	156 N	ASL	41.0	66.9	(G)	66.9	MG/KG	95% Gamma	(1,4,5)	41	MG/KG	Mean-N	(c)
Silver	0.4 J	116	MG/KG	10-SO09-00	3/22	0.17 - 2.42	116	39.1 N	ASL	5.40	57.8	(NP)	57.8	MG/KG	99% Cheb-m	(6)	5	MG/KG	Mean-N	(d)
Vanadium	10.2 J	45.4	MG/KG	10-SO11-00	22/22	0.2 - 12.13	45.4	7.82 N	ASL	21.8	26.5	(G)	26.5	MG/KG	95% Gamma	(1,5)	22	MG/KG	Mean-N	(c)
Zinc	14.2	5,340	MG/KG	10-SO11-00	22/22	3.5 - 8	5340	2,346 N	ASL	959	1,694	(G)	1,694	MG/KG	95% Gamma	(1,4,5)	959	MG/KG	Mean-N	(c)

[1] Minimum/Maximum detected concentrations

[2] Maximum concentration is used for screening.

[4] Risk-Based Concentration Table, October 25, 2005, U.S. EPA Region III, Jennifer Hubbard. (N=Noncarcinogenic, C=Carcinogenic)
RBC value for cadmium-food used as surrogate for cadmium.
RBC value for chromium VI used for total chromium.
The soil value of 400 mg/kg is from Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.
RBC value for manganese-nonfood used as surrogate for manganese.
RBC value for mercuric chloride used as surrogate for mercury.
RBC for aluminum withdrawn from October 2005 RBC table due to expiration of NCEA provisional toxicity value. Value is from the April 2005 RBC Table.

[5] Rationale Codes
Selection Reason: Above Screening Levels (ASL)

J = Estimated Value
L = Biased Low
D = Diluted

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.
Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data using H-Statistic (95% UCL-T);
95% UCL Chebyshev MVUE (95% Cheb); 99% UCL Chebyshev (mean, sd) (99% Cheb-m); 95% UCL based on Approximate
Gamma Distribution (95% Gamma); 95% UCL based on Adjusted Gamma Distribution (95% Adj Gamma)
(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.
(3) Shapiro-Wilks W Test indicates data are normally distributed.
(4) Anderson-Darling test indicates data are gamma distributed.
(5) K-Smirnov test indicates data are gamma distributed.
(6) Data do not fit normal, lognormal, or gamma distribtution.
(7) For lead, arithemetic mean concentration used as exposure point concentration.

N - Normal
T- Log-Normal
G - Gamma
NP - Non-Parametic

(a) Data are determined to lognormally distributed; use MVUE mean.
(b) Data are normally distributed; use normal mean.
(c) Data are determined to best fit a gamma distribution; use normal mean.
(d) Data distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed); use normal mean.

Table 2-4
Combined Surface/Subsurface Soil Contaminants of Potential Concern and Exposure Point Concentrations
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

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	Screening [4] Toxicity Value	Rationale for [5] Contaminant Selection	Arithmetic Mean	95% UCL of (N/T/G/NP)	Reasonable Maximum Exposure				Central Tendancy			
												Exposure Point Concentration Calculation				Exposure Point Concentration Calculation			
												RME Value	Units	Statistic	Rationale	Value	Units	Statistic	Rationale
Benzo(a)anthracene	3.90E-02 J	2.60E+01	mg/kg	10-SO12-01	28/53	0.34 - 17	2.60E+01	8.75E-01 C	ASL	1.12E+00	4.30E+00 (NP)	4.30E+00	mg/kg	97.5% Cheb-m	(6)	1.12E+00	mg/kg	Mean-N	(c)
Benzo(a)pyrene	4.10E-02 J	6.60E+00 J	mg/kg	10-SO12-01	28/53	0.34 - 17	6.60E+00	8.75E-02 C	ASL	7.29E-01	2.00E+00 (NP)	2.00E+00	mg/kg	97.5% Cheb-m	(6)	7.29E-01	mg/kg	Mean-N	(c)
Benzo(b)fluoranthene	4.10E-02 J	1.00E+01 J	mg/kg	10-SO12-01	31/53	0.34 - 17	1.00E+01	8.75E-01 C	ASL	8.38E-01	2.39E+00 (NP)	2.39E+00	mg/kg	97.5% Cheb-m	(6)	8.38E-01	mg/kg	Mean-N	(c)
Benzo(k)fluoranthene	4.40E-02 J	9.50E+00 J	mg/kg	10-SO12-01	28/53	0.34 - 17	9.50E+00	8.75E+00 C	ASL	7.32E-01	2.20E+00 (NP)	2.21E+00	mg/kg	97.5% Cheb-m	(6)	7.32E-01	mg/kg	Mean-N	(c)
Dibenz(a,h)anthracene	3.90E-02 J	1.30E+00	mg/kg	10-SO06-01	16/53	0.34 - 17	1.30E+00	8.75E-02 C	ASL	5.42E-01	1.47E+00 (NP)	1.47E+00	mg/kg	95% Cheb-m	(6)	5.42E-01	mg/kg	Mean-N	(c)
Indeno(1,2,3-cd)pyrene	4.00E-02 J	2.20E+00	mg/kg	10-SO06-01	26/53	0.34 - 17	2.20E+00	8.75E-01 C	ASL	6.35E-01	1.57E+00 (NP)	1.57E+00	mg/kg	95% Cheb-m	(6)	6.35E-01	mg/kg	Mean-N	(c)
Heptachlor epoxide	1.20E-03 J	1.30E-01 D	mg/kg	SSP-LDFL1927-SS01-00	3/33	0.0018 - 0.018	1.30E-01	7.02E-02 C	ASL	4.99E-03	2.20E-02 (NP)	2.20E-02	mg/kg	95% Cheb-m	(6)	4.99E-03	mg/kg	Mean-N	(c)
Aluminum	4.04E+02	2.27E+04	mg/kg	SSP-LDFL1927-SB06-01-P	53/53	5.7 - 60.09	2.27E+04	7.82E+03 N	ASL	6.47E+03	7.61E+03 (G)	7.61E+03	mg/kg	95% Gamma	(1, 4, 5)	6.47E+03	mg/kg	Mean-N	(b)
Antimony	4.30E-01 L	3.62E+01	mg/kg	10-SO10-00	14/53	0.36 - 18.02	3.62E+01	3.13E+00 N	ASL	1.22E+00	5.46E+00 (NP)	5.46E+00	mg/kg	97.5% Cheb-m	(6)	1.22E+00	mg/kg	Mean-N	(c)
Arsenic	3.10E-01 J	1.24E+02 J	mg/kg	10-SO07-00	51/53	0.68 - 3	1.24E+02	4.26E-01 C	ASL	1.49E+01	2.66E+01 (T)	2.66E+01	mg/kg	95% UCL-T	(1)	1.53E+01	mg/kg	Mean-T	(a)
Cadmium	8.50E-02 J	1.00E+01	mg/kg	10-SO11-00	38/53	0.049 - 1.5	1.00E+01	7.82E+00 N	ASL	1.29E+00	2.81E+00 (NP)	2.81E+00	mg/kg	97.5% Cheb-m	(6)	1.29E+00	mg/kg	Mean-N	(c)
Chromium	1.40E+00	1.81E+02	mg/kg	10-SO04-01	53/53	0.14 - 3	1.81E+02	2.35E+01 N	ASL	2.57E+01	3.44E+01 (T)	3.44E+01	mg/kg	95% UCL-T	(1)	2.55E+01	mg/kg	Mean-T	(a)
Copper	1.60E+00 J	1.40E+04	mg/kg	10-SO06-00	52/53	0.65 - 7.51	1.40E+04	3.13E+02 N	ASL	7.29E+02	2.51E+03 (T)	2.51E+03	mg/kg	95% Cheb	(1)	7.29E+02	mg/kg	Mean-N	(a)
Iron	7.17E+02	5.47E+04	mg/kg	10-SO11-00	53/53	3.1 - 30.04	5.47E+04	2.35E+03 N	ASL	1.57E+04	1.84E+04 (N)	1.84E+04	mg/kg	95% UCL-N	(3)	1.69E+04	mg/kg	Mean-T	(b)
Lead	1.70E+00	3.26E+03	mg/kg	10-SO11-00	53/53	0.51 - 0.94	3.26E+03	4.00E+02	ASL	4.77E+02	2.11E+03 (T)	4.77E+02	mg/kg	Mean	(7)	4.77E+02	mg/kg	Mean-N	(a)
Manganese	6.00E+00	7.18E+02	mg/kg	10-SO11-00	53/53	0.082 - 4.5	7.18E+02	1.56E+02 N	ASL	1.48E+02	2.6E+02 (NP)	2.64E+02	mg/kg	97.5% Cheb-m	(6)	1.48E+02	mg/kg	Mean-N	(c)
Mercury	2.80E-02 J	4.05E+01	mg/kg	SSP-LDFL1927-SS15-00	43/53	0.018 - 1.18	4.05E+01	2.35E+00 N	ASL	3.47E+00	1.75E+01 (T)	1.75E+01	mg/kg	95% Cheb	(1)	5.46E+00	mg/kg	Mean-T	(a)
Nickel	6.90E-01 J	3.35E+02	mg/kg	10-SO04-01	50/53	0.25 - 12.01	3.35E+02	1.56E+02 N	ASL	3.39E+01	6.18E+01 (T)	6.18E+01	mg/kg	95% UCL-T	(1)	3.41E+01	mg/kg	Mean-T	(a)
Silver	2.30E-01 J	1.16E+02	mg/kg	10-SO09-00	8/53	0.16 - 3	1.16E+02	3.91E+01 N	ASL	2.38E+00	1.60E+01 (NP)	1.60E+01	mg/kg	97.5% Cheb-m	(6)	2.38E+00	mg/kg	Mean-N	(c)
Vanadium	1.80E+00 J	4.55E+01	mg/kg	SSP-LDFL1927-SB06-01-P	53/53	0.18 - 15.02	4.55E+01	7.82E+00 N	ASL	1.92E+01	2.21E+01 (G)	2.21E+01	mg/kg	95% Gamma	(1, 4, 5)	1.92E+01	mg/kg	Mean-N	(b)
Zinc	4.80E+00 J	5.34E+03	mg/kg	10-SO11-00	52/53	3.3 - 8	5.34E+03	2.35E+03 N	ASL	6.56E+02	2.94E+03 (T)	2.94E+03	mg/kg	95% UCL-T	(1)	1.04E+03	mg/kg	Mean-T	(a)

[1] Minimum/Maximum detected concentrations

[2] Maximum concentration is used for screening.

