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FINAL THIRD FIVE YEAR REVIEW REPORT NB NORFOLK VA

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CH2M HILL

Final

Third Five-Year Review Report

Naval Station Norfolk
Norfolk, Virginia

Contract Task Order WE77

February 2014

Prepared for

Department of the Navy
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Mid-Atlantic

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Prepared by

CH2MHILL

Virginia Beach, Virginia

Final

Five-Year Review Report

Naval Station Norfolk
Norfolk, Virginia

December 2013

This report documents the completion of the Five-year Review for the following sites at Naval Station Norfolk:

- Site 1(Operable Unit [OU] 1)—Camp Allen Landfill (CALF)
- Site 2 (OU 2)—Naval Magazine (NM) Slag Pile
- Site 3 (OU 3)—Q-Area Drum Storage Yard (QADSY)
- Site 6 (OU 6 and 7)—CD Landfill
- Site 18 (OU 14)– Former NM Disposal Area
- Site 20 (OU4)—Building LP-20
- Site 22 (OU 8)—Camp Allen Salvage Yard (CASY)
- Site 23 (OU 10)—Building LP-20 Plating Shop
- Solid Waste Management Unit (SWMU) 14 (OU13) – Q-50 Satellite Accumulation Area

A Five-year Review is required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in accordance with CERCLA §121(c), as amended, and the National Oil and Hazardous Substances Pollution Contingency Plan, Part 300.430(f)(4)(ii) of the Code of Federal Regulations.

Approved by:

D. A. Culler, Jr. Date
Captain, United States Navy
Commanding Officer
Naval Station Norfolk

M. H. Johansson 2/5/2014 Date
Captain, United States Navy
Commanding Officer
Naval Support Activity Norfolk

Executive Summary

The Department of the Navy (Navy) conducted this Five-year Review for Naval Station Norfolk (NSN) in Norfolk, Virginia, as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), in accordance with CERCLA §121(c), as amended, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Part 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR). The report has been prepared in accordance with the USEPA Comprehensive Five-year Review Guidance (USEPA, 2001) and Navy Policy on Five Year Reviews (CNO, 2011). It summarizes the evaluation of remedies and Remedial Actions (RAs) that resulted in hazardous substances, pollutants, or contaminants remaining at sites above levels that allow for unlimited use and unrestricted exposure (UU/UE), and for which there is a Record of Decision (ROD) or Decision Document (DD) in place. This document presents the Third Five-year Review Report for NSN, and has been conducted for RAs completed at the following nine sites:

- Site 1 (OU 1) —Camp Allen Landfill (CALF)
- Site 2 (OU 2)—Naval Magazine (NM) Slag Pile
- Site 3 (OU 3)—Q-Area Drum Storage Yard (QADSY)
- Site 6 (OU 6 and 7)—CD Landfill
- Site 18 (OU 14) – Former NM Disposal Area
- Site 20 (OU 4) —Building LP-20
- Site 22 (OU 8)—Camp Allen Salvage Yard (CASY)
- Site 23 (OU 10)—Building LP-20 Plating Shop
- Solid Waste Management Unit (SWMU) 14 – Q-50 Satellite Accumulation Area

This review was conducted between May 1, 2013, and October 23, 2013. The First and Second Five-year Review Reports were signed on October 3, 2003, and October 23, 2008, respectively. The triggering action for this statutory review presented herein is October 23, 2008, the Navy signature date on the Second Five-year Review Report.

