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NWS YORKTOWN
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EMAIL AND ATTACHED U S EPA REGION III COMMENTS ON THE DRAFT SITE 22 RECORD OF DECISION NWS YORKTOWN VA
07/23/2012
U S EPA REGION III PHILADELPHIA PA

Marrow, Monica/VBO

From: Friedmann, William/VBO
Sent: Monday, July 23, 2012 4:55 PM
To: Sawyer, Stephanie/VBO
Subject: FW: Yorktown Site 22 ROD - Frank Fritz comments
Attachments: Site 22 Draft ROD EPA RPM Comment.docx; Site 22 ROD EPA LEGAL Comment.PDF

Stephanie,
Comments from EPA. I will send another e-mail to you that states that these are the comments we need to address before going to EPA leadership.
Thanks,
Bill

From: Moshood Oduwole [mailto:Oduwole.Moshood@epamail.epa.gov]
Sent: Monday, July 23, 2012 2:26 PM
To: Friedmann, William/VBO; wmsmith@deq.virginia.gov; james.gravette@navy.mil; Forshey, Adam/VBO
Subject: Fw: Yorktown Site 22 ROD - Frank Fritz comments

All,

Please see the 2 attached documents, they contain my comments and Frank Fritz's comments. Also, please see below the typed comments from of Frank. Based on the typed comments below (it looks to me like Steve's comments are also captured here).

Moshood Oduwole
Remedial Project Manager
US EPA Region III
Hazardous Site Cleanup Division
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----- Forwarded by Moshood Oduwole/R3/USEPA/US on 07/23/2012 02:12 PM -----

From: Frank Fritz/R3/USEPA/US
To: Moshood Oduwole/R3/USEPA/US@EPA
Cc: Steven Hirsh/R3/USEPA/US@EPA
Date: 07/20/2012 03:50 PM
Subject: Yorktown Site 22 ROD - Frank Fritz comments

Thanks for the opportunity to review this ROD. I've marked some comments in pencil on a hard copy. Below are typed comments.

In General

Contingency Remedy

Steve Hirsh wants this ROD to include a contingency remedy, or something like it.

Please read our ROD guidance, Section 8.3 and Highlight 8-8, about contingency remedies and how we modify the ordinary format of a ROD.

We need to agree on a contingency remedy and on the circumstances or criteria under which the Navy must implement the contingency remedy. In general, the idea seems to be: If MNA is not working for VOCs, then the Navy shall implement Alternative 3 or 4.

We need to have a concrete, objectively measurable way of determining if MNA is not working. For example: TCE and VC concentrations are above MCLs and have remained constant through X quarters of sampling? How do you phrase it? Kathy Davies could help.

It would be very helpful to get a good, recent example of a contingency remedy, especially a contingency for MNA. A private side EPA ROD might be good. Kathy Davies might be able to help find one.

Note that the ROD must be modified in several ways, as outlined in Highlight 8-8. Please read this Highlight carefully and, if you really want the Navy to proceed this way, ask them to make the changes noted in Highlight 8-8. In particular:

- Declaration has to
    - list the components of both the selected and contingency remedy and
    - say both selected and contingency remedy meet the statutory requirements
- RAOs - do they need to modified in any way to accommodate the contingency remedy? Need different criteria for success? Maybe not.
- Description of Alternatives - should identify any uncertainties about MNA and the extent of additional testing needed to determine if MNA will work. Selected and contingency remedy should be fully described.
    - current draft does not discuss the "optimization remedy component" in the description of alternatives. The "optimization remedy component" is first mentioned and described on page 2-21. It's the Navy's attempt at dealing with EPA's concerns.
- Selected Remedy - the contingency remedy should be identified. Additional testing/investigations to occur as part of remedial design to further evaluate the selected remedy should be discussed. The criteria that will be used to decide to implement the contingency remedy and the vehicle for invoking the contingency (e.g., an ESD) should be identified.
- Statutory Determinations - should document that both selected remedy and contingency remedy satisfy the statutory requirements.

Consistently describing Selected Remedy (and Contingency Remedy) in Declaration and Selected Remedy Section

The components of the selected remedy -- mainly monitoring requirements and land use controls -- are described in slightly different ways in the declaration and the selected remedy section. Try to make them the same.

Sparing Use of Acronyms

Acronyms can be difficult to understand for anybody but experts. This document is intended for citizens and judges, not experts. So try to use acronyms sparingly, for phrases that are repeated many times.

For example, I recommend spelling out acronyms like CSM, EVO, EISB, ISCO and NFA.

Chemical v. Constituent

Please use "chemical" in place of "constituent." It's easier to understand.

Please use "chemicals of concerns" instead of "constituents of concern" to follow EPA's ROD guidance.

Section/Paragraph/Page	Comments
2.5	This section gives no hint of uncertainty about whether MNA is occurring at this site, or whether it will work. You probably should ask for some discussion of uncertainty, lack of sampling in accordance with EPA MNA guidance, etc, to support the idea that a contingency remedy or something like it is necessary.
2.5, second to last paragraph	Try to use plainer English, if at all possible. This section contains too much highly technical jargon, which is too difficult for readers like judges or the public to understand. For example, instead of saying Since microbial utilization of a carbon source drives reductive dechlorination, EISB at Site 22 will create enhanced bioremediation conditions. you might say something like Injecting emulsified vegetable oil into the groundwater will introduce more carbon, which should encourage microbes "eat" more and, in the process, breakdown chlorinated VOCs into less toxic chemicals.
2.6 Current and Potential Land and Water Uses	At the end of the last paragraph, please add: However, the Commonwealth of Virginia considers all aquifer groundwater of potential beneficial use as potable water.
Risk Assessment	The risk assessment should include some statements about the potential for intrusion of vapors into future buildings. We need to show that there is potential risk from vapor intrusion if we are going to include LUCs to control those risks.
2.9.2	As the beginning of the first paragraph, please insert: This section summarizes a comparison and analysis of the four alternatives with respect to the National Contingency Plan's nine evaluation criteria. The nine criteria are summarized in Table 7.
2.11.2 LTM	Steve would like this section to say that Navy will submit a report of LTM results to EPA and VDEQ. In last sentence of 1st paragraph, Steve would like it to say that, if an LTM plan is developed, LTM will initially be conducted on a quarterly basis and the Navy shall submit reports of the results to EPA and VDEQ. In the report, the Navy may make suggestions on reducing monitoring frequency. Then say who would decide on whether to reduce frequency. Alternatively, the ROD could say that LTM shall be conducted in accordance with a LTM monitoring plan. The Navy shall submit a draft LTM plan to EPA and VDEQ for review and approval within ___ days/months of [some event]. The Navy shall implemented the LTM plan as approved by EPA and VDEQ.
2.11.2 LUCs	Please add text and a map, which show the reader the areas where land use controls will be imposed. Please add a statement that LUCs shall be maintained until the concentration of COCs are at levels that allow for unlimited use and unrestricted exposure.

For a LUC objective for vapor intrusion, I suggest something like this:

- Prohibit occupation of any future buildings in the area shown on Figure ___ unless (1) an investigation, concurred upon by the Navy, EPA and VDEQ, shows that risks to human health from vapor intrusion are within acceptable limits or (2) the Navy, EPA and VDEQ concur on the design of a vapor mitigation system for the building, and the vapor mitigation system is installed and operating properly and successfully.
-

Need to specify a time by which Navy will submit a LUC RD, e.g., "Within [90] days of the last signature on this ROD"

Frank A. Fritz III
Assistant Regional Counsel
U.S. EPA Region III (3RC44)
1650 Arch St
Philadelphia, PA 19103
215-814-2664
215-814-2603 fax

Draft

Record of Decision

Site 22 Groundwater – Burn Pad

Naval Weapons Station Yorktown, Yorktown, Virginia
June 2012

1 Declaration

1.1 Site Name and Location

This Record of Decision (ROD) presents the selected remedy for groundwater at Environmental Restoration Program (ERP) Site 22, Burn Pad, at Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia. WPNSTA Yorktown was placed on the United States Environmental Protection Agency (USEPA) National Priorities List effective October 15, 1992 (USEPA Identification [ID]: VA8170024170).

1.2 Statement of Basis and Purpose

This remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended. This decision is based on information contained in the Administrative Record (AR) file for the site. Information not specifically summarized in this ROD or its references[1], but contained in the AR, has been considered and is relevant to the selection of the remedy at Site 22. Thus, the ROD is based upon and relies upon the entire AR file for the site remedy selection decision.

The United States Department of the Navy (Navy) is the lead agency and provides funding for ERP activities at Site 22. The Navy and USEPA Region 3, the lead regulatory agency, issue this ROD jointly. The Commonwealth of Virginia, Virginia Department of Environmental Quality (VDEQ), the support regulatory agency, has reviewed this ROD and the materials on which it is based, and concurs with the decision.

1.3 Assessment of the Site

Groundwater is the only remaining environmental medium to be addressed at Site 22. A No Further Action (NFA) ROD was signed for soil at Site 22 in September 2003, and an NFA ROD for sediment and surface water at Site 22 was signed in September 2011. Therefore, this ROD serves as the final ROD for Site 22.

Previous investigations concerning groundwater at Site 22 did not identify any potential ecological risks, but did identify the presence of constituents of concern (COCs) at concentrations that pose a potential threat to human health. —Trichloroethene (TCE) in shallow groundwater (Yorktown-Eastover aquifer) was identified as posing a potential risk under the future construction worker exposure scenario. Vinyl chloride (VC) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) in shallow groundwater (Yorktown-Eastover aquifer) were identified as posing a potential risk under the future residential use exposure scenario.

The response action selected in this ROD is necessary to protect the public health, welfare, and/or the environment from actual or threatened releases of hazardous substances.

[1] Reference phrases, presented as ***Bold Italicized Text***, are followed by a corresponding number from the References Section.

1.4 Description of Selected Remedy

The selected remedy for Site 22 groundwater is comprised of the following components:

Refining the conceptual site model (CSM) through a pre-design investigation

Implementing Enhanced In Situ Bioremediation (EISB) of RDX using emulsified vegetable oil (EVO) bio-barriers perpendicular to groundwater flow in the target treatment area with RDX above 100 micrograms per liter (µg/L) to accelerate the total time for achieving cleanup levels

Using monitored natural attenuation (MNA) for the dissolved TCE and VC plumes and the remaining dissolved RDX plume (less than 100 µg/L) following active treatment

Conducting periodic groundwater monitoring and synoptic groundwater level measurements

Enforcing Land Use Controls (LUCs) in the form of land and groundwater use restrictions (controls on intrusive activities such as excavation, residential development, or groundwater use) until cleanup levels are met

The selected remedy will address COCs in groundwater at Site 22. The primary source of contamination was the release of chemicals that occurred during waste handling and the burning of materials on the ground surface. The contaminants that were released to the ground surface leached into the soil as a result of infiltration of rain water, causing downward migration of contamination into subsurface soil and ultimately creating a dissolved phase groundwater plume. The contaminated soil at Site 22 was excavated and disposed of offsite in the fall of 2002 resulting in unlimited use and unrestricted exposure to soil at Site 22. Groundwater at Site 22 is not a principal threat waste.

1.5 Statutory Determinations

The selected remedy is protective of human health and the environment, complies with federal and state regulations that are applicable or relevant and appropriate to the remedial action, is cost effective, utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable, and satisfies the preference for treatment as a principal element of the remedy. Because the remedy will result in pollutants or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, the Navy will conduct statutory reviews every 5 years to ensure that the remedy remains protective of human health and the environment. This review will be conducted after the remedy is in place and at the same time as other sites that already require statutory five-year reviews. The next five-year review is scheduled for 2012, therefore, the first five-year review for this site is not expected until 2017.

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information related to Site 22 can be found in the AR.

COCs and their respective concentrations (Section 2.5, **Table 2**)

Current and reasonably anticipated future land use assumptions and current and potential future uses of groundwater (Section 2.6)

Baseline risk represented by the COCs (Section 2.7, **Table 4**)

Cleanup levels established for COCs and the basis for these levels (Section 2.8, Table 5)

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 2.9, **Table 6**)

How source materials constituting principal threats will be addressed (Section 2.10)

Key factor(s) that led to selecting the remedy (such as a description of how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (Section 2.11.1)

Potential land and groundwater use that will be available at the site as a result of the selected remedy (Section 2.11.4, **Table 9**)

1.7 Authorizing Signatures

Captain Lowell D. Crow Commanding Officer Naval Weapons Station Yorktown Yorktown, Virginia	Date
Ronald J.Borsellino Director Harzadous Site Cleanup DivisionOffice of Federal Facility Remediation and Site Assessment USEPA (Region 3)	Date

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2 Decision Summary

2.1 Site Name, Location, and Description

Site 22 (Burn Pad)
Naval Weapons Station Yorktown
Yorktown, Virginia
USEPA ID: VA8170024170

WPNSTA Yorktown is a 10,624-acre installation located on the Virginia Peninsula between the York River and the James River in Virginia (**Figure 1**). WPNSTA Yorktown is bounded on the northwest by WPNSTA Yorktown Cheatham Annex and the King’s Creek Commerce Center; on the northeast by the York River and the Colonial National Historic Parkway; on the southwest by Route 143 and Interstate 64; and on the southeast by Route 238 and the town of Lackey.

Site 22, the Burn Pad, encompasses a 9-acre area, located in the northeastern portion of WPNSTA Yorktown (**Figure 1**). An access road runs north-south and provides vehicle access to the site from the north (**Figure 2**). Site 22 consists of a grassy field surrounded by woods, situated on a flat, elevated area, with its ground surface sloping steeply to the east, south, and southwest toward the Eastern Branch of Felgates Creek and its unnamed tributary.

FIGURE 1
Regional Location Map

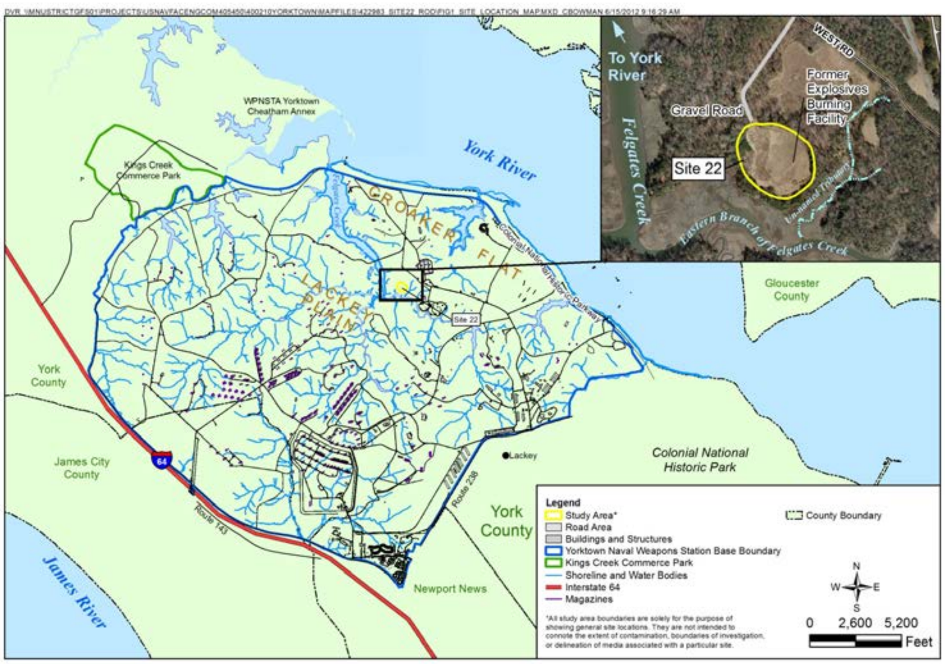
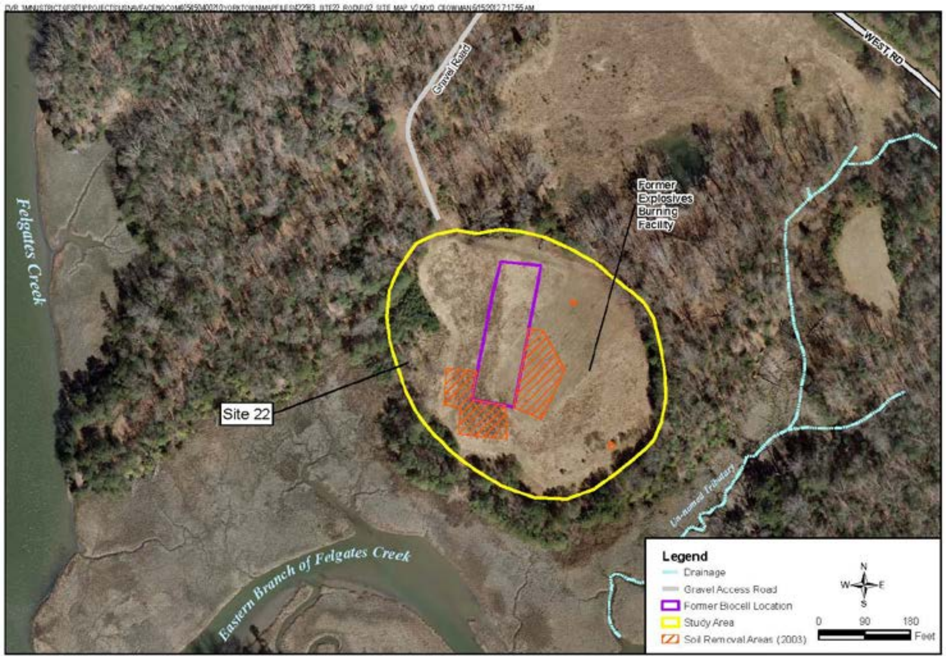


FIGURE 2
Site Map



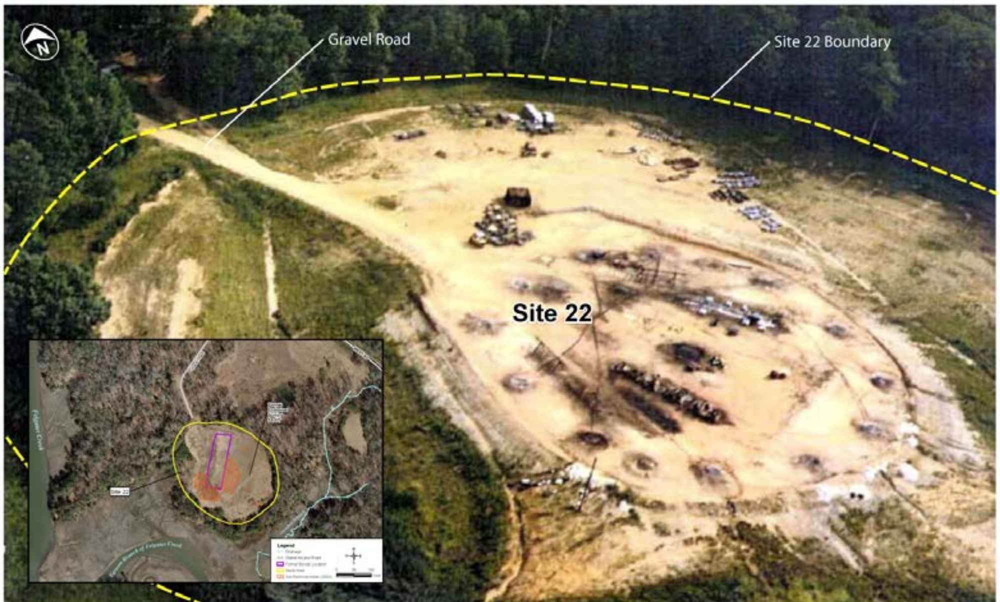
2.2 Site History and Enforcement Activities

Originally named the United States Mine Depot, WPNSTA Yorktown was established in 1918 to support the laying of mines in the North Sea during World War I. For 20 years after World War I, the depot continued to receive, reclaim, store, and issue mines, depth charges, and related materials. During World War II, the facility was expanded to include three trinitrotoluene loading plants and new torpedo overhaul facilities. A research and development laboratory for experimentation with high explosives was established in 1944. In 1947, a quality evaluation laboratory was developed to monitor special tasks assigned to the facility, which included the design and development of depth charges and advanced underwater weapons. On August 7, 1959, the depot was renamed the United States Naval Weapons Station. Today, the primary mission of WPNSTA Yorktown is to provide ordnance, technical support, and related services to sustain the war-fighting capability of the armed forces in support of national military strategy.

Site 22 was used for burning waste explosives and spent solvents generated from loading operations from the early 1940s until 1995. The ash from the burned solvents and explosives was transported to the Burning Pad Residue Landfill.

Site 22 once contained a 150-foot-diameter, circular array of 11 steel burning pans that were used for burning waste plastic explosives and spent solvents. A historical photograph taken in 1983 is included as **Figure 3**, and shows the numerous burn pads in a circular formation in the central and southern portion of Site 22.

FIGURE 3
Site 22 Historical Aerial Photograph



Source and date of photograph unknown.

In 1996, a 153-foot by 86-foot biocell was constructed at Site 22 and used for the treatment of nitramine-contaminated soils and trinitrotoluene-contaminated soils from WPNSTA Yorktown Sites 7 and 19 (**Figure 2**). Use of the biocell ended in 1999, and it was subsequently removed.

In 2002, a removal action was completed to remove contaminated soils from Site 22 (Figure 2). The COCs included the following: carcinogenic polynuclear aromatic hydrocarbons, Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine, cadmium, copper, and lead. Contaminated soil was excavated to a depth of 2 feet, and confirmation samples were collected. Approximately 3,450 cubic yards of soil were removed. A ROD (Ref. 1) was signed in 2003 documenting that NFA for unlimited use and unrestricted exposure was necessary for soil at Site 22. In addition, a ROD (Ref. 2) documenting that NFA was necessary for sediment and surface water at Site 22 was signed in September 2011.

Groundwater at Site 22 has been characterized during several investigations. **Table 1** provides a chronological list and brief summary of previous groundwater investigations conducted at Site 22. The respective investigation documents are a part of the AR and can be referenced for further details for specific sampling strategies, media investigations, and when and where the sampling was performed. The documents listed are available in the AR and provide detailed information used to support remedy selection at Site 22.

TABLE 1
Summary of Previous Groundwater Studies and Investigations at Site 22

Previous Study / Investigation* (Document and Document Date)	Sites	Investigation Activities
Round Two Remedial Investigation Report, Sites 4, 21, and 22 Baker, 2001	Sites 4, 21, and 22	From August to November 1996, groundwater, surface water, and surface/subsurface sediment samples were collected to evaluate potential risks to human health and the environment (**Figure 4**). Samples were analyzed for Target Compound List (TCL) VOCs, TCL semivolatile organic compounds, TCL pesticides/polychlorinated biphenyls, explosives and Target Analyte List metals and cyanide. The ***analytical results*** (Ref. 3) of six groundwater samples at Site 22 were used to complete a Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA). The HHRA indicated no unacceptable non-cancer hazards or cancer risks to current or future receptors under a beneficial use scenario for groundwater. The ERA, which was based on a screening of groundwater concentrations at Site 22 against marine surface water screening levels, indicated aquatic receptors would potentially be at risk from exposure to 1,1-dichloroethene, TCE, di-n-butylphthalate, aldrin, and several explosives and metals if groundwater contaminants from Site 22 were to discharge to a surface water body without dilution or natural attenuation. The ***analytical results*** (Ref. 4) of six co-located surface water and sediment samples at Site 22 were used to complete an HHRA and an ERA. The HHRA indicated no unacceptable non-cancer hazards or cancer risks to current or future receptors from exposure to surface water and sediment. The ERA indicated potential risk to ecological receptors from exposure to several pesticides, explosives, and metals in sediment.
Remedial Investigation Report for Groundwater at Sites 4, 21, and 22 CH2M HILL, 2009	Sites 4, 21, and 22	From Spring 2007 to Spring 2008, groundwater, groundwater seep, surface water, and surface and subsurface sediment samples were collected to evaluate potential risks to human health and the environment. Upgradient surface water and sediment samples were also collected to assess site-specific background conditions (**Figure 4**). Samples were analyzed for TCL VOCs, TCL semivolatile organic compounds, TCL pesticides and polychlorinated biphenyls, explosives, and Target Analyte List metals and cyanide. The ***analytical results*** (Ref. 5) of 12 groundwater samples at Site 22 were used to complete an HHRA and ERA. The HHRA indicated potential cancer risks to future residents due to exposure to VC, RDX, and arsenic, as well as non-cancer hazards to future residents from exposure to RDX, arsenic, and heptachlor epoxide, and to construction workers due to exposure to TCE. TCE, heptachlor epoxide, VC, RDX, and arsenic were identified as human health COCs within the Yorktown-Eastover aquifer at Site 22 under a future exposure scenario. However, based on the final results of the remedial investigation (RI), the COCs in groundwater at Site 22 identified for action were TCE, VC, and RDX (refer to Section 2.5.1 of this ROD). The RI concluded that development of a Feasibility Study (FS) for Site 22 groundwater was warranted. The ERA indicated no COCs were identified for seep exposures at Site 22. Similarly, no COCs were identified for food web exposures. Thus, risks to ecological receptors were considered acceptable. Groundwater is generally considered only as a transport medium since there are no ecological exposures to groundwater until it discharges to a water body or surfaces as a seep. The ***analytical results*** (Ref 6) of 11 co-located surface water and sediment, two independently located sediment samples, and six co-located background surface water and sediment samples were used to complete a HHRA and ERA. The ERA was completed to reevaluate conditions in surface water and sediment following the soil removal action. The HHRA and ERA identified no unacceptable risk to human health or the environment. Based on the results of the HHRA and ERA, the RI concluded that no unacceptable risk to human health or the environment from exposure to surface water or sediment is present at Site 22; therefore, no additional action was recommended to address surface water and sediment adjacent to the site.
Feasibility Study Report for Groundwater at Site 22 CH2M HILL, 2011	Site 22	An FS was generated to ***evaluate alternatives*** (Ref. 7) for remediation of TCE, VC, and RDX present at unacceptable levels in the groundwater. The preferred alternative as presented in the FS was Alternative 2 - Hot Spot Treatment of RDX using EISB and Associated Performance Monitoring; MNA of TCE, VC and RDX; and LUCs.

FIGURE 4
Historical Sample Layout

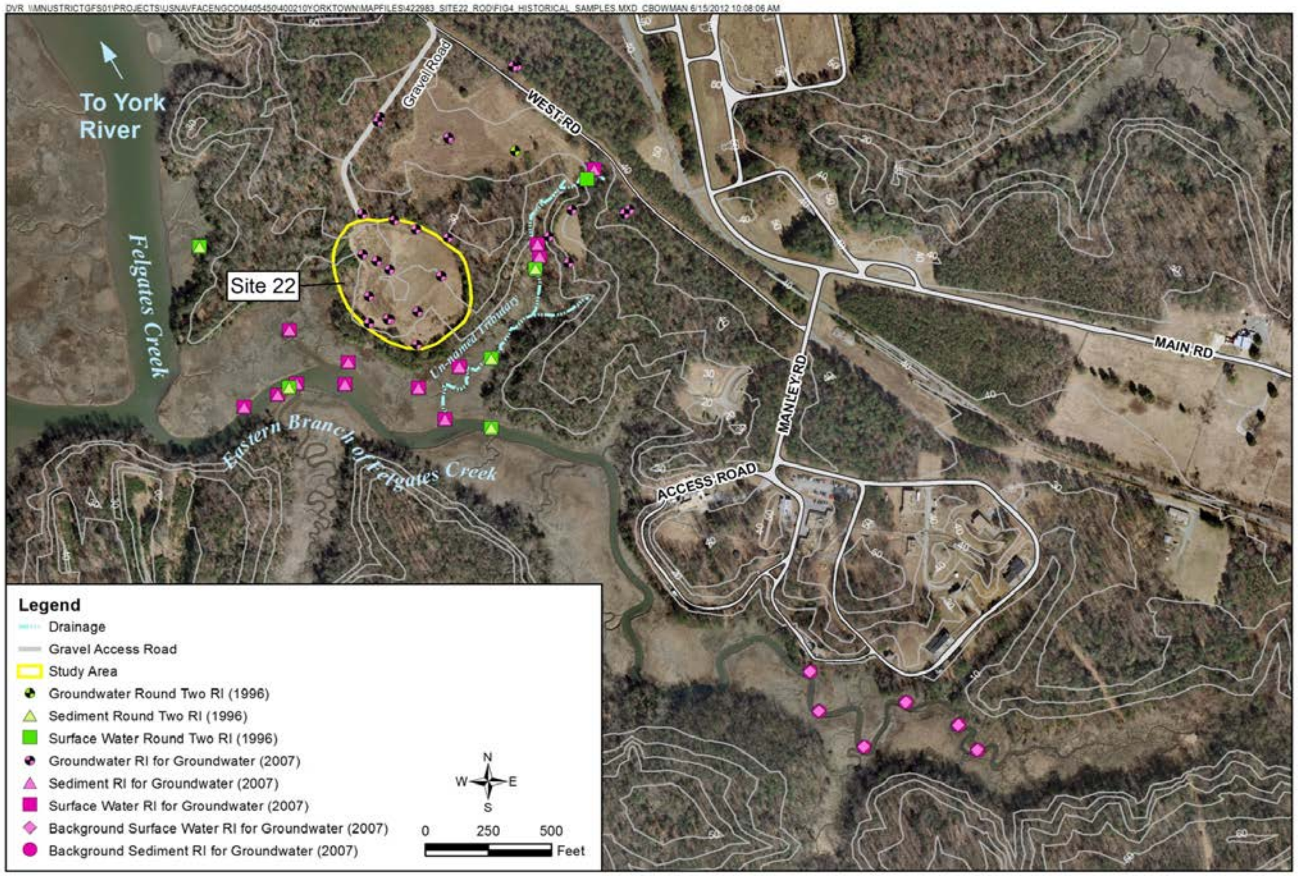


***Figure 4** illustrates the most recent activities conducted at each sampling location at Site 22 (sample locations associated with adjacent Sites 4 and 21 are included for completeness). In instances of samples collected in the same location across multiple reports, the most recent sampling event is shown.

2.3 Community Participation

Community participation at WPNSTA Yorktown includes a Restoration Advisory Board (RAB), public meetings, a public information repository, newsletters, fact sheets, public notices, and an ERP Website. The Community Involvement Plan for WPNSTA Yorktown, updated in 2009, provides detailed information on community participation for the ERP. The RAB was formed in 1994 and consists of community members and representatives from USEPA Region 3, VDEQ, and the Navy. RAB meetings are held twice a year and are open to the public to provide opportunity for public comment and input.

The investigations conducted at Site 22, the findings, and the documents in the AR form the basis for this ROD. A Proposed Plan (PP) was developed and made available for public review to request public input on the selected remedy for groundwater. In accordance with 40 Code of Federal Regulations 300.430(f)(3)(i)(A), a notice of availability of the PP was published in *The Virginia Gazette* and the *Daily Press* on May 12 and 13, 2012, respectively. The PP was available for review during the public comment period in accordance with Section 117(a) of CERCLA at the York County Public Library – Yorktown (8500 George Washington Memorial Highway, Yorktown, Virginia 23692, 757-890-3376). The public comment period ran from May 14 through June 28, 2012, and included a public meeting to present the PP, which was held on May 24, 2012 at the York County Public Library – Yorktown. No comments were received during the public comment period.

This ROD, the PP, and all other information that supports the selected remedy for groundwater at Site 22 are available in the AR. The AR is accessible through the WPNSTA Yorktown ERP public website at http://go.usa.gov/yFb or by contacting the WPNSTA Yorktown Public Affairs Officer at:

Public Affairs Office
P.O. Drawer 160
Yorktown, VA 23691-0160
Phone: (757) 887-4939

2.4 Scope and Role of Operable Unit

Comprehensive environmental restoration activities at WPNSTA Yorktown began in 1984 under the Navy Assessment and Control of Installation Pollutants program, prior to state and federal regulatory oversight of environmental activities at the installation. The Navy Assessment and Control of Installation Pollutants program was modified to become the ERP in 1986 (then known as the Installation Restoration Program) to meet the requirements of CERCLA, as amended. WPNSTA Yorktown was added to the National Priorities List on October 15, 1992 (USEPA ID: VA8170024170). A Federal Facilities Agreement (FFA) between the Navy and USEPA Region 3 was signed in August 1994. This FFA identified CERCLA sites, Site Screening Areas, and areas of concern for investigation and possible cleanup, and provided the framework and a schedule to accomplish this work. Subsequent to the FFA, additional sites, Site Screening Areas, and areas of concern were added to the ERP. Site 22 was evaluated in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan under the Navy's ERP, the status of which can be found in the current version of the Site Management Plan in the AR file for WPNSTA Yorktown.

This ROD presents the selected remedy for groundwater at Site 22. The selected remedy documented in this ROD for groundwater at Site 22 does not include or affect any other media at Site 22 or any other sites at WPNSTA Yorktown. The WPNSTA Yorktown ERP consists of 31 sites including Site 22 as detailed below:

There are 28 Installation Restoration Program sites at various phased of investigation or cleanup. Although RODs are in place for select media at some sites, below is a summary based on the last media being addressed at each site:

- Fourteen (14) sites under investigation (Sites 1, 3, 6, 7, 9, 19, 23, 24, 25, 26, 31, 32, 33, and 34)

- One (1) site at the remedy decision stage (Site 22)
- Two (2) sites in long-term management (Sites 12 and 16)
- Ten (10) closed sites (Sites 4, 5, 11, 17, 18, 21, 27, 28, 29, and 30)

There are 3 Munitions Response Program sites at various phases of investigation and cleanup. Below is a summary based on the last media being addressed at each site.

- Two (2) sites under investigation (UXO 2 and 3)
- One (1) closed site (UXO 1)

2.5 Site Characteristics

Site 22 consists primarily of a flat, grass-covered open area surrounded by woods; elevations for the site range from 20 to 32 feet above mean sea level. The southern and eastern edges of the site slope steeply toward the east, south, and southwest, toward the Eastern Branch of Felgates Creek and its unnamed tributary (**Figure 2**). Felgates Creek is a tidally influenced tributary to the York River. A gravel road runs north-south and provides vehicle access to Site 22 from the north. The site is currently unused except for periodic recreational hunting, and is located within a restricted area of WPNSTA Yorktown.

The hydrogeology at Site 22 consists of unsaturated soils at the ground surface, which are lithologically consistent with the Yorktown confining unit (gray silt and clay). The uppermost saturated unit in the Site 22 area is the Yorktown-Eastover aquifer, which lies below the 10- to 30-foot-thick Yorktown confining unit. The Yorktown-Eastover aquifer consists of coarse, shelly, gray sand, and is approximately 25 to 50 feet thick in the vicinity of Site 22. This aquifer overlies the Eastover-Calvert confining unit. There is no current or expected future use for groundwater at Site 22; drinking water is supplied to WPNSTA Yorktown and the surrounding area by the City of Newport News Waterworks.

Groundwater at Site 22 ranges from 5 to 20 feet bgs and flows to the south toward drainage channels and the Eastern Branch of Felgates Creek (**Figure 5**).

A ***CSM*** (Ref. 8) was developed to summarize site conditions, contaminant distribution, transport pathways, potential receptors, exposure pathways, and land use for Site 22 (**Figure 6**). The sources of contamination were releases of chemicals that occurred during waste handling and burning of materials on the ground surface. No subsurface burial of materials at Site 22 is known to have occurred. Some of the contaminants that were released to the ground surface leached into the soil as a result of infiltration of stormwater, causing downward migration of contamination into subsurface soil and ultimately creating a dissolved-phase groundwater plume. Much of the contamination remained relatively close to the land surface due to adsorption to soil. The contaminated soil at Site 22 was excavated and disposed of offsite and an NFA ROD documenting unlimited use and unrestricted exposure for soil was signed in November 2003. Contaminant concentrations in the groundwater of the Yorktown-Eastover aquifer at Site 22 are likely to decrease in the future because the source is no longer present and there is no ongoing release mechanism.

FIGURE 5

Yorktown-Eastover Aquifer Potentiometric Surface Map

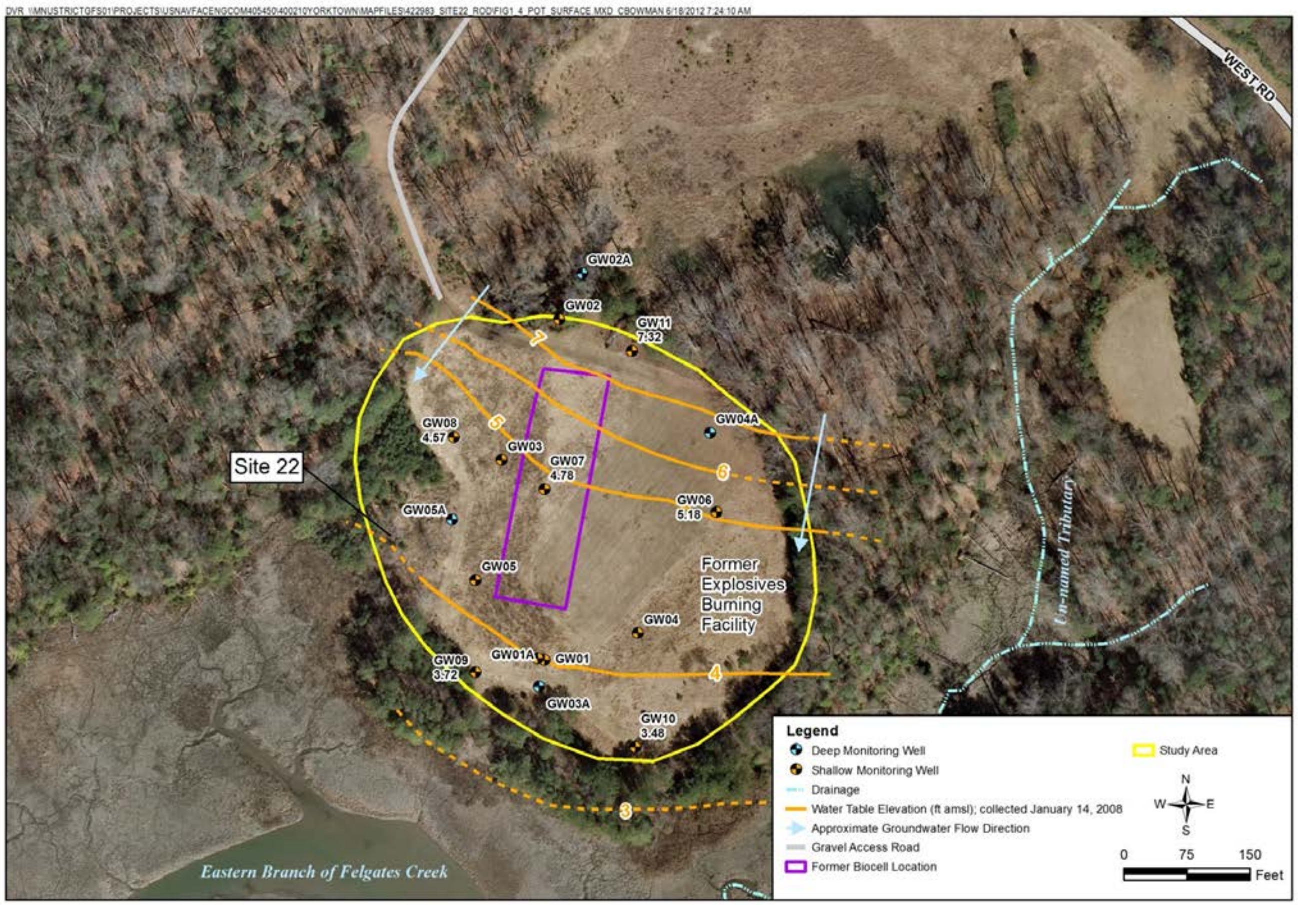
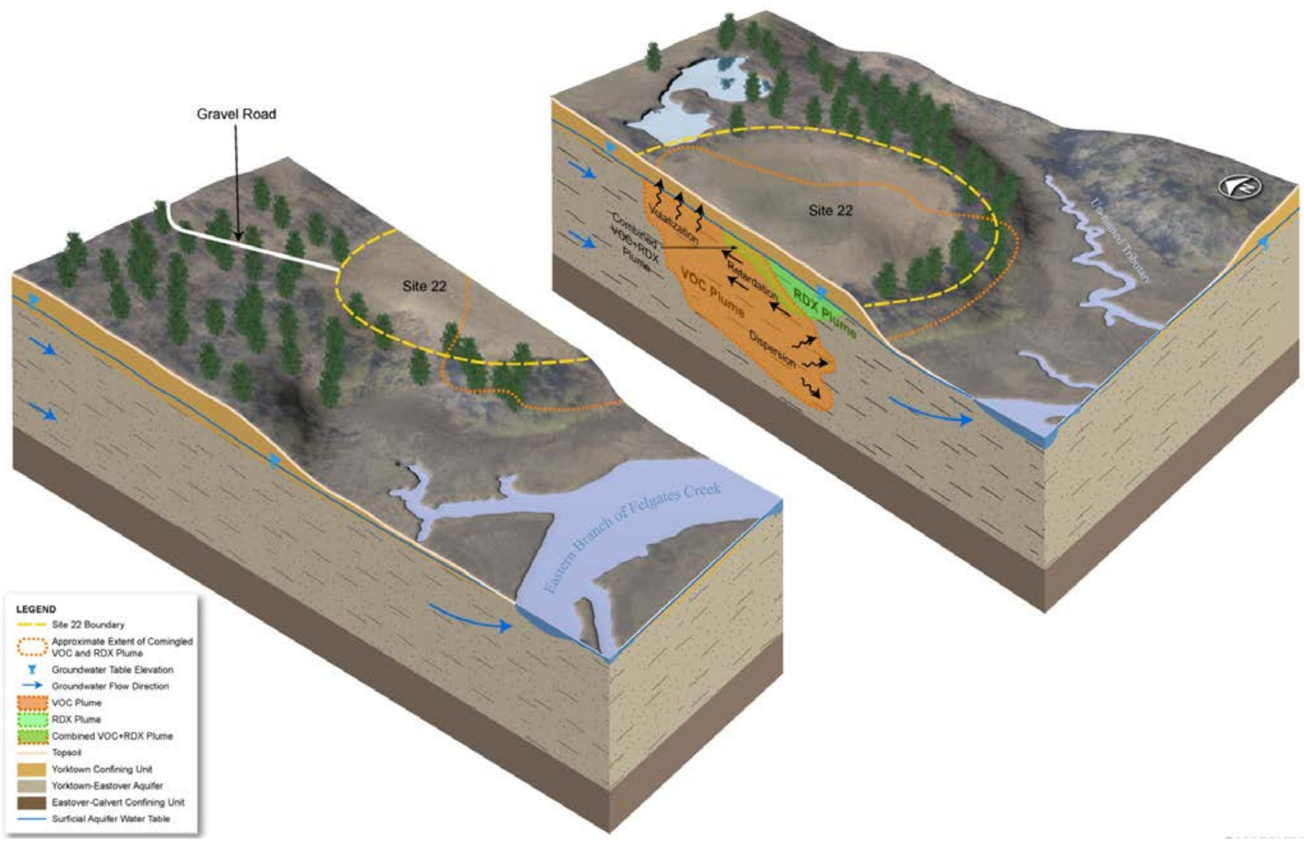


FIGURE 6
Conceptual Site Model



2.5.1 Nature and Extent of Contamination in Groundwater

Numerous investigations (Ref. 9) have been conducted to characterize potential impacts at Site 22 (**Table 1**). Based on the results of these investigations, the COCs in groundwater at Site 22 are TCE, VC, and RDX. Sampling locations from previous investigations are depicted on **Figure 4**, and the nature and extent of contamination is discussed as follows. Maximum concentrations of constituents identified as site COCs detected in Site 22 groundwater are presented in **Table 2**.

TABLE 2
Maximum Detected Concentrations of Site 22 Constituents of Concern

VOCs	Concentration (µg/L)	MCL (µg/L)
TCE	650	5
VC	17	2
Explosives	**Concentration (µg/L)**	**RSL (µg/L)**
RDX	150	0.61

The ***Results*** (Ref. 10) of the investigations at Site 22 indicated that TCE, VC, and RDX concentrations exceeded their respective Maximum Contamination Level (MCL) or Regional Screening Level (RSL) in shallow groundwater. TCE was detected at concentrations exceeding the MCL (5 µg/L) in five shallow monitoring wells, VC was detected at concentrations exceeding the MCL (2 µg/L) in two shallow monitoring wells, and RDX was detected at concentrations exceeding the RSL (0.61 µg/L) in 10 shallow monitoring wells.

The TCE, VC, and RDX groundwater contamination is present in a "corridor" that runs through the middle of Site 22 from north to south (**Figure 7**). Analytical results indicated the VOCs and RDX detected in groundwater were within the upper portion of the Yorktown-Eastover aquifer. The highest concentrations of TCE, VC, and RDX were detected between 10 and 50 feet bgs along the central portion of the site in sand containing a number of silt and clay stringers that may be retarding the downward mobility of the contaminants. No COCs were identified in samples taken from the base of the Yorktown-Eastover aquifer, which lies above the Eastover Calvert confining unit. Contaminant discharge to surface water via groundwater was not found to exceed any risk screening values (adjusted RSLs or ecological screening values) at Site 22; groundwater is therefore not a significant continuing source of contaminants to the aquatic habitats adjacent to the site.

2.5.2 Fate and Transport of COCs in Groundwater

The lateral groundwater seepage velocity at Site 22 is approximately 0.128 foot per day. However, contaminants are not expected to migrate as rapidly as groundwater because of a tendency for sorption to soil particles (retardation). Contaminants may also be migrating in groundwater through dispersion, which may slowly increase the size of the contaminant plume in groundwater. Volatilization of some contaminants from the groundwater into the air is also a possible migration pathway where elevated concentrations of chlorinated solvents are present.

TCE and VC

The source of TCE and its degradation product, VC, are likely releases from burn activities previously conducted at Site 22. Chlorinated VOC concentrations such as TCE and VC can change over time due to dilution and dispersion, but the primary mechanism for reductions under naturally occurring conditions is ***biodegradation*** (Ref. 11). Historical groundwater data for monitoring well YS22-GW04 demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time (**Table 3**).

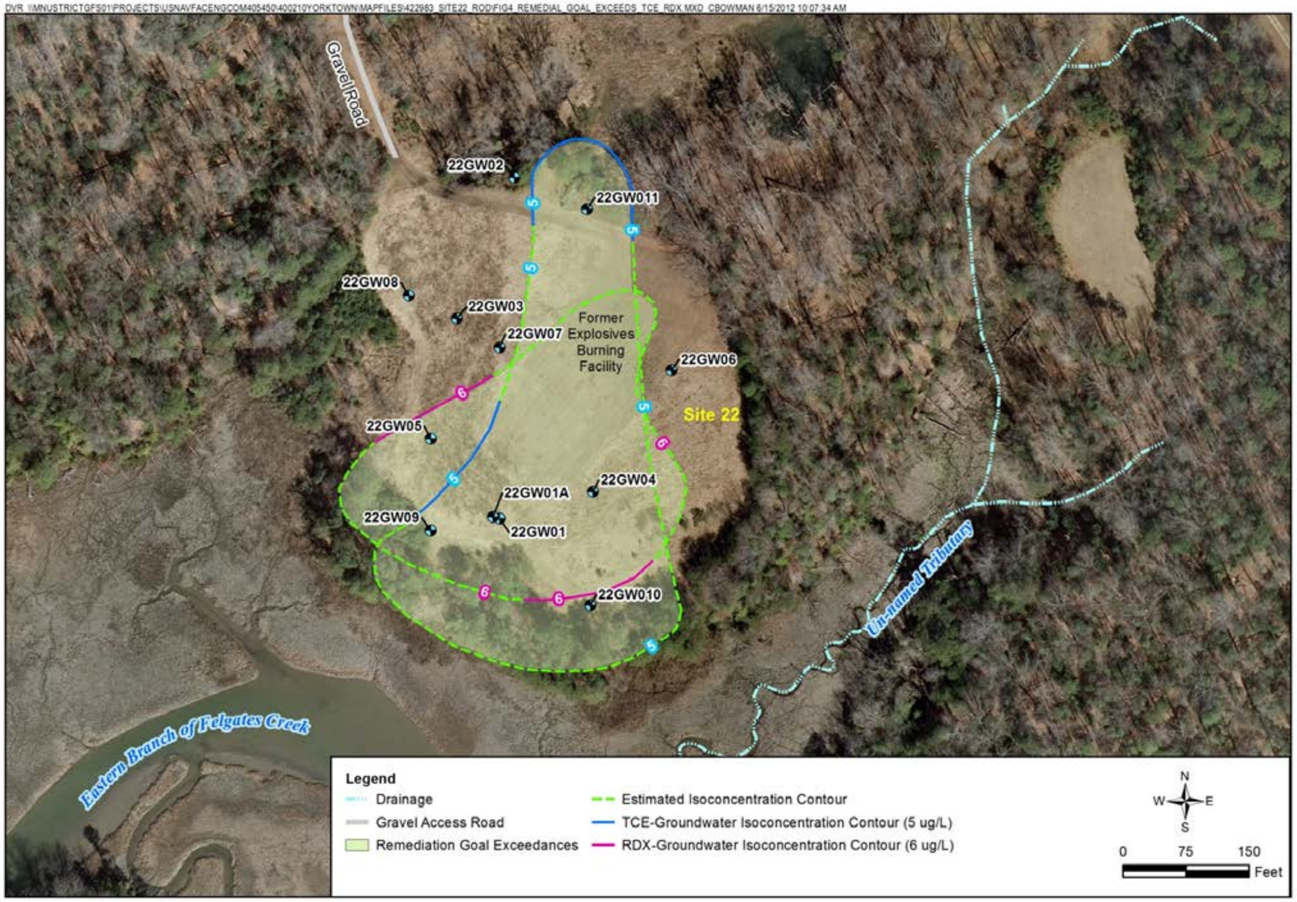
TABLE 3
TCE and Associated Degradation Products in Monitoring Well YS22-GW04 at Site 22

VOCs (µg/L)	11/12/1996	10/25/2007
TCE	1200	69
1,1-Dichloroethene	1700	37
cis-1,2-Dichloroethene	Not Analyzed	22
trans-1,2-Dichloroethene	Not Analyzed	10U
Total 1,2-Dichloroethene	*370*	*32*
VC	Not Detected	10U

U - The material was analyzed for, but not detected.

Commented [m1]: We can make this claim at this particular monitoring well but does it translate to Site-Wide decreasing trent?. Can we say the same at 22GW010 with 650 ug/l TCE?.

FIGURE 7
Remedial Goal Exceedances TCE and RDX



Note: Remedial goals are detailed in Section 2.8.

Biodegradation of chlorinated ethenes is a well-understood process whereby these VOCs undergo transformations through two primary pathways: use as an electron acceptor by dehalorespiring organisms (reductive dechlorination) or by co-metabolism (a fortuitous destruction of contaminants by organisms intending to metabolize other organic compounds). Biological reductive dechlorination is a microbially mediated process in which chlorinated VOCs serve as the electron acceptor for metabolism, coupled with oxidation of an available electron donor. Reductive dechlorination results in the sequential replacement of a chlorine atom on the chlorinated VOC molecule with hydrogen and can ultimately lead to complete dechlorination to innocuous end-products, such as chloride and ethane. Another process whereby VC undergoes biodegradation is through direct intracellular oxidation by oxygen-dependent microbes, which can use the contaminant as an energy source. Biodegradation of chlorinated ethenes is a mechanism of degradation at Site 22, as evidenced by the presence of TCE daughter products and Dehalococcoides bacterial species at the site.

Geochemical and microbial samples were collected from two wells (YS22-GW01 and YS22-GW04) at Site 22. Results from these two locations suggest the site is characterized by low concentrations of native and/or anthropogenic carbon (0.5U and 1.0 milligram per liter, respectively). Since microbial utilization of a carbon source drives reductive dechlorination, EISB at Site 22 will create enhanced bioremediation conditions. In addition to the geochemical data, the presence of the Dehalococcoides bacterial species (0.134J and 0.493 cells per milliliter, respectively), which is the only microbe identified to be capable of degrading chlorinated ethenes completely to ethane, was identified at Site 22.

RDX

The source of RDX are likely releases from burn activities previously conducted at Site 22. RDX can be biodegraded under most redox conditions and by a variety of microorganisms. Three mechanisms for the biodegradation of RDX have been identified: two-electron reduction, single-electron reduction/denitration, and direct enzymatic cleavage. The denitration pathway is considered the major pathway for biodegradation in the natural environment, resulting in the formation of benign products such as nitrite, ammonia, formaldehyde, and formic acid. Under ideal (laboratory) conditions, the biodegradation rate for RDX is exponential, and could decay as much as 1 to 5 times in a day (that is, a half-life of 0.2 to 1 day). RDX is not volatile and not very mobile; therefore, biodegradation is believed to be the primary attenuation mechanism for this chemical.

2.6 Current and Potential Future Land and Resource Uses

Site 22 is currently unused except for periodic recreational hunting, and is predominantly characterized by vegetated fields within a locked wire gate. Site 22 is located inside an area encumbered by the Explosive Safety Quantity Distance, which limits the activities that can be performed to explosives-related functions; therefore, the site cannot be developed for real estate purposes. It is anticipated that WPNSTA Yorktown will remain a military installation for the foreseeable future, and use of Site 22 will remain the same.

Groundwater from the Yorktown-Eastover aquifer in the vicinity of Site 22 is not a current or anticipated future source of drinking water at WPNSTA Yorktown due to generally low natural water quality and yield and a more readily available potable water source. Potable water at WPNSTA Yorktown is currently supplied by the City of Newport News Waterworks.

2.7 Summary of Site Risks

The baseline risk assessment estimates what risks the site poses if no action was 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 baseline risk assessment for this site.

Potential human health and ecological risks at Site 22 were evaluated for groundwater and documented in the 2009 RI report (**Appendix A**). The following subsections and **Table 4** briefly summarize the findings of the risk assessments.

2.7.1 Summary of Human Health Risk Assessment

As part of the 2009 RI report for Site 22, an HHRA was completed. Based on the human health CSM (**Appendix B**), risks were quantitatively evaluated for future adult construction workers and future adult/child residents exposed to shallow groundwater using reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios. Exposure pathways that were quantified included inhalation/ingestion of and dermal contact with groundwater for hypothetical future lifetime adult and child residents and ingestion and dermal contact with groundwater for hypothetical future construction workers. Based on current site use and conditions, there are no ***complete exposure pathways*** (Ref. 12) for groundwater at Site 22.

The RME calculation determines risk based on the highest level of human exposure that could reasonably be expected to occur, whereas the CTE level reflects human exposure to average concentrations across the site. The potential non-cancer hazards, expressed as the hazard index (HI), and cancer risk estimates were calculated using RME concentrations. For non-cancer effects, an HI represents the ratio between the reference dose and the dose for a person in contact with site chemicals of potential concern. An HI exceeding 1.0 indicates that potential health effects may occur. For known or suspected carcinogens, acceptable exposure levels generally are concentration levels that represent an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} (a 1 in 10,000 chance of developing cancer) and 10^{-6} (a 1 in 1,000,000 chance of developing cancer) using information on the relationship between dose and response.

Potential unacceptable human health risks (Ref. 13) were identified under a future resident and/or construction worker exposure scenario due to exposure to TCE, heptachlor epoxide, VC, RDX, and arsenic within the Yorktown-Eastover aquifer (**Table 4**).

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TABLE 4
Summary of Potential Human Health Risks for Site 22 COCs

Receptor	Exposure Pathway	COC	Exposure Point Concentration	RME Cancer Risk	RME Non-Cancer Risk (HI)	CTE Cancer Risk	CTE Non-Cancer Risk (HI)	Cancer Toxicity Factor (Cancer Slope Factor) milligrams per kilogram per day^{-1}	Non-Cancer Toxicity Factor (Reference Dose) milligrams per kilograms per day
Future Resident Adult	Ingestion	VC	17	N/A	0.16	Not Applicable (N/A)	0.016	0.72	0.003
		Heptachlor epoxide	0.142	N/A	0.3	N/A	0.089	9.1	0.000013
		RDX	94.17	N/A	0.86	N/A	0.076	0.11	0.003
		Arsenic	6.96	N/A	0.64	N/A	0.21	1.5	0.0003
		Total*	--	--	**2.9**[1]	--	0.62	--	--
	Dermal Contact	VC	17	N/A	0.0083	N/A	0.00077	0.72	0.003
		Heptachlor epoxide	0.142	N/A	0.62	N/A	0.17	9.1	0.000013
		RDX	94.17	N/A	0.0077	N/A	0.00064	0.11	0.003
		Arsenic	6.96	N/A	0.0033	N/A	0.00068	1.5	0.0003
		Total*	--	--	0.8	--	0.21	--	--
	Inhalation/Shower	TCE	315	1.6 x 10-5	0.039	4.0×10^{-6}	0.026	0.007	0.17
		VC	17	2.7 x 10-6	0.018	6.8×10^{-7}	0.012	0.015	0.029
		Total*	--	3.3 x 10-5	0.1	8.2×10^{-6}	0.9	--	--
	Total Across All Exposure Routes	--	--	3.3 x 10-5	**3.8**[1]	8.2×10^{-6}	0.07	--	--
Future Resident Child	Ingestion	VC	17	N/A	0.36	N/A	0.053	0.72	0.003
		Heptachlor epoxide	0.142	N/A	0.70	N/A	0.30	9.1	0.000013
		RDX	94.17	N/A	**2.0**	N/A	0.25	0.11	0.003
		Arsenic	6.96	N/A	**1.5**	N/A	0.70	1.5	0.0003
		Total*	--	--	**6.8**	--	**2.1**	--	--
	Dermal Contact	VC	17	N/A	0.020	N/A	0.0015	0.72	0.003
		Heptachlor epoxide	0.142	N/A	**1.4**	N/A	0.34	9.1	0.000013
		RDX	94.17	N/A	0.017	N/A	0.0013	0.11	0.003
		Arsenic	6.96	N/A	0.0098	N/A	0.0015	1.5	0.0003
		Total*	--	--	**1.8**	--	0.41	--	--
	Total Across All Exposure Routes	--	--	N/A	**8.7**	N/A	**2.5**	--	--
Future Lifetime Resident (Adult/Child)	Ingestion	TCE	315	6.1 x 10-5	N/A	5.3×10^{-6}	N/A	0.013	N/A
		VC	17	**1.8 x 10-4**	N/A	1.4×10^{-5}	N/A	0.72	0.003
		Heptachlor epoxide	0.142	1.0 x 10-5	N/A	4.4×10^{-6}	N/A	9.1	0.000013
		RDX	94.17	**1.5 x 10-4**	N/A	1.0×10^{-5}	N/A	0.11	0.003
		Arsenic	6.96	**1.6 x 10-4**	N/A	3.9×10^{-5}	N/A	1.5	0.0003
		Total*	--	**6.4 x 10-4**	N/A	8.7×10^{-5}	N/A	--	--
	Dermal Contact	TCE	315	1.0 x 10-5	N/A	6.0×10^{-7}	N/A	0.013	N/A
		VC	17	9.8 x 10-6	N/A	4.9×10^{-7}	N/A	0.72	0.003
		Heptachlor epoxide	0.142	4.0 x 10-5	N/A	6.1×10^{-6}	N/A	9.1	0.000013
		RDX	94.17	1.4 x 10-6	N/A	6.2×10^{-8}	N/A	0.11	0.003
		Arsenic	6.96	8.9 x 10-7	N/A	9.8×10^{-8}	N/A	1.5	0.0003
		Total*	--	8.4 x 10-5	N/A	1.1×10^{-5}	N/A	--	--
	Inhalation/Shower	TCE	315	1.6 x 10-5	N/A	4.0×10^{-6}	N/A	0.007	0.17
		VC	17	2.7 x 10-6	N/A	6.8×10^{-7}	N/A	0.015	0.029
		Total*	--	3.3 x 10-5	N/A	8.2×10^{-6}	N/A	--	--
	Total Across All Exposure Routes	--	--	**7.6 x 10-4**	N/A	**1.1 x 10-4**	N/A	--	--
Future Construction Worker - Adult	Dermal Contact	TCE	315	1.7 x 10-7	N/A	2.3×10^{-8}	N/A	0.013	N/A
		VC	17	2.3 x 10-7	0.0074	2.6×10^{-8}	0.00085	0.72	0.003
		Heptachlor epoxide	0.142	4.4 x 10-7	0.26	2.0×10^{-7}	0.12	9.1	0.000013
		RDX	94.17	1.7 x 10-8	0.0036	2.1×10^{-9}	0.00044	0.11	0.003
		Arsenic	6.96	4.4 x 10-8	0.0068	1.7×10^{-8}	0.0026	1.5	0.0003
		Total*	--	1.2 x 10-6	0.47	4.0×10^{-7}	0.17	--	--
	Inhalation	TCE	315	2.2 x 10-5	**1.3**	1.3×10^{-6}	0.077	0.007	0.17
		VC	17	3.9 x 10-6	0.61	2.0×10^{-7}	0.032	0.015	0.029
		Total*	--	4.8 x 10-5	**3.3**	3.7×10^{-6}	0.28	--	--
	Total Across All Exposure Routes	--	--	4.9 x 10-5	**3.7**	4.1×10^{-6}	0.45	--	--

*Exposure pathway totals are additive and include all chemicals that contribute to potential risk

1 = No COCs identified with an HI >1

Bold/Yellow Shaded text indicates potential unacceptable human health risk

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Although arsenic and heptachlor epoxide contributed to the total RME cancer risk for the future lifetime resident (adult/child) scenario, the Navy, in partnership with USEPA and VDEQ, agree that no additional action is required for these constituents for the following reasons:

- Although arsenic was considered a human health COC under the RME scenario, concentrations of arsenic did not pose risk under the CTE scenario
- Dissolved arsenic concentrations did not exceed the MCL (10 µg/L)
- Arsenic concentrations are consistent with natural background concentrations rather than a site-related CERCLA source
- Heptachlor epoxide (YS22-GW03 at 0.21 µg/L) only slightly exceeded the MCL (0.2 µg/L) in 1 out of 13 samples
- The low concentrations of heptachlor epoxide suggest its presence is attributable to routine pesticide treatment activities by the base and not a CERCLA-regulated release

The HHRA concluded TCE and VC in groundwater exceed MCLs and contribute to potential risk under hypothetical future exposure scenarios in the upper portion of the Yorktown-Eastover aquifer. No MCL exists for RDX, but concentrations were found to pose potential risk under hypothetical future exposure scenarios. COCs were not detected above MCLs or RSLs in the deep portion of the Yorktown-Eastover aquifer. The Navy, in partnership with USEPA and VDEQ, agree that remedial action for groundwater is necessary to address TCE, VC, and RDX in the upper portion of the Yorktown-Eastover aquifer.

2.7.2 Summary of Ecological Risk Assessment

As part of the 2009 RI report for Site 22, an ERA was completed. Complete pathways for ecological receptors were limited to exposure to surface water, surface sediment, and surface soil. Surface soil was not evaluated in the ERA because risks associated with this medium were addressed during the previous remedial action. Groundwater was considered only as a transport medium since there were no ecological exposures to groundwater until it discharged to a water body or surfaced as a seep. Based on the results of the ERA, the Navy, USEPA Region 3, and VDEQ agree that groundwater at Site 22 does not pose unacceptable ecological risks to current receptors based on the following:

- No ecological COCs were identified for surface water, sediment, or seep exposures (NFA - ROD signed in September 2011)
- Source areas were removed during previous site activities
- Groundwater is not a significant continuing source of contaminants to the aquatic habitats adjacent to the site.

The ERA concluded there are ***no potentially unacceptable risk*** (Ref. 14) due to exposure to groundwater seeps, surface water, or sediment at Site 22. The Navy, in partnership with the USEPA and VDEQ agree that no further action for groundwater is necessary to prevent exposure to ecological receptors.

2.7.3 Basis for Response Action

It is the current judgment of the Navy and USEPA, with the concurrence of VDEQ, that the selected remedy in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

While there are no potential ecological risks from exposure to site groundwater, there are potential future human health risks from TCE, VC, and RDX. TCE in shallow groundwater (Yorktown-Eastover aquifer) was identified as posing a potential risk under the future construction worker exposure scenario, and VC and RDX in shallow groundwater (Yorktown-Eastover aquifer) were identified as posing a potential risk under the future residential use exposure scenario (**Table 4**).

2.8 Remedial Action Objectives

The site-specific remedial action objectives (RAOs) for Site 22 groundwater are as follow:

- Reduce TCE, VC, and RDX concentrations in groundwater to established risk-based cleanup levels.
- Prevent human (residential and construction worker) exposure to groundwater until cleanup levels are met.

Cleanup levels for groundwater were developed for site-related COCs (TCE, VC, and RDX) with cancer risks exceeding 1 in 10,000 or with concentrations exceeding the established MCLs (**Table 5**). MCLs were used to establish the groundwater cleanup levels for TCE and VC (5 µg/L and 2 µg/L, respectively). Attainment of MCLs is considered to be protective and suitable for unlimited use and unrestricted exposure. Because no MCL has been established for RDX, a risk-based cleanup level of 6 µg/L was calculated. Cleanup level exceedances for TCE and RDX are spatially shown on **Figure 7**; VC exceeded the MCL in two wells located within the TCE plume (22GW09 and 22GW11) and fall within the footprint of the TCE plume, and therefore is not shown. The cleanup level for RDX was determined based on Remedial Goal Option calculations, which incorporate pathways for the ingestion, dermal absorption, and inhalation of volatiles and particulates for future residents using the same exposure assumptions as the HHRA.

TABLE 5
Remediation Goals (Cleanup Levels) for COCs at Site 22

COC	Remediation Goal (µg/L)
TCE	5 µg/L
VC	2 µg/L
RDX	6 µg/L

2.9 Description of Remedial Alternatives

The objective of this section is to provide a brief explanation of the remedial alternatives developed for Site 22 groundwater.

2.9.1 Description of Remedy Components

Remedial alternatives were ***developed and evaluated*** (Ref. 15) to address COCs in groundwater at Site 22, as detailed in the 2011 FS Report. Following the initial screening of groundwater remediation technologies, the following remedial alternatives were selected for detailed evaluation and comparative analysis:

- **Alternative 1** – No Action
- **Alternative 2 –** Hot Spot Treatment of RDX using EISB and Associated Performance Monitoring; MNA of TCE, VC, and RDX; and LUCs
- **Alternative 3 –** Hot Spot Treatment of RDX, TCE, and VC using In situ Chemical Oxidation (ISCO) and Associated Performance Monitoring; MNA of TCE, VC and RDX; and LUCs
- **Alternative 4 –** Hot Spot Treatment of TCE, VC, and RDX using EISB and Associated Performance Monitoring; MNA of TCE, RDX, and VC; and LUCs

Based on the results of the alternatives evaluation, Hot Spot Treatment of RDX using EISB and Associated Performance Monitoring; MNA of TCE, VC, and RDX; and LUCs (Alternative 2) was selected as the Preferred Alternative. With the exception of the No Action alternative (Alternative 1), each of the alternatives includes monitoring and implementation of LUCs to prevent exposure. A No Action Alternative is required by the National Oil and Hazardous Substances Pollution Contingency Plan and serves as the baseline against which the other alternatives are compared. For Alternatives 2, 3, and 4, monitoring and LUCs would be maintained until the RAOs are met, with 5-year statutory reviews to ensure protection of human health and the environment. A description of each remedial alternative is provided in **Table 6**.

TABLE 6
Description of Remedial Alternatives for Site 22

Alternative	Components	Details	Cost
1-No Action	None	Allow the COCs to breakdown naturally over time.	Capital Cost: $0 O&M Present Value: $0 Total Present Value: $0 Cost Estimate Timeframe: 0 years
2-Hot Spot Treatment of RDX using EISB and Associated Performance Monitoring, MNA of TCE, VC, and RDX; and LUCs	• Implementing EISB in areas where RDX concentrations exceed 100 µg/L using EVO bio-barriers • MNA for dissolved TCE, VC, and RDX plumes where concentrations are less than100 µg/L • Conducting periodic groundwater monitoring and water-level measurements • LUCs	Injecting a suitable insoluble substrate to the subsurface providing a carbon source for microorganisms to enhances the biodegradation of RDX. Regular, long-term monitoring performed to demonstrate 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 hydrogeologic, geochemical, or microbiological parameters that might reduce the effectiveness of the Remedial Action LUCs to prevent exposure and control changes in site use. 5-year reviews	Capital Cost: $708,026 O&M Present Value:$1,028,565 Total Present Value:$1,907,000 Cost Estimate Timeframe: 34 years
3-Hot Spot Treatment of RDX, TCE and VC using ISCO and Associated Performance Monitoring; MNA of TCE, VC, and RDX; and LUCs	• ISCO using permanganate (MN04) in active target treatment areas where TCE, VC, and RDX concentrations exceed100 µg/L • MNA for dissolved TCE, VC, and RDX plumes where concentrations are less than100 µg/L • Conducting periodic groundwater monitoring and water-level measurements • LUCs	Injection of oxidizing agent to promote abiotic, in situ oxidation of COCs through reaction of oxidants with COCs to produce innocuous substances such as carbon dioxide, water, and chloride. Electron donor source is provided to enhance naturally occurring reductive dechlorination process. Regular, long-term monitoring performed to demonstrate 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 hydrogeologic, geochemical, or microbiological parameters that might reduce the effectiveness of the Remedial Action LUCs prevent exposure and control changes in site use. 5-year reviews	Capital Cost:$1,228,931 O&M Present Value:$833,902 Total Present Value:$2,482,000 Cost Estimate Timeframe: 25 years
4-Hot Spot Treatment of TCE, VC, and RDX using EISB and Associated Performance Monitoring; MNA of TCE, RDX, and VC; and LUCs	• EISB of RDX, TCE, and VC using EVO bio-barriers in areas with TCE, VC, and RDX concentrations greater than 100 µg/L • MNA for dissolved RDX, TCE, and VC plumes where concentrations are less than100 µg/L • Conducting periodic groundwater monitoring and water-level measurements • LUCs	Injection of substrates into groundwater to facilitate reductive chlorination, thereby producing an electron donor source for biodegradation. Regular, long-term monitoring performed to demonstrate 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 hydrogeologic, geochemical, or microbiological parameters that might reduce the effectiveness of the Remedial Action LUCs prevent exposure and control changes in site use. 5-year reviews	Capital Costs: $1,024,061 O&M Present Value: $994,759 Total Present Value: $2,718,000 Cost Estimate Timeframe: 29 years

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2.9.2 Summary of Comparative Analysis of Alternatives

A comparative analysis of the four alternatives and the optimization remedy component with respect to the nine evaluation criteria was completed and is summarized in **Table 7**. An optimization remedy component includes the development of a plan for additional plume treatment if an unacceptable risk is indicated during monitoring and 5-year reviews. **Table 8** depicts a comparison of the alternatives to the criteria to support ranking of the alternatives. Alternative 1 (No Action) does not achieve RAOs designed to protect human health and the environment; therefore, it fails the first threshold criterion and is not considered further in this ROD.

TABLE *7*
Evaluation Criteria for Remedial Alternative Analysis

CERCLA Criteria	Definition
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 Applicable Or Relevant And Appropriate Requirements (ARARs)	Addresses whether an alternative will meet all of the ARARs or other 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, O&M, and present-worth costs.
Modifying Criteria	
State Acceptance	Considers the state agency comments on the PP.
Community Acceptance	Provides the public's general response to the remedial alternatives described in the PP. The specific responses to the public comments are addressed in the "responsiveness summary" section of the ROD.

TABLE 8
Relative-Ranking of Remedial Alternatives

CERCLA Criteria	No Action (ALT 1)	EISB and Performance Monitoring of RDX with MNA of TCE, VC, and RDX and LUCs (ALT 2)	ISCO, Performance Monitoring and MNA of TCE, VC, and RDX and LUCs (ALT 3)	EISB, Performance Monitoring, and MNA of TCE, VC, and RDX and LUCs (ALT 4)
Threshold Criteria				
Protection of human health and the environment	❍	●	●	●
Compliance with ARARs	N/A	●	●	●
Primary Balancing Criteria				
Long-term effectiveness and permanence	❍	●	●	●
Reduction in toxicity, mobility, or volume through treatment	❍	●	●	●
Short-term effectiveness	❍	**O**	**O**	**O**
Implementability	●	**O**	**O**	**O**
Cost	N/A	● $1,907,000	**O** $2,482,000	**O** $2,718,000
Modifying Criteria				
State Acceptance	NC	NC	NC	NC
Community Acceptance	NC	NC	NC	NC

Ranking: ● High **O** Moderate ❍ Low N/A=Not Applicable

Rankings are provided as qualitative descriptions of the relative compliance of each alternative with the criteria.

NC = No significant comments were received from State or Community Members on the PP.

Threshold Criteria

Overall Protection of Human Health and the Environment

With the exception of Alternative 1 (No Action), each alternative is protective of human health and the environment by reducing or controlling risks posed by the site through treatment and/or LUCs. Alternative 2 employs treatment to reduce RDX concentrations in a faster timeframe than would occur naturally. Alternatives 3 and 4 employ treatment to reduce concentrations in the RDX, TCE, and VC target areas to reduce the remedial timeframe. Performance monitoring will be conducted to confirm that the remedies are functioning and protective, and that LUCs will be implemented and maintained to provide adequate protection of human health and the environment by controlling exposure to contaminated site media until RAOs are met.

Compliance with Applicable or Relevant and Appropriate Requirements

The ARARs for the selected remedy at Site 22 are listed in **Appendix C**. Alternatives 2, 3, and 4 are expected to comply with the federal and state ARARs. Alternatives 2, 3, and 4 would all require measures to be taken to establish performance monitoring and LUCs. All of these alternatives would also require additional measures to ensure compliance with ARARs related to the injections of reagents into the subsurface.

Primary Balancing Criteria

Long-Term Effectiveness and Permanence

Each alternative with the exception of Alternative 1 is expected to achieve long-term effectiveness and permanence at the conclusion of remedial activities in reducing concentrations of TCE, VC, and RDX. Once RAOs are achieved, all alternatives, except Alternative 1, are expected to be effective in the long-term, as active treatment is intended to treat the contamination (treatment for RDX using EISB for Alternative 2, treatment for RDX, TCE, and VC using ISCO for Alternative 3, and treatment for RDX, TCE, and VC using EISB for Alternative 4) and allow natural attenuation to reduce groundwater contaminant concentration to below cleanup levels. Some emissions (nitrogen oxide, particulate matter less than 10 micrometers in aerodynamic diameter, carbon dioxide associated with greenhouse gas, and criteria pollutants) from reagent production, transportation, and heavy machinery use may persist for an extended period after RAOs are achieved for Alternatives 2, 3, and 4.

Reduction in Toxicity, Mobility, or Volume through Treatment

Alternative 1 does not include active treatment. Therefore, no contaminants are treated or destroyed under this alternative except through natural attenuation processes. Alternatives 2 (treatment of RDX), 3 (treatment of RDX, TCE, and VC), and 4 (treatment of RDX, TCE, and VC) are each expected to reduce toxicity, mobility, and volume by treating the groundwater, which is a statutory preference. For Alternative 2, some active treatment of TCE and VC is assumed to occur where the VOC plumes overlap with the RDX treatment area. Also, while MNA is not considered a treatment, the natural reduction of contaminant concentrations through a variety of physical, chemical, or biological activities is expected to occur over time for Alternatives 2, 3, and 4.

Short-Term Effectiveness

Alternative 1 allows natural attenuation to reduce the contaminant plumes, but does not provide measures to prevent exposure to site-related COCs. Therefore, Alternative 1 is not considered protective of either human health or the environment and will pose a potential risk. The short-term effectiveness associated with Alternatives 2, 3, and 4 are similar with regard to how they affect the community and the local environment. Alternatives 2, 3, and 4 all rely on direct injection technology for implementation. The community would be impacted due to the transportation of injection materials and the generated investigation-derived waste.

While the relative-rankings of the remedial alternatives provided in **Table 8** provide information relative to the compliance of each alternative with the short term effectiveness criteria, the following summaries provide a ranking of each alternative relative to each other.

Alternative 2 would least impact the environment due to a lower amount of construction or intrusive activities and environmental impacts (fewer injection points and EISB injections and a limited extent of treatment area). RAOs are estimated to be achieved in an estimated 34 years.

Alternative 3 has the highest impact on workers and the community due to the high use of heavy machinery, handling of chemical oxidants, and transportation of chemical oxidant on public roads and highways. This alternative has the highest greenhouse gas emissions and energy consumption primary due to oxidant and polyvinyl chloride manufacturing. RAOs are estimated to be achieved in an estimated 25 years.

Alternative 4 will have a moderate impact on workers and the community due to the highest amount of intrusive activities (greater number of injection points and EISB injections) and the high volume of heavy machinery traffic and frequency of site visits. This alternative has the highest sulfur oxide emissions, nitrogen oxide, particulate matter less than 10 micrometers in aerodynamic diameter, and emissions due to fuel consumption. RAOs are estimated to be achieved in an estimated 29 years.

Alternative 2 provides the greatest short-term effectiveness due to its minimization of intrusive activities compared to Alternatives 3 and 4.

Implementability

Alternatives 2, 3, and 4 can each be implemented using standard and widely available technologies. All materials and services needed for implementation are readily and commercially available. These three alternatives (2, 3, and 4) require engineering and construction services, and each alternative requires thorough monitoring to ensure they continue to operate on a path toward achieving RAOs. Each of the three alternatives (2, 3 and 4) is reliable provided they are designed and implemented correctly.

Cost

An order of magnitude cost for each alternative has been estimated based on a variety of key assumptions, including an assumed 35-year project life. The estimated timeframe required to achieve the cleanup levels varies by alternative (**Table 6**). The estimated capital cost for implementation of Alternative 2 ($708,026) is less than that of Alternative 3 ($1.2 million) or Alternative 4 ($1.0 million). The estimated present value cost for Alternative 2 is $1.9 million, less than for Alternative 3 ($2.5 million) and Alternative 4 ($2.7 million). Alternative 2 has a lower capital cost due to the type and quantity of injection materials.

Table 6 provides details of the cost summaries, and **Table 8** provides a relative ranking of the four alternatives.

Modifying Criteria

State Acceptance

State involvement has been solicited throughout the CERCLA and remedy selection process. VDEQ, as the designated state support agency in Virginia, has reviewed this ROD and has given concurrence on the selected remedy for groundwater at Site 22. The selected remedy, Alternative 2 (Hot Spot treatment of the RDX target area [concentrations above 100 µg/L] using EISB and associated performance monitoring; MNA of TCE, VC, and RDX; and LUCs), is consistent with the VDEQ’s preference for active treatment of high-concentration target areas.

Community Acceptance

The public meeting was held on May 24, 2012, to present the PP and answer community questions regarding the proposed remedial action at Site 22. The questions and concerns raised at the meeting were general inquiries for informational purposes only; but no comments were received requiring amendment to the PP, and no additional written comments, concerns, or questions were received from community members during the public comment period.

2.10 Principal Threat Wastes

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 an exposure occur. Although no “threshold level” of risk has been established to identify principal threat waste, a general guideline is to consider a principal threat to be those source materials with toxicity and mobility characteristics that combine to pose a potential risk several orders of magnitude greater than the risk level that is acceptable for the current or reasonably anticipated future land use, given realistic exposure scenarios. Contaminated groundwater is generally not considered to be a source material, and VOC concentrations are below 1 percent of the aqueous solubility of each COC, indicating that groundwater contamination likely consists of a dissolved phase plume with no dense non-aqueous phase liquid present. Therefore, the groundwater at Site 22 is not considered to be a principal threat waste. However, the selected remedy includes a treatment technology that will be used to permanently reduce TCE, VC, and RDX concentrations in groundwater to established risk-based cleanup levels.

2.11 Selected Remedy

Based on the ***comparative analysis*** (Ref. 16), the selected remedy to address risk associated with groundwater at Site 22 is Alternative 2, consisting of three components: (1) Hot Spot Treatment of RDX using EISB and Associated Performance Monitoring; (2) MNA of RDX, TCE, and VC; and (3) LUCs.

2.11.1 Summary of the Rationale for the Selected Remedy

Based on the evaluation of the data and information currently available, the Navy, in partnership with USEPA, has determined that the selected remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. 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; 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. If, however, the Navy, USEPA, and VDEQ determine after two years following the second injection event that the remedy is not performing as anticipated, a plan for additional plume treatment will be developed.

Alternative 2 is the selected remedy for remediation of groundwater contamination at Site 22. Alternative 2 was chosen over Alternatives 3 and 4 (not including the No Action alternative) because the cost versus benefit comparison (such as length of time, sustainability, and other factors) indicated that although Alternative 2 takes longer to reach RAOs, it is protective, more cost-effective and results in less short term risk during implementation. Targeting areas using EISB where RDX concentrations exceed 100 µg/L decreases the environmental impacts of construction or intrusive activities by reducing the extent of the treatment area. Although no active treatment process would be employed specifically for VOCs, some active treatment of TCE and VC would occur where the VOC plumes overlap with the RDX target treatment area. Outside the influence of the RDX treatment area, natural biodegradation and other attenuation processes would be occurring. Therefore, reduction of toxicity, mobility, or volume of the plumes is acceptable.

2.11.2 Description of the Selected Remedy

The selected remedy (Alternative 2) for groundwater at Site 22 consists of the following elements:

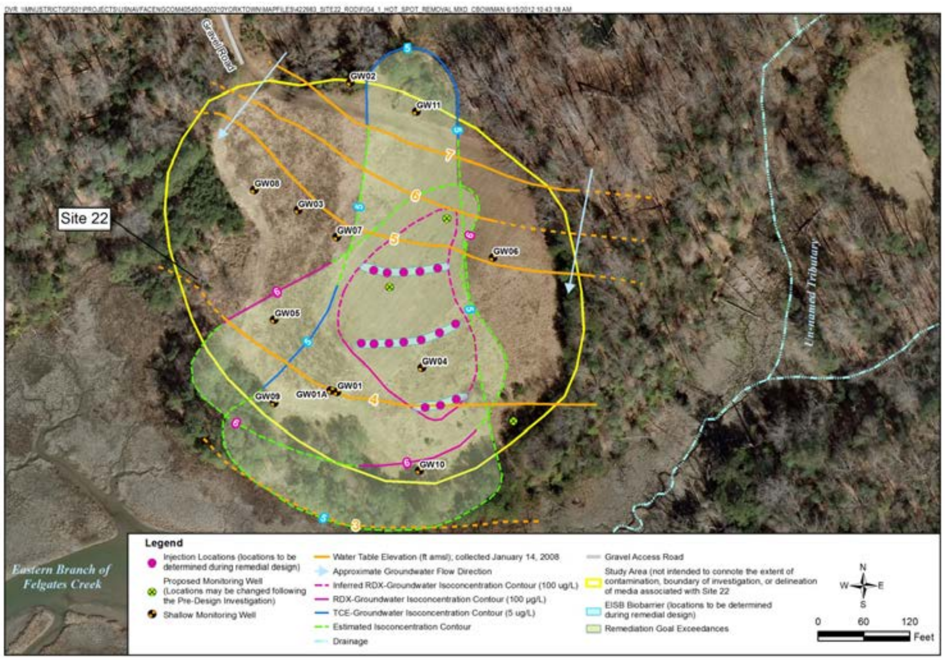
- EISB of RDX using EVO bio-barriers perpendicular to groundwater flow in the target treatment area with RDX above 100 µg/L to accelerate the total time for achieving cleanup levels
- MNA for the dissolved TCE and VC plumes and the remaining dissolved RDX plume (less than 100 µg/L) following active treatment
- Performance and long-term groundwater monitoring for COCs and MNA parameters
- LUCs in the form of land and groundwater use restrictions until cleanup levels are met

Figure 8 presents a conceptual illustration of the potential implementation of the selected remedy (Alternative 2).

The Navy will implement the selected remedy in phases to optimize treatment in groundwater at Site 22. Prior to completing the Remedial Design (RD) of Alternative 2, a pre-design investigation will be performed to refine the CSM. The remedy implementation approach will be finalized during RD.

FIGURE 8

Alternative 2 - Hot Spot Treatment of RDX using EISB and Associated Performance Monitoring; MNA of TCE, VC, and RDX; and LUCs



Pre-Design Investigation

Prior to the final design of the selected remedy (Alternative 2), a pre-design investigation will be implemented for greater resolution of the lateral and vertical extent of TCE, VC, and RDX and to identify the precise areas, depths, and lithologic units requiring RDX treatment. Based on historical data, the only monitoring well with RDX concentrations above 100 µg/L in groundwater is YS22-GW04 (at 150 µg/L in 2007). This investigation is expected to include installation of at least three new monitoring wells, one round of groundwater samples from new and select existing monitoring wells for TCE, VC, and RDX (**Figure 8**), and groundwater samples from 30 direct-push technology points to pinpoint the RDX treatment area. Additional transects will be added if RDX concentrations along the transect perimeter exceed 100 µg/L.

EISB of RDX Using EVO Bio-barriers

EISB of RDX using EVO bio-barriers will be implemented in the target treatment area, defined as where RDX concentrations exceed 100 µg/L, through direct injection of a suitable insoluble substrate to the shallow groundwater. The introduced substrate will serve multiple purposes, including depleting competing electron acceptors, creating strongly reducing conditions, and producing an electron donor source for biodegradation. Additionally, a pH buffer (either as a pre-buffered substrate, such as sodium bicarbonate, or as an additional injection) may be required to raise the existing groundwater pH. Based on the observed effectiveness of EISB during field investigations for other Navy projects with similar subsurface conditions, it is assumed that no laboratory treatability studies or field pilot studies are warranted prior to full-scale implementation of Alternative 2.

Before this alternative is implemented, baseline groundwater samples will be collected to confirm assumptions made in the conceptual design and to modify as necessary the application locations, substrate, and the corresponding monitoring locations. Based on current site conditions, conceptual design elements for implementation of EISB are presented in **Figure 8**.

Upon completion of the pre-design investigation, an injection method will be determined (pneumatic fracturing, direct-push, or permanent injection wells). One bio-barrier is anticipated to be placed directly upgradient of the area with the highest RDX concentrations as determined during the pre-design investigation. Two additional bio-barriers are assumed, one to the north and one to the south of this primary line. The southernmost bio-barrier will help prevent further migration of the RDX plume. Within each bio-barrier, or transect line, the injection wells will be spaced approximately 20 feet apart. The radius of influence of each injection point is assumed to be 10 feet. As shown on **Figure 8**, approximately 15 permanent injection locations are estimated for the target treatment area. The vertical target interval will be determined during the design. For cost-estimating purposes, it was assumed that each location will have two co-located permanent injection wells, each with 10-foot screens to more effectively distribute EVO to units with lower permeability across a 20-foot-depth interval. It was also assumed that two injections would be completed with a 2-year interval. If necessary, as treatment progresses and the concentrations of COCs and their daughter products change, the type and quantity of substrate, frequency of injection, and the location of injection may be revised.

Monitored Natural Attenuation of VOCs and RDX

MNA refers to the reliance on natural processes to achieve cleanup levels. Natural attenuation processes include a variety of physical, chemical, or biological processes that under favorable conditions act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in groundwater. These processes include biodegradation; dispersion; dilution; sorption; volatilization; and chemical or biological stabilization, transformation, or destruction of contaminants. Biodegradation pathways for chlorinated VOCs were discussed in Section 2.5.

MNA will be implemented in the area outside the target treatment area and will rely on natural attenuation processes to achieve the cleanup levels for TCE (5 µg/L), VC (2 µg/L), and RDX (6 µg/L). Reducing conditions predominantly present at the site are favorable for biologically mediated degradation of the chlorinated VOCs and RDX. In addition, the RDX target treatment area may overlap with a portion of the TCE and VC plumes, resulting in enhanced biodegradation of these constituents within this area. Natural attenuation will continue under this alternative until the COC concentrations decline to below cleanup levels.

Performance Monitoring and Long-term Monitoring

Following substrate injection, initial effectiveness of the remedial technology (EVO bio-barriers and MNA) will be evaluated through one year of quarterly performance groundwater monitoring following each of the two rounds of substrate injections. Following the completion of this performance monitoring, the data will be evaluated to determine if the long-term reduction in COC concentrations will be monitored as part of a long-term monitoring plan designed to evaluate the achievement of RAOs over time or determine if additional injections are required. If a long-term monitoring plan is developed, LTM will initially be conducted on a quarterly basis and over time will be reduced to semi-annually, annually, then every five years, until no additional LTM is needed.

If it is determined through LTM data, that the remedy is not acting as designed, optimization data will be collected to assess changes to the remedy. Based on current site conditions, it was assumed for cost-estimating purposes that any new monitoring wells plus the 12 existing shallow monitoring wells and one existing deep monitoring well will be included in the performance and long-term monitoring plans. Because contaminants will remain onsite following remedy implementation, the need for additional action to achieve the cleanup levels will be evaluated and documented during CERCLA 5-year reviews.

Land Use Controls

Throughout implementation of the remedy, the Navy will implement LUCs to prevent unacceptable risks to human receptors from exposure to COCs in groundwater. Under Alternative 2, the site will be designated as a "restricted use" area in the base geographic information system. This designation will place controls on groundwater at Site 22.

The associated LUCs will meet the following objectives:

- Prohibit activities that would result in contact with groundwater except for environmental monitoring
- Prohibit the withdrawal of groundwater except for environmental monitoring
- Prohibit construction of new buildings at the site without evaluation of potential vapor intrusion and/or ensuring vapor intrusion mitigation measures are included in building design
- Maintain the integrity of any current or future remedial or monitoring system

The Navy will develop and submit to USEPA and VDEQ a LUC RD. The LUC RD will provide for implementation and maintenance actions, including periodic inspections and reporting. The Navy will implement, maintain, monitor, report on, and enforce the LUCs according to the LUC RD.

Although the Navy may transfer these responsibilities to another party by contract, property transfer agreement, or through other means, the Navy will remain ultimately responsible for remedy integrity and will: 1) perform CERCLA Section 121(c) 5-year reviews; 2) notify the appropriate regulators and/or local government representatives of any known LUC deficiencies or violations; 3) provide access to the property to conduct any necessary response; 4) retain the ability to change, modify, or terminate LUCs; and 5) ensure that the LUC objectives are met to maintain remedy protectiveness.

2.11.3 Summary of the Estimated Remedy Costs

Table 6 presents a cost estimate summary for implementation of the selected remedy. ***Detailed cost estimates*** (Ref. 17) are provided in the 2011 FS report. The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

2.11.4 Expected Outcomes of the Selected Remedy

Site 22 is currently only being used for periodic hunting activities. This use is expected to continue, and there are no other planned land uses in the foreseeable future. Cleanup levels for the selected remedy are based on established risk-based cleanup levels suitable for unlimited use and unrestricted exposure. Exposure will be controlled through LUCs until COCs in groundwater (TCE, VC, and RDX) are reduced to the cleanup levels. Remedial activities at Site 22 will consist of Hot Spot treatment of RDX using EISB and associated performance monitoring; MNA of RDX, TCE, and VC; and LUCs. **Table 9** identifies the potential unacceptable human health risks (there are no potential unacceptable ecological risks), the RAOs established to address these unacceptable risks, the remedy component(s) that will be implemented to achieve each RAO, what metrics will be used to confirm the RAOs are met, and the expected outcome from implementation of the remedy components.

TABLE 9
Expected Outcomes

Risk						
Human Health	**Ecological**	**RAO**	**Remedy Component**	**Metric**	**Expected Outcomes**	
Groundwater						
Ingestion of, dermal contact with, and inhalation of TCE, VC, and RDX in groundwater for hypothetical future lifetime adult and child residents; ingestion of and dermal contact with groundwater for hypothetical future construction workers	No exposure pathway	To reduce TCE, VC, and RDX concentrations in groundwater to established risk-based cleanup levels	Hot Spot treatment of RDX using EISB bio-barriers in areas where concentrations exceed 100 µg/L and associated performance monitoring	Monitor shallow groundwater concentrations to confirm reduction of RDX concentrations to cleanup levels (Frank Fritz's comment)~~below 100 µg/L and plume stabilization~~	Reduction of RDX concentrations in the groundwater plume to cleanup level (Fritz's comment)	No further treatment or monitoring after achieving cleanup goals that allow for unlimited use and unrestricted exposure or groundwater
			MNA for TCE, VC, and RDX	Monitor groundwater COC concentrations and their degradation products, geochemical parameters, and sensitive metals to confirm the natural degradation process is occurring until concentrations are at or below cleanup levels	Reduction of RDX, TCE, and VC concentrations in the groundwater plume to cleanup level (Fritz;s coment)	
				Monitor shallow groundwater COC concentrations and their degradation products for potential toxic transformation products to confirm concentrations are not created at levels that threaten human health		
		To maintain LUCs to prevent human (residential and construction worker) exposure to groundwater until cleanup levels are met.	LUCs	Annual LUC inspections until cleanup levels are met for groundwater COCs	Elimination of groundwater exposure pathway	Removal of groundwater LUCs

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2.11.5 Statutory Determinations

In accordance with the National Oil and Hazardous Substances Pollution Contingency Plan, the selected remedy meets the following statutory requirements:

Protection of Human Health and the Environment— The selected remedy will protect human health (there are no potential ecological risks) from known site risks to future receptors through groundwater treatment and monitoring to reduce COC concentrations, and through LUCs to restrict the use of and exposure to shallow groundwater and shallow groundwater emissions until concentrations are reduced to established risk-based cleanup levels that allow for unrestricted use and unlimited exposure.

Compliance with ARARs—The selected remedy will meet all identified ARARs. Federal and state ARARs for Site 22, summarized by classification, are presented in **Appendix C**. The classification of ARARs identified includes chemical-specific, location-specific, and action-specific requirements.

Cost-Effectiveness—The selected remedy provides the most reasonable value relative to the cost through the use of active treatment in the high-concentration target area, while allowing for MNA in the low-concentration target areas.

Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable—The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner at Site 22. The selected remedy provides treatment through substrate injection that enhances biologically mediated degradation of the chlorinated COCs and RDX through natural microbial degradation processes to reduce contaminant mass. Because the long-term effectiveness and permanence, as well as reduction of toxicity and volume, are achieved through the selected remedy, the Navy, USEPA, and VDEQ concur 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 considering state and community acceptance.

Preference for Treatment as a Principal Element—The selected remedy uses treatment of the high-concentration target area as a principal element, and therefore satisfies the statutory preference for treatment.

Five-Year Review Requirements—This remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above established risk-based cleanup levels. The Navy will maintain LUCs and conduct a statutory remedy review every 5 years after initiating remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. If the remedy is determined not to be protective of human health and the environment because, for example, LUCs have failed or treatment is unsuccessful, then additional remedial actions would be evaluated by the FFA parties and the Navy may be required to undertake additional remedial action.

2.12 Documentation of Significant Changes

The PP for Site 22 was released for public comment on May 14, 2012. The public comment period ran from May 14 to June 28, 2012 with the public meeting to discuss the plan on May 24, 2012. General inquiries were received during the public meeting on May 24, 2012, but no comments were received requiring amendment to the PP, and no additional written comments, concerns, or questions were received from community members during the public comment period. It was determined that no significant changes to the remedy as originally identified in the PP were necessary or appropriate.

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3 Responsiveness Summary

The participants in the public meeting held on May 24, 2012, included representatives of the Navy and VDEQ. Two community members attended the meeting. Questions received during the public meeting were general inquiries and are included in ***meeting transcript*** (Ref. 18). There were no comments received at the public meeting requiring amendment to the PP, and no additional written comments, concerns, or questions were received from community members during the public comment period.

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References

Reference Number	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the AR
1	***ROD***	Section 2.2	Baker Environmental, Inc. (Baker). 2003. Record of Decision Site 22 Burn Pad, Naval Weapons Station, Yorktown, Virginia. September. AR No. 01375.
2	***ROD***	Section 2.2	CH2M HILL. 2011. Record of Decision, Site 4 – Burning Pad Residue Landfill, Site 21 – Battery and Drum Disposal Area & Site 22 – Burn Pad, Naval Weapons Station, Yorktown, Virginia. August. AR No. 000262.
3	***analytical results***	Table 1	Baker. 2001. Round Two Remedial Investigation Report, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. January. Tables 4-36 through 4-38. AR No. 01296, 01297, and 01298.
4	***analytical results***	Table 1	Baker. 2001. Round Two Remedial Investigation Report, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. January. Tables 4-15 through 4-20 and Tables 4-39 through 4-41. AR No. 01296, 01297, and 01298.
5	***analytical results***	Table 1	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Table 6-3. AR No. 000024.
6	***analytical results***	Table 1	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Tables 7-1 and 7-7. AR No. 000024.
7	***evaluate alternatives***	Table 1	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Section 6. AR No. 000181.
8	***CSM***	Section 2.5	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Section 2.2.3. AR No. 000181.
9	***Numerous investigations***	Section 2.5.1	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Sections 2.1 and 2.2. AR No. 000181.
10	***Results***	Section 2.5.1	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Sections 2.2.1. AR No. 000181.
11	***biodegradation***	Section 2.5.2	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Section 10.5.3. AR No. 000024.

Reference Number	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the AR
12	***complete exposure pathways***	Section 2.7.1	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Section 8.4.2. AR No. 000024.
13	***Potential unacceptable human health risks***	Section 2.7.1	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Tables 8-14 and 8-15. AR No. 000024.
14	***no potentially unacceptable risk***	Section 2.7.2	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Section 9.5.4. AR No. 000024.
15	***developed and evaluated***	Section 2.9.1	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Section 4.2. AR No. 000181.
16	***comparative analysis***	Section 2.11	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Section 6. AR No. 000181.
17	***Detailed cost estimates***	Section 2.11.3	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Appendix C. AR No. 000181.
18	***meeting transcript***	Section 3	CH2M HILL. 2009. Proposed Plan, Site 1: Landfill Near Incinerator, Naval Weapons Station Yorktown, Cheatham Annex. January. AR No. Pending.

Detailed site information reference in this ROD in bold blue text is contained in the AR. For access to information contained in the AR for WPNSTA Yorktown please contact:

Public Affairs Office, NAVFAC Atlantic
6506 Hampton Blvd
Norfolk, Virginia 23508
Phone: (757) 322-8005

Appendix A

Appendix B

Appendix C

i

Draft

Record of Decision

Site 22 Groundwater – Burn Pad

Naval Weapons Station Yorktown, Yorktown, Virginia

June 2012

1 Declaration

1.1 Site Name and Location

This Record of Decision (ROD) presents the selected remedy for groundwater at Environmental Restoration Program (ERP) Site 22, Burn Pad, at Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia. WPNSTA Yorktown was placed on the United States Environmental Protection Agency (USEPA) National Priorities List effective October 15, 1992 (USEPA Identification [ID]: VA8170024170).

1.2 Statement of Basis and Purpose

This remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended. This decision is based on information contained in the Administrative Record (AR) file for the site. Information not specifically summarized in this ROD or its references[1], but contained in the AR, has been considered and is relevant to the selection of the remedy at Site 22. Thus, the ROD is based upon and relies upon the entire AR file for the site remedy selection decision.

The United States Department of the Navy (Navy) is the lead agency and provides funding for ERP activities at Site 22. The Navy and USEPA Region 3, the lead regulatory agency, issue this ROD jointly. The Commonwealth of Virginia, Virginia Department of Environmental Quality (VDEQ), the support regulatory agency~~, has reviewed this ROD and the materials on which it is based, and~~ concurs with the decision.

1.3 Assessment of the Site

Groundwater is the only remaining environmental medium to be addressed at Site 22. A No Further Action ~~(NFA)~~ ROD was signed for soil at Site 22 in September 2003, and an NFA ROD for sediment and surface water at Site 22 was signed in September 2011. Therefore, this ROD serves as the final ROD for Site 22.

Previous investigations concerning groundwater at Site 22 did not identify any potential ecological risks, but did identify the presence of ~~constituents~~ of concern (COCs) at concentrations that pose a potential threat to human health. Trichloroethene (TCE) in shallow groundwater (Yorktown-Eastover aquifer) was identified as posing a potential risk under the future construction worker exposure scenario. Vinyl chloride (VC) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) in shallow groundwater (Yorktown-Eastover aquifer) were identified as posing a potential risk under the future residential use exposure scenario.

The response action selected in this ROD is necessary to protect the public health, welfare, and/or the environment from actual or threatened releases of hazardous substances.

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[1] Reference phrases, presented as ***Bold Italicized Text***, are followed by a corresponding number from the References Section.

1.4 Description of Selected Remedy

The selected remedy for Site 22 groundwater is comprised of the following components:

Refining the conceptual site model (CSM) through a pre-design investigation

Implementing Enhanced In Situ Bioremediation (EISB) of RDX using emulsified vegetable oil (EVO) bio-barriers perpendicular to groundwater flow in the target treatment area (with RDX above 100 micrograms per liter (µg/L) to accelerate the total time for achieving cleanup levels

Using monitored natural attenuation (MNA) for the dissolved TCE and VC plumes and the remaining dissolved RDX plume (less than 100 µg/L) following active treatment

Conducting periodic groundwater monitoring and synoptic groundwater level measurements

Enforcing Land Use Controls (LUCs) in the form of land and groundwater use restrictions (controls on intrusive activities such as excavation, residential development, or groundwater use) until cleanup levels are met

The selected remedy will address COCs in groundwater at Site 22. The primary source of contamination was the release of chemicals that occurred during waste handling and the burning of materials on the ground surface. The contaminants that were released to the ground surface leached into the soil as a result of infiltration of rain water, causing downward migration of contamination into subsurface soil and ultimately creating a dissolved phase groundwater plume. The contaminated soil at Site 22 was excavated and disposed of offsite in the fall of 2002 resulting in unlimited use and unrestricted exposure to soil at Site 22. Groundwater at Site 22 is not a principal threat waste.

1.5 Statutory Determinations

The selected remedy is protective of human health and the environment, complies with federal and state regulations that are applicable or relevant and appropriate to the remedial action, is cost effective, utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable and satisfies the preference for treatment as a principal element of the remedy. Because the remedy will result in pollutants or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, the Navy will conduct statutory reviews every 5 years to ensure that the remedy remains protective of human health and the environment. This review will be conducted after the remedy is in place and at the same time as other sites that already require statutory five-year reviews. The next five-year review is scheduled for 2012, therefore, the first five-year review for this site is not expected until 2017.

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information related to Site 22 can be found in the AR.

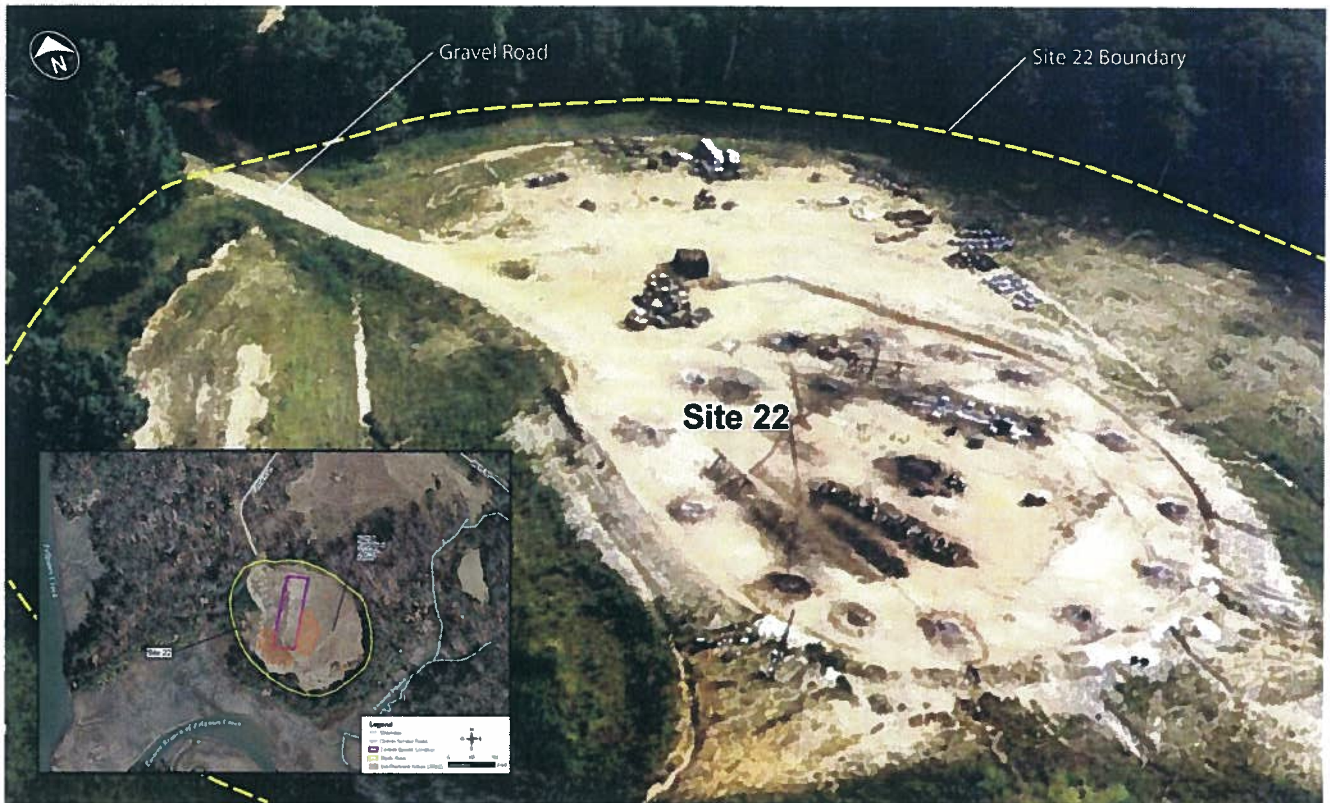
COCs and their respective concentrations (Section 2.5, **Table 2**)

Current and reasonably anticipated future land use assumptions and current and potential future uses of groundwater (Section 2.6)

Baseline risk represented by the COCs (Section 2.7, **Table 4**)

Cleanup levels established for COCs and the basis for these levels (Section 2.8, Table 5)

FIGURE 3
Site 22 Historical Aerial Photograph



Source and date of photograph unknown.

In 1996, a 153-foot by 86-foot biocell was constructed at Site 22 and used for the treatment of nitramine-contaminated soils and trinitrotoluene-contaminated soils from WPNSTA Yorktown Sites 7 and 19 (**Figure 2**). Use of the biocell ended in 1999, and it was subsequently removed.

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In 2002, a removal action was completed to remove contaminated soils from Site 22 (Figure 2). The COCs included the following: carcinogenic polynuclear aromatic hydrocarbons, Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine, cadmium, copper, and lead. Contaminated soil was excavated to a depth of 2 feet, and confirmation samples were collected. Approximately 3,450 cubic yards of soil were removed. A ROD (Ref. 1) was signed in 2003 documenting that NFA for unlimited use and unrestricted exposure was necessary for soil at Site 22. In addition, a ROD (Ref. 2) documenting that NFA was necessary for sediment and surface water at Site 22 was signed in September 2011.

Groundwater at Site 22 has been characterized during several investigations. **Table 1** provides a chronological list and brief summary of previous groundwater investigations conducted at Site 22. The respective investigation documents are a part of the AR and can be referenced for further details for specific sampling strategies, media investigations, and when and where the sampling was performed. The documents listed are available in the AR and provide detailed information used to support remedy selection at Site 22.

TABLE 1
Summary of Previous Groundwater Studies and Investigations at Site 22

Previous Study / Investigation* (Document and Document Date)	Sites	Investigation Activities
Round Two Remedial Investigation Report, Sites 4, 21, and 22 Baker, 2001	Sites 4, 21, and 22	From August to November 1996, groundwater, surface water, and surface/subsurface sediment samples were collected to evaluate potential risks to human health and the environment (**Figure 4**). Samples were analyzed for Target Compound List (TCL) VOCs, TCL semivolatile organic compounds, TCL pesticides/polychlorinated biphenyls, explosives and Target Analyte List metals and cyanide. The ***analytical results*** (Ref. 3) of six groundwater samples at Site 22 were used to complete a Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA). The HHRA indicated no unacceptable non-cancer hazards or cancer risks to current or future receptors under a beneficial use scenario for groundwater. The ERA, which was based on a screening of groundwater concentrations at Site 22 against marine surface water screening levels, indicated aquatic receptors would potentially be at risk from exposure to 1,1-dichloroethene, TCE, di-n-butylphthalate, aldrin, and several explosives and metals if groundwater contaminants from Site 22 were to discharge to a surface water body without dilution or natural attenuation. The ***analytical results*** (Ref. 4) of six co-located surface water and sediment samples at Site 22 were used to complete an HHRA and an ERA. The HHRA indicated no unacceptable non-cancer hazards or cancer risks to current or future receptors from exposure to surface water and sediment. The ERA indicated potential risk to ecological receptors from exposure to several pesticides, explosives, and metals in sediment.
Remedial Investigation Report for Groundwater at Sites 4, 21, and 22 CH2M HILL, 2009	Sites 4, 21, and 22	From Spring 2007 to Spring 2008, groundwater, groundwater seep, surface water, and surface and subsurface sediment samples were collected to evaluate potential risks to human health and the environment. Upgradient surface water and sediment samples were also collected to assess site-specific background conditions (**Figure 4**). Samples were analyzed for TCL VOCs, TCL semivolatile organic compounds, TCL pesticides and polychlorinated biphenyls, explosives, and Target Analyte List metals and cyanide. The ***analytical results*** (Ref. 5) of 12 groundwater samples at Site 22 were used to complete an HHRA and ERA. The HHRA indicated potential cancer risks to future residents due to exposure to VC, RDX, and arsenic, as well as non-cancer hazards to future residents from exposure to RDX, arsenic, and heptachlor epoxide, and to construction workers due to exposure to TCE. TCE, heptachlor epoxide, VC, RDX, and arsenic were identified as human health COCs within the Yorktown-Eastover aquifer at Site 22 under a future exposure scenario. However, based on the final results of the remedial investigation (RI), the COCs in groundwater at Site 22 identified for action were TCE, VC, and RDX (refer to Section 2.5.1 of this ROD). The RI concluded that development of a Feasibility Study (FS) for Site 22 groundwater was warranted. The ERA indicated no COCs were identified for seep exposures at Site 22. Similarly, no COCs were identified for food web exposures. Thus, risks to ecological receptors were considered acceptable. Groundwater is generally considered only as a transport medium since there are no ecological exposures to groundwater until it discharges to a water body or surfaces as a seep. The ***analytical results*** (Ref 6) of 11 co-located surface water and sediment, two independently located sediment samples, and six co-located background surface water and sediment samples were used to complete a HHRA and ERA. The ERA was completed to reevaluate conditions in surface water and sediment following the soil removal action. The HHRA and ERA identified no unacceptable risk to human health or the environment. Based on the results of the HHRA and ERA, the RI concluded that no unacceptable risk to human health or the environment from exposure to surface water or sediment is present at Site 22; therefore, no additional action was recommended to address surface water and sediment adjacent to the site.
Feasibility Study Report for Groundwater at Site 22 CH2M HILL, 2011	Site 22	An FS was generated to ***evaluate alternatives*** (Ref. 7) for remediation of TCE, VC, and RDX present at unacceptable levels in the groundwater. The preferred alternative as presented in the FS was Alternative 2 - **Hot Spot Treatment of RDX using EISB and Associated Performance Monitoring; MNA of TCE, VC and RDX; and LUCs.**

- One (1) site at the remedy decision stage (Site 22)
- Two (2) sites in long-term management (Sites 12 and 16)
- Ten (10) closed sites (Sites 4, 5, 11, 17, 18, 21, 27, 28, 29, and 30)

There are 3 Munitions Response Program sites at various phases of investigation and cleanup. Below is a summary based on the last media being addressed at each site.

- Two (2) sites under investigation (UXO 2 and 3)
- One (1) closed site (UXO 1)

2.5 Site Characteristics

Site 22 consists primarily of a flat, grass-covered open area surrounded by woods; elevations for the site range from 20 to 32 feet above mean sea level. The southern and eastern edges of the site slope steeply toward the east, south, and southwest, toward the Eastern Branch of Felgates Creek and its unnamed tributary (**Figure 2**). Felgates Creek is a tidally influenced tributary to the York River. A gravel road runs north-south and provides vehicle access to Site 22 from the north. The site is currently unused except for periodic recreational hunting, and is located within a restricted area of WPNSTA Yorktown.

The hydrogeology at Site 22 consists of unsaturated soils at the ground surface, which are lithologically consistent with the Yorktown confining unit (gray silt and clay). The uppermost saturated unit in the Site 22 area is the Yorktown-Eastover aquifer, which lies below the 10- to 30-foot-thick Yorktown confining unit. The Yorktown-Eastover aquifer consists of coarse, shelly, gray sand, and is approximately 25 to 50 feet thick in the vicinity of Site 22. This aquifer overlies the Eastover-Calvert confining unit. There is no current or expected future use for groundwater at Site 22; drinking water is supplied to WPNSTA Yorktown and the surrounding area by the City of Newport News Waterworks.

Groundwater at Site 22 ranges from 5 to 20 feet bgs and flows to the south toward drainage channels and the Eastern Branch of Felgates Creek (**Figure 5**).

A ***CSM*** (Ref. 8) was developed to summarize site conditions, contaminant distribution, transport pathways, potential receptors, exposure pathways, and land use for Site 22 (**Figure 6**). The sources of contamination were releases of chemicals that occurred during waste handling and burning of materials on the ground surface. No subsurface burial of materials at Site 22 is known to have occurred. Some of the contaminants that were released to the ground surface leached into the soil as a result of infiltration of stormwater, causing downward migration of contamination into subsurface soil and ultimately creating a dissolved-phase groundwater plume. Much of the contamination remained relatively close to the land surface due to adsorption to soil. The contaminated soil at Site 22 was excavated and disposed of offsite and an NFA ROD ~~documenting~~ unlimited use and unrestricted exposure ~~for~~ soil was signed in November 2003. Contaminant concentrations in the groundwater of the Yorktown-Eastover aquifer at Site 22 are likely to decrease in the future because the source is no longer present and there is no ongoing release mechanism.

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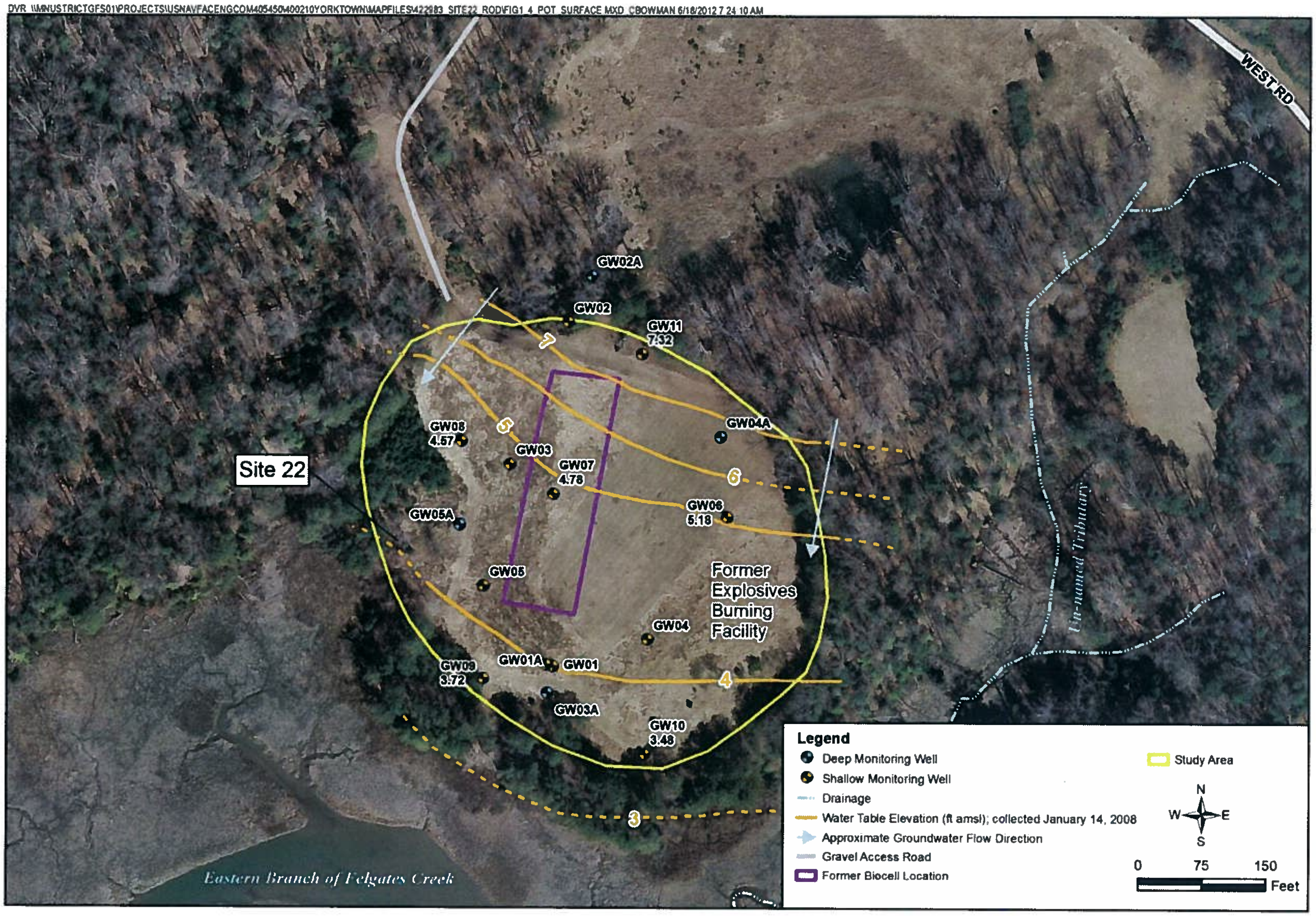
FIGURE 5
Yorktown-Eastover Aquifer Potentiometric Surface Map



2.5.1 Nature and Extent of Contamination in Groundwater

Numerous investigations (Ref. 9) have been conducted to characterize potential impacts at Site 22 (**Table 1**). Based on the results of these investigations, the COCs in groundwater at Site 22 are TCE, VC, and RDX. Sampling locations from previous investigations are depicted on **Figure 4**, and the nature and extent of contamination is discussed as follows. Maximum concentrations of constituents identified as site COCs detected in Site 22 groundwater are presented in **Table 2**.

TABLE 2
Maximum Detected Concentrations of Site 22 Constituents of Concern

VOCs	Concentration (µg/L)	MCL (µg/L)
TCE	650	5
VC	17	2
Explosives	**Concentration (µg/L)**	**RSL (µg/L)**
RDX	150	0.61

The ***Results*** (Ref. 10) of the investigations at Site 22 indicated that TCE, VC, and RDX concentrations exceeded their respective Maximum Contamination Level (MCL) or Regional Screening Level (RSL) in shallow groundwater. TCE was detected at concentrations exceeding the MCL (5 µg/L) in five shallow monitoring wells, VC was detected at concentrations exceeding the MCL (2 µg/L) in two shallow monitoring wells, and RDX was detected at concentrations exceeding the RSL (0.61 µg/L) in 10 shallow monitoring wells.

The TCE, VC, and RDX groundwater contamination is present in a "corridor" that runs through the middle of Site 22 from north to south (**Figure 7**). Analytical results indicated the VOCs and RDX detected in groundwater were within the upper portion of the Yorktown-Eastover aquifer. The highest concentrations of TCE, VC, and RDX were detected between 10 and 50 feet bgs along the central portion of the site in sand containing a number of silt and clay stringers that may be retarding the downward mobility of the contaminants. No COCs were identified in samples taken from the base of the Yorktown-Eastover aquifer, which lies above the Eastover Calvert confining unit. Contaminant discharge to surface water via groundwater was not found to exceed any risk screening values (adjusted RSLs or ecological screening values) at Site 22; groundwater is therefore not a significant continuing source of contaminants to the aquatic habitats adjacent to the site.

2.5.2 Fate and Transport of COCs in Groundwater

The lateral groundwater seepage velocity at Site 22 is approximately 0.128 foot per day. However, contaminants are not expected to migrate as rapidly as groundwater because of a tendency for sorption to soil particles (retardation). Contaminants may also be migrating in groundwater through dispersion, which may slowly increase the size of the contaminant plume in groundwater. Volatilization of some contaminants from the groundwater into the air is also a possible migration pathway where elevated concentrations of chlorinated solvents are present.

TCE and VC

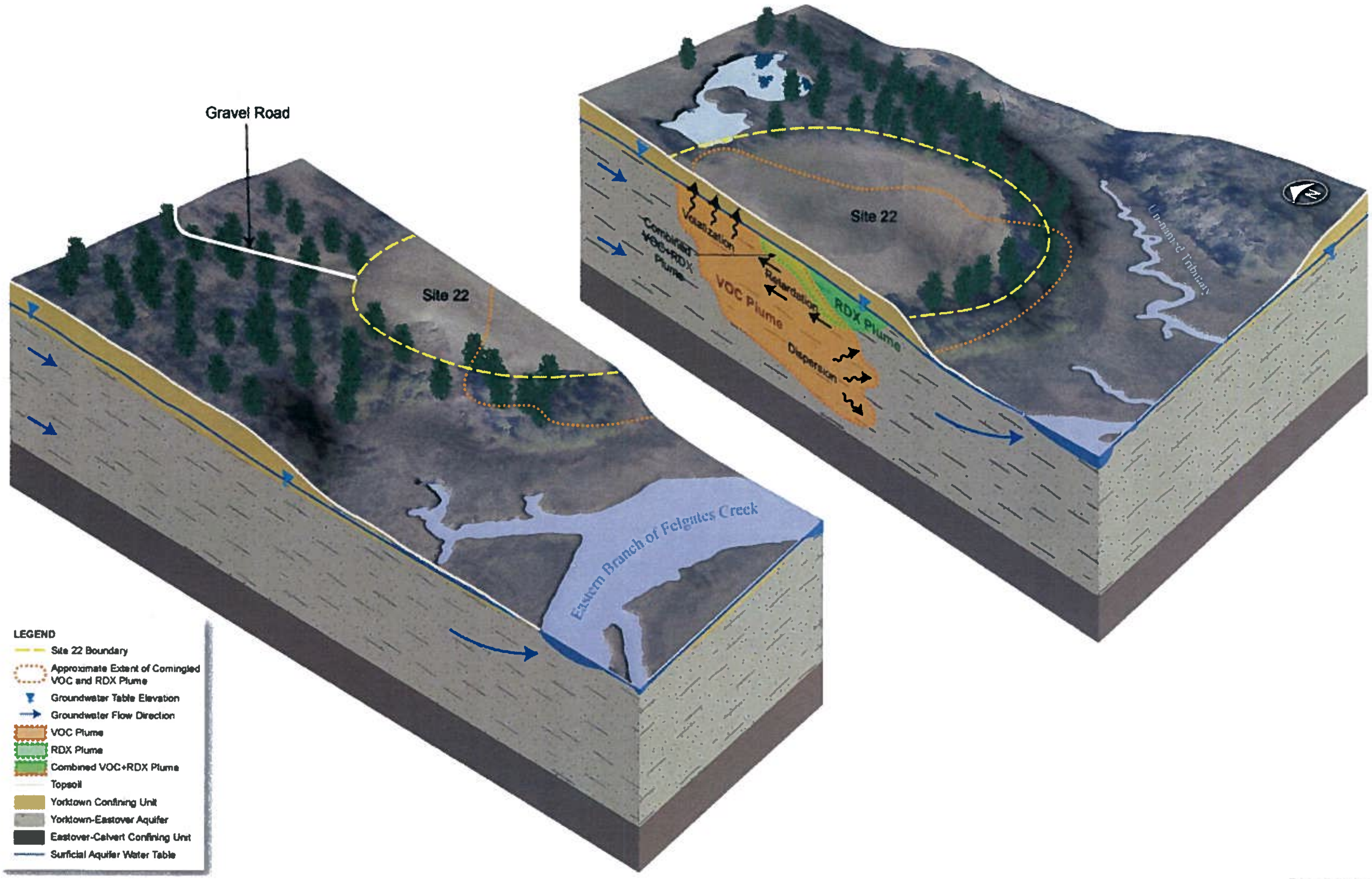
The source of TCE and its degradation product, VC, are likely releases from burn activities previously conducted at Site 22. Chlorinated VOC concentrations such as TCE and VC can change over time due to dilution and dispersion, but the primary mechanism for reductions under naturally occurring conditions is ***biodegradation*** (Ref. 11). Historical groundwater data for monitoring well YS22-GW04 demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time (**Table 3**).

TABLE 3
TCE and Associated Degradation Products in Monitoring Well YS22-GW04 at Site 22

VOCs (µg/L)	11/12/1996	10/25/2007
TCE	1200	69
1,1-Dichloroethene	1700	37
cis-1,2-Dichloroethene	Not Analyzed	22
trans-1,2-Dichloroethene	Not Analyzed	10U
Total 1,2-Dichloroethene	***370***	***32***
VC	Not Detected	10U

U - The material was analyzed for, but not detected.

FIGURE 6
Conceptual Site Model



Biodegradation of chlorinated ethenes is a well-understood process whereby these VOCs undergo transformations through two primary pathways: use as an electron acceptor by dehalorespiring organisms (reductive dechlorination) or by co-metabolism (a fortuitous destruction of contaminants by organisms intending to metabolize other organic compounds). Biological reductive dechlorination is a microbially mediated process in which chlorinated VOCs serve as the electron acceptor for metabolism, coupled with oxidation of an available electron donor. Reductive dechlorination results in the sequential replacement of a chlorine atom on the chlorinated VOC molecule with hydrogen and can ultimately lead to complete dechlorination to innocuous end-products, such as chloride and ethane. Another process whereby VC undergoes biodegradation is through direct intracellular oxidation by oxygen-dependent microbes, which can use the contaminant as an energy source. Biodegradation of chlorinated ethenes is a mechanism of degradation at Site 22, as evidenced by the presence of TCE daughter products and Dehalococcoides bacterial species at the site.

Geochemical and microbial samples were collected from two wells (YS22-GW01 and YS22-GW04) at Site 22. Results from these two locations suggest the site is characterized by low concentrations of native and/or anthropogenic carbon (0.5U and 1.0 milligram per liter, respectively). Since microbial utilization of a carbon source drives reductive dechlorination, EISB at Site 22 will create enhanced bioremediation conditions. In addition to the geochemical data, the presence of the Dehalococcoides bacterial species (0.134J and 0.493 cells per milliliter, respectively), which is the only microbe identified to be capable of degrading chlorinated ethenes completely to ethane, was identified at Site 22.

RDX

The source of RDX are likely releases from burn activities previously conducted at Site 22. RDX can be biodegraded under most redox conditions and by a variety of microorganisms. Three mechanisms for the biodegradation of RDX have been identified: two-electron reduction, single-electron reduction/denitration, and direct enzymatic cleavage. The denitration pathway is considered the major pathway for biodegradation in the natural environment, resulting in the formation of benign products such as nitrite, ammonia, formaldehyde, and formic acid. Under ideal (laboratory) conditions, the biodegradation rate for RDX is exponential, and could decay as much as 1 to 5 times in a day (that is, a half-life of 0.2 to 1 day). RDX is not volatile and not very mobile; therefore, biodegradation is believed to be the primary attenuation mechanism for this chemical.

2.6 Current and Potential Future Land and Resource Uses

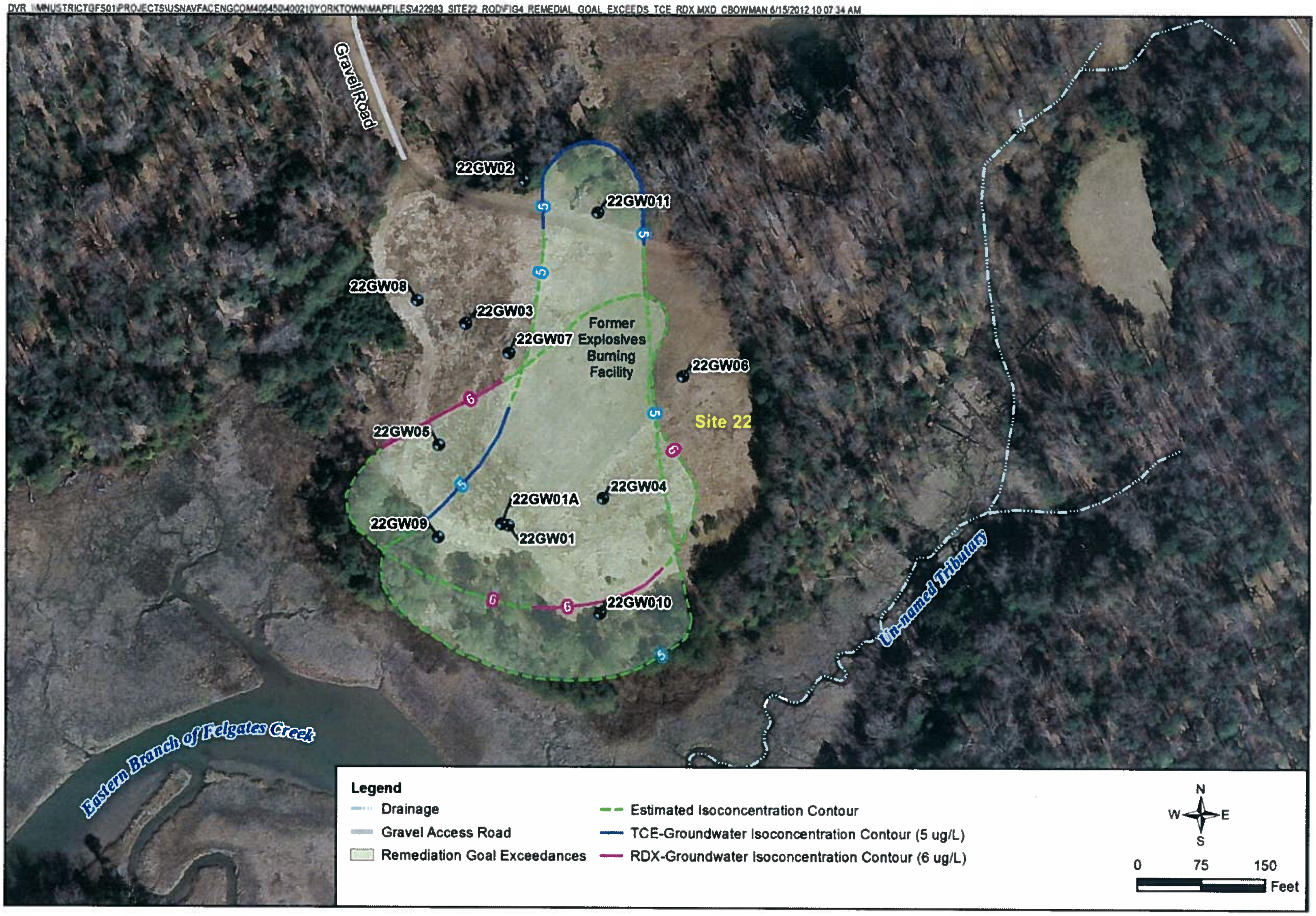
Site 22 is currently unused except for periodic recreational hunting, and is predominantly characterized by vegetated fields within a locked wire gate. Site 22 is located inside an area encumbered by the Explosive Safety Quantity Distance, which limits the activities that can be performed to explosives-related functions; therefore, the site cannot be developed for real estate purposes. It is anticipated that WPNSTA Yorktown will remain a military installation for the foreseeable future, and use of Site 22 will remain the same.

Groundwater from the Yorktown-Eastover aquifer in the vicinity of Site 22 is not a current or anticipated future source of drinking water at WPNSTA Yorktown due to generally low natural water quality and yield and a more readily available potable water source. Potable water at WPNSTA Yorktown is currently supplied by the City of Newport News Waterworks.

2.7 Summary of Site Risks

The baseline risk assessment estimates what risks the site poses if no action was 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 baseline risk assessment for this site.

FIGURE 7
Remedial Goal Exceedances TCE and RDX



Note: Remedial goals are detailed in Section 2.8.

Potential human health and ecological risks at Site 22 were evaluated for groundwater and documented in the 2009 RI report (**Appendix A**). The following subsections and **Table 4** briefly summarize the findings of the risk assessments.

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2.7.1 Summary of Human Health Risk Assessment

As part of the 2009 RI report for Site 22, an HHRA was completed. Based on the human health CSM (**Appendix B**), risks were quantitatively evaluated for future adult construction workers and future adult/child residents exposed to shallow groundwater using reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios. Exposure pathways that were quantified included inhalation/ingestion of and dermal contact with groundwater for hypothetical future lifetime adult and child residents and ingestion and dermal contact with groundwater for hypothetical future construction workers. Based on current site use and conditions, there are no ***complete exposure pathways*** (Ref. 12) for groundwater at Site 22.

The RME calculation determines risk based on the highest level of human exposure that could reasonably be expected to occur, whereas the CTE level reflects human exposure to average concentrations across the site. The potential non-cancer hazards, expressed as the hazard index (HI), and cancer risk estimates were calculated using RME concentrations. For non-cancer effects, an HI represents the ratio between the reference dose and the dose for a person in contact with site chemicals of potential concern. An HI exceeding 1.0 indicates that potential health effects may occur. For known or suspected carcinogens, acceptable exposure levels generally are concentration levels that represent an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} (a 1 in 10,000 chance of developing cancer) and 10^{-6} (a 1 in 1,000,000 chance of developing cancer) using information on the relationship between dose and response.

Potential unacceptable human health risks (Ref. 13) were identified under a future resident and/or construction worker exposure scenario due to exposure to TCE, heptachlor epoxide, VC, RDX, and arsenic within the Yorktown-Eastover aquifer (**Table 4**).

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Although arsenic and heptachlor epoxide contributed to the total RME cancer risk for the future lifetime resident (adult/child) scenario, the Navy, in partnership with USEPA and VDEQ, agree that no additional action is required for these ~~constituents~~ for the following reasons:

- Although arsenic was considered a human health COC under the RME scenario, concentrations of arsenic did not pose risk under the CTE scenario
- Dissolved arsenic concentrations did not exceed the MCL (10 µg/L)
- Arsenic concentrations are consistent with natural background concentrations rather than a site-related CERCLA source
- Heptachlor epoxide (YS22-GW03 at 0.21 µg/L) only slightly exceeded the MCL (0.2 µg/L) in 1 out of 13 samples
- The low concentrations of heptachlor epoxide suggest its presence is attributable to routine pesticide treatment activities by the base and not a CERCLA-regulated release

The HHRA concluded TCE and VC in groundwater exceed MCLs and contribute to potential risk under hypothetical future exposure scenarios in the upper portion of the Yorktown-Eastover aquifer. No MCL exists for RDX, but concentrations were found to pose potential risk under hypothetical future exposure scenarios. COCs were not detected above MCLs or RSLs in the deep portion of the Yorktown-Eastover aquifer. The Navy, in partnership with USEPA and VDEQ, agree that remedial action for groundwater is necessary to address TCE, VC, and RDX in the upper portion of the Yorktown-Eastover aquifer.

2.7.2 Summary of Ecological Risk Assessment

As part of the 2009 RI report for Site 22, an ERA was completed. Complete pathways for ecological receptors were limited to exposure to surface water, surface sediment, and surface soil. Surface soil was not evaluated in the ERA because risks associated with this medium were addressed during the previous remedial action. Groundwater was considered only as a transport medium since there were no ecological exposures to groundwater until it discharged to a water body or surfaced as a seep. Based on the results of the ERA, the Navy, USEPA Region 3, and VDEQ agree that groundwater at Site 22 does not pose unacceptable ecological risks to current receptors based on the following:

- No ecological COCs were identified for surface water, sediment, or seep exposures (NFA - ROD signed in September 2011)
- Source areas were removed during previous site activities
- Groundwater is not a significant continuing source of contaminants to the aquatic habitats adjacent to the site.

The ERA concluded there are ***no potentially unacceptable risk*** (Ref. 14) due to exposure to groundwater seeps, surface water, or sediment at Site 22. The Navy, in partnership with the USEPA and VDEQ agree that no further action for groundwater is necessary to prevent exposure to ecological receptors.

2.7.3 Basis for Response Action

~~It is the current judgment of the Navy and USEPA, with the concurrence of VDEQ, that~~ the selected remedy in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

While there are no potential ecological risks from exposure to site groundwater, there are potential future human health risks from TCE, VC, and RDX. TCE in shallow groundwater (Yorktown-Eastover aquifer) was identified as posing a potential risk under the future construction worker exposure scenario, and VC and RDX in shallow groundwater (Yorktown-Eastover aquifer) were identified as posing a potential risk under the future residential use exposure scenario (**Table 4**).

2.8 Remedial Action Objectives

The site-specific remedial action objectives (RAOs) for Site 22 groundwater are as follow:

- Reduce TCE, VC, and RDX concentrations in groundwater to established risk-based cleanup levels.
- Prevent human (residential and construction worker) exposure to groundwater until cleanup levels are met.

Cleanup levels for groundwater were developed for site-related COCs (TCE, VC, and RDX) with cancer risks exceeding 1 in 10,000 or with concentrations exceeding the established MCLs (**Table 5**). MCLs were used to establish the groundwater cleanup levels for TCE and VC (5 µg/L and 2 µg/L, respectively). Attainment of MCLs is considered to be protective and suitable for unlimited use and unrestricted exposure. Because no MCL has been established for RDX, a risk-based cleanup level of 6 µg/L was calculated. Cleanup level exceedances for TCE and RDX are spatially shown on **Figure 7**; VC exceeded the MCL in two wells located within the TCE plume (22GW09 and 22GW11) and fall within the footprint of the TCE plume, and therefore is not shown. The cleanup level for RDX was determined based on Remedial Goal Option calculations, which incorporate pathways for the ingestion, dermal absorption, and inhalation of volatiles and particulates for future residents using the same exposure assumptions as the HHRA.

TABLE 5
Remediation Goals (Cleanup Levels) for COCs at Site 22

COC	Remediation Goal (µg/L)
TCE	5 µg/L
VC	2 µg/L
RDX	6 µg/L

2.9 Description of Remedial Alternatives

The objective of this section is to provide a brief explanation of the remedial alternatives developed for Site 22 groundwater.

2.9.1 Description of Remedy Components

Remedial alternatives were ***developed and evaluated*** (Ref. 15) to address COCs in groundwater at Site 22, as detailed in the 2011 FS Report. Following the initial screening of groundwater remediation technologies, the following remedial alternatives were selected for detailed evaluation and comparative analysis:

- **Alternative 1** – No Action
- **Alternative 2 –** Hot Spot Treatment of RDX using EISB and Associated Performance Monitoring; MNA of TCE, VC, and RDX; and LUCs
- **Alternative 3 –** Hot Spot Treatment of RDX, TCE, and VC using In situ Chemical Oxidation (ISCO) and Associated Performance Monitoring; MNA of TCE, VC and RDX; and LUCs
- **Alternative 4 –** Hot Spot Treatment of TCE, VC, and RDX using EISB and Associated Performance Monitoring; MNA of TCE, RDX, and VC; and LUCs

Based on the results of the alternatives evaluation, Hot Spot Treatment of RDX using EISB and Associated Performance Monitoring; MNA of TCE, VC, and RDX; and LUCs (Alternative 2) was selected as the Preferred Alternative. With the exception of the No Action alternative (Alternative 1), each of the alternatives includes monitoring and implementation of LUCs to prevent exposure. A No Action Alternative is required by the National Oil and Hazardous Substances Pollution Contingency Plan and serves as the baseline against which the other alternatives are compared. For Alternatives 2, 3, and 4, monitoring and LUCs would be maintained until the RAOs are met, with 5-year statutory reviews to ensure protection of human health and the environment. A description of each remedial alternative is provided in **Table 6**.

2.9.2 Summary of Comparative Analysis of Alternatives

A comparative analysis of the four alternatives and the optimization remedy component with respect to the nine evaluation criteria was completed and is summarized in **Table 7**. An optimization remedy component includes the development of a plan for additional plume treatment if an unacceptable risk is indicated during monitoring and 5-year reviews. **Table 8** depicts a comparison of the alternatives to the criteria to support ranking of the alternatives. Alternative 1 (No Action) does not achieve RAOs designed to protect human health and the environment; therefore, it fails the first threshold criterion and is not considered further in this ROD.

TABLE 7
Evaluation Criteria for Remedial Alternative Analysis

CERCLA Criteria	Definition
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 Applicable Or Relevant And Appropriate Requirements (ARARs)	Addresses whether an alternative will meet all of the ARARs or other 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, O&M, and present-worth costs.
Modifying Criteria	
State Acceptance	Considers the state agency comments on the PP.
Community Acceptance	Provides the public's general response to the remedial alternatives described in the PP. The specific responses to the public comments are addressed in the "responsiveness summary" section of the ROD.

TABLE 8
Relative-Ranking of Remedial Alternatives

CERCLA Criteria	No Action (ALT 1)	EISB and Performance Monitoring of RDX with MNA of TCE, VC, and RDX and LUCs (ALT 2)	ISCO, Performance Monitoring and MNA of TCE, VC, and RDX and LUCs (ALT 3)	EISB, Performance Monitoring, and MNA of TCE, VC, and RDX and LUCs (ALT 4)
Threshold Criteria				
Protection of human health and the environment	❍	●	●	●
Compliance with ARARs	N/A	●	●	●
Primary Balancing Criteria				
Long-term effectiveness and permanence	❍	●	●	●
Reduction in toxicity, mobility, or volume through treatment	❍	●	●	●
Short-term effectiveness	❍	⊙	⊙	⊙
Implementability	●	⊙	⊙	⊙
Cost	N/A	● $1,907,000	⊙ $2,482,000	⊙ $2,718,000
Modifying Criteria				
State Acceptance	NC	NC	NC	NC
Community Acceptance	NC	NC	NC	NC

Ranking: ● High ⊙ Moderate ❍ Low N/A=Not Applicable

Rankings are provided as qualitative descriptions of the relative compliance of each alternative with the criteria.

NC = No significant comments were received from State or Community Members on the PP.

hasn't state concurred w/ Alt. 1?

Threshold Criteria

Overall Protection of Human Health and the Environment

With the exception of Alternative 1 (No Action), each alternative ~~is protective of~~ protects human health and the environment by reducing or controlling risks posed by the site through treatment and/or LUCs. Alternative 2 employs treatment to reduce RDX concentrations in a faster timeframe than would occur naturally. Alternatives 3 and 4 employ treatment to reduce concentrations in the RDX, TCE, and VC target areas to reduce the remedial timeframe. Performance monitoring will be conducted to confirm that the remedies are functioning and protective, and that LUCs ~~will be~~ have been implemented and maintained to provide adequate protection of human health and the environment by controlling exposure to contaminated ~~site media~~ groundwater and vapors until RAOs are met.

Compliance with Applicable or Relevant and Appropriate Requirements

The ARARs for the selected remedy at Site 22 are listed in **Appendix C**. Alternatives 2, 3, and 4 are expected to comply with the federal and state ARARs. Alternatives 2, 3, and 4 would all require measures to be taken to establish performance monitoring and LUCs. All of these alternatives would also require additional measures to ensure compliance with ARARs related to the injections of reagents into the subsurface.

Primary Balancing Criteria

Say in plainer English or be more specific

Long-Term Effectiveness and Permanence

Each alternative with the exception of Alternative 1 is expected to achieve long-term effectiveness and permanence at the conclusion of remedial activities in reducing concentrations of TCE, VC, and RDX. Once RAOs are achieved, all alternatives, except Alternative 1, are expected to be effective in the long-term, as active treatment is intended to treat the contamination (treatment for RDX using EISB for Alternative 2, treatment for RDX, TCE, and VC using ISCO for Alternative 3, and treatment for RDX, TCE, and VC using EISB for Alternative 4) and allow natural attenuation to reduce groundwater contaminant concentration to below cleanup levels. Some emissions (nitrogen oxide, particulate matter less than 10 micrometers in aerodynamic diameter, carbon dioxide associated with greenhouse gas, and criteria pollutants) from reagent production, transportation, and heavy machinery use may persist for an extended period after RAOs are achieved for Alternatives 2, 3, and 4.

Reduction in Toxicity, Mobility, or Volume through Treatment

valid assumption regarding?

~~Alternative 1 does not include active treatment. Therefore, no contaminants are treated or destroyed under this alternative except through natural attenuation processes.~~ Alternatives 2 (treatment of RDX), 3 (treatment of RDX, TCE, and VC), and 4 (treatment of RDX, TCE, and VC) are each expected to reduce toxicity, mobility, and volume by treating the groundwater, which is a statutory preference. For Alternative 2, some active treatment of TCE and VC is assumed to occur where the VOC plumes overlap with the RDX treatment area. Also, while MNA is not considered a treatment, the natural reduction of contaminant concentrations through a variety of physical, chemical, or biological activities is expected to occur over time for Alternatives 2, 3, and 4.

Short-Term Effectiveness

~~Alternative 1 allows natural attenuation to reduce the contaminant plumes, but does not provide measures to prevent exposure to site-related COCs. Therefore, Alternative 1 is not considered protective of either human health or the environment and will pose a potential risk.~~ The short-term effectiveness associated with Alternatives 2, 3, and 4 are similar with regard to how they affect the community and the local environment. Alternatives 2, 3, and 4 all rely on direct injection technology for implementation. The community would be impacted due to the transportation of injection materials and the generated investigation-derived waste.

While the relative-rankings of the remedial alternatives provided in **Table 8** provide information relative to the compliance of each alternative with the short term effectiveness criteria, the following summaries provide a ranking of each alternative relative to each other.

Alternative 2 would least impact the environment due to a lower amount of construction or intrusive activities and environmental impacts (fewer injection points and EISB injections and a limited extent of treatment area). RAOs are estimated to be achieved in an estimated 34 years.

Alternative 3 has the highest impact on workers and the community due to the high use of heavy machinery, handling of chemical oxidants, and transportation of chemical oxidant on public roads and highways. This alternative has the highest greenhouse gas emissions and energy consumption primary due to oxidant and polyvinyl chloride manufacturing. RAOs are estimated to be achieved in an estimated 25 years.

Alternative 4 will have a moderate impact on workers and the community due to the highest amount of intrusive activities (greater number of injection points and EISB injections) and the high volume of heavy machinery traffic and frequency of site visits. This alternative has the highest sulfur oxide emissions, nitrogen oxide, particulate matter less than 10 micrometers in aerodynamic diameter, and emissions due to fuel consumption. RAOs are estimated to be achieved in an estimated 29 years.

Alternative 2 provides the greatest short-term effectiveness due to its minimization of intrusive activities compared to Alternatives 3 and 4.

Why does Table 8 say Alt 2, 3, & 4 all moderate on short-term effectiveness?

Implementability

Alternatives 2, 3, and 4 can each be implemented using standard and widely available technologies. All materials and services needed for implementation are readily and commercially available. These three alternatives (2, 3, and 4) require engineering and construction services, and each alternative requires thorough monitoring to ensure they continue to operate on a path toward achieving RAOs. Each of the three alternatives (2, 3 and 4) is reliable provided they are designed and implemented correctly.

Cost

An order of magnitude cost for each alternative has been estimated based on a variety of key assumptions, including an assumed 35-year project life. The estimated timeframe required to achieve the cleanup levels varies by alternative (**Table 6**). The estimated capital cost for implementation of Alternative 2 ($708,026) is less than that of Alternative 3 ($1.2 million) or Alternative 4 ($1.0 million). The estimated present value cost for Alternative 2 is $1.9 million, less than for Alternative 3 ($2.5 million) and Alternative 4 ($2.7 million). Alternative 2 has a lower capital cost due to the type and quantity of injection materials.

Table 6 provides details of the cost summaries, and **Table 8** provides a relative ranking of the four alternatives.

Modifying Criteria

State Acceptance

State involvement has been solicited throughout the CERCLA and remedy selection process. VDEQ, as the designated state support agency in Virginia, has reviewed this ROD and has given concurrence on the selected remedy for groundwater at Site 22. The selected remedy, Alternative 2 (Hot Spot treatment of the RDX target area [concentrations above 100 µg/L] using EISB and associated performance monitoring; MNA of TCE, VC, and RDX; and LUCs), is consistent with the VDEQ's preference for active treatment of high-concentration target areas.

Community Acceptance

The public meeting was held on May 24, 2012, to present the PP and answer community questions regarding the proposed remedial action at Site 22. The questions and concerns raised at the meeting were general inquiries for informational purposes only; but no comments were received requiring amendment to the PP, and no additional written comments, concerns, or questions were received from community members during the public comment period.

2.10 Principal Threat Wastes

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 an exposure occur. Although no "threshold level" of risk has been established to identify principal threat waste, a general guideline is to consider a principal threat to be those source materials with toxicity and mobility characteristics that combine to pose a potential risk several orders of magnitude greater than the risk level that is acceptable for the current or reasonably anticipated future land use, given realistic exposure scenarios. Contaminated groundwater is generally not considered to be a source material, and VOC concentrations are below 1 percent of the aqueous solubility of each COC, indicating that groundwater contamination likely consists of a dissolved phase plume with no dense non-aqueous phase liquid present. Therefore, the groundwater at Site 22 is not considered to be a principal threat waste. However, the selected remedy includes a treatment technology that will be used to permanently reduce TCE, VC, and RDX concentrations in groundwater to established risk-based cleanup levels.

2.11 Selected Remedy

Based on the ***comparative analysis*** (Ref. 16), the selected remedy to address risk associated with groundwater at Site 22 is Alternative 2, consisting of three components: (1) Hot Spot Treatment of RDX using EISB and Associated Performance Monitoring; (2) MNA of RDX, TCE, and VC; and (3) LUCs.

2.11.1 Summary of the Rationale for the Selected Remedy

Based on the evaluation of the data and information currently available, the Navy, in partnership with USEPA, has determined that the selected remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. 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; 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. If, however, the Navy, USEPA, and VDEQ determine after two years following the second injection event that the remedy is not performing as anticipated a plan for additional plume treatment will be developed.

Alternative 2 is the selected remedy for remediation of groundwater contamination at Site 22. Alternative 2 was chosen over Alternatives 3 and 4 (not including the No Action alternative) because the cost versus benefit comparison (such as length of time, sustainability, and other factors) indicated that although Alternative 2 takes longer to reach RAOs, it is protective, more cost-effective and results in less short term risk during implementation. Targeting areas using EISB where RDX concentrations exceed 100 µg/L decreases the environmental impacts of construction or intrusive activities by reducing the extent of the treatment area. Although no active treatment process would be employed specifically for VOCs, some active treatment of TCE and VC would occur where the VOC plumes overlap with the RDX target treatment area. Outside the influence of the RDX treatment area, natural biodegradation and other attenuation processes would be occurring. Therefore, reduction of toxicity, mobility, or volume of the plumes is acceptable.

2.11.2 Description of the Selected Remedy

The selected remedy (Alternative 2) for groundwater at Site 22 consists of the following elements:

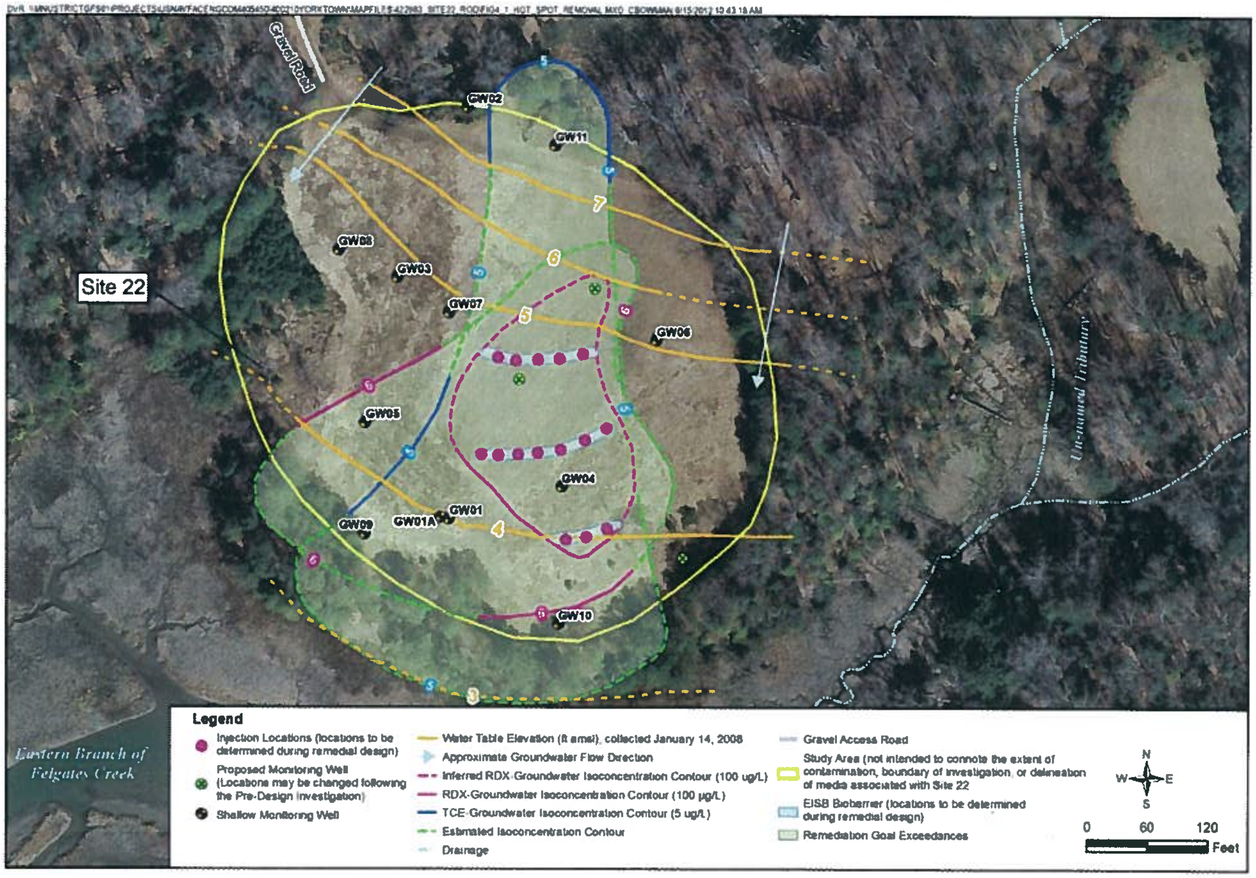
- EISB of RDX using EVO bio-barriers perpendicular to groundwater flow in the target treatment area with RDX above 100 µg/L to accelerate the total time for achieving cleanup levels
- MNA for the dissolved TCE and VC plumes and the remaining dissolved RDX plume (less than 100 µg/L) following active treatment
- Performance and long-term groundwater monitoring for COCs and MNA parameters
- LUCs in the form of land and groundwater use restrictions until cleanup levels are met

Figure 8 presents a conceptual illustration of the potential implementation of the selected remedy (Alternative 2).

The Navy will implement the selected remedy in phases to optimize treatment in groundwater at Site 22. Prior to completing the Remedial Design (RD) of Alternative 2, a pre-design investigation will be performed to refine the CSM. The remedy implementation approach will be finalized during RD.

FIGURE 8

Alternative 2 - Hot Spot Treatment of RDX using EISB and Associated Performance Monitoring; MNA of TCE, VC, and RDX; and LUCs



Pre-Design Investigation

Prior to the final design of the selected remedy (Alternative 2), a pre-design investigation will be implemented for greater resolution of the lateral and vertical extent of TCE, VC, and RDX and to identify the precise areas, depths, and lithologic units requiring RDX treatment. Based on historical data, the only monitoring well with RDX concentrations above 100 µg/L in groundwater is YS22-GW04 (at 150 µg/L in 2007). This investigation is expected to include installation of at least three new monitoring wells, one round of groundwater samples from new and select existing monitoring wells for TCE, VC, and RDX (**Figure 8**), and groundwater samples from 30 direct-push technology points to pinpoint the RDX treatment area. Additional transects will be added if RDX concentrations along the transect perimeter exceed 100 µg/L.

EISB of RDX Using EVO Bio-barriers

EISB of RDX using EVO bio-barriers will be implemented in the target treatment area, defined as where RDX concentrations exceed 100 µg/L, through direct injection of a suitable insoluble substrate to the shallow groundwater. The introduced substrate will serve multiple purposes, including depleting competing electron acceptors, creating strongly reducing conditions, and producing an electron donor source for biodegradation. Additionally, a pH buffer (either as a pre-buffered substrate, such as sodium bicarbonate, or as an additional injection) may be required to raise the existing groundwater pH. Based on the observed effectiveness of EISB during field investigations for other Navy projects with similar subsurface conditions, it is assumed that no laboratory treatability studies or field pilot studies are warranted prior to full-scale implementation of Alternative 2.

Before this alternative is implemented, baseline groundwater samples will be collected to confirm assumptions made in the conceptual design and to modify as necessary the application locations, substrate, and the corresponding monitoring locations. Based on current site conditions, conceptual design elements for implementation of EISB are presented in **Figure 8**.

Upon completion of the pre-design investigation, an injection method will be determined (pneumatic fracturing, direct-push, or permanent injection wells). One bio-barrier is anticipated to be placed directly upgradient of the area with the highest RDX concentrations as determined during the pre-design investigation. Two additional bio-barriers are assumed, one to the north and one to the south of this primary line. The southernmost bio-barrier will help prevent further migration of the RDX plume. Within each bio-barrier, or transect line, the injection wells will be spaced approximately 20 feet apart. The radius of influence of each injection point is assumed to be 10 feet. As shown on **Figure 8**, approximately 15 permanent injection locations are estimated for the target treatment area. The vertical target interval will be determined during the design. For cost-estimating purposes, it was assumed that each location will have two co-located permanent injection wells, each with 10-foot screens to more effectively distribute EVO to units with lower permeability across a 20-foot-depth interval. It was also assumed that two injections would be completed with a 2-year interval. If necessary, as treatment progresses and the concentrations of COCs and their daughter products change, the type and quantity of substrate, frequency of injection, and the location of injection may be revised.

Monitored Natural Attenuation of VOCs and RDX

MNA refers to the reliance on natural processes to achieve cleanup levels. Natural attenuation processes include a variety of physical, chemical, or biological processes that under favorable conditions act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in groundwater. These processes include biodegradation; dispersion; dilution; sorption; volatilization; and chemical or biological stabilization, transformation, or destruction of contaminants. Biodegradation pathways for chlorinated VOCs were discussed in Section 2.5.

MNA will be implemented in the area outside the target treatment area and will rely on natural attenuation processes to achieve the cleanup levels for TCE (5 µg/L), VC (2 µg/L), and RDX (6 µg/L). Reducing conditions predominantly present at the site are favorable for biologically mediated degradation of the chlorinated VOCs and RDX. In addition, the RDX target treatment area may overlap with a portion of the TCE and VC plumes, resulting in enhanced biodegradation of these constituents within this area. Natural attenuation will continue under this alternative until the COC concentrations decline to below cleanup levels.

Performance Monitoring and Long-term Monitoring

Following substrate injection, initial effectiveness of the remedial technology (EVO bio-barriers and MNA) will be evaluated through one year of quarterly performance groundwater monitoring following each of the two rounds of substrate injections. Following the completion of this performance monitoring, the data will be evaluated to determine if the long-term reduction in COC concentrations will be monitored as part of a long-term monitoring plan designed to evaluate the achievement of RAOs over time or determine if additional injections are required. If a long-term monitoring plan is developed, LTM will initially be conducted on a quarterly basis and over time will be reduced to semi-annually, annually, then every five years, until no additional LTM is needed.

If it is determined through LTM data, that the remedy is not acting as designed, optimization data will be collected to assess changes to the remedy. Based on current site conditions, it was assumed for cost-estimating purposes that any new monitoring wells plus the 12 existing shallow monitoring wells and one existing deep monitoring well will be included in the performance and long-term monitoring plans. Because contaminants will remain onsite following remedy implementation, the need for additional action to achieve the cleanup levels will be evaluated and documented during CERCLA 5-year reviews.

Land Use Controls

Throughout implementation of the remedy, the Navy will implement LUCs to prevent unacceptable risks to human receptors from exposure to COCs in groundwater. Under Alternative 2, the site will be designated as a "restricted use" area in the base geographic information system. This designation will place controls on groundwater at Site 22.

The associated LUCs will meet the following objectives:

- Prohibit activities that would result in contact with groundwater except for environmental monitoring
- Prohibit the withdrawal of groundwater except for environmental monitoring
- Prohibit construction of new buildings at the site without evaluation of potential vapor intrusion and/or ensuring vapor intrusion mitigation measures are included in building design
- Maintain the integrity of any current or future remedial or monitoring system

The Navy will develop and submit to USEPA and VDEQ a LUC RD. The LUC RD will provide for implementation and maintenance actions, including periodic inspections and reporting. The Navy will implement, maintain, monitor, report on, and enforce the LUCs according to the LUC RD.

Although the Navy may transfer these responsibilities to another party by contract, property transfer agreement, or through other means, the Navy will remain ultimately responsible for remedy integrity and will: 1) perform CERCLA Section 121(c) 5-year reviews; 2) notify the appropriate regulators and/or local government representatives of any known LUC deficiencies or violations; 3) provide access to the property to conduct any necessary response; 4) retain the ability to change, modify, or terminate LUCs; and 5) ensure that the LUC objectives are met to maintain remedy protectiveness.

2.11.3 Summary of the Estimated Remedy Costs

Table 6 presents a cost estimate summary for implementation of the selected remedy. ***Detailed cost estimates*** (Ref. 17) are provided in the 2011 FS report. The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

2.11.4 Expected Outcomes of the Selected Remedy

Site 22 is currently only being used for periodic hunting activities. This use is expected to continue, and there are no other planned land uses in the foreseeable future. Cleanup levels for the selected remedy are based on established risk-based cleanup levels suitable for unlimited use and unrestricted exposure. Exposure will be controlled through LUCs until COCs in groundwater (TCE, VC, and RDX) are reduced to the cleanup levels. Remedial activities at Site 22 will consist of Hot Spot treatment of RDX using EISB and associated performance monitoring; MNA of RDX, TCE, and VC; and LUCs. **Table 9** identifies the potential unacceptable human health risks (there are no potential unacceptable ecological risks), the RAOs established to address these unacceptable risks, the remedy component(s) that will be implemented to achieve each RAO, what metrics will be used to confirm the RAOs are met, and the expected outcome from implementation of the remedy components.

2.11.5 Statutory Determinations

In accordance with the National Oil and Hazardous Substances Pollution Contingency Plan, the selected remedy meets the following statutory requirements:

Protection of Human Health and the Environment— The selected remedy will protect human health (there are no potential ecological risks) from known site risks to future receptors through groundwater treatment and monitoring to reduce COC concentrations, and through LUCs to restrict the use of and exposure to shallow groundwater and shallow groundwater emissions until concentrations are reduced to established risk-based cleanup levels that allow for unrestricted use and unlimited exposure.

Compliance with ARARs—The selected remedy will meet all identified ARARs. Federal and state ARARs for Site 22, summarized by classification, are presented in **Appendix C**. The classification of ARARs identified includes chemical-specific, location-specific, and action-specific requirements.

Cost-Effectiveness—The selected remedy provides the most reasonable value relative to the cost through the use of active treatment in the high-concentration target area, while allowing for MNA in the low-concentration target areas.

Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable—The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner at Site 22. The selected remedy provides treatment through substrate injection that enhances biologically mediated degradation of the chlorinated COCs and RDX through natural microbial degradation processes to reduce contaminant mass. Because the long-term effectiveness and permanence, as well as reduction of toxicity and volume, are achieved through the selected remedy, the Navy, USEPA, and VDEQ concur 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 considering state and community acceptance.

Preference for Treatment as a Principal Element—The selected remedy uses treatment of the high-concentration target area as a principal element, and therefore satisfies the statutory preference for treatment.

Five-Year Review Requirements—This remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above established risk-based cleanup levels. The Navy will maintain LUCs and conduct a statutory remedy review every 5 years after initiating remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. If the remedy is determined not to be protective of human health and the environment because, for example, LUCs have failed or treatment is unsuccessful, then additional remedial actions would be evaluated by the FFA parties and the Navy may be required to undertake additional remedial action.

2.12 Documentation of Significant Changes

The PP for Site 22 was released for public comment on May 14, 2012. The public comment period ran from May 14 to June 28, 2012 with the public meeting to discuss the plan on May 24, 2012. General inquiries were received during the public meeting on May 24, 2012, but no comments were received requiring amendment to the PP, and no additional written comments, concerns, or questions were received from community members during the public comment period. It was determined that no significant changes to the remedy as originally identified in the PP were necessary or appropriate.

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3 Responsiveness Summary

The participants in the public meeting held on May 24, 2012, included representatives of the Navy and VDEQ. Two community members attended the meeting. Questions received during the public meeting were general inquiries and are included in ***meeting transcript*** (Ref. 18). There were no comments received at the public meeting requiring amendment to the PP, and no additional written comments, concerns, or questions were received from community members during the public comment period.

Please get a copy of transcript. Gail Rodrigues will want to see it.

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