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PROPOSED PLAN SITE 3 NWS YORKTOWN VA
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NAVFAC MIDLANT

NAVFAC Naval Facilities Engineering Command

Proposed Plan – Site 3
Naval Weapons Station Yorktown
Yorktown, Virginia
May 2014

1. Introduction

This **Proposed Plan**[1] describes the preferred alternatives for **groundwater**, surface water and sediment at **Environmental Restoration Program (ERP)** Site 3, the Group 16 Magazines Landfill, located on Naval Weapons Station (WPNSTA) Yorktown, in Yorktown, Virginia. A **Record of Decision (ROD)** was signed for soil at Site 3 in 1999 and was amended to document No Further Action in an **Explanation of Significant Difference (ESD)** signed in 2008. The preferred alternative for **sediment** and **surface water** is No Action (NA). The preferred alternative for groundwater consists of the following five components:

1) Refining the **conceptual site model (CSM)** through a pre-design investigation to verify groundwater characteristics; 2) Implementing **Enhanced In-Situ Bioremediation (EISB)** of trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC) through the injection of an **electron donor** and a **microbial culture** into the area of highest concentration in order to accelerate the time for achieving remedial goals (RGs); 3) Conducting **Monitored Natural Attenuation (MNA)** of TCE, cis-1,2-DCE, and VC following active treatment; 4) Monitoring of arsenic and manganese concentrations to verify that levels do not increase over the current acceptable concentrations; (if levels increase a **contingency remedy** may be considered); and, 5) Implementing **Land Use Controls (LUCs)** to prohibit groundwater use and to prohibit residential use of the site until such time as contaminants in groundwater are at levels that allow for unlimited use and unrestricted exposure; and to restrict any intrusive activity, such as digging, to authorized personnel.

This Proposed Plan also summarizes the other remedial alternatives that were evaluated for groundwater and the rationale for the proposal of the preferred alternative for groundwater. The NA alternative for sediment and surface water is being proposed following completion of the 2012 **Remedial Investigation (RI)**, which demonstrated that these media pose no unacceptable risks to human health or ecological **receptors**. Because there are no unacceptable risks at the site from exposure to sediment and surface water, evaluation of other remedial action alternatives for these media is not necessary.

This Proposed Plan is issued jointly by the U.S. Navy (Navy), the lead agency for site activities, and the **U.S. Environmental Protection Agency (USEPA)** Region 3, the lead regulatory agency, in consultation with the **Virginia Department of Environmental Quality (VDEQ)**, the support regulatory agency.

Mark Your Calendar for the Public Comment Period

Public Comment Period
May 12, 2014 to June 26, 2014

Submit Written Comments

The Navy, USEPA, and VDEQ will accept written comments on the Proposed Plan during the public comment period. To submit comments or obtain further information, please refer to the comment page located at the end of this Proposed Plan.

Attend the Public Meeting

May 15, 2014 at 3:00 p.m.

Yorktown Public Library
8500 George Washington Memorial Highway
Yorktown, Virginia

(757) 890-5207

The Navy will hold a public meeting to explain the Proposed Plan. Verbal and written comments will be accepted at this meeting.

Location of Administrative Record File:

http://go.usa.gov/DynG
Internet access is available at the: Yorktown Public Library 8500 George Washington Memorial Highway, Yorktown, Virginia

[1] A glossary of key terms is provided at the end of this Proposed Plan; terms included in the glossary are identified in bold print the first time they appear.

This Proposed Plan will be available for public review and comment at the York County Public Library – Yorktown (8500 George Washington Memorial Highway, Yorktown, Virginia 23692, (757) 890-5207) during a 45-day **public comment period** that includes a public meeting and that fulfills community participation responsibilities as required under Section 117(a) of the **Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)**, as amended, and Section 300.430(f)(2) and (3) of the **National Oil and Hazardous Substances Pollution Contingency Plan (NCP)**. The Navy and USEPA Region 3, in consultation with VDEQ, will make the final decision on this plan for Site 3 groundwater after reviewing and considering all information submitted during the 45-day public comment period.

In addition to presenting the preferred alternatives for Site 3 surface water, sediment, and groundwater, this Proposed Plan summarizes the findings of previous CERCLA investigations that have been conducted for these media at Site 3. Information documenting all environmental investigations at Site 3 is available to the public in the **Administrative Record (AR)** file for WPNSTA Yorktown which can be accessed at http://go.usa.gov/DynG. Details regarding the dates of the public comment period, the date and time of the public meeting, and the location of the AR are included in the text box entitled "Mark Your Calendar" on the first page of this Plan.

2. Site Background

Site 3, the Group 16 Magazines Landfill, is a two-acre wooded area behind the former Group 16 Magazines, located in the northern portion of WPNSTA Yorktown, west of Indian Field Creek and south of Site 1 (**Figure 1**). North and south of Site 3 are two unnamed tributaries that lead into Indian Field Creek.

Site 3 is named for its proximity to the former Group 16 Magazines; however, the history of this landfill is unrelated to operations at the Magazines. The site was originally used for sand mining and consisted of one 10-foot deep **borrow pit**. Between 1940 and 1970, Site 3 was operated as a landfill. Approximately 90 tons of waste were disposed of in the borrow pit and reportedly included **solvents**, sludge from boiler cleaning operations, grease trap wastes, Imhoff tank skimmings (containing oil and grease), and animal carcasses. Test pit investigations performed in 1997 confirmed the presence of scrap metal, 55-gallon metal drums, grease, wax, lumber, banding, concrete blocks, plastic sheeting, and other debris. A ROD was signed in 1999 to remove the waste and contaminated soil from Site 3. Following the completion of the removal action, conducted later that year, it was determined that soil posed no unacceptable risk from **unlimited use and unrestricted exposure** and no further action was necessary for Site 3 soil. An ESD, documenting the amendment to the selected remedy in the ROD was signed in 2008. The 2012 RI documented no unacceptable risk from **unlimited use and unrestricted exposure** to sediment and surface water; therefore, NA is required for these media as documented in the AR and this Proposed Plan.

2.1 Previous Groundwater Investigations and Actions

Site 3 environmental media have been characterized as part of several investigations since 1984. Detailed information from these investigations is available in the AR for WPNSTA Yorktown, and the pertinent reports are shown in **Table 1**. The investigations related to only groundwater, surface water, and sediment at Site 3 are summarized in the paragraphs below.

Initial Assessment Study (IAS) (NEESA, 1984)

The IAS was conducted to identify sites posing a potential threat to human health or the environment because of prior waste management activities. The IAS concluded that because contaminant migration pathways to groundwater and surface water were present at Site 3, sampling would be required to document the presence of contamination and determine the need for further characterization and/or remediation.

Confirmation Study Round I and II (Dames & Moore, 1986 and 1988)

In 1986 and 1988, groundwater, surface water, and sediment samples were collected at Site 3 to verify the presence or absence of contamination. These investigations indicated that TCE concentrations were above federal **Maximum Contaminant Levels (MCLs)** in groundwater. No further site investigations were recommended in the final Confirmation Study Round II.

Remedial Investigation Interim Report (Versar, 1991)

This report presented no new data, but summarized and evaluated existing data from the Confirmation Studies and, based on these data evaluations, provided recommendations for additional efforts to be conducted to complete an RI. The Interim Report recommended additional investigation activities consisting of groundwater, surface water and sediment sampling, a hydrogeologic investigation, a site boundary survey, and a risk assessment.

Remedial Investigation – Round One (Baker and Weston, 1993)

Soil, groundwater, surface water, and sediment samples were collected in 1992 during the Round One RI. The results indicated the presence of TCE and other chlorinated **volatile organic compounds (VOCs)** and metals in groundwater. Metals were also detected in surface soil and sediment. The Round One RI recommended that further groundwater investigation be conducted at Site 3 to evaluate potential seasonal variation of TCE concentrations. It was also recommended that a geophysical investigation be conducted to define the boundaries of waste disposal. Further investigation of surface water or sediment was not recommended.

Figure 1 - Site 3 Location Map

Table 1 - Documents Pertaining to Groundwater Investigations at Site 3

Document Title/Milestone	Aurthor/Date	AR Document Number
Initial Assessment Study of Naval Supply Center (Norfolk) Cheatham Annex and Yorktown Fuels Division	NEESA, 1984	00247
Confirmation Study Step IA (Verification), Round One, Naval Weapons Station Yorktown	Dames & Moore, 1986	00256 and 00135C
Confirmation Study Step IA (Verification), Round Two, Naval Weapons Station Yorktown	Dames & Moore, 1988	00259
Final Remedial Investigation Interim Report, Fleet and Industrial Supply Center (Norfolk), Cheatham Annex	Versar, 1991	00812
Final Round One Remedial Investigation Report for Sites 1-9, 11, 12, 16-19, and 21, Naval Weapons Station Yorktown	Baker and Weston, 1993	00313
Final Round Two Remedial Investigation Report for Sites 1 and 3, Naval Weapons Station Yorktown	Baker, 1998	00998-00999
Phase I Remedial Investigation Report for Groundwater at Sites 1, 3, 6, 7, 11, 17, 24, and 25, Naval Weapons Station Yorktown	CH2M HILL, 2007	002158
Explanation of Significant Differences for Site 3, Naval Weapons Station Yorktown	CH2M HILL, 2008	002351
Final Phase II Remedial Investigation Report, Sites 1 and 3, Naval Weapons Station Yorktown	CH2M HILL, 2012	002631-002633
Feasibility Study Report for Groundwater at Site 3, Naval Weapons Station Yorktown	CH2M HILL, 2014	Pending

Remedial Investigation – Round Two (Baker, 1998)

During the Round Two RI, surface soil, subsurface soil, sediment, surface water, and groundwater samples were collected. The results of the Round Two RI indicated the presence of chlorinated VOCs and metals in groundwater, metals in sediment and surface water, and semi-volatile organic compounds (SVOCs) and metals in surface and subsurface soil. The Round Two RI recommended removal of a surface soil SVOC "hot spot" at Site 3 and that land use controls (LUCs) be implemented to restrict the use of groundwater from the Columbia and Yorktown aquifers as a potable water source.

The Navy, in partnership with the USEPA Region 3 and VDEQ, agreed to proceed with evaluating remedial alternatives for soil while an alternatives evaluation for groundwater, surface water and sediment was postponed pending the results of further investigation.

Phase 1 Remedial Investigation (CH2M HILL, 2007)

In 2004, groundwater samples were collected to assess the nature and extent of groundwater contamination. The primary contaminants identified at Site 3 were TCE and its associated biodegradation daughter products. However, the extent of contamination could not be fully defined based on the data that had been collected to date. As a result, it was recommended that **membrane interface probe (MIP)** and **Direct Push Technology (DPT)** be used in conjunction with additional groundwater sampling to vertically and horizontally delineate the extent of VOCs in groundwater. In addition, groundwater/ surface water interface sampling was recommended.

Phase 2 Remedial Investigation (CH2M HILL, 2012)

In September 2009, MIP and DPT investigations, groundwater sampling, hydraulic conductivity testing, and surface water, sediment, and sediment pore-water sampling were completed.

Results of the Phase 2 RI indicated that VOC contamination was widespread across the site and contributes to unacceptable risk to multiple receptors due to elevated concentrations in groundwater. Manganese and arsenic were also present in groundwater at levels posing unacceptable risks to future residential receptors adjacent to Indian Field Creek, and total petroleum hydrocarbons (TPH) within the diesel range were present in soil between 15 and 19 feet below the ground surface, but do not pose quantifiable human health or ecological risks.

The Phase 2 RI report concluded that remedial action is necessary to address TCE, cis-1,2-DCE, VC, arsenic, and manganese in groundwater at the site. No human health or ecological risks were identified for exposure to surface water, sediment, or sediment pore water.

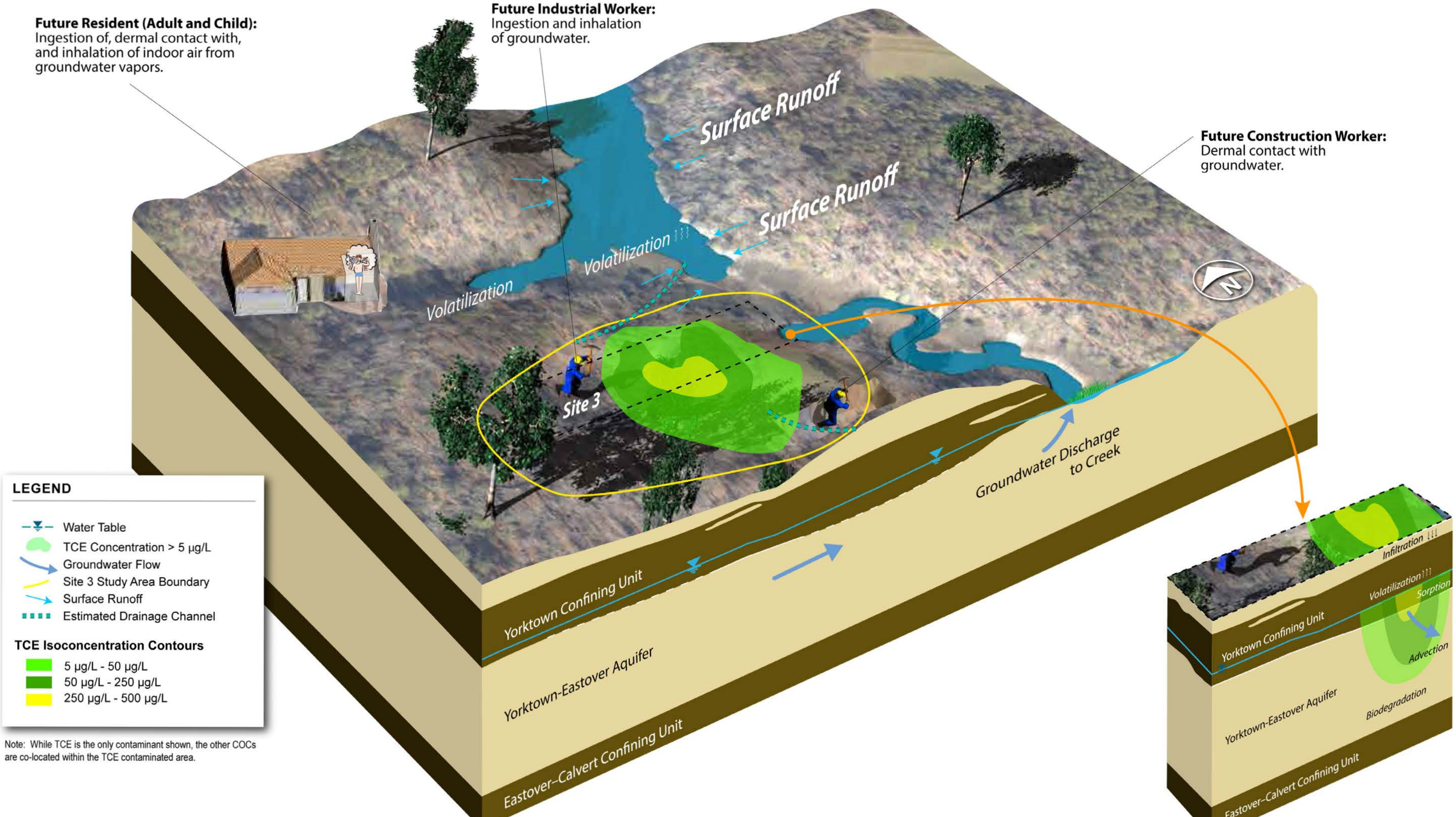
Feasibility Study Report for Groundwater at Site 3 (CH2M HILL, 2014)

The Feasibility Study (FS) evaluated alternatives for remediation of TCE, cis-1,2-DCE, VC, arsenic and manganese present at levels posing unacceptable human health risks in groundwater. The preferred alternative identified in the FS is Alternative 3: Refinement of the conceptual site model through a pre-design investigation to verify groundwater characteristics; Remediation of TCE, cis-1,2-DCE, and VC using EISB and associated performance monitoring; MNA of TCE, cis-1,2-DCE, and VC; monitoring of arsenic and manganese; and LUCs.

3. Site Characteristics

A Conceptual Site Model is a graphical representation of the relevant information available to illustrate what is known about a contaminated site, including site conditions, contaminant distribution, potential receptors, exposure pathways and land use. The Conceptual Site Model for Site 3 is depicted in **Figure 2**. Site 3 is generally grassy and surrounded by woods.

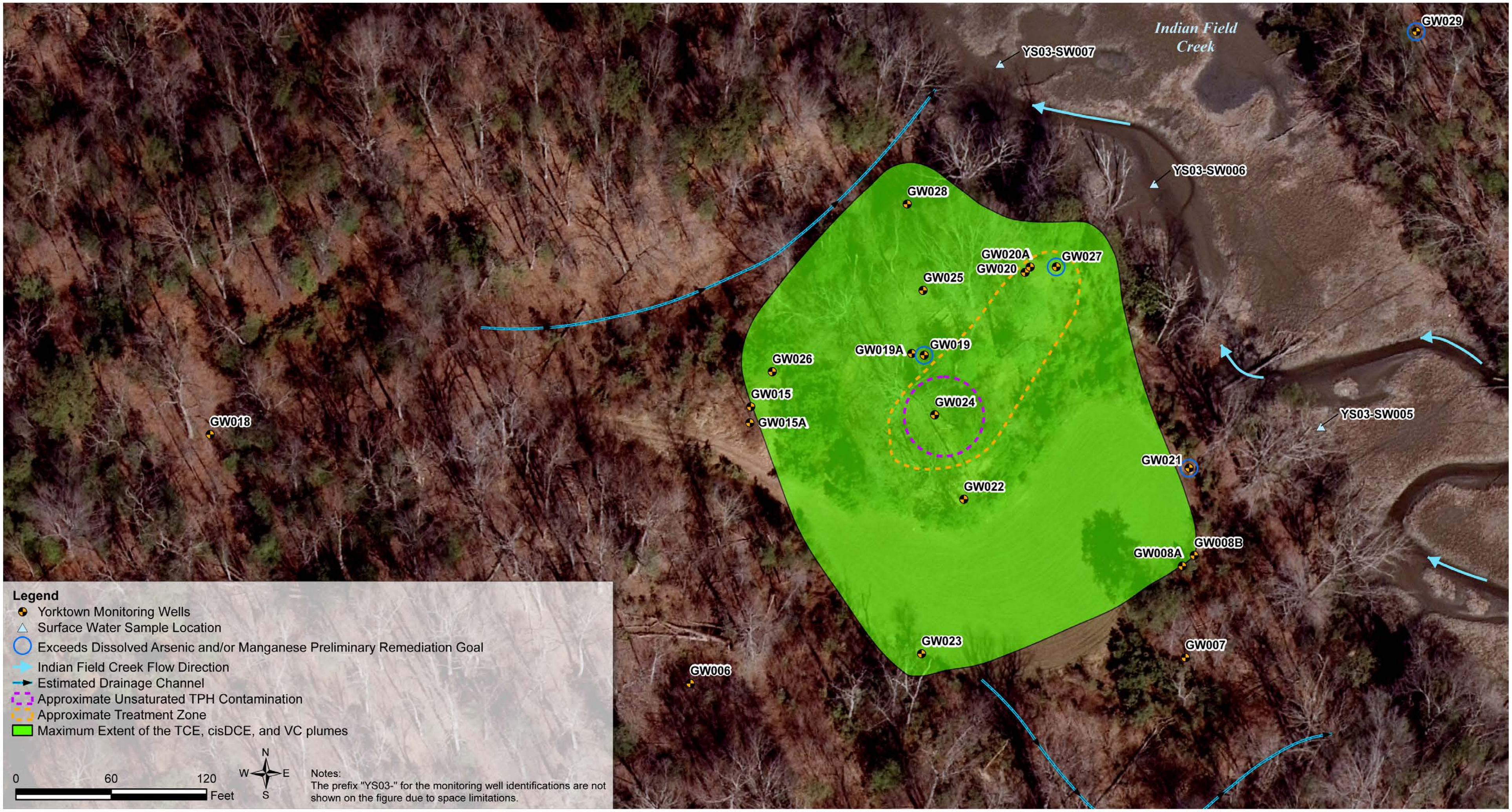
Figure 2 - Conceptual Site Model



Note: While TCE is the only contaminant shown, the other COCs are co-located within the TCE contaminated area.

Figure 2 Conceptual Site Model

Figure 3 - Groundwater Contamination



The topography slopes to the northeast, with steeper slopes adjacent to Indian Field Creek and the unnamed tributary to Indian Field Creek along the northern border of the site. Surface water runoff generally follows the topography and flows toward Indian Field Creek.

The surface **geology** at Site 3 is lithologically consistent with the Yorktown **confining unit**. Groundwater is first encountered at the site within the Yorktown-Eastover aquifer, which extends between 20 and 40 feet below the confining unit. The aquifer is confined except in low-lying areas adjacent to the creek, where the Yorktown confining unit is missing. Based on a United States Geological Survey study conducted at WPNSTA Yorktown (Brockman et al., 1997), the Yorktown-Eastover aquifer may be up to 80 feet thick. The Yorktown-Eastover aquifer is underlain by the approximately 100- to 200-foot-thick Eastover-Calvert confining unit. This confining unit was not encountered in the deepest boring at the site, which extended to a depth of approximately 80 feet bgs. Groundwater generally flows eastward towards Indian Field Creek.

There is no current or expected future use of groundwater as a potable water supply at Site 3. Drinking water is supplied to WPNSTA Yorktown and the surrounding area by the City of Newport News Waterworks.

3.1 Nature and Extent of Groundwater Contamination

The VOC plume generally occurs beneath the former landfill area and extends 250 to 300 feet toward Indian Field Creek. The plume is present within the uppermost portion of the Yorktown-Eastover aquifer (top 35 feet). TCE is the most extensive VOC in groundwater with smaller contributions from cis-1,2-DCE and VC. Historically, the highest concentration detected at the site was 860 micrograms per liter (µg/L) at monitoring well GW019 in 1996. During the more recent 2009 Phase II RI sampling event, the maximum concentration of TCE in groundwater was 400 µg/L at GW024, which exceeds both the USEPA tapwater Regional Screening Level (RSL) and the federal MCL (2 µg/L and 5 µg/L, respectively). **Figure 3** presents the maximum horizontal extent of the VOC plume beneath Site 3. Arsenic and manganese were the only metals observed above screening criteria. Dissolved arsenic was detected above its RSL of 0.045 µg/L and MCL of 10 µg/L in two downgradient wells – 34.7 µg/L at GW021 and 25.8 at GW029. GW029 is located on the eastern side of Indian Field Creek, whereas Site 3 is located on the western side of the creek; therefore, GW029 is not influenced by a potential release from Site 3. Because shallow groundwater discharges into the creek, the groundwater flow direction at GW021 flows to the east towards the creek and at GW029 likely flows to the west towards the creek. The elevated arsenic concentrations are likely due to reducing conditions near wetlands rather than the result of site activities. Dissolved manganese was detected above 320 milligrams per liter (mg/L), which exceeds the RSL of 88 µg/L, in three downgradient monitoring wells (GW019A, GW021, and GW027); the highest concentration was detected in GW021 at 1,260 µg/L. Two of these monitoring wells (GW021 and GW027) were also located close to Indian Field Creek **(Figure 3)** and detections are considered to reflect natural conditions associated with dissolution from aquifer soils under reducing conditions.

Maximum detected groundwater concentrations for constituents of potential concern are provided in **Table 2**.

Table 2 – Maximum Detected Concentrations for Constituents of Concern (2009) VOCs

VOCs	Concentration (µg/L)
Trichloroethene	400
cis-1,2-Dichloroethene	1,400
Vinyl Chloride	1,200
Metals	**Concentration (µg/L)**
Arsenic (dissolved)	34.7
Manganese (dissolved)	1,260

µg/L – micrograms per liter

3.2 Fate and Transport of Contamination

The primary source of contamination at Site 3 was attributed to leaching of contaminants from the buried wastes in the landfill into the subsurface soil which ultimately created a **dissolved-phase groundwater VOC plume** (TCE, cis-1,2-DCE and VC). The primary mechanism for reductions in chlorinated VOC concentrations under naturally-occurring conditions is degradation. Analytical data indicate that the site exhibits reducing conditions, which are ideal for the biodegradation of chlorinated VOCs. The presence of the TCE biodegradation daughter products cis-1,2-DCE and VC are further evidence that natural biodegradation is occurring at the site. Since all contaminated soil and waste was excavated and disposed of offsite between 1999 and 2000, contaminant concentrations in the shallow groundwater are expected to continue to decrease via natural degradation in the future because no ongoing source is present and there is no potential future release mechanism.

3.3 Principal Threats

"**Principal threat wastes**" are source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should the potential for exposure exist. The contaminated soil and waste has been removed from the site. Contaminated groundwater generally is not considered to be a source material, and the chlorinated VOC concentrations found at Site 3 are not indicative of the presence of **dense non-aqueous phase liquid (DNAPL)**. Therefore, the groundwater at Site 3 is not considered to be a principal threat waste.

4. Scope and Role of Response Action

WPNSTA Yorktown was placed on the **National Priorities List (NPL)** in October 1992. A **Federal Facility Agreement (FFA)**, signed in 1994, identified 16 Sites for remedial investigation and 19 site screening areas (SSAs) for the **Site Screening Process (SSP)**. Subsequent to the FFA, six additional SSAs were identified for consideration under CERCLA. A summary of how the Navy, in partnership with USEPA Region 3 and VDEQ, is addressing all CERCLA sites at WPNSTA Yorktown is provided in the Site Management Plan, which is updated annually and available in the AR file.

The Alternatives for groundwater presented in this Proposed Plan (other than No Action) were developed to mitigate all potential unacceptable risks to human health and the environment from groundwater at Site 3, and the preferred alternative is intended to be the final remedy for groundwater at the site. Because there are no unacceptable risks associated with unlimited use and unrestricted exposure to soil, surface water, and sediment at Site 3, as documented in the RI (surface water and sediment) and in the 1999 ROD, as amended in the 2008 ESD (soil), a groundwater remedial action represents the final action for Site 3.

5. Summary of Site Risks

The Navy and USEPA Region 3, in consultation with VDEQ, agree that a remedial action is necessary to protect human health from actual or threatened exposure to TCE, cis-1,2-DCE, VC, arsenic, and manganese in the shallow groundwater at Site 3. Results of the human health and ecological risk assessments conducted for groundwater at Site 3 are presented in the 2012 RI report and are summarized below. General information regarding how human health and ecological risk evaluations are conducted is provided in text boxes within this section.

A **Human Health Risk Assessment (HHRA)** evaluated the potential risks for current and future site use (see, "What is Human Health Risk and How is it Calculated?") associated with current and hypothetical future receptors and the scenarios under which they could potentially be exposed to contamination if no remedial action were implemented. Site 3 is located within a restricted area of WPNSTA and is secured with a locked gate. In addition, the site is located inside an area encumbered by the restrictions imposed through the delineation of an Explosives Safety Quantity Distance (ESQD) which limits activities that can be performed within the ESQD. The site is currently open land, used for hunting during the deer and turkey hunting seasons. Based upon current site use and conditions, there are no complete **exposure pathways** for groundwater at Site 3. Current potential receptors for surface water and sediment are adult and child trespassers who could be exposed through dermal contact or ingestion. The hypothetical future receptors for groundwater are construction and industrial workers, adult and child residents, and lifetime residents. Potential groundwater exposure routes are ingestion; dermal contact; and inhalation, through showering or breathing indoor air. The future residential land use scenario evaluated in this assessment is very conservative because it assumes that land use will change in the future to allow residential development. Even if residential land use occurred, it is unlikely that the Yorktown-Eastover aquifer groundwater would be used as a potable water supply because of the availability of existing water supplies which are better with respect to both water quality and quantity.

Health risks are based on a conservative estimate of the potential **cancer risk** and the potential to cause other health effects not related to cancer (**non-cancer hazard**, or **hazard index [HI]**). USEPA identifies an acceptable cancer risk range of 1 in 10,000 (10^{-4}) to 1 in 1 million (10^{-6}) and an acceptable non-cancer hazard as an HI of less than or equal to 1.

TCE, cis-1,2-DCE, VC, arsenic, and manganese were identified as potential human health **Chemicals of Concern (COCs)** within the Yorktown-Eastover aquifer at Site 3 under future resident, industrial worker, and construction worker exposure scenarios. No potential current or future unacceptable human health risks associated with sediment or surface water were identified.

Using conservative assumptions (**Reasonable Maximum Exposure** [**RME**] scenario), the HHRA for Site 3 determined that potential risks to future adult and child residents and future industrial workers exposed to groundwater at Site 3 exceeded the acceptable non-carcinogenic HI of 1 and the carcinogenic risk range of 10^{-6} to 10^{-4} (**Table 3**). The future construction worker RME non-carcinogenic hazard associated with exposure to groundwater exceeded the acceptable HI; however, there were no individual target organ HIs greater than 1.0 and the RME carcinogenic risk (1.7×10^{-5}) is within the acceptable risk range. VOC contamination is widespread across the site and contributes to unacceptable risks to multiple future receptors due to concentrations in groundwater. VOC concentrations in groundwater also exceed MCLs.

An **ecological risk assessment (ERA)** was also completed as part of the 2012 RI report. Surface water, sediment and sediment pore water were evaluated as part of the ERA for Site 3. Groundwater is generally considered only as a transport medium because there are no ecological exposures to groundwater until it **discharges** to a water body or surfaces as a seep. Therefore, groundwater was considered qualitatively during the ERA, but was not evaluated as an ecologically-relevant medium. Based on the ERA, there are no unacceptable risks to ecological receptors from exposure to surface water, sediment, or sediment pore water at Site 3. Furthermore, none of the primary contaminants in the Site 3 groundwater (TCE, cis-1,2-DCE and VC) were detected in the sediment pore water, surface water, or bulk sediment samples. Based on this evaluation, and since the source area at Site 3 has been removed and groundwater is not a significant continuing source to the aquatic habitats adjacent to this site, Site 3 groundwater does not pose unacceptable ecological risks.

Table 3 – RME Risks and Hazards for Site 3 Groundwater COCs

Receptor	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $>10^{-4}$	Hazard Index	Chemicals with HI>1
Future Resident Adult	Ingestion	N/A		4.4E+01	cis-1,2-Dichloroethene, Trichloroethene, Vinyl chloride, Arsenic-dissolved
	Dermal Contact	N/A		4.3E+00	cis-1,2-Dichloroethene, Trichloroethene
	Inhalation /Shower	N/A		7.7E-01	
	Inhalation /Indoor Air	N/A		1.2E+01	Trichloroethene, Vinyl chloride
	Total	N/A		6.1E+01	cis-1,2-Dichloroethene, Trichloroethene, Vinyl chloride, Arsenic-dissolved
Future Resident Child	Ingestion	N/A		1.0E+02	cis-1,2-Dichloroethene, Trichloroethene, Vinyl chloride, Arsenic-dissolved, Manganese-dissolved
	Dermal Contact	N/A		9.9E+00	cis-1,2-Dichloroethene, Trichloroethene, Vinyl chloride
	Inhalation /Shower	N/A		1.4E+01	Trichloroethene, Vinyl chloride
	Inhalation /Indoor Air	N/A		5.6E+01	Trichloroethene, Vinyl chloride
	Total	N/A		1.8E+02	cis-1,2-Dichloroethene, Trichloroethene, Vinyl chloride, Arsenic-dissolved, Manganese-dissolved
Future Resident Adult/Child	Ingestion	1.8E-02	Trichloroethene, Vinyl chloride, Arsenic-dissolved	N/A	
	Dermal Contact	3.7E-03	Vinyl chloride	N/A	
	Inhalation /Shower	3.9E-04	Vinyl chloride	N/A	
	Inhalation /Indoor Air	2.5E-03	Vinyl chloride, Trichloroethene	N/A	
	Total	2.4E-02	Trichloroethene, Vinyl chloride, Arsenic-dissolved	N/A	
Future Industrial Worker - Adult	Ingestion	3.0E-03	Vinyl chloride, Arsenic-dissolved	1.6E+01	cis-1,2-Dichloroethene, Trichloroethene, Vinyl chloride
	Dermal Contact	N/A		N/A	
	Inhalation /Indoor Air	4.1E-04	Vinyl chloride	1.4E+01	Trichloroethene, Vinyl chloride
	Total	3.4E-03	Vinyl chloride	3.0E+01	cis-1,2-Dichloroethene, Trichloroethene, Vinyl chloride
Future Construction Worker - Adult	Ingestion	N/A		N/A	
	Dermal Contact	1.7E-05		2.4E+00	Trichloroethene
	Inhalation /Excavation	5.5E-08		4.7E-01	
	Total	1.7E-05		2.9E+00	Trichloroethene

6. Remedial Action Objectives

There are no unacceptable risks associated with exposure to surface water or sediment; however, Remedial Action is necessary to protect human health from exposure to the site-related COCs: TCE, cis-1,2-DCE, VC, arsenic, and manganese within the groundwater at Site 3. Therefore, the following **remedial action objectives (RAOs)** were established for Site 3 groundwater:

- Reduce TCE, cis-1,2-DCE, VC, arsenic, and manganese concentrations in groundwater to risk-based cleanup levels
- Prevent future human receptors (resident and industrial worker) exposure to groundwater until risk-based cleanup levels are met
- Prevent unacceptable risk to ecological receptors from exposure to TCE, cis-1,2-DCE, VC, arsenic, and manganese in groundwater that discharges to Indian Field Creek[2]

Remediation goals (RGs) were developed for site-related groundwater COCs that contribute to a potential unacceptable risk to human health under future residential or industrial worker scenarios (**Table 4**).

[2] Current COC concentrations in groundwater do not pose risk to ecological receptors; however, remedial actions to address VOCs in groundwater can temporarily increase concentrations of metals in groundwater.

What is Human Health Risk and How is it Calculated?

A Human Health Risk Assessment (HHRA) estimates the likelihood of health problems occurring if no cleanup action were taken at a site. This is also referred to as "baseline risk." HHRAs are conducted using a stepped process (as outlined in Navy and USEPA HHRA policy and guidance). To estimate baseline risk at a site, the Navy performs the following four-step process:

Step 1: Data Collection and Evaluation

Step 2: Exposure Assessment

Step 3: Toxicity Assessment

Step 4: Risk Characterization

During Data Collection and Evaluation (**Step 1**), the concentrations of chemicals detected at a site are evaluated, including:

- Identifying and evaluating area(s) where site-related chemicals may be found (source areas) and at what concentrations.
- Evaluating potential movement (transport) of chemicals in the environment.
- Comparing site concentrations to risk-based screening levels to determine which chemicals may pose the greatest threat to human health (called "chemicals of potential concern" [COPCs]). Constituents are not excluded from the risk assessment process if they are within the range of background.

In **Step 2**, the Exposure Assessment, potential exposures to the COPCs identifi ed in Step 1 are evaluated. This step includes:

- Identifying possible exposure **media** (for example, soil, air, groundwater, surface water, and/or sediment).
- Evaluating if/how people may be exposed (exposure pathways).
- Evaluating routes of exposure (for example, ingestion).
- Identifying the concentrations of COPCs to which people might be exposed.
- Identifying the potential frequency and length of exposure.
- Calculating a "reasonable maximum exposure" (RME) dose that portrays the highest level of human exposure that could reasonably be expected to occur.

In the Toxicity Assessment (**Step 3**), both cancer and non-cancer toxicity values are identified for oral, dermal, and inhalation exposures to the COPCs. The toxicity values are identified using the hierarchy of toxicity value sources approved by USEPA.

Step 4 is Risk Characterization, where the information developed in Steps 1-3 is used to estimate potential risk to people. The following approach is used:

- Two types of risk are considered: cancer risk and non-cancer hazard.
- The likelihood of developing cancer as a result of site exposure is expressed as an upper-bound probability; for example, a "1 in 10,000 chance." In other words, for every 10,000 people that might be exposed under the conditions identified in Step 2, one additional case of cancer may occur as a result of site exposure. Unacceptable risk exists when the Expected Lifetime Cancer Risk (ELCR) of 1 x 10^{-4} is exceeded.
- For non-cancer health effects, a "hazard index" (HI) is calculated. The HI represents the sum of the Hazard Quotients (HQs) for individual contaminants. Each HQ represents the ratio between the "reference dose," which is the dose at which no adverse health effects are expected to occur, and the RME dose for a person contacting the contaminant at the site. The key concept here is that a "threshold level" (measured as an HI of 1) exists below which no adverse non-cancer health effects are expected to occur. The potential risks from the individual COPCs and exposure pathways are summed and a total site risk is calculated for each receptor.

  The uncertainties associated with the risk estimates are presented and their effects on the conclusions of the HHRA are discussed.

What is Ecological Risk and How is it Calculated?

An ecological risk assessment (ERA) is conceptually similar to a human health risk assessment except that it evaluates the potential risks and impacts to ecological receptors (plants, animals other than humans and domesticated species, habitats [such as wetlands], and communities [groups of interacting plant and animal species]). ERAs are conducted using a tiered, step-wise process (as outlined in Navy and USEPA ERA policy and/or guidance) and are punctuated with Scientific Management Decision Points (SMDPs). SMDPs represent points in the ERA process where agreement among stakeholders on conclusions, actions, or methodologies is needed so that the ERA process can continue (or terminate) in a technically defensible manner. The results of the ERA at a particular SMDP are used to determine how the ERA process should proceed, for example, to the next step in the process or directly to a later step. The process continues until a final decision has been reached (i.e., remedial action if unacceptable risks are identified, or no further action if risks are acceptable). The process can also be iterative if data needs are identified at any step; the needed data are collected and the process starts again at the point appropriate to the type of data collected.

An ERA has three principal components:

1. Problem Formulation establishes the goals, scope, and focus of the ERA and includes:

- Compiling and reviewing existing information on the habitats, plants, and animals that are present on or near the site
- Identifying and evaluating area(s) where site-related chemicals may be found (source areas) and at what concentrations
- Evaluating potential movement (transport) of chemicals in the environment
- Identifying possible exposure media (soil, air, water, sediment)
- Evaluating if/how the plants and animals may be exposed (exposure pathways)
- Evaluating routes of exposure (for example, ingestion)
- Identifying specific receptors (plants and animals) that could be exposed
- Specifying how the risk will be measured (assessment and measurement endpoints) for all complete exposure pathways

2. Risk Analysis, which includes:
    - Exposure Estimate - An estimate of potential exposures (concentrations of chemicals in applicable media) to plants and animals (receptors). This includes direct exposures of chemicals in site media (such as soil) to lower trophic level receptors (organisms low on the food chain such as plants and insects) and upper trophic level receptors (organisms higher on the food chain such as birds and mammals. This also includes the estimated chemicals dose to upper trophic level receptors via consumption of chemicals accumulated in lower food chain organisms.
    - Effects Assessment - The concentrations of chemicals at which an adverse effect may occur are determined.
3. Risk Calculation or Characterization:
    - The information developed in the first two steps is used to estimate the potential risk to plants and/or animals by comparing the exposure estimates with the effects threshold.
    - Also included is an evaluation of the uncertainties (that is, potential degree of error) associated with the predicted risk estimate and their effects on ERA conclusions.

The three principal components of an ERA are implemented as an 8-step, 3-tier process as follows:

1. Screening-Level ERA (Steps 1-2; Tier 1) – The Screening Level ERA (SLERA) conducts an assessment of ecological risk using the three steps described above and very conservative assumptions (such as using maximum chemical concentrations).
2. Baseline ERA (Steps 3-7; Tier 2) – If potential risks are identified in the SLERA, a Baseline ERA (BERA) is typically conducted. The BERA is a reiteration of the three steps described above but uses more site-specific and realistic exposure assumptions, as well as additional methods not included in the SLERA, such as consideration of background concentrations. The BERA may also include the collection of site-specific data (such as measuring the concentrations of chemicals in the tissues of organisms, for example, fish) to address key risk issues identified in the SLERA.
3. Risk Management (Step 8; Tier 3) – Step 8 develops recommendations on ways to address any unacceptable ecological risks that are identified in the BERA and may also include other activities, such as evaluating remedial alternatives.

MCLs are the highest level of a contaminant allowed in drinking water, are considered to be protective, and allow for unlimited use and unrestricted exposure; therefore, MCLs were established as the RGs for TCE, cis-1,2-DCE, VC, and arsenic. Because no MCL has been established for manganese, a risk-based RG was calculated. The RG for manganese was determined based on **Remedial Goal Option (RGO)** calculations (USEPA, 1991), which incorporate pathways for the ingestion, dermal absorption, and inhalation of volatiles and particulates for future residents and the same exposure assumptions as the HHRA.

Table 4 – Remediation Goals for COCs in Groundwater at Site 3

Chemical of Concern	Remediation Goal
Trichloroethene	5 µg/L
cis-1,2-Dichloroethene	70 µg/L
Vinyl chloride	2 µg/L
Arsenic, dissolved	10 µg/L
Manganese, dissolved	320 µg/L

µg/L – micrograms per liter

7. Summary of Remedial Alternatives

No remedial action is required for sediment and surface water because there are no unacceptable risks at the site from exposure to sediment and surface water.

The remedial alternatives developed and evaluated to address COCs in groundwater at Site 3 are detailed in the FS. Following the screening of groundwater remediation technologies, the following remedial alternatives were selected for detailed evaluation and comparative analysis:

- Alternative 1 – No Action
- Alternative 2 – Monitored Natural Attenuation (TCE, cis-1,2-DCE, and VC); Monitoring (arsenic and manganese); and Land Use Controls
- Alternative 3 – Enhanced In-Situ Bioremediation (EISB) (TCE, cis-1,2-DCE, and VC); Monitored Natural Attenuation (TCE, cis-1,2-DCE, and VC); Monitoring (arsenic and manganese); and Land Use Controls
- Alternative 4 – In-Situ Chemical Reduction (ISCR) (TCE, cis-1,2-DCE, and VC); Monitored Natural Attenuation (TCE, cis-1,2-DCE, and VC); Monitoring (arsenic and manganese); and Land Use Controls
- Alternative 5 – In-Situ Chemical Oxidation (ISCO) (TCE, cis-1,2-DCE, and VC); Monitored Natural Attenuation (TCE, cis-1,2-DCE, and VC); Monitoring (arsenic and manganese); and Land Use Controls

Based on the results of the detailed evaluation and comparative analysis, Alternative 3 was selected as the Preferred Alternative for groundwater. With the exception of the no-action alternative (Alternative 1), each of the alternatives includes monitored natural attenuation of TCE, cis-1,2-DCE, and VC, monitoring of arsenic and manganese, and the implementation of LUCs to prevent exposures presenting any unacceptable risks. In addition, each of the Alternatives 3, 4 and 5 includes an active treatment component for groundwater: EISB (Alternative 3); ISCR (Alternative 4); and ISCO (Alternative 5). Alternative 1 is required by the NCP and serves as the baseline against which the other alternatives are compared. For Alternatives 2, 3, 4, and 5, monitoring and LUCs would be maintained until the RAOs are met. As long as contaminants remain on the site at levels that do not allow for unlimited use and unrestricted exposure, 5-year statutory reviews will be conducted to ensure protection of human health and the environment. A description of each remedial alternative is provided in **Table 5**.

Elevated concentrations of dissolved arsenic and manganese in groundwater are likely the result of several factors, which may include naturally-occurring reducing conditions near Indian Field Creek, the reducing conditions resulting from TCE, cis-1,2-DCE, and VC contamination in groundwater, and/or low levels of TPH in unsaturated subsurface soils (15-19 feet below ground surface) which contribute to reducing conditions but which do not pose a risk to human health or the environment. As discussed in Section 9, if it is determined by the Navy, EPA, and VDEQ during performance monitoring or LTM that the primary cause of the elevated concentrations of dissolved arsenic and manganese detected in groundwater is a result of the low levels of TPH that remain in deep subsurface soils at the site (e.g., the TPH is acting as a source of carbon that is mobilizing these metals), a contingency remedy that includes the removal and off-base disposal of these soils may be considered.

8. Evaluation of Remedial Alternatives

The NCP identifies nine evaluation criteria for use in a comparative analysis of remedial alternatives **(Table 6)**. Each remedial alternative for Site 3 groundwater was evaluated against these criteria **(Table 7)** and in comparison to one another. The contingency remedy for soils was evaluated against the NCP criteria on its own since it can be added to any of the proposed alternatives.

8.1 Threshold Criteria

Protection of Human Health and the Environment

Alternative 1 (no action) does not protect human health and the environment; therefore, because it fails this threshold criterion, it will not be considered further in this analysis. Alternatives 2, 3, 4, and 5 are all protective of human health and the environment. All four alternatives rely to some degree on MNA to reduce the concentrations of site-related COCs plus LUCs to maintain protection of human health and the environment until RAOs are achieved. The time estimated for each of the four remedial alternatives to reach RAOs ranges from 9 years (Alternative 3) to 19 years (Alternative 2). Alternative 2 relies solely on natural attenuation to meet RAOs, whereas Alternatives 3, 4, and 5 engage active treatment technologies (EISB, ISCR, or ISCO) to accelerate the remediation timeframe. The soil contingency remedy is considered protective of human health and the environment because it would facilitate the attenuation of arsenic and manganese in groundwater.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Alternatives 2 through 5 and the soil contingency remedy are expected to comply with ARARs, including the MCLs established under the federal Safe Drinking Water Act. All four alternatives and the soil contingency remedy would all require performance monitoring associated with MNA and LUCs. Alternatives 3 through 5 would also comply with federal and Commonwealth of Virginia ARARs related to underground injections of reagents and erosion and sediment controls applicable to larger construction areas. The soil contingency remedy would also comply with federal and Commonwealth of Virginia ARARs related to the management of excavated soil.

8.2 Primary Balancing Criteria

Long-term Effectiveness and Permanence

Alternatives 2 through 5 are expected to be effective in the long-term and to provide a permanent means of reducing the concentrations of the COCs. Until RAOs are achieved, all four alternatives are expected to have **residual risks** of the same magnitude. Some residual risk will remain because Alternatives 2 through 5 rely on MNA and LUCs. For each alternative, with planning and implementation, the controls put in place would effectively ensure continued compliance with RAOs. The soil contingency remedy is also expected to be effective in the long-term and provides a permanent means of reducing the concentrations of TPH in deep subsurface soil.

Reduction in Toxicity, Mobility, or Volume through Treatment

Alternatives 3, 4, and 5 all employ some form of treatment to address contaminants in groundwater. Alternative 3 would be synergistic with the existing anaerobic conditions observed in the plume and therefor is expected to be highly effective at reducing toxicity, mobility, and volume of contamination in groundwater by treating groundwater over an extensive area. Alternatives 4 and 5 would be moderately effective because, while they also include active treatment, the treatment is applied over a smaller area. Alternative 2 does not satisfy this criterion because active treatment would not be a component of this alternative; however, natural reduction of contaminant concentrations through a variety of physical, chemical, or biological activities is expected to occur over time. The soil excavation in the soil contingency remedy would not satisfy this criterion, since no treatment would be involved. However, the decrease in contaminant concentrations in groundwater as a result of the excavation would significantly reduce risks from exposure to groundwater.

Short-Term Effectiveness

Alternative 2 is considered highly effective in the short term because it would minimally affect the community, workers, or the local environment, as the site would not be changed from current conditions. Alternatives 3, 4, and 5 are considered to be moderately effective in the short term. Alternatives 3, 4, and 5 all rely on direct injection technology for implementation; therefore, the community, site workers, and environment would be impacted due to construction activities, reagent injections, waste generation, and a high volume of vehicle traffic (transport of materials, equipment, and workers to the site as well as heavy machinery use during construction).

The short-term effectiveness of the soil contingency remedy is considered to be moderate. The timeframe to achieve RAOs would be shortened by active soil removal. The actual time to implement the contingency remedy would be short.

Table 5 - Description of Groundwater Remedial Alternatives for Site 3

Alternative	Componenets	Details	Cost
Alternative 1	No action	Allow the COCs to breakdown naturally over time.	Capital Cost: $0 O&M Present Value: $0 Total Present Value: $0
Alternative 2	• Refining the CSM through a pre-design investigation to verify groundwater characteristics • MNA of TCE, cis-1,2-DCE, VC • Monitoring of arsenic and manganese • LUCs*	Conduct monitoring activities to determine the effectiveness of natural attenuation processes Estimated duration of 19 years Long-term monitoring performed to verify that: • COC concentrations continue to decrease • Potentially toxic transformation products are not created at levels that are a threat to human health • Impacted area is not expanding • There are no changes in hydrogeological, geochemical, or microbiological parameters that might reduce the effectiveness of the Remedial Action LUCs in the form of land and groundwater use restrictions*	Capital Cost: $0 O&M Present Value: $0 Total Present Value: $0
Alternative 3	• Refining the CSM through a pre-design investigation to verify groundwater characteristics • EISB of TCE, cis-1,2-DCE, and VC using injection of an electron donor and/or microbial cultures in two target areas: 1) where TCE is >250 µg/L, cis-1,2-DCE is >3,200 µg/L, and VC is >100 µg/L, and 2) where TCE is >50 µg/L, cis-1,2-DCE is >700 µg/L, and VC is >20 µg/L • MNA for TCE, cis-1,2-DCE, and VC • Monitoring of arsenic and manganese • LUCs*	• Refining the CSM through a pre-design investigation to verify groundwater characteristics • EISB of TCE, cis-1,2-DCE, and VC using injection of an electron donor and/or microbial cultures in two target areas: 1) where TCE is >250 µg/L, cis-1,2-DCE is >3,200 µg/L, and VC is >100 µg/L, and 2) where TCE is >50 µg/L, cis-1,2-DCE is >700 µg/L, and VC is >20 µg/L • MNA for TCE, cis-1,2-DCE, and VC • Monitoring of arsenic and manganese LUCs*	Capital Cost: $0 O&M Present Value: $0 Total Present Value: $0
Alternative 4	• Refining the CSM through a pre-design investigation to verify groundwater characteristics • ISCR of TCE, cis-1,2-DCE, and VC in one target area: 1) where TCE is >250 µg/L, cis-1,2-DCE is >3,200 µg/L, and VC is >100 µg/L • MNA for TCE, cis-1,2-DCE, and VC • Monitoring of arsenic and manganese • LUCs*	Injection of reducing agents into groundwater to accelerate abiotic reduction of VOCs Estimated duration of 11 years Long-term monitoring performed to verify that: • COC concentrations continue to decrease • Potentially toxic transformation products are not created at levels that are a threat to human health • Impacted area is not expanding • There are no changes in hydrogeological, geochemical, or microbiological parameters that might reduce the effectiveness of the Remedial Action LUCs in the form of land and groundwater use restrictions*	Capital Cost: $0 O&M Present Value: $0 Total Present Value: $0
Alternative 5	• Refining the CSM through a pre-design investigation to verify groundwater characteristics ISCO of TCE, cis-1,2-DCE, and VC in one target area: 1) where TCE is >250 µg/L, cis-1,2-DCE is >3,200 µg/L, and VC is >100 µg/L • MNA for TCE, cis-1,2-DCE, and VC • Monitoring of arsenic and manganese • LUCs*	Injection of oxidizing agents to create oxidizing conditions, thereby stabilizing the VOC plume and precipitating manganese and arsenic dissolved in groundwater Estimated duration of 11 years Long-term monitoring performed to verify that: • COC concentrations continue to decrease • Potentially toxic transformation products are not created at levels that are a threat to human health • Impacted area is not expanding • There are no changes in hydrogeological, geochemical, or microbiological parameters that might reduce the effectiveness of the Remedial Action LUCs in the form of land and groundwater use restrictions*	Capital Cost: $0 O&M Present Value: $0 Total Present Value: $0
Contingency Remedy - Soil Removal	• Excavate TPH-contaminated soil	If low levels of TPH are determined to be the primary cause of elevated levels of dissolved arsenic and manganese in groundwater, removal and offsite disposal of TPH-contaminated soil as a contingency remedy measure to enable attenuation of arsenic and manganese by removing source of organic carbon, which may be facilitating manganese and arsenic dissolution.	Capital Cost: $624,000 O&M Present Value: $0 Total Present Value: $624,000

* Implementing LUCs to prohibit groundwater use and to prohibit residential use of the site until such time as contaminants in groundwater are at levels that allow for unlimited use and unrestricted exposure; and to restrict any intrusive activity, such as digging, to authorized personnel.

Table 6- Evaluation Criteria for Groundwater Remedial Alternative Analysis

Alternative	Cost
Threshold Criteria	
Protection of Human health and the environment	Addresses whether an alternative provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through mitigation, engineering controls, or institutional controls.
Compliance with ARARs	Addresses whether an alternative will meet all of the applicable or relevant and appropriate requirements in federal and state environmental laws and/or justifies a waiver of the requirements.
Primary Balancing Criteria	
Long-term effectiveness and permanence	Addresses the expected residual risk and the ability of an alternative to maintain reliable protection of human health and the environment over time, once clean-up goals have been met.
Reduction in toxicity, mobility, or volume through treatment	Discusses the anticipated performance of the treatment technologies an alternative may employ.
Short-term effectiveness	Considers the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.
Implementability	Evaluates the technical and administrative feasibility of an alternative, including the availability of materials and services needed to implement an option.
Present-worth cost	Compares the estimated initial, operation and maintenance, and present-worth costs.
Modifying Criteria	
State acceptance	Considers the state agency comments on the Proposed Plan.
Community acceptance	Provides the public's general response to the remedial alternatives described in the Proposed Plan, RI report, and the FS report. The specific responses to the public comments are addressed in the "Responsiveness Summary" section of the ROD.

Implementability

Alternative 2 is the easiest of the remaining alternatives to implement, since it doesn't involve any additional active treatment. Alternatives 3, 4, and 5 can each be implemented using standard and widely available technologies. These three alternatives (3, 4 and 5) require engineering and construction services, and each alternative requires thorough monitoring to ensure that it continues to operate on a path toward achieving RAOs. Each of the three alternatives (3, 4 and 5) is reliable provided it is designed and implemented correctly. Soil excavation, as outlined in the soil contingency remedy, is a reliable and demonstrated technology that is technically feasible for the site and could be easily implemented with available labor, materials, and equipment.

Cost

An order of magnitude (OOM) cost for each alternative was estimated based on assumptions described in the FS. The timeframes required to achieve the RGs vary among the alternatives. The least expensive alternative is Alternative 3, with an estimated total present-value cost of $953,000. Alternative 2 has a slightly higher estimated present-value cost of $1,117,000 due to the longer duration of the alternative. Alternatives 4 and 5 have comparable estimated present-value costs of $1,313,000 and $1,324,000, respectively. Alternative 2 has the lowest total capital cost, estimated at $13,000. Alternatives 3, 4, and 5 have estimated capital costs of $169,000, $479,000, and $496,000, respectively. The soil contingency remedy has estimated capital costs of $624,000. There are no other costs associated with the soil contingency remedy.

Table 7 provides a relative ranking of the five alternatives with respect to the Threshold and Primary Balancing criteria.

8.3 Modifying Criteria

State Acceptance

State involvement has been solicited throughout the CERCLA remedy selection process. The Commonwealth of Virginia through VDEQ supports the Preferred Alternatives, NA for surface water and sediment and Alternative 3 for groundwater. VDEQ's final concurrence will be solicited following the review of all comments received during the public comment period.

Community Acceptance

Community acceptance will be evaluated after the public comment period for the Proposed Plan, and public comments will be addressed and documented in the forthcoming ROD for Site 3 groundwater, surface water and sediment.

9. Preferred Groundwater Alternative

Based on the results of the comparative analysis, the Preferred Alternative for groundwater is Alternative 3, consisting of the following components: 1) Refining the conceptual site model through a pre-design investigation to verify groundwater characteristics; 2) Implementing EISB of TCE, cis-1,2-DCE, and VC through the injection of an electron donor and a microbial culture into the area of highest concentration in order to accelerate the time for achieving RGs; 3) Conducting MNA of TCE, cis-1,2-DCE, and VC following active treatment;

Table 7 - Relative Ranking of Groundwater Remedial Alternatives

CERCLA Criteria	Alternative 1 - No Action	Alternative 2 - MNA (TCE, cis-1,2-DCE, and VC); Monitoring (arsenic and manganese); and LUCs	Alternative 3 - EISB (TCE, cis-1,2-DCE, and VC); MNA (TCE, cis-1,2-DCE, and VC); Monitoring (arsenic and manganese); and LUCs	Alternative 4 – ISCR (TCE, cis-1,2-DCE, and VC); MNA (TCE, cis-1,2-DCE, and VC); Monitoring (arsenic and manganese); and LUCs	Alternative 5 – ISCO (TCE, cis-1,2-DCE, and VC); MNA (TCE, cis-1,2-DCE, and VC); Monitoring (arsenic and manganese); and LUCs
Threshold Criteria					
Protection of Human Health and the Environment	○	●	●	●	●
Compliance with ARARs	○	●	●	●	●
Primary Balancing Criteria					
Long-term Effectiveness and Permanence	○	●	●	●	●
Reduction in Toxicity, Mobility, or Volume through Treatment	○	○	●	◐	◐
Short-term Effectiveness	○	●	◐	◐	◐
Implementability	●	●	◐	◐	◐
Present-worth Cost	No Cost	◐	●	○	○

Relative Ranking: ● High ◐ Moderate ○ Low
Rankings are provided as qualitative descriptions of the relative compliance of each alternative with the criteria

4) Monitoring of arsenic and manganese concentrations to verify that levels do not increase over the current acceptable concentrations; (if levels increase a contingency remedy may be considered); and, 5) Implementing LUCs to prohibit groundwater use and to prohibit residential use of the site until such time as contaminants in groundwater are at levels that allow for unlimited use and unrestricted exposure; and to restrict any intrusive activity, such as digging, to authorized personnel.

Alternative 3 is protective of human health and environment, complies with ARARs, and provides the best balance of tradeoffs with respect to long and short-term effectiveness; reduction of toxicity, mobility and volume of contaminants through treatment; implementability; and cost. Alternative 3 has the lowest cost and the shortest estimated timeframe for remediation of 9 years, and it meets the statutory preference for active treatment as a component of the remedy. In addition, Alternative 3 would be synergistic with natural attenuation processes for TCE, cis-1,2-DCE, and VC and may enhance natural biodegradation in the downgradient portion of the plume. The Navy expects the Preferred Alternative to satisfy the following statutory requirements of CERCLA §121(b): (1) be protective of human health and the environment; (2) comply with ARARs (or justify a waiver); (3) be cost-effective; (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment as a principal element.

Further, in accordance with the Navy's, Vision for Sustaining Our Environment, Alternative 3 was evaluated using the approaches described in the Sustainable Environmental Remediation (NAVFAC, 2009) under each of the NCP Criteria for Site 3. The eight sustainability metrics include: Energy Consumption, Greenhouse Gas Emissions, Criteria Pollutant Emissions, Water Impacts, Ecological Impacts, Resource Consumption, Worker Safety, and Community Impacts. The rankings in the sustainability evaluation for Alternatives 3, 4, and 5 were similar and lower than for Alternative 2; Alternatives 4 and 5 would likely have the highest water consumption and highest air emissions for nitrogen oxides, sulfur oxides, and particulate matter.

Cost versus benefit (such as length of time, sustainability, etc.) comparison indicates that Alternative 3 is the most cost-effective of the alternatives presented to address groundwater. Therefore, Alternative 3 is the preferred alternative for remediation of groundwater contamination at Site 3.

Contingency Remedy for Arsenic and Manganese in Groundwater

While not expected, if the Navy, EPA, and VDEQ determine during the pre-design investigation, performance monitoring or LTM that the low levels of TPH, which remain in deep unsaturated soils (15-19 feet below ground surface) and do not themselves pose a risk to human health or the environment, are acting as a carbon source resulting in the mobilization of arsenic and manganese in groundwater, the contingency remedy (TPH soil removal) may be considered.

The contingency remedy removes localized TPH contamination to decrease arsenic and manganese in groundwater. This contingency remedy is protective of human health and the environment and is expected to facilitate attenuation. It would also comply with ARARs and provides long-term effectiveness and permanence. The decrease in arsenic and manganese groundwater concentrations resulting from the soil excavation would reduce toxicity, mobility, and volume of contaminants in the plume.

The contingency remedy's short-term effectiveness is considered moderate and it could be quickly and easily implemented at a low cost.

10. Community Participation

The Navy and USEPA Region 3, in consultation with VDEQ, will make the final decision on this approach for Site 3 after reviewing and considering all information and comments submitted during the 45-day public comment period. The public comment period for this Proposed Plan will extend from May 5, 2014 to June 18, 2014 and a public meeting to discuss the Proposed Plan will be held May 15, 2014 at 3:30 p.m. Details regarding the public comment period and public meeting are included in the text box in Section 1 entitled, "Mark Your Calendar." The Navy will summarize and respond to all comments submitted during the public comment period in a responsiveness summary that will be included in the final decision document, the ROD, which will follow this Proposed Plan. This Proposed Plan and the ROD will become part of the AR file for WPNSTA Yorktown.

Public participation is encouraged since the preferred alternatives presented in this Proposed Plan may be modified or other alternatives selected based on new information and/or public comments received. The public is encouraged to gain a more comprehensive understanding of Site 3 and the Navy's ERP by attending this and other public meetings advertised in the Daily Press and Virginia Gazette newspapers and by accessing information included in the AR file. Minutes of all public meetings will be included in the file.

Location of Administrative Record and Information Repository

Available online at: http://go.usa.gov/DynG

Internet access is available at the:
Yorktown Public Library
8500 George Washington Memorial Highway
Yorktown, Virginia
(757) 890-5207

During the comment period, interested parties may submit written comments to the following address:

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Glossary of Terms

Abiotic: Characterized by absence of life; abiotic materials include non-living environmental media (e.g., water, soils, sediments).

Administrative Record (AR): A compilation of documents relied upon to select a remedial response. The AR is available to the public and is in the ERP Information Repository.

Applicable or Relevant and Appropriate Requirements (ARARs):

- Applicable requirements, as defined in 40 CFR § 300.5, are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by the state in a timely manner and that are more stringent than federal requirements may be applicable.
- Relevant and appropriate requirements, as defined in 40 CFR § 300.5, means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by the state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate.

Borrow Pit: An area where material (usually soil, gravel or sand) has been dug for use at another location.

Cancer Risk: The incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen.

Chemicals of concern (COCs): Specific chemicals that are identified for evaluation in the site assessment process.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA): A federal law, commonly referred to as the "Superfund" Program, CERCLA provides for cleanup and emergency response in connection with existing inactive hazardous waste disposal sites that endanger public health and safety or the environment.

Conceptual Site Model (CSM): A three-dimensional understanding of contaminant sources, pathways, and receptors and tools needed to identify and fill data gaps, screen remedial alternatives, and evaluate the performance of Remedial Actions.

Confining Unit: A geologic formation that consists of impermeable or distinctly less permeable material bounding one or more aquifers.

Contingency Remedy: A cleanup technology or approach specified in the site remedy decision document that functions as a backup remedy in the event that the selected remedy fails to perform as anticipated.

Dense Non-Aqueous Phase Liquid (DNAPL): One of a group of organic substances that are relatively insoluble in water and more dense than water. DNAPLs tend to sink vertically through sand and gravel aquifers to the underlying layer.

Direct Push Technology (DPT): Investigation tools that drive or push small diameter rods and tools into the ground.

Discharge: The location at which groundwater leaves an aquifer and flows to the surface.

Ecological Risk Assessment (ERA): An evaluation of the risk posed to the environment if remedial activities are not performed at the site.

Electron Donor: chemical entity that donates electrons to another compound.

Enhanced In-Situ Bioremediation (EISB): Injecting insoluble or soluble substrates into a media to facilitate biodegradation.

Environmental Restoration Program (ERP): The Navy program charged with implementing environmental cleanups under CERCLA at Navy installations. The Navy, as lead agency, acts in partnership with USEPA Region 3 and VDEQ to address environmental investigations at Navy facilities through the ERP.

Explanation of Significant Difference (ESD): A document that significantly changes, but does not fundamentally alter, the remedy selected in a Record of Decision.

Exposure Pathway: The pathway a chemical takes from the source of contamination to the exposed individual.

Federal Facility Agreement (FFA): Agreement negotiated by the Navy, USEPA and the State to establish a procedural framework and schedule for developing, implementing and monitoring appropriate response actions at the federal facility in accordance with CERCLA and the NCP.

Geology: Soil and rock that underlie the ground's surface.

Groundwater: Subsurface water that occurs in soil and geologic formations that are fully saturated.

Hazard Index (HI): Summation of the non-cancer risks to which an individual is exposed. An HI value of 1.0 or less indicates that non-cancer adverse human health effects are unlikely to occur.

Human Health Risk Assessment (HHRA): An assessment of the risks posed to human health through potential exposures to contaminants present at a site if no remedial action is taken at the site.

Land Use Controls (LUCs): Physical, legal, or administrative methods that restrict the use of or limit access to real property to manage risks to human health and the environment.

Maximum Contaminant Levels (MCLs): Enforceable standards that apply to public water systems, promulgated by USEPA under the Safe Drinking Water Act. The highest level of a contaminant that is allowed in drinking water.

Membrane Interface Probe (MIP): a direct push tool used to log the relative concentration of volatile organic compounds (VOCs) with depth in soil.

Microbial Culture: Is a method of multiplying microbial organisms by letting them reproduce in predetermined culture media under controlled laboratory conditions.

Monitored Natural Attenuation (MNA): Monitoring of the constituents in groundwater in order to verify the reduction in mass or concentration of a compound in groundwater over time or distance from the source of constituents of concern due to naturally occurring physical, chemical, and biological processes, such as; biodegradation, dispersion, dilution, adsorption, and volatilization.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): Provides the organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants.

National Priorities List (NPL): A list developed by USEPA of uncontrolled hazardous substance release sites in the United States that are considered priorities for long-term remedial evaluation and response.

Non-Cancer Hazard: Probability that a chemical will produce a non-cancer effect in humans. The estimate of this probability for an individual chemical is identified as the hazard quotient (HQ), and the sum of the HQs for the various COCs at a site is identified as the HI.

Principal Threat Wastes: As defined by the NCP, source materials that generally cannot be reliably contained or would present a significant risk to human health or the environment should an exposure occur.

Proposed Plan: A document that presents background information on site history and contamination and requests public input regarding a proposed cleanup alternative.

Public Comment Period: The time allowed for the members of an affected community to express views and concerns regarding an action proposed to be taken by the Navy and USEPA, such as a rulemaking, permit, or Superfund-remedy selection.

Reasonable Maximum Exposure (RME): The highest exposure that is reasonably expected to occur at a site. The intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures.

Receptors: Humans, animals, or plants that may be exposed to risks from contaminants present at a given site.

Record of Decision (ROD): A legal document that describes the cleanup action or alternative selected for a site, the basis for choosing that alternative, and public comment on the selected alternative.

Remedial Action Objectives (RAOs): Specific goals for protecting human health and the environment. RAOs are developed by evaluating ARARs protective of human health and environment and the results of remedial investigations and risk assessments.

Remedial Goal Option (RGO): The incorporation of ingestion, dermal absorption, and inhalation of volatiles and particulate pathways for future residents to determine remediation goals.

Remediation Goals (RGs): Clean-up goals developed based on readily available information including the results of the baseline risk assessment. They also are used during analysis of remedial alternatives in the remedial investigation/feasibility study (RI/FS).

Remedial Investigation (RI): Extensive technical study conducted to characterize the nature and extent of contamination present and the risks posed by a site.

Residual Risk: Hazards which remain on site after Remedial Action has been completed.

Sediment: Matter that settles to the bottom of a liquid.

Site Screening Process (SSP): Process to determine if an area should be considered a Site for further investigation.

Site Management Plan: Annual document generated in accordance with the FFA, which provides a 5-year plan for CERCLA Installation Restoration activities.

Solvents: Materials such as degreasers, cleaners, extractants, and diluents.

Surface Water: A body of water on the surface of the earth.

Synergistic: The various parts of the remedy working together to produce an enhanced result.

Unlimited Use and Unrestricted Exposure: Full use of all environmental media including groundwater, soil, and surface water with no limits placed on the use of the environmental media due to risks posed.

U.S. Environmental Protection Agency (USEPA): The federal agency responsible for administration and enforcement of CERCLA (and other environmental statutes and regulations), and with final approval authority for the selected alternative.

Virginia Department of Environmental Quality (VDEQ): The Commonwealth agency responsible for administration and enforcement of environmental regulations.

Volatile Organic Compounds (VOCs): Compounds that easily vaporize and have low water solubility. Many VOCs are manufactured chemicals such as those associated with paint, solvents, and petroleum.

Please print or type your comments here

Mark Your Calendar for the Public Comment Period

Public Comment Period

May 12, 2014 to June 26, 2014

Submit Written Comments

The Navy will accept written comments on this Proposed Plan during the public comment period. To submit comments or obtain further information, please refer to the names and contact information included at the end of Section 10. A blank sheet has been added at the end of this document to be used for writing comments.

Attend the Public Meeting

May 15, 2014 at 3:00 p.m.
Yorktown Public Library
8500 George Washington
Memorial Highway
Yorktown, Virginia

The Navy will hold a public meeting to explain the Proposed Plan. Oral and written comments will be accepted at this meeting.

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Place stamp here

NAVFAC Mid-Atlantic
Attention: Mr. Jim Gravette
9742 Maryland Avenue
Bldg. N-26, Room 3208
Norfolk, VA 23511-3095