The objective of the Five-year Review is to evaluate the effectiveness of the remedies to determine whether the remedies continue to be protective of human health and the environment in accordance with the requirements set forth in the RODs. This evaluation was accomplished through a review of various reports and documents pertaining to post-remedy-implementation activities, analytical data, and findings, and through interviews, site visits, and inspections. The community was notified of the review process through public notices in local newspaper advertisements published on May 8, 2013, in *The Virginian Pilot*. The Five-year Review report identifies any circumstance that may prevent a particular remedy from functioning as designed or providing sufficient protection of human health and the environment. The overall evaluation of the effectiveness of each remedy is presented as a protectiveness statement developed for each site and provided as follows. As outlined in this Five-year Review, the remedies for all sites are currently protective of human health and the environment. However, remedies for Sites 1, 3, and 20 were found to be protective in the short-term; additional investigations and/or actions are planned at these sites to address future protectiveness of human health and the environment. A summary of the RA completed for each site and the technical performance assessment, issues and recommendations, and protectiveness statements based on this Five-year Review are provided as follows.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: NSN		
USEPA ID: VA6170061463		
Region: 3	**State:** VA	**City/County:** Norfolk
SITE STATUS		
NPL Status: Final		
Multiple Operable Units (OUs)? Yes	**Has the site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency name:** United States Navy		
Author name (Federal or State Project Manager): Naval Facilities Engineering Command (NAVFAC)		
Author affiliation: United States Navy		
Review period: May 1, 2013 – October 23, 2013		
Date of site inspection: May 8, 2013		
Type of review: Statutory		
Review number: 3		
Triggering action date: October 23, 2008		
Due date *(5 years after triggering action date)*: October 23, 2013		

Issues/Recommendations

OU1 – Site 1: Action Requiring Follow-Up from Third Five-Year Review Report

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	To be determined (TBD)	Federal Facility	United States Environmental Protection Agency (USEPA)/State	July 2015
OU(s): OU1 (Site 1)	**Issue Category:** Monitoring			
	Issue: A Regional Screening Level (RSL) was established for 1,4-dioxane. The 2012 groundwater data indicates the constituent is present in site groundwater above the established RSL.			
	Recommendation: Evaluate the extent of 1,4-dioxane in site groundwater and its presence in treated effluent. If the data evaluation indicates 1,4-dioxane should be considered a contaminant of concern (COC) for Site 1, the NSN Tier I Partnering Team will determine if modifications to the existing remedy, LUC boundary, and/or treatment system are warranted.			

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	TBD	Federal Facility	USEPA/State	October 2016
OU(s): OU1 (Site 1)	**Issue Category:** Monitoring			
	Issue: Toxicity values were established for dioxins and furans. Based on site history, these constituents have the potential to be present in site groundwater.			
	Recommendation: Determine if dioxins and furans are present in site groundwater above established screening values. If a data evaluation indicates these compounds should be considered a COC for Site 1, the NSN Tier I Partnering Team will determine if modifications to the existing remedy, LUC boundary, and/or treatment system are warranted.			

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	TBD	Federal Facility	USEPA/State	October 2015
OU(s): OU1 (Site 1)	**Issue Category:** Monitoring			
	Issue: Perfluorinated compounds (PFCs) have been identified by the USEPA as an emerging contaminant. Based on site history, these constituents have the potential to be present in site groundwater.			
	Recommendation: Determine the presence or absence of PFCs in site groundwater. If PFCs are present, concentrations will be compared to Tier I toxicological values when established by USEPA. If a data evaluation indicates these compounds should be considered a COC for Site 1 (based on Tier I toxicological values), modifications to the existing remedy, LUC boundary, and/or treatment system are warranted as required under CERCLA.			

OU1 – Site 1: Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	TBD	Federal Facility	USEPA/State	October 2015
OU(s): OU1 (Site 1)	**Issue Category:** Monitoring			
	Issue: The VI investigation completed in 2011 indicates there are no significant pathways for Vapor Intrusion within Building MCA600. However, an additional sampling event was recommended by USEPA to confirm the findings.			
	Recommendation: Include chloroform and carbon tetrachloride analysis in groundwater LTM scheduled in 2013 and collect an additional round of indoor/outdoor air and subslab vapor samples in Building MCA600. A Supplemental VI Report will be completed to summarize the additional investigation.			

Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	October 2018
OU(s): OU1 (Site 1)	**Issue Category:** Remedy Performance			
	Issue: The current remedy is not expected to remediate the Columbia and Yorktown aquifers to beneficial use.			
	Recommendation: Conduct optimization analysis to determine time frame and practicability of reaching maximum contaminant levels (MCLs) in the Columbia and Yorktown Aquifers.			

Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	TBD	Federal Facility	USEPA/State	September 2014
OU(s): OU1 (Site 1)	**Issue Category:** Monitoring			
	Issue: Data gaps are present in the groundwater long-term monitoring (LTM) network for Area B; contamination south of the Elementary School is likely deeper than the existing shallow monitoring wells are screened and the deep chlorinated VOC plume remains undefined to the southeast.			
	Recommendation: Evaluate data gaps by installing and sampling new monitoring wells. If COCs are present above clean up goals, then the NSN Tier I Partnering Team will determine if modifications to the existing remedy, LUC boundary, and/or treatment system are warranted.			

Protectiveness Statement(s)		
Operable Unit: OU1 (Site 1)	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):* Not applicable (N/A)

Protectiveness Statement:

The remedy at Site 1, consisting of containment (through groundwater extraction and treatment) with LUCs, is currently protective in the short term for human health and the environment. Exposure pathways that could result in an unacceptable risk are being controlled through engineered LUCs (such as site security, fencing, and signage) and institutional controls (ICs). However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure continued protectiveness: 1) complete an groundwater evaluation to determine if 1,4-dioxane, dioxins, and furans should be considered a COC for the site and revise the site remedy, LUC boundary, and/or treatment system as warranted, 2) determine the presence/absence of PFCs in site groundwater and compare to Tier I toxicological values once established by USEPA 3) complete additional sampling (groundwater and VI) at Building MCA600 and 4) evaluate data gaps in groundwater LTM and modify the LTM network as warranted.

OU2 – Site 2: Action Requiring Follow-Up from Third Five-Year Review Report				
None				
OU2 – Site 2: Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU2 (Site 2)	**Issue Category:** Changed Site Conditions			
	Issue: An erosional feature located along the asphalt parking lot is present; the hole continues to be observed to ensure the asphalt cover is not affected.			
	Recommendation: Continue to observe during quarterly site inspections and complete repairs if warranted.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU2 (Site 2)	**Issue Category:** No Issue			
	Issue: Debris (tires, concrete, refrigerator, and so forth) has been observed at the site during two site visits; the Navy removed all debris from the site prior to the subsequent site inspection.			
	Recommendation: Continue to observe and report debris as found at the site during quarterly site inspections and complete removals when warranted.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU2 (Site 2)	**Issue Category:** Monitoring			
	Issue: Exit strategy for exiting groundwater LTM is not defined; the ROD estimates groundwater monitoring will be conducted every 5 years over a 30 year period.			
	Recommendation: Discuss groundwater monitoring data with the NSN Tier I Partnering Team to establish an exit strategy for groundwater LTM.			

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU2 (Site 2)	Protective	N/A

Protectiveness Statement:

The remedy at Site 2, NM Area Slag Pile, is protective by preventing direct contact with soil. Supporting inspection information and monitoring data indicate the asphalt and soil covers are in good condition. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in unacceptable risks are being controlled through a combination of covers, LUCs, and the implementation of ICs.

OU3 – Site 3: Action Requiring Follow-Up from Third Five-Year Review Report				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	TBD	Federal Facility	USEPA/State	July 2014
OU(s): OU3 (Site 3)	**Issue Category:** Remedy Performance			
	Issue: An RSL was established for 1,4-dioxane. Historical detection of 1,1,1-trichloroethane (TCA) in site groundwater data indicates the constituent may be present in site groundwater above the established RSL.			
	Recommendation: Evaluate the presence of 1,4-dioxane in site groundwater. If a data evaluation indicates 1,4-dioxane should be considered a contaminant of concern (COC) for Site 3, the NSN Tier I Partnering Team will determine if modifications to the existing remedy and/or LUC boundary are necessary.			

OU3 – Site 3: Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU3 (Site 3)	**Issue Category:** Remedy Performance			
	Issue: The current remedy is not expected to remediate the groundwater to cleanup goals within the next 30 years since the remaining groundwater contamination is detected outside of the radius of influence of the existing systems. All elevated concentrations of COC are within the existing LUC boundary.			
	Recommendation: Conduct optimization analysis to determine timeframe and practicability of reaching cleanup goals in a more efficient manner.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU3 (Site 3)	**Issue Category:** Monitoring			
	Issue: Existing exit strategy to cease groundwater monitoring requires revision.			
	Recommendation: Discuss groundwater monitoring data with the NSN Tier I Partnering Team to establish an exit strategy for groundwater LTM.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU3 (Site 3)	**Issue Category:** Remedy Performance			
	Issue: Current cleanup goals for carbon tetrachloride, 1,1-dichloroethene (DCE), and vinyl chloride (VC) are less than the MCL; the conservative cleanup goals are calculated based on potential future risk to indoor air.			
	Recommendation: NSN Tier I Partnering Team will establish appropriate cleanup goals for groundwater at Site 3 and complete the appropriate documentation.			

Protectiveness Statement(s)		
Operable Unit: OU3 (Site 3)	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):* N/A

Protectiveness Statement:

The remedy at Site 3, consisting of air sparge (AS)/soil vapor extraction (SVE), LTM, and LUCs, is currently protective of human health and the environment. Exposure pathways that could result in an unacceptable risk are being controlled by LUCs and ICs. However, in order ensure the remedy's protectiveness for the long-term, a groundwater evaluation to determine if 1,4-dioxane should be considered a COC for the site and revision the site remedy and/or LUC boundary is warranted.

OU6 & 7 – Site 6: Action Requiring Follow-Up from Third Five-Year Review Report				
None				
OU6 & 7 – Site 6: Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU6 & 7 (Site 6)	**Issue Category:** Site Access/Security			
	Issue: The existing fencing and gates are in poor condition and require maintenance.			
	Recommendation: Repair fencing and gates and continue to inspect the site during quarterly site inspections. Report any discrepancies to the NSN Tier I Partnering Team.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU6 & 7 (Site 6)	**Issue Category:** No Issue			
	Issue: Debris (tires) has been observed at the site during several site visits. The Navy currently working on removing all surficial debris from the site.			
	Recommendation: Remove miscellaneous debris and continue to inspect the site during quarterly site inspections. Report any discrepancies to the NSN Tier I Partnering Team.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU6 & 7 (Site 6)	**Issue Category:** Monitoring			
	Issue: Groundwater monitoring program is transitioning to wholly CERCLA (ROD defined groundwater monitoring as following the Virginia Solid Waste Management Regulations [VSWMR]). Additionally, no exit strategy to cease groundwater monitoring is defined.			
	Recommendation: Discuss cleanup goals with the NSN Tier I Partnering Team to establish appropriate cleanup goals for groundwater and an exit strategy to cease LTM (as appropriate and based upon waste remaining in place) at Site 6.			

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU6 & 7 (Site 6)	Protective	N/A

Protectiveness Statement:

The landfill cap remedy at Site 6 is protective by preventing direct contact with the soil and groundwater. Supporting inspection information and monitoring data indicate the landfill cap is in good condition. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the cap and enforcement of LUCs.

OU14 – Site 18: Action Requiring Follow-Up from Third Five-Year Review Report				
None				
OU14 – Site 18: Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU14 (Site 18)	**Issue Category:** Monitoring			
	Issue: No exit strategy to cease groundwater monitoring is defined.			
	Recommendation: Discuss groundwater monitoring data with the NSN Tier I Partnering Team to establish an exit strategy for groundwater LTM.			

Protectiveness Statement(s)		
Operable Unit: OU14 (Site 18)	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* N/A

Protectiveness Statement:

The remedy at Site 18 is protective by preventing direct contact with the groundwater. Supporting inspection information and monitoring data indicate bioremediation of the groundwater has reduced concentrations for all constituents of potential concern (COPCs) with the exception of VC at three site monitoring wells. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through the enforcement of LUCs.