[4] Risk-Based Concentration Table, October 25, 2005, U.S. EPA Region III, Jennifer Hubbard. (N=Noncarcinogenic, C=Carcinogenic)
RBC value for cadmium-food used as surrogate for cadmium.
RBC value for chromium VI used for total chromium.
The soil value of 400 mg/kg is from Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.
RBC value for manganese-nonfood used as surrogate for manganese.
RBC value for mercuric chloride used as surrogate for mercury.
RBC for aluminum withdrawn from October 2005 RBC table due to expiration of NCEA provisional toxicity value. Value is from the April 2005 RBC Table.

[5] Rationale Codes
Selection Reason: Above Screening Levels (ASL)

J = Estimated Value
L = Biased Low
D = Diluted

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.
Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data using H-Statistic (95% UCL-T); 95% UCL Chebyshev MVUE (95% Cheb); 99% UCL Chebyshev (mean, sd) (99% Cheb-m); 95% UCL based on Approximate Gamma Distribution (95% Gamma); 95% UCL based on Adjusted Gamma Distribution (95% Adj Gamma)
(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.
(3) Shapiro-Wilks W Test indicates data are normally distributed.
(4) Anderson-Darling test indicates data are gamma distributed.
(5) K-Smirnov test indicates data are gamma distributed.
(6) Data do not fit normal, lognormal, or gamma distribtution.
(7) For lead, arithemetic mean concentration used as exposure point concentration.

N - Normal
T- Log-Normal
G - Gamma
NP - Non-Parametic

(a) Data are determined to lognormally distributed; use MVUE mean.
(b) Data are determined to best fit a gamma distribution; use normal mean.
(c) Data distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed); use normal mean.

Table 2-5
Groundwater Contaminants of Potential Concern and Exposure Point Concentrations
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

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	Screening [4] Toxicity Value	Rationale for [5] Contaminant Selection	Arithmetic Mean	95% UCL of (N/T/G/NP)	Reasonable Maximum Exposure				Central Tendancy Exposure			
												Exposure Point Concentration Calculation				Exposure Point Concentration			
												Value	Units	Statistic	Rationale	Value	Units	Statistic	Rationale
1,1,2,2-Tetrachloroethane	0.57	0.57	UG/L	10-MW10-04B	1/26	0.5 - 5	0.57	0.0527 C	ASL	0.52	1.03 (NP)	0.57	UG/L	Max	(2,6)	0.52	UG/L	Mean-N	(c)
Benzene	0.4 J	0.49 J	UG/L	10-MW13-04B	2/26	0.5 - 5	0.49	0.336 C	ASL	0.52	1.03 (NP)	0.49	UG/L	Max	(2,6)	0.52	UG/L	Mean-N	(c)
Chloroform	0.3 J	0.6 J	UG/L	SSP-LDFL1927-MW05-01D	2/26	0.5 - 5	0.6	0.155 C	ASL	0.51	1.02 (NP)	0.60	UG/L	Max	(2,6)	0.51	UG/L	Mean-N	(c)
Trichloroethene	0.2 J	0.2 J	UG/L	SSP-LDFL1927-MW02-01D	1/26	0.5 - 5	0.2	0.0264 C	ASL	0.50	1.01 (NP)	0.20	UG/L	Max	(2,6)	0.50	UG/L	Mean-N	(c)
Vinyl chloride	0.21 J	0.9 J	UG/L	SSP-LDFL1927-MW02-01D	5/26	0.5 - 5	0.9	0.015 C	ASL	0.55	1.06 (NP)	0.90	UG/L	Max	(2,6)	0.55	UG/L	Mean-N	(c)
2-Methylnaphthalene	8	8	UG/L	SSP-LDFL1927-MW10-01D-P	1/15	5 - 5	8	2.43 N	ASL	2.87	3.51 (NP)	3.51	UG/L	95% UCL-N	(6)	2.87	UG/L	Mean-N	(c)
Butylbenzylphthalate	64	64	UG/L	10-MW13-04B	1/15	5 - 5	64	35 C	ASL	6.60	24.47 (NP)	24.5	UG/L	95% Cheb-m	(6)	6.60	UG/L	Mean-N	(c)
bis(2-Ethylhexyl)phthalate	4 J	34	UG/L	10-MW13-04B	2/15	5 - 5	34	4.78 C	ASL	4.7	13.8 (NP)	13.8	UG/L	95% Cheb-m	(6)	4.70	UG/L	Mean-N	(c)
Aldrin	0.016 J	0.044 J	UG/L	SSP-LDFL1927-MW03-01D	6/15	0.0091 - 0.011	0.044	0.00394 C	ASL	0.015	0.030 (NP)	0.030	UG/L	95% Cheb-m	(6)	0.01	UG/L	Mean-N	(c)
Dieldrin	0.022 J	0.043 J	UG/L	SSP-LDFL1927-MW02-01D	6/15	0.018 - 0.19	0.043	0.00419 C	ASL	0.019	0.032 (NP)	0.032	UG/L	95% Cheb-m	(6)	0.02	UG/L	Mean-N	(c)
Heptachlor epoxide	0.0098 J	0.07 J	UG/L	SSP-LDFL1927-MW11-01D	4/15	0.0091 - 0.011	0.07	0.00736 C	ASL	0.015	0.040 (NP)	0.040	UG/L	95% Cheb-m	(6)	0.02	UG/L	Mean-N	(c)
beta-BHC	0.02 J	0.056	UG/L	SSP-LDFL1927-MW03-01D	4/15	0.0091 - 0.011	0.056	0.0372 C	ASL	0.013	0.029 (NP)	0.029	UG/L	95% Cheb-m	(6)	0.01	UG/L	Mean-N	(c)
Antimony	11.5 J	12.2 J	UG/L	10-MW14-04B	2/26	10 - 60	12.2	1.46 N	ASL	4.19	6.53 (NP)	6.53	UG/L	95% Cheb-m	(6)	4.19	UG/L	Mean-N	(c)
Arsenic	3 J	52.9	UG/L	10-MW07-04B	19/26	2.6 - 10	52.9	0.0446 C	ASL	14.1	21.1 (G)	21.1	UG/L	95% Gamma	(4,5)	14.05	UG/L	Mean-N	(b)
Cadmium	1.3 J	5.8	UG/L	10-MW09-04B	3/26	0.48 - 5	5.8	1.83 N	ASL	0.63	1.76 (NP)	1.76	UG/L	95% Cheb-m	(6)	0.63	UG/L	Mean-N	(c)
Cobalt	1.3 J	218	UG/L	10-MW14-04B	3/26	1.9 - 50	218	73 N	ASL	9.21	92.3 (NP)	92.3	UG/L	99% Cheb-m	(6)	9.21	UG/L	Mean-N	(c)
Iron	420	249,000	UG/L	10-MW14-04B	22/26	32.2 - 100	249000	1,095 N	ASL	20,301	39,922 (G)	39,922	UG/L	95% Adj Gamma	(4,5)	20301.40	UG/L	Mean-N	(b)
Manganese	45.6	2,220	UG/L	10-MW14-04B	26/26	2 - 15	2220	73 N	ASL	362	536 (T)	536	UG/L	95% UCL-T	(1)	338.82	UG/L	Mean-T	(a)
Nickel	1.6 J	135	UG/L	10-MW14-04B	9/26	1.8 - 40	135	73 N	ASL	6.51	57.7 (NP)	57.7	UG/L	99% Cheb-m	(6)	6.5	UG/L	Mean-N	(c)
Selenium	6.8 J	31.4 J	UG/L	10-MW01-04B	4/26	5 - 5.3	31.4	18.3 N	ASL	5.02	10.8 (NP)	10.8	UG/L	95% Cheb-m	(6)	5.0	UG/L	Mean-N	(c)

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[4] Risk-Based Concentration Table, October 25, 2005, U.S. EPA Region III, Jennifer Hubbard.
RBC value for cadmium-water used as surrogate for cadmium.
RBC value for manganese-nonfood used as surrogate for manganese.
RBC for cobalt withdrawn from October 2005 RBC table due to expiration of NCEA provisional toxicity value. Value is from the April 2005 RBC Table.

[5] Rationale Codes
Selection Reason: Above Screening Levels (ASL)
J = Estimated Value
C = Carcinogenic
N = Noncarcinogenic

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.
Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data using H-Statistic (95% UCL-T);
95% UCL Chebyshev MVUE (95% Cheb); 97.5% UCL Chebyshev MVUE (97.5% Cheb); 95% UCL Chebyshev (mean, sd) (95% Cheb-m);
99% UCL Chebyshev (mean, sd) (99% Cheb-m); 95% UCL based on Approximate Gamma Distribution (95% Gamma);
95% UCL based on Adjusted Gamma Distribution (95% Adj Gamma)
Statistics: Maximum Detected Value (Max); Mean of Log-transformed Data using the Minimum Variance Unbiased Estimate (MVUE) method (Mean-T);
Mean value of Normally-distributed data (Mean-N).
(1) Shapiro-Wilk W Test indicates data are log-normally distributed.
(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.
(3) Shapiro-Wilks W Test indicates data are normally distributed.
(4) Anderson-Darling test indicates data are gamma distributed.
(5) K-Smirnov test indicates data are gamma distributed.
(6) Data do not fit normal, lognormal, or gamma distribtution.
(a) Data are determined to lognormally distributed; use MVUE mean.
(b) Data are determined to best fit a gamma distribution; use normal mean.
(c) Data distribution tests are inconclusive (data are not normal, log-normal, or gamma-distributed); use normal mean.

N - Normal
T- Log-Normal
G - Gamma
NP - Non-Parametic

Table 2-6
Dry Dock 8 Soil Contaminants of Potential Concern and Exposure Point Concentrations
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

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	Screening [4] Toxicity Value	Rationale for [5] Contaminant Selection	Arithmetic Mean	95% UCL of (N/T/NP)	Reasonable Maximum Exposure Exposure Point Concentration			
												Value	Units	Statistic	Rationale
Benzo(a)pyrene	0.041 J	0.21 J	MG/KG	10-SO16-00	3/8	0.35 - 0.63	0.21	0.0875 C	ASL	1.85E-01	2.43E-01 N	2.10E-01	mg/kg	Max	(2,3)
Aluminum	404	11,800	MG/KG	10-SO16-02	8/8	6.9 - 45.57	11800	7,821 N	ASL	3.25E+03	7.01E+03 T	7.01E+03	mg/kg	95% Gamma	(1, 4, 5)
Arsenic	1.4	6.7	MG/KG	10-SO16-02	6/8	0.83 - 2.27	6.7	0.426 C	ASL	2.20E+00	4.26E+00 T	6.70E+00	mg/kg	95% Gamma	(1, 4, 5)
Chromium	1.4	26.4	MG/KG	10-SO16-02	8/8	0.17 - 2.27	26.4	23.5 N	ASL	8.00E+00	1.62E+01 T	2.64E+01	mg/kg	95% Gamma	(1, 4, 5)
Iron	717	24,000	MG/KG	10-SO16-02	8/8	3.8 - 22.78	24000	2,346 N	ASL	5.76E+03	1.35E+04 T	2.40E+04	mg/kg	95% Gamma	(1, 4, 5)
Manganese	6	235	MG/KG	10-SO16-02	8/8	0.099 - 3.41	235	156 N	ASL	5.03E+01	1.25E+02 T	2.35E+02	mg/kg	95% Cheb	(1)
Vanadium	1.8 J	24.3	MG/KG	10-SO16-02	8/8	0.23 - 11.39	24.3	7.82 N	ASL	9.10E+00	1.42E+01 N	2.43E+01	mg/kg	95% UCL-N	(3)

* Surface soil & subsurface soil combined

[1] Minimum/Maximum calculated air concentrations from soil concentrations. Air concentrations calculated as Cair = Csoil*1000*(1/PEF+1/VF)

[2] VF only included in calculation for VOCs. VF calculated on Table 2.2 Supplement. PEF = 1.32E9 m3/kg.

[3] Maximum concentration is used for screening.

[4] Background values not available.
RBC value for chromium VI used for total chromium.
RBC value for manganese-nonfood used as surrogate for manganese.
RBC for aluminum withdrawn from October 2005 RBC table due to expiration of NCEA provisional toxicity value. Value is from the April 2005 RBC Table.

J = Estimated Value
C = Carcinogenic
N = Noncarcinogenic

Rationale Codes
Selection Reason: Above Screening Levels (ASL)

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data using H-Statistic (95% UCL-T);

95% UCL Chebyshev MVUE (95% Cheb); 95% UCL based on Approximate Gamma Distribution (95% Gamma).

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilks W Test indicates data are normally distributed.

(4) Anderson-Darling test indicates data are gamma distributed.

(5) K-Smirnov test indicates data are gamma distributed.

N - Normal

T- Log-Normal

NP - Non-Parametic

Table 2-7
Non-Cancer Toxicity Data
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

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)
Aldrin	Chronic	3.0E-05	mg/kg-day	N/A	3.0E-05	mg/kg-day	Liver	1000/1	IRIS	08/09/04
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aluminum	Chronic	1.0E+00	mg/kg-day	NA	1.0E+00	mg/kg-day	CNS	100	PPRTV	08/09/04
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	Chronic	4.0E-04	mg/kg-day	15%	6.0E-05	mg/kg-day	Blood	1000/1	IRIS	08/09/04
	Subchronic	2.0E-04	mg/kg-day	15%	3.0E-05	mg/kg-day	Blood	300	PPRTV	08/09/04
Arsenic	Chronic	3.0E-04	mg/kg-day	95%	3.0E-04	mg/kg-day	Skin/vascular	3/1	IRIS	08/09/04
	Subchronic	3.0E-04	mg/kg-day	95%	3.0E-04	mg/kg-day	Skin/vascular	3	HEAST	07/01/97
Benzene	Chronic	4.0E-03	mg/kg-day	NA	4.0E-03	mg/kg-day	Blood	300/1	IRIS	08/09/04
	Subchronic	3.0E-03	mg/kg-day	NA	3.0E-03	mg/kg-day	Blood	3000	NCEA	07/08/98
Benzo(a)anthracene	Chronic	N/A	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	N/A
Benzo(a)pyrene	Chronic	N/A	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	N/A
Benzo(b)fluoranthene	Chronic	N/A	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	N/A
Benzo(k)fluoranthene	Chronic	N/A	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	N/A
beta-BHC	Chronic	N/A	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	N/A
bis(2-Ethylhexyl)phthalate)	Chronic	2.0E-02	mg/kg-day	NA	2.0E-02	mg/kg-day	Liver	1000/1	IRIS	08/09/04
	Subchronic	2.0E-02	mg/kg-day	NA	2.0E-02	mg/kg-day	Reproductive	3000	NCEA	03/28/96
Butylbenzyphthalate	Chronic	2.0E-01	mg/kg-day	N/A	2.0E-01	mg/kg-day	Liver	1000/1	IRIS	08/16/05
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium (food)	Chronic	1.0E-03	mg/kg-day	2.5%	2.5E-05	mg/kg-day	Kidney	10/1	IRIS	08/09/04
(for soil)	Subchronic	N/A	mg/kg-day	N/A	N/A	mg/kg-day	N/A	N/A	N/A	N/A
Cadmium (water)	Chronic	5.0E-04	mg/kg-day	5.0%	2.5E-05	mg/kg-day	Kidney	10/1	IRIS	08/09/04
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 2-7
Non-Cancer Toxicity Data
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

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)
Chloroform	Chronic	1.0E-02	mg/kg-day	NA	1.0E-02	mg/kg-day	Liver	1000/1	IRIS	08/09/04
	Subchronic	1.0E-02	mg/kg-day	NA	1.0E-02	mg/kg-day	Liver	1000	HEAST	07/01/97
Chromium (hexavalent)	Chronic	3.0E-03	mg/kg-day	2.5%	7.5E-05	mg/kg-day	NOAEL	300/3	IRIS	08/09/04
	Subchronic	2.0E-02	mg/kg-day	2.5%	5.0E-04	mg/kg-day	NOAEL	100	HEAST	07/01/97
Cobalt	Chronic	2.0E-02	mg/kg-day	NA	2.0E-02	mg/kg-day	Blood	10/1	PPRTV	08/09/04
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copper	Chronic	4.0E-02	mg/kg-day	NA	4.0E-02	mg/kg-day	Gastrointestinal	N/A	HEAST	07/01/97
	Subchronic	4.0E-02	mg/kg-day	N/A	4.0E-02	mg/kg-day	Gastrointestinal		HEAST	07/01/97
Dibenzo(a,h)anthracene	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dieldrin	Chronic	5.0E-05	mg/kg-day	N/A	5.0E-05	mg/kg-day	Liver	100/1	IRIS	08/09/04
	Subchronic	5.0E-05	mg/kg-day	N/A	5.0E-05	mg/kg-day	Liver	100	HEAST	07/01/97
Heptachlor epoxide	Chronic	1.3E-05	mg/kg-day	N/A	1.3E-05	mg/kg-day	Liver	1000/1	IRIS	08/09/04
	Subchronic	1.3E-05	mg/kg-day	N/A	1.3E-05	mg/kg-day	Liver	1000	HEAST	07/01/97
Indeno(1,2,3-cd)pyrene	Chronic	N/A	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	N/A
Iron	Chronic	3.0E-01	mg/kg-day	N/A	3.0E-01	mg/kg-day	Gastrointestinal, Blood, Liver	1	NCEA	01/05/99
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	Chronic	N/A	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	N/A
Manganese (nonfood)	Chronic	2.0E-02	mg/kg-day	4%	8.0E-04	mg/kg-day	CNS	1/1	IRIS	08/09/04
	Subchronic	N/A	mg/kg-day	N/A	N/A	mg/kg-day	N/A	N/A	N/A	N/A
Manganese (food)	Chronic	1.4E-01	mg/kg-day	4%	5.6E-03	mg/kg-day	CNS	1/1	IRIS	08/09/04
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mercury (as Mercuric chloride)	Chronic	3.0E-04	mg/kg-day	7%	2.1E-05	mg/kg-day	Immune System	1000/1	IRIS	08/09/04
	Subchronic	3.0E-04	mg/kg-day	7%	2.1E-05	mg/kg-day	Kidney	1000	HEAST	07/01/97
2-Methylnaphthalene	Chronic	4.0E-03	mg/kg-day	N/A	4.0E-03	mg/kg-day	Lung	1000/1	IRIS	08/09/04
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 2-7
Non-Cancer Toxicity Data
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

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)
Nickel	Chronic	2.0E-02	mg/kg-day	4%	8.0E-04	mg/kg-day	Decreased Body Weight	300/1	IRIS	08/09/04
	Subchronic	2.0E-02	mg/kg-day	4%	8.0E-04	mg/kg-day	Whole body	300	HEAST	07/01/97
Selenium	Chronic	5.0E-03	mg/kg-day	30-80%	5.0E-03	mg/kg-day	Whole body	3/1	IRIS	08/09/04
	Subchronic	5.0E-03	mg/kg-day	30-80%	5.0E-03	mg/kg-day	Whole body	3	HEAST	07/01/97
Silver	Chronic	5.0E-03	mg/kg-day	4%	2.0E-04	mg/kg-day	Skin	3/1	IRIS	08/09/04
	Subchronic	5.0E-03	mg/kg-day	4%	2.0E-04	mg/kg-day	Skin	3	HEAST	07/01/97
1,1,2,2-Tetrachloroethane	Chronic	6.0E-02	mg/kg-day	N/A	6.0E-02	mg/kg-day	Liver	N/A	PPRTV	08/09/04
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Trichloroethene	Chronic	6.0E-03	mg/kg-day	N/A	6.0E-03	mg/kg-day	Liver, Kidney, Fetus	3000		1986
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	Chronic	1.0E-03	mg/kg-day	2.6%	2.6E-05	mg/kg-day	Kidney	300	NCEA	05/01/00
	Subchronic	7.0E-03	mg/kg-day	2.6%	1.8E-04	mg/kg-day	Lifetime	100	HEAST	07/01/97
Vinyl chloride	Chronic	3.0E-03	mg/kg-day	N/A	3.0E-03	mg/kg-day	Liver	30/1	IRIS	08/09/04
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Zinc	Chronic	3.0E-01	mg/kg-day	N/A	3.0E-01	mg/kg-day	Blood	3/1	IRIS	08/09/04
	Subchronic	3.0E-01	mg/kg-day	N/A	3.0E-01	mg/kg-day	Blood	3	HEAST	07/01/97

N/A = 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 (Interim).

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%.

HEAST= Health Effects Assessment Summary Tables

IRIS = Integrated Risk Information System

NCEA = National Center for Environmental Assessment

PPRTV = Provisional Peer Reviewed Toxicity Values

RESP = Respiratory System

CNS = Central Nervous System

NOAEL = No adverse effect level

(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.

Table 2-8
Cancer Toxicity Data
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

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 (MM/DD/YY)
Aldrin	1.7E+01	N/A	1.7E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	8/5/2004
Aluminum	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	NCEA	8/13/1999
Antimony	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	IRIS	8/5/2004
Arsenic	1.5E+00	95%	1.5E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	8/5/2004
Benzene	5.5E-02	N/A	5.5E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	8/5/2004
Benzo(a)anthracene	7.3E-01	58% - 89%	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	RBC - NCEA	10/15/2003
Benzo(a)pyrene	7.3E+00	58% - 89%	7.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	8/5/2004
Benzo(b)fluoranthene	7.3E-01	58% - 89%	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	RBC - NCEA	10/15/2003
Benzo(k)fluoranthene	7.3E-02	58% - 89%	7.3E-02	$(mg/kg\text{-}day)^{-1}$	B2	NCEA	7/1/1993
beta-BHC	1.8E+00	N/A	1.8E+00	$(mg/kg\text{-}day)^{-1}$	C	IRIS	8/5/2004
bis(2-Ethylhexyl)phthalate)	1.4E-02	N/A	1.4E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	8/5/2004
Butylbenzylphthalate	1.9E-03	N/A	1.9E-03	$(mg/kg\text{-}day)^{-1}$		P-RBC	4/7/2005
Cadmium-Soil	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	8/5/2004
Cadmium-Water	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	8/5/2004
Chloroform	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	8/5/2004
Chromium (VI)	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	8/5/2004
Cobalt	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	NA	IRIS	8/5/2004
Copper	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	8/5/2004
Dibenzo(a,h)anthracene	7.3E+00	58% - 89%	7.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	NCEA	7/1/1993
Dieldrin	1.6E+01	N/A	1.6E+01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	8/5/2004
Heptachlor Epoxide	9.1E+00	N/A	9.1E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	8/5/2004
Indeno(1,2,3-cd)pyrene	7.3E-01	58% - 89%	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	RBC - NCEA	10/15/2003
Iron	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	NA	NCEA	1/5/1999
Lead	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	NA	IRIS	8/5/2004

Table 2-8
Cancer Toxicity Data
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

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 (MM/DD/YY)
Manganese (nonfood)	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	8/5/2004
Manganese (food)	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	8/5/2004
Mercury	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	8/5/2004
2-Methylnaphthalene	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	IRIS	8/5/2004
Nickel	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	IRIS	8/5/2004
Selenium	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	IRIS	8/5/2004
Silver	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	IRIS	8/5/2004
1,1,2, 2-Tetrachloroethane	2.0E-01	N/A	2.0E-01	$(mg/kg\text{-}day)^{-1}$	C	IRIS	8/9/2004
Trichloroethene	1.1E-02	N/A	1.1E-02	$(mg/kg\text{-}day)^{-1}$	B1		1986
Vanadium	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	IRIS	8/5/2004
Vinyl chloride (lifetime from adult)	7.2E-01	N/A	7.2E-01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	8/5/2004
Vinyl chloride (lifetime from birth)	1.4E+00	N/A	1.4E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	8/5/2004
Zinc	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	8/5/2004

N/A-Not available

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

NCEA = National Center for Environmental Assessment

RBC = EPA Region III RBC Table, 4/7/2005

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

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evalution Manual (Part E, Supplemetnal Guidance for Dermal Risk Assessment (Interim). 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%.

Table 2-9
Future Construction Worker Receptor Summary of Risks and Hazards
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

Receptor	Exposure Point/Route	Chemical of Potential Concern	RME Cancer Risk	RME Non- Cancer Hazard	CTE Non Cancer Hazard	COC
Future Construction Worker - Combined Surface/Subsurface Soil	Ingestion	Benzo(a)anthracene	2.1E-07	NA	NA	no
		Benzo(a)pyrene	9.8E-07	NA	NA	no
		Benzo(b)fluoranthene	1.2E-07	NA	NA	no
		Benzo(k)fluoranthene	1.1E-08	NA	NA	no
		Dibenz(a,h)anthracene	7.2E-07	NA	NA	no
		Indeno(1,2,3-cd)pyrene	7.7E-08	NA	NA	no
		Heptachlor Epoxide	1.3E-08	8.0E-03	1.6E-03	no
		Aluminum	NA	3.6E-02	2.7E-02	no
		Antimony	NA	1.3E-01	2.5E-02	no
		Arsenic	2.7E-06	4.2E-01	2.1E-01	no
		Cadmium	NA	1.3E-02	5.3E-03	no
		Chromium	NA	8.1E-03	5.3E-03	no
		Copper	NA	2.9E-01	7.5E-02	no
		Iron	NA	2.9E-01	2.3E-01	no
		Lead	Lead risk evaluated seperately using IEUBK Model (Figure 2-5 and 2-6)			no
		Manganese	NA	6.2E-02	3.0E-02	no
		Mercury	NA	2.7E-01	7.5E-02	no
		Nickel	NA	1.5E-02	7.0E-03	no
		Silver	NA	1.5E-02	2.0E-03	no
		Vanadium	NA	1.0E-01	7.9E-02	no
		Zinc	NA	4.6E-02	1.4E-02	no
		Exp. Route Total	4.8E-06	1.7E+00	7.9E-01	
	Dermal Absorption	Benzo(a)anthracene	5.6E-08	NA	NA	no
		Benzo(a)pyrene	2.6E-07	NA	NA	no
		Benzo(b)fluoranthene	3.1E-08	NA	NA	no
		Benzo(k)fluoranthene	2.9E-09	NA	NA	no
		Dibenz(a,h)anthracene	1.9E-07	NA	NA	no
		Indeno(1,2,3-cd)pyrene	2.1E-08	NA	NA	no
		Heptachlor Epoxide	3.6E-09	2.1E-03	1.4E-04	no
		Aluminum	NA	7.4E-04	1.8E-04	no
		Antimony	NA	1.8E-02	1.2E-03	no
		Arsenic	1.7E-07	2.6E-02	4.3E-03	no
		Cadmium	NA	1.1E-02	1.5E-03	no
		Chromium	NA	6.7E-03	1.4E-03	no
		Copper	NA	6.1E-03	5.2E-04	no
		Iron	NA	6.0E-03	1.6E-03	no
		Lead	Lead risk evaluated seperately using IEUBK Model (Figure 2-5 and 2-6)			no
		Manganese	NA	3.2E-02	5.2E-03	no
		Mercury	NA	8.1E-02	7.4E-03	no
		Nickel	NA	7.5E-03	1.2E-03	no
		Silver	NA	7.8E-03	3.4E-04	no
		Vanadium	NA	8.3E-02	2.1E-02	no
		Zinc	NA	9.5E-04	9.8E-05	no
		Exp. Route Total	7.4E-07	2.9E-01	4.6E-02	
Total across all exposure routes for soil			5.5E-06	2.0E+00	8.3E-01	
Groundwater	Dermal Absorption	1,1,2,2-Tetrachloroethane	3.5E-09	2.0E-05	--	no
		Benzene	1.5E-09	4.9E-04	--	no
		Chloroform	NA	1.2E-04	--	no
		Trichloroethene	1.1E-10	1.1E-04	--	no
		Vinyl chloride	1.4E-08	4.5E-04	--	no
		2-Methylnaphthalene	NA	2.8E-02	--	no
		Butylbenzylphthalate	7.7E-09	4.0E-03	--	no
		bis(2-Ethylhexyl)phthalate	5.7E-08	1.4E-02	--	no
		Aldrin	9.0E-09	1.2E-03	--	no
		Dieldrin	6.9E-08	6.0E-03	--	no
		Heptachlor epoxide	3.3E-08	2.0E-02	--	no
		beta-BHC	1.1E-08	NA	--	no
		Antimony	NA	5.6E-02	--	no
		Arsenic	1.2E-07	1.8E-02	--	no
		Cadmium	NA	1.8E-02	--	no
		Cobalt	NA	4.8E-04	--	no
		Iron	NA	3.4E-02	--	no
		Manganese	NA	1.7E-01	--	no
		Nickel	NA	3.7E-03	--	no
		Selenium	NA	5.6E-04	--	no
	Exp. Route Total		3.2E-07	3.8E-01	--	
	Inhalation Emissions from Water at NNSY	1,1,2,2-Tetrachloroethane	2.4E-09	NA	--	no
		Benzene	3.8E-10	1.1E-04	--	no
		Chloroform	1.2E-09	7.7E-05	--	no
		Trichloroethene	3.0E-11	NA	--	no
		Vinyl chloride	4.1E-10	6.8E-05	--	no
		2-Methylnaphthalene	NA	NA	--	no
	Exposure Route Total		4.5E-09	2.6E-04	--	no
Total across all expousre routes for groundwater			3.3E-07	3.8E-01	--	no
Total of Receptor Risks Across All Media/all routes			5.9E-06	2.4E+00	--	

Note:
Shaded cells indicate RME or CTE risk or hazard above EPA's acceptable levels

Table 2-10
Current/Future On-Site Worker Summary of Risks and Hazards
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

Receptor	Exposure Point/Route	Chemical of Potential Concern	Cancer Risk	CTE Cancer Risk	RME Non-Cancer Hazard	CTE Non-Cancer Hazard	COC
Current/Future on-site worker exposed to surface soil	Ingestion	Benzo(a)anthracene	3.7E-07	--	NA	--	no
		Benzo(a)pyrene	4.1E-06	--	NA	--	no
		Benzo(b)fluoranthene	7.9E-07	--	NA	--	no
		Dibenz(a,h)anthracene	1.4E-06	--	NA	--	no
		Indeno(1,2,3-cd)pyrene	2.6E-07	--	NA	--	no
		Heptachlor Epoxide	3.8E-07	--	8.9E-03	--	no
		Aluminum	NA	--	6.2E-03	--	no
		Antimony	NA	--	4.5E-02	--	no
		Arsenic	1.8E-05	--	1.1E-01	--	no
		Cadmium	NA	--	3.2E-03	--	no
		Chromium	NA	--	1.2E-02	--	no
		Copper	NA	--	6.8E-02	--	no
		Iron	NA	--	8.4E-02	--	no
		Lead	Lead risk evaluated seperately using IEUBK Model (Figure 2-5 and 2-6)				no
		Manganese	NA	--	1.4E-02	--	no
		Mercury	NA	--	3.5E-02	--	no
		Nickel	NA	--	3.3E-03	--	no
		Silver	NA	--	1.1E-02	--	no
		Vanadium	NA	--	2.6E-02	--	no
		Zinc	NA	--	5.5E-03	--	no
	Exp. Route Total		2.5E-05	--	4.3E-01	--	
	Dermal Absorption	Benzo(a)anthracene	3.2E-07	--	NA	--	no
		Benzo(a)pyrene	3.5E-06	--	NA	--	no
		Benzo(b)fluoranthene	6.8E-07	--	NA	--	no
		Dibenz(a,h)anthracene	1.2E-06	--	NA	--	no
		Indeno(1,2,3-cd)pyrene	2.2E-07	--	NA	--	no
		Heptachlor Expoxide	2.5E-07	--	5.9E-03	--	no
		Aluminum	NA	--	4.1E-04	--	no
		Antimony	NA	--	2.0E-02	--	no
		Arsenic	3.5E-06	--	2.2E-02	--	no
		Cadmium	NA	--	8.4E-04	--	no
		Chromium	NA	--	4.7E-03	--	no
		Copper	NA	--	4.5E-03	--	no
		Iron	NA	--	5.5E-03	--	no
		Lead	Lead risk evaluated seperately using IEUBK Model (Figure 2-5 and 2-6)				no
		Manganese	NA	--	2.2E-02	--	no
		Mercury	NA	--	3.3E-02	--	no
		Nickel	NA	--	5.4E-03	--	no
		Silver	NA	--	1.9E-02	--	no
		Vanadium	NA	--	6.6E-02	--	no
		Zinc	NA	--	3.6E-04	--	no
	Exp. Route Total		9.6E-06	--	2.1E-01	--	
Total across all exposure routes for surface soil			3.4E-05	--	6.4E-01	--	

Table 2-10
Current/Future On-Site Worker Summary of Risks and Hazards
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

Receptor	Exposure Point/Route	Chemical of Potential Concern	Cancer Risk	CTE Cancer Risk	RME Non-Cancer Hazard	CTE Non-Cancer Hazard	COC
Current/Future on-site worker exposed to groundwater	Ingestion	1,1,2,2-Tetrachloroethane	4.0E-07	1.2E-07	9.3E-05	7.5E-05	no
		Benzene	9.4E-08	3.2E-08	1.2E-03	1.1E-03	no
		Chloroform	NA	NA	5.9E-04	4.3E-04	no
		Trichloroethene	7.7E-09	6.0E-09	3.3E-04	7.1E-04	no
		Vinyl chloride	4.4E-06	8.5E-07	2.9E-03	1.6E-03	no
		2-Methylnaphthalene	NA	NA	8.6E-03	6.1E-03	no
		Butylbenzylphthalate	1.6E-07	1.4E-08	1.2E-03	2.8E-04	no
		bis(2-Ethylhexyl)phthalate	6.8E-07	7.3E-08	6.8E-03	2.0E-03	no
		Aldrin	1.8E-06	2.7E-07	9.9E-03	4.2E-03	no
		Dieldrin	1.8E-06	3.3E-07	6.3E-03	3.2E-03	no
		Heptachlor epoxide	1.3E-06	1.5E-07	3.0E-02	1.0E-02	no
		beta-BHC	1.8E-07	2.5E-08	NA	NA	no
		Antimony	NA	NA	1.6E-01	9.0E-02	no
		Arsenic	1.1E-04	2.3E-05	6.9E-01	4.0E-01	no
		Cadmium	NA	NA	3.4E-02	1.1E-02	no
		Cobalt	NA	NA	4.5E-02	3.9E-03	no
		Iron	NA	NA	1.3E+00	5.8E-01	no[1]
		Manganese	NA	NA	2.6E-01	1.5E-01	no
		Nickel	NA	NA	2.8E-02	2.8E-03	no
		Selenium	NA	NA	2.1E-02	8.6E-03	no
	Exp. Route Total		1.2E-04	2.5E-05	2.6E+00	1.3E+00	
Total across all exposure routes for groundwater			1.2E-04	2.5E-05	2.6E+00	1.3E+00	
Total across all exposure routes and media			1.6E-04	--	3.3E+00	--	

Note:
Shaded cells indicate RME or CTE risk or hazard above EPA's acceptable levels
[1] - RME risk or hazard exceeds EPA's Acceptable level, but CTE risk or hazard is below target threshold of 1

Table 2-11
Future On-Site Worker Summary of Risks and Hazards
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

Receptor	Exposure Point/Route	Chemical of Potential Concern	Cancer Risk	CTE Cancer Risk	Non-Cancer Hazard	CTE Non-Cancer Hazard	COC
Future On-Site Worker Exposed to Surface/Subsurface soil	Ingestion	Benzo(a)anthracene	1.1E-06	--	NA	--	no
		Benzo(a)pyrene	5.1E-06	--	NA	--	no
		Benzo(b)fluoranthene	6.1E-07	--	NA	--	no
		Benzo(k)fluoranthene	5.6E-08	--	NA	--	no
		Dibenz(a,h)anthracene	3.8E-06	--	NA	--	no
		Indeno(1,2,3-cd)pyrene	4.0E-07	--	NA	--	no
		Heptachlor Epoxide	7.0E-08	--	1.7E-03	--	no
		Aluminum	NA	--	7.4E-03	--	no
		Antimony	NA	--	1.3E-02	--	no
		Arsenic	1.4E-05	--	8.7E-02	--	no
		Cadmium	NA	--	2.7E-03	--	no
		Chromium	NA	--	1.1E-02	--	no
		Copper	NA	--	6.1E-02	--	no
		Iron	NA	--	6.0E-02	--	no
		Lead	Lead risk evaluated seperately using IEUBK Model (Figure 2-5 and 2-6)				no
		Manganese	NA	--	1.3E-02	--	no
		Mercury	NA	--	5.7E-02	--	no
		Nickel	NA	--	3.0E-03	--	no
		Silver	NA	--	3.1E-03	--	no
		Vanadium	NA	--	2.2E-02	--	no
		Zinc	NA	--	9.6E-03	--	no
	Exp. Route Total		2.5E-05	--	3.5E-01	--	no
	Dermal Absorption	Benzo(a)anthracene	9.4E-07	--	NA	--	no
		Benzo(a)pyrene	4.4E-06	--	NA	--	no
		Benzo(b)fluoranthene	5.2E-07	--	NA	--	no
		Benzo(k)fluoranthene	4.8E-08	--	NA	--	no
		Dibenz(a,h)anthracene	3.2E-06	--	NA	--	no
		Indeno(1,2,3-cd)pyrene	3.4E-07	--	NA	--	no
		Heptachlor Expoxide	4.6E-08	--	1.1E-03	--	no
		Aluminum	NA	--	4.9E-04	--	no
		Antimony	NA	--	5.9E-03	--	no
		Arsenic	2.8E-06	--	1.7E-02	--	no
		Cadmium	NA	--	7.2E-04	--	no
		Chromium	NA	--	4.4E-03	--	no
		Copper	NA	--	4.1E-03	--	no
		Iron	NA	--	4.0E-03	--	no
		Lead	Lead risk evaluated seperately using IEUBK Model (Figure 2-5 and 2-6)				no
		Manganese	NA	--	2.1E-02	--	no
		Mercury	NA	--	5.4E-02	--	no
		Nickel	NA	--	5.0E-03	--	no
		Silver	NA	--	5.2E-03	--	no
		Vanadium	NA	--	5.5E-02	--	no
		Zinc	NA	--	6.3E-04	--	no
	Exp. Route Total		1.2E-05	--	1.8E-01	--	
Total across all exposure routes for surface/subsurface soil			3.7E-05	--	5.3E-01	--	

Table 2-11
Future On-Site Worker Summary of Risks and Hazards
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

Receptor	Exposure Point/Route	Chemical of Potential Concern	Cancer Risk	CTE Cancer Risk	Non-Cancer Hazard	CTE Non-Cancer Hazard	COC
Future On-Site Worker exposed to groundwater	Ingestion	1,1,2,2-Tetrachloroethane	4.0E-07	1.2E-07	9.3E-05	7.5E-05	no
		Benzene	9.4E-08	3.2E-08	1.2E-03	1.1E-03	no
		Chloroform	NA	NA	5.9E-04	4.3E-04	no
		Trichloroethene	7.7E-09	6.0E-09	3.3E-04	7.1E-04	no
		Vinyl chloride	4.4E-06	8.5E-07	2.9E-03	1.6E-03	no
		2-Methylnaphthalene	NA	NA	8.6E-03	6.1E-03	no
		Butylbenzylphthalate	1.6E-07	1.4E-08	1.2E-03	2.8E-04	no
		bis(2-Ethylhexyl)phthalate	6.8E-07	7.3E-08	6.8E-03	2.0E-03	no
		Aldrin	1.8E-06	2.7E-07	9.9E-03	4.2E-03	no
		Dieldrin	1.8E-06	3.3E-07	6.3E-03	3.2E-03	no
		Heptachlor epoxide	1.3E-06	1.5E-07	3.0E-02	1.0E-02	no
		beta-BHC	1.8E-07	2.5E-08	NA	NA	no
		Antimony	NA	NA	1.6E-01	9.0E-02	no
		Arsenic	1.1E-04	2.3E-05	6.9E-01	4.0E-01	no
		Cadmium	NA	NA	3.4E-02	1.1E-02	no
		Cobalt	NA	NA	4.5E-02	3.9E-03	no
		Iron	NA	NA	1.3E+00	5.8E-01	no[1]
		Manganese	NA	NA	2.6E-01	1.5E-01	no
		Nickel	NA	NA	2.8E-02	2.8E-03	no
		Selenium	NA	NA	2.1E-02	8.6E-03	no
	Exp. Route Total		1.2E-04	2.5E-05	2.6E+00	1.3E+00	
Total across all exposure routes for groundwater			1.2E-04	2.5E-05	2.6E+00	1.3E+00	
Total across all exposure routes and media			1.6E-04	--	3.1E+00	--	

Note:
Shaded cells indicate RME or CTE risk or hazard above EPA's acceptable levels

[1] - RME risk or hazard exceeds EPA's Acceptable level, but CTE risk or hazard is below target threshold of 1

Table 2-12
Future Resident Receptor Summary of Risks and Hazards
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

Receptor	Exposure Point/Route	Chemical of Potential Concern	RME Cancer Risk	CTE Cancer Risk	RME Non-Cancer Hazard	CTE Non-Cancer Hazard	COC
Future Resident exposed to site soil	Ingestion	Benzo(a)anthracene	4.9E-06	3.4E-07	NA	NA	no
		Benzo(a)pyrene	2.3E-05	2.2E-06	NA	NA	no
		Benzo(b)fluoranthene	2.7E-06	2.6E-07	NA	NA	no
		Benzo(k)fluoranthene	2.5E-07	2.2E-08	NA	NA	no
		Dibenz(a,h)anthracene	1.7E-05	1.7E-06	NA	NA	no
		Indeno(1,2,3-cd)pyrene	1.8E-06	2.0E-07	NA	NA	no
		Heptachlor Expoxide	3.1E-07	1.9E-08	2.2E-02	1.6E-03	no
		Aluminum	NA	NA	9.7E-02	2.8E-02	no
		Antimony	NA	NA	1.7E-01	1.3E-02	no
		Arsenic	6.2E-05	9.6E-06	1.1E+00	2.2E-01	no[1]
		Cadmium	NA	NA	3.6E-02	5.5E-03	no
		Chromium	NA	NA	1.5E-01	3.6E-02	no
		Copper	NA	NA	8.0E-01	7.8E-02	no
		Iron	NA	NA	7.9E-01	2.4E-01	no
		Lead	Lead risk evaluated seperately using IEUBK Model (Figure 2-5 and 2-6)				yes
		Manganese	NA	NA	1.7E-01	3.2E-02	no
		Mercury	NA	NA	7.4E-01	7.8E-02	no
		Nickel	NA	NA	3.9E-02	7.3E-03	no
		Silver	NA	NA	4.1E-02	2.0E-03	no
		Vanadium	NA	NA	2.8E-01	8.2E-02	no
		Zinc	NA	NA	1.3E-01	1.5E-02	no
	Exp. Route Total		1.1E-04	1.4E-05	4.6E+00	8.4E-01	
	Dermal Absorption	Benzo(a)anthracene	2.0E-06	5.1E-08	NA	NA	no
		Benzo(a)pyrene	9.4E-06	3.3E-07	NA	NA	no
		Benzo(b)fluoranthene	1.1E-06	3.8E-08	NA	NA	no
		Benzo(k)fluoranthene	1.0E-07	3.3E-09	NA	NA	no
		Dibenz(a,h)anthracene	6.9E-06	2.4E-07	NA	NA	no
		Indeno(1,2,3-cd)pyrene	7.4E-07	2.9E-08	NA	NA	no
		Heptachlor Expoxide	1.3E-07	2.8E-09	7.9E-03	2.4E-04	no
		Aluminum	NA	NA	2.7E-03	3.1E-04	no
		Antimony	NA	NA	3.3E-02	9.7E-04	no
		Arsenic	5.9E-06	3.3E-07	9.5E-02	7.3E-03	no
		Cadmium	NA	NA	4.0E-02	2.5E-03	no
		Chromium	NA	NA	2.5E-02	2.4E-03	no
		Copper	NA	NA	2.2E-02	8.7E-04	no
		Iron	NA	NA	2.2E-02	2.7E-03	no
		Lead	Lead risk evaluated seperately using IEUBK Model (Figure 2-5 and 2-6)				yes
		Manganese	NA	NA	1.2E-01	8.8E-03	no
		Mercury	NA	NA	3.0E-01	1.2E-02	no
		Nickel	NA	NA	2.8E-02	2.0E-03	no
		Silver	NA	NA	2.9E-02	5.7E-04	no
		Vanadium	NA	NA	3.0E-01	3.5E-02	no
		Zinc	NA	NA	3.5E-03	1.7E-04	no
	Exp. Route Total		2.6E-05	1.0E-06	1.0E+00	7.7E-02	
Total across all exposure routes for soil			1.4E-04	1.5E-05	5.6E+00	9.1E-01	
Future resident exposured to Groundwater	Ingestion	1,1,2,2-Tetrachloroethane	1.7E-06	5.5E-07	6.1E-04	3.7E-04	no
		Benzene	4.0E-07	1.5E-07	7.8E-03	5.6E-03	no
		Chloroform	NA	NA	3.8E-03	2.2E-03	no
		Trichloroethene	3.3E-08	2.9E-08	2.1E-03	3.5E-03	no
		Vinyl chloride	1.9E-05	4.1E-06	1.9E-02	7.8E-03	no
		2-Methylnaphthalene	NA	NA	5.6E-02	3.1E-02	no
		Butylbenzyphthalate	6.9E-07	6.7E-08	7.8E-03	1.4E-03	no
		bis(2-Ethylhexyl)phthalate	2.9E-06	3.5E-07	4.4E-02	1.0E-02	no
		Aldrin	7.7E-06	1.3E-06	6.5E-02	2.1E-02	no
		Dieldrin	7.7E-06	1.6E-06	4.1E-02	1.6E-02	no
		Heptachlor epoxide	5.5E-06	7.4E-07	2.0E-01	5.0E-02	no
		beta-BHC	7.7E-07	1.2E-07	NA	NA	no

Table 2-12
Future Resident Receptor Summary of Risks and Hazards
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

Receptor	Exposure Point/Route	Chemical of Potential Concern	RME Cancer Risk	CTE Cancer Risk	RME Non-Cancer Hazard	CTE Non-Cancer Hazard	COC
Future resident exposured to Groundwater	Ingestion	Antimony	NA	NA	1.0E+00	4.5E-01	no[1]
		Arsenic	4.7E-04	1.1E-04	4.5E+00	2.0E+00	no[3]
		Cadmium	NA	NA	2.3E-01	5.4E-02	no
		Cobalt	NA	NA	3.0E-01	2.0E-02	no
		Iron	NA	NA	8.5E+00	2.9E+00	no[2]
		Manganese	NA	NA	1.7E+00	7.2E-01	no[2]
		Nickel	NA	NA	1.8E-01	1.4E-02	no
		Selenium	NA	NA	1.4E-01	4.3E-02	no
	Exp. Route Total		5.2E-04	1.2E-04	1.7E+01	6.3E+00	
	Dermal	1,1,2,2-Tetrachloroethane	2.1E-07	4.6E-08	7.4E-05	2.5E-05	no
		Benzene	6.0E-08	1.5E-08	1.2E-03	4.5E-04	no
		Chloroform	NA	NA	3.4E-04	1.0E-04	no
		Trichloroethene	5.6E-09	3.3E-09	3.6E-04	3.2E-04	no
		Vinyl chloride	9.6E-07	1.4E-07	9.6E-04	2.1E-04	no
		2-Methylnaphthalene	NA	NA	1.2E-01	3.5E-02	no
		Butylbenzyphthalate	1.7E-06	2.7E-07	1.9E-02	6.9E-03	no
		bis(2-Ethylhexyl)phthalate	4.4E-06	3.5E-07	6.6E-02	8.2E-03	no
		Aldrin	6.9E-07	7.9E-08	5.7E-03	1.0E-03	no
		Dieldrin	5.3E-06	7.2E-07	2.8E-02	5.9E-03	no
		Heptachlor epoxide	2.6E-06	2.3E-07	9.1E-02	1.3E-02	no
		beta-BHC	8.4E-07	8.9E-08	NA	NA	no
		Antimony	NA	NA	4.6E-02	5.9E-03	no
		Arsenic	2.7E-06	2.6E-07	3.0E-02	4.0E-03	no
		Cadmium	NA	NA	3.0E-02	2.1E-03	no
		Cobalt	NA	NA	3.7E-05	1.6E-05	no
		Iron	NA	NA	5.2E-05	5.7E-03	no
		Manganese	NA	NA	2.1E+01	3.6E-02	no[1]
		Nickel	NA	NA	2.8E-01	1.4E-04	no
		Selenium	NA	NA	9.7E-04	8.5E-05	no
	Exp. Route Total		1.9E-05	2.2E-06	2.2E+01	1.2E-01	
	Inhalation	1,1,2,2-Tetrachloroethane	3.7E-06	--	--	--	no
		Benzene	8.4E-07	--	--	--	no
		Chloroform	2.6E-06	--	--	--	no
		Trichloroethene	6.4E-08	--	--	--	no
		Vinyl chloride	1.9E-06	--	--	--	no
		2-Methylnaphthalene	NA	--	--	--	no
	Exp. Route Total		9.1E-06	--	--	--	
Total across all exposure routes for groundwater			5.5E-04	1.2E-04	3.9E+01	6.5E+00	
Total across all media all expousre routes			6.9E-04	1.4E-04	4.4E+01	7.4E+00	

Note:
Shaded cells indicate RME or CTE risk or hazard above EPA's acceptable levels

[1] - RME risk or hazard exceeds EPA's Acceptable level, but CTE risk or hazard is below target threshold of 1

[2] - RME and CTE hazard exceeds EPA's target risk level of 1, but these constituents are essential human nutrients and risks are therefore considered acceptable.

[3] - Following stastical analysis of arsenic in groundwater, this constituent was determined to be naturally occuring and not site related and therefore was not retained as a COC.

TABLE 2-13
Descriptions of Alternatives
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

Alternative	Components	Details	Cost
1—No Action	Existing Site 10 Area	Not Applicable	Capital Cost $0 Annual O&M $0 Present-Worth $0 Time Frame >70 years
2 – Institutional Contols	- Land Use Controls (LUCs)	- Survey Plat/Deed Restriction - Remedial Design for LUCs - Annual Integrity Inspections - Statutory remedy 5-year reviews	Capital Cost $10,000 Annual O&M $1,272 Present-Worth $58,000 Time Frame 30 years
3 – Soil Excavation, Backfill, and Site Restoration	- Soil excavation backfill and site restoration (326,000 cy)	- Soil and Debris excavation - Non-hazardous assumption - TCLP testing for every 1,000 cy - Transportation and disposal	Capital Cost is estimated to exceed $35,000,000 for transportation and disposal only; additional costs were not quantified.

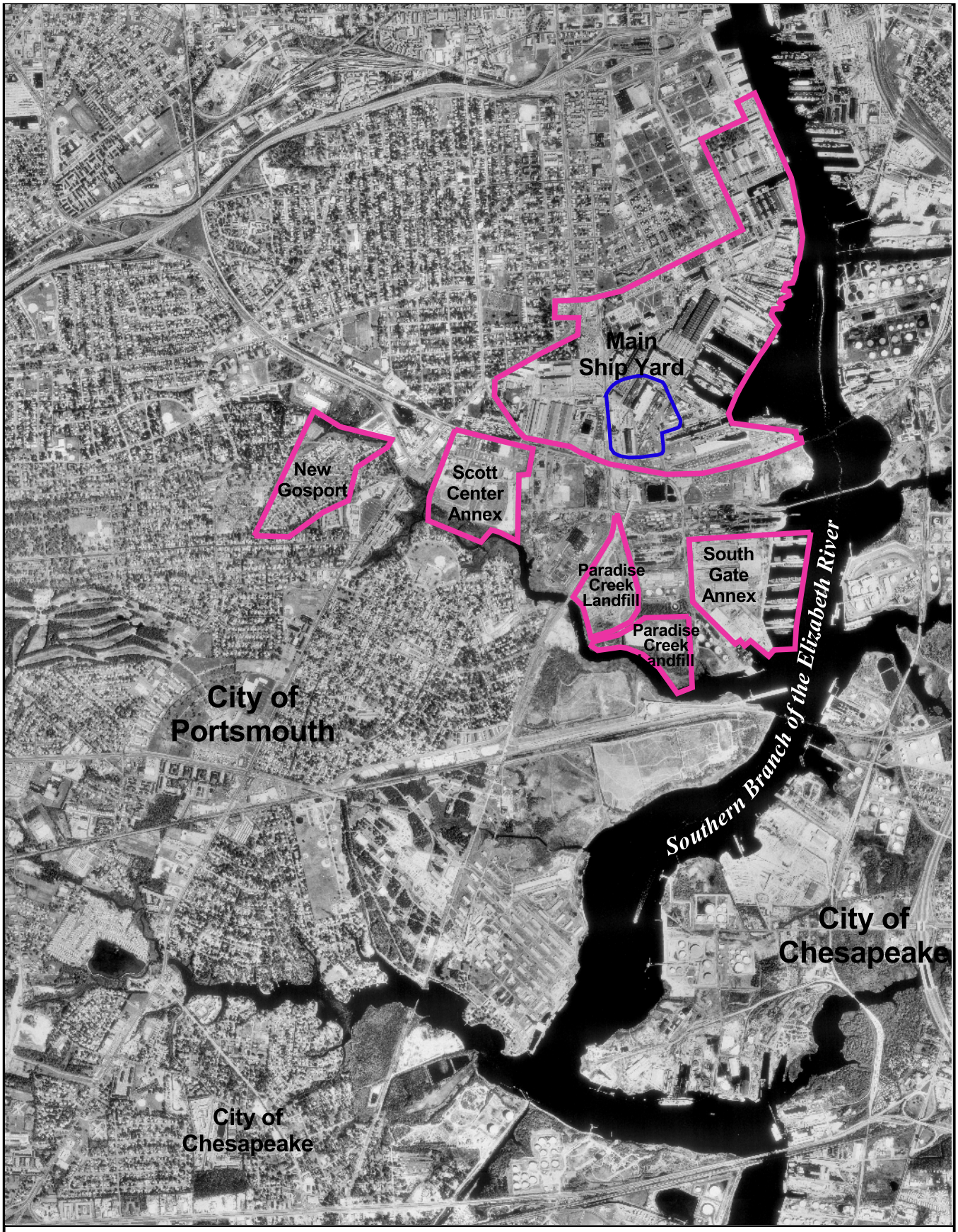
TABLE 2-14

Comparative Analysis of Alternatives
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

	Alternative 1 (No Action)	**Alternative 2 (Institutional Controls)**	**Alternative 3 (Soil Excavation, Backfill, Site Restoration)**
Overall Protection of Human Health / Environment	Not Effective	Effective	Effective
Compliance with ARARs	Not Compliant	Compliant	Compliant
Long Term Effectiveness and Permanence	Not Effective	Effective	Effective
Reduction of Toxicity, Mobility, or Volume	None	None	Moderate
Short Term Effectiveness	Effective under current land use	Effective	Effective
Implementability	Feasible	Feasible	Very difficult
Cost	None	Low	Exorbitant

Figures

File Path: v:\18gis\st-juliens\figures\sites3-6_ri.apr



LEGEND

Norfolk Naval Shipyard and Navy Annexes

Site 10

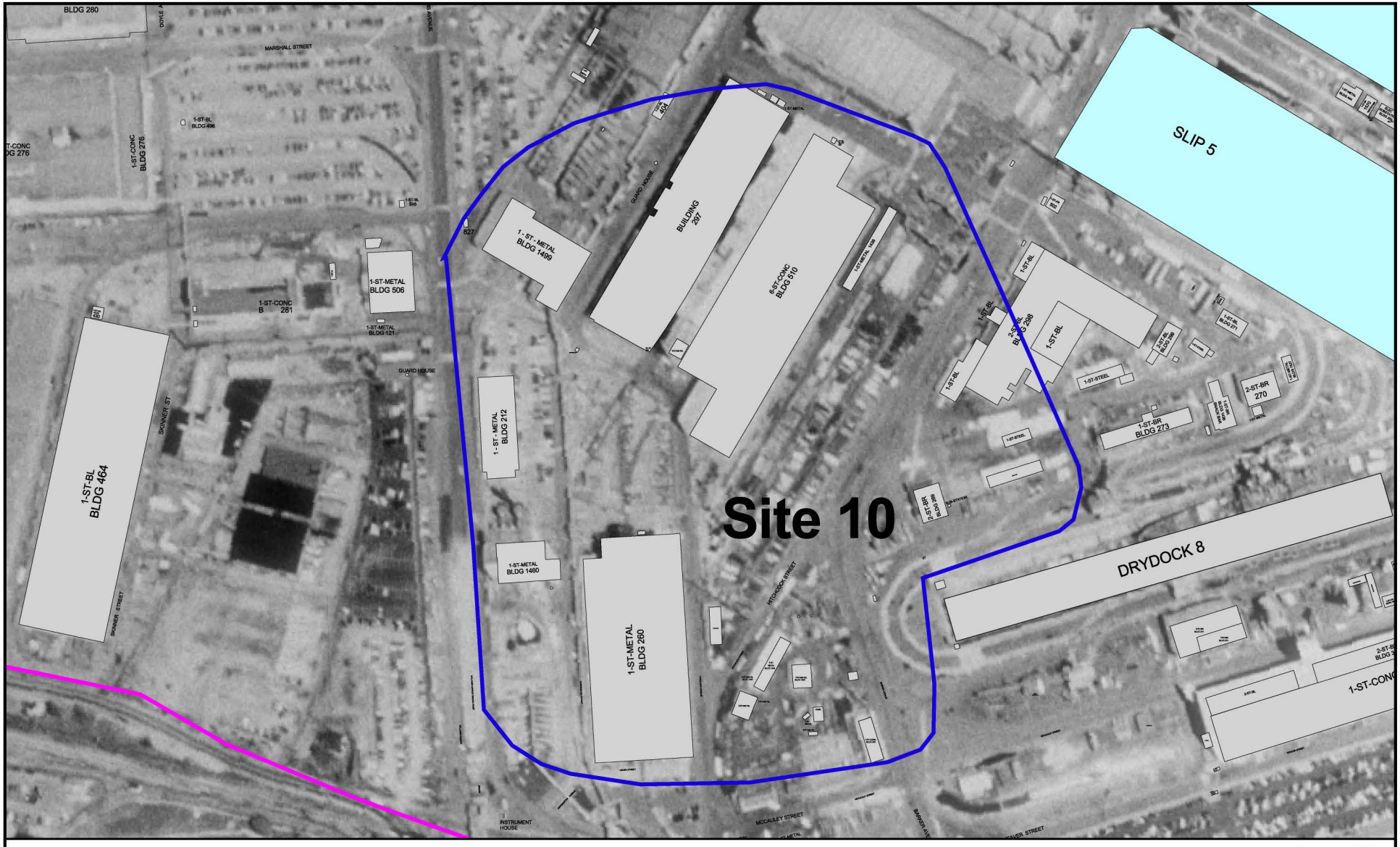
N

0 3000 6000 Feet

Figure 2-1
Location Map
Site 10 ROD
Norfolk Naval Shipyard
Portsmouth, Virginia

CH2MHILL

\\ariadne\proj\18gis\nnsy\figures\nnsy_site10.apr



LEGEND

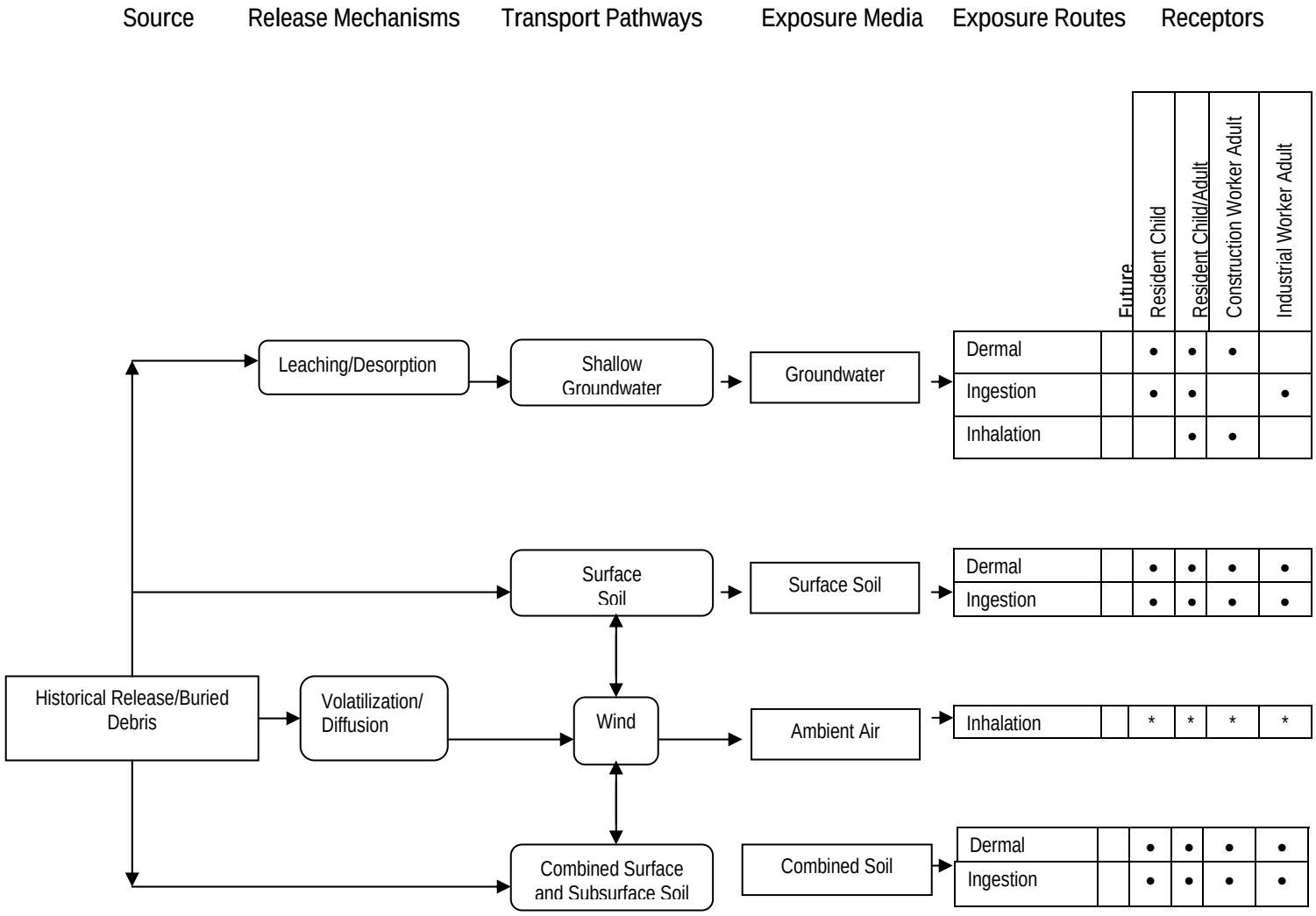
- Base Boundary
- Landfill Limits

N

0 300 600 Feet

Figure 2-2
Site Boundary and Vicinity
Site 10 ROD
Norfolk Naval Shipyard
Portsmouth, Virginia

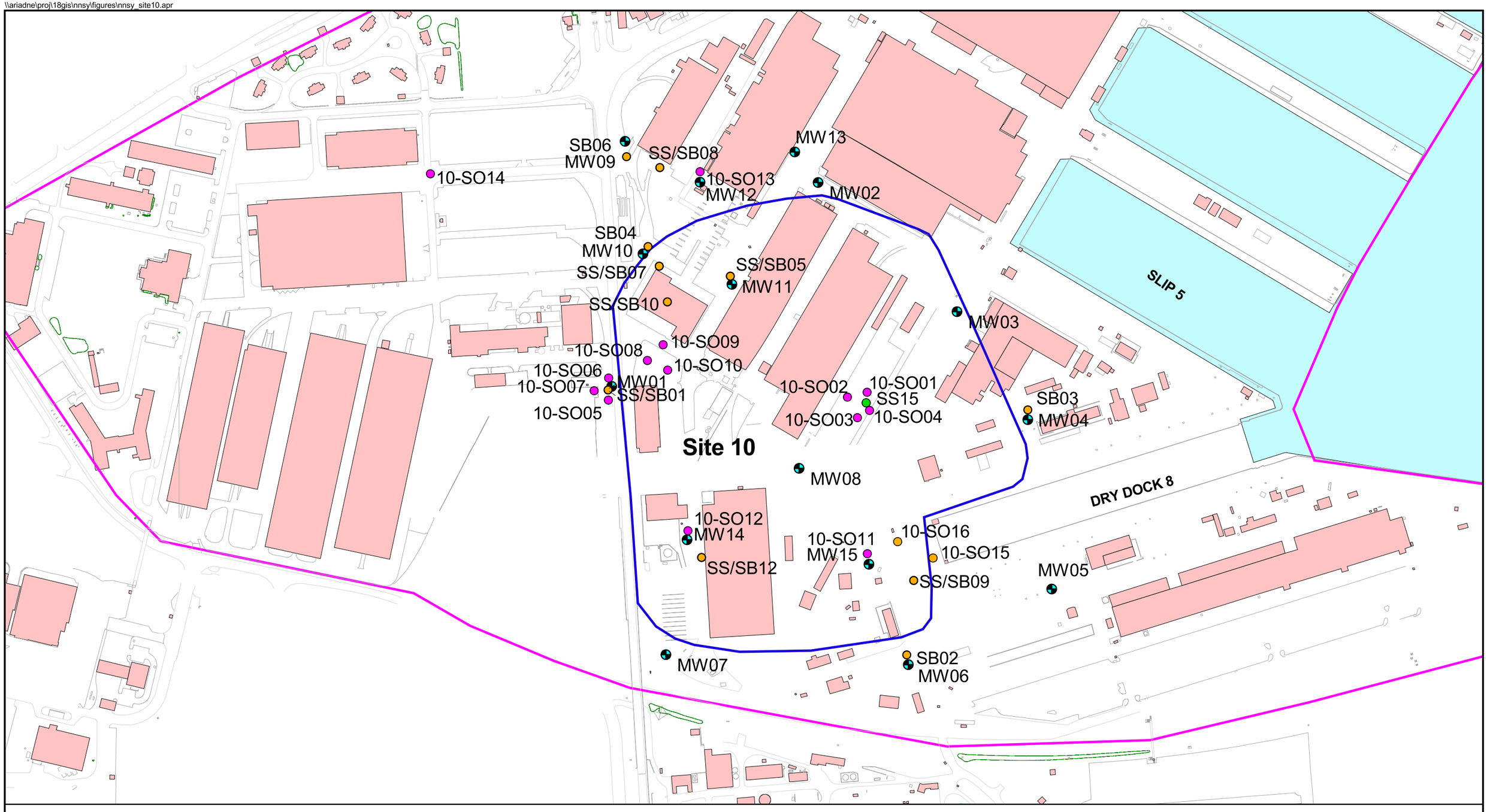
CH2MHILL



*Evaluated qualitatively in HHRA

FIGURE 2-3
CONCEPTUAL SITE MODEL
Site 10 Record of Decision
Norfolk Naval Shipyard
Portsmouth, Virginia

\\ariadne\proj\18gis\nnsy\figures\nnsy_site10.apr



LEGEND

- Base Boundary
- Site 10
- Monitoring Wells
- Surface and Subsurface Soil Sampling Locations
- Surface Soil Sampling Locations
- Subsurface Soil Sampling Locations

N

0 300 600 Feet

Notes:
-Samples were collected during two separate events.
-The Site Screening Process was conducted in 2001, and the Supplemental Site Investigation was conducted in 2004.

Figure 2-4
Soil and Groundwater Sample Locations
Site 10 ROD
Norfolk Naval Shipyard
Portsmouth, Virginia

CH2MHILL

Figure 2-5
Future Industrial Worker Exposure to Lead in Surface Soil
Calculations of Blood Lead Concentrations (PbBs)
U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 8/14/01

Exposure Variable	PbB Equation[1] 1*	2**	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1 GSDi = 1.9	Using Equation 1 GSDi = 2.3	Using Equation 2 GSDi = 1.9	Using Equation 2 GSDi = 2.3
PbS	X	X	Soil lead concentration	ug/g or ppm	741	741	741	741
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.9	2.3	1.9	2.3
PbB_0	X	X	Baseline PbB	ug/dL	1.4	1.8	1.4	1.8
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050	0.050	--	--
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	0.050	0.050
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	1.0	1.0
K_{SD}		X	Mass fraction of soil in dust	--	--	--	0.7	0.7
$AF_{S,D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{S,D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	219	219	219	219
$AT_{S,D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PbB_{adult}	**PbB of adult worker, geometric mean**			**ug/dL**	**2.5**	**2.9**	**2.5**	**2.9**
$PbB_{fetal,\ 0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**6.4**	**10.2**	**6.4**	**10.2**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**	**10.0**	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**			**%**	**1.0%**	**5.2%**	**1.0%**	**5.2%**

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}).
When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same $PbB_{fetal,0.95}$.

***Equation 1, based on Eq. 1, 2 in USEPA (1996).**

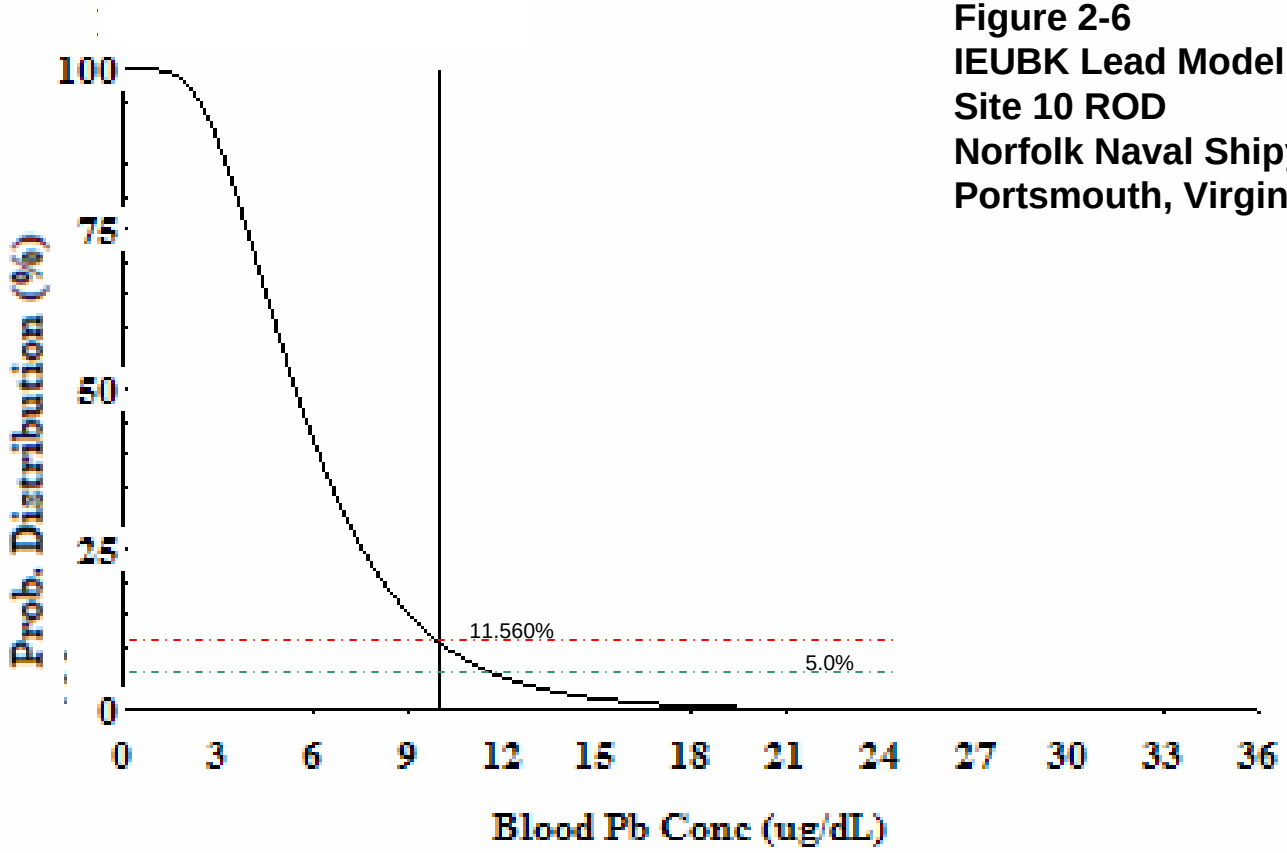
PbB_{adult} =	$(PbS*BKSF*IR_{S+D}*AF_{S,D}*EF_S/AT_{S,D}) + PbB_0$
$PbB_{fetal,\ 0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

****Equation 2, alternate approach based on Eq. 1, 2, and A-19 in USEPA (1996).**

PbB_{adult} =	$PbS*BKSF*([(IR_{S+D})*AF_S*EF_S*W_S]+[K_{SD}*(IR_{S+D})*(1-W_S)*AF_D*EF_D])/365+PbB_0$
$PbB_{fetal,\ 0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Figure 2-6
IEUBK Lead Model Output for Future Residents
Site 10 ROD
Norfolk Naval Shipyard
Portsmouth, Virginia



Cutoff = 10.000 ug/dl
Geo Mean = 5.709
GSD = 1.600
% Above = 11.650

Age Range = 0 to 84 months
Time Step = Hourly
Run Mode = Site Risk Assessment

The IEUBK evaluation resulted in a geometric mean blood concentration of 5.7 µg/dL for children 0 to 84 months old. EPA considers lead in soil not to be a health concern if less than 5 percent of the population has a blood-lead level greater than 10 µg/dL. According to the model output for Site 10, 11.650 percent of the population would have a blood level greater than EPA's recommended level of 10 µg/dL Therefore, lead is retained as a COC in site soil.

Appendix A
Federal and State ARARs

Table A-1
Federal Chemical-Specific ARARs for Alternative 2 – Land Use Controls
Site 10, NNSY

Requirement	Prerequisite	Citation	ARAR Determination	Comment
EPA Region III RBC Tables*				
Chemical concentrations corresponding to fixed levels of human health risk (i.e., a hazard quotient of 1, or lifetime cancer risk of 10^{-6}, whichever occurs at a lower concentration).	Assessment of potential human health risks.	EPA Region III RBC Tables	TBC	Residential risk is assumed; therefore, remedial action clean up goals are not established. Residential RBCs for soil are TBC guidance should the Navy consider use of the property for any unrestricted use or unlimited exposure, if such use is in accordance with this ROD and CERCLA.

There are no Federal Location-Specific, Virginia Location-Specific, Federal Action-Specific, Virginia Action-Specific, or Virginia Chemical-Specific ARARs for Alternative 2.

ARAR – Applicable or relevant and appropriate requirement

EPA – Environmental Protection Agency

RBC- Risk-Based Concentration

TBC – To be considered