OU4 – Site 20: Action Requiring Follow-Up from Third Five-Year Review Report				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	TBD	Federal Facility	USEPA/State	October 2016
OU(s): OU4 (Site 20)	**Issue Category:** Monitoring			
	Issue: An evaluation of VI at Building LP-20 (considered the worst case scenario by the NSN Tier I Partnering Team based on the existing conceptual site model [CSM] and detected concentrations of COCs in groundwater) indicated no current risk to receptors is present; however a potential future risk is present. Therefore, an evaluation of the VI pathway for buildings within 100 feet of the COC plume is recommended.			
	Recommendation: Complete the assessment of occupied site buildings to evaluate VI based on the presence of COCs in groundwater.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	TBD	Federal Facility	USEPA/State	July 2014
OU(s): OU4 (Site 20)	**Issue Category:** Monitoring			
	Issue: An RSL was established for 1,4-dioxane. The historical detection of 1,1,1-TCA indicates 1,4-dioxane may be present at Site 20.			
	Recommendation: Evaluate the presence of 1,4-dioxane in site groundwater and treated effluent. If a data evaluation indicates 1,4-dioxane should be considered a COC for Site 20, the NSN Tier I Partnering Team will determine if modifications to the existing remedy and/or LUC boundary are necessary in accordance with CERCLA.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	TBD	Federal Facility	USEPA/State	October 2015
OU(s): OU4 (Site 20)	**Issue Category:** Monitoring			
	Issue: Perfluorinated compounds (PFCs) have been identified by the USEPA as an emerging contaminant. Based on site history, these constituents have the potential to be present in site groundwater.			
	Recommendation: Determine the presence or absence of PFCs in site groundwater. If PFCs are present, concentrations will be compared to Tier I toxicological values when established by USEPA. If a data evaluation indicates these compounds should be considered a COC for Site 20 (based on Tier I toxicological values), the NSN Tier I Partnering Team will determine if modifications to the existing remedy, LUC boundary, and/or treatment system(s) are warranted.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	October 2018

OU(s): OU4 (Site 20)	**Issue Category:** Remedy Performance
	Issue: The remedy enhancement (groundwater extraction and treatment) is not functioning at the site (the system has been down for approximately 18 months); the Navy is currently working on plans to operate the system in a more efficient manner.
	Recommendation: Complete additional investigation (resolve data gaps in regards to the extent of COC contamination in the shallow and deep aquifers) to evaluate the most effective location(s) for extraction well(s) and treatment components to operate the extraction system.

OU4 – Site 20: Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	No	Federal Facility	USEPA/State	NA

OU(s): OU4 (Site 20)	**Issue Category:** Remedy Performance
	Issue: The Decision Document (Baker, 1996e) acknowledges the AS/SVE system is not anticipated to remediate site groundwater within 30 years.
	Recommendation: Conduct optimization analysis to determine timeframe and practicability of reaching MCLs within 30 years.

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	TBD	Federal Facility	USEPA/State	NA

OU(s): OU4 (Site 20)	**Issue Category:** Monitoring
	Issue: Data gaps are present in groundwater LTM network; the lateral extent of shallow groundwater COC contamination is not completely defined (4 locations) and the lateral/vertical extent of COC contamination is not defined in the deep aquifer.
	Recommendation: Evaluate data gaps by installing and sampling new monitoring wells. If COCs are present above clean up goals, then the NSN Tier I Partnering Team will determine if modifications to the existing remedy, LUC boundary, and/or treatment system are warranted.

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU4 (Site 20)	Short-term Protective	N/A

Protectiveness Statement:

The remedy at Site 20, consisting of treatment of shallow groundwater (through AS/SVE and enhanced by groundwater extraction and treatment) with LUCs, is currently protective in the short term of human health and the environment. Exposure pathways that could result in an unacceptable risk are being controlled through the enforcement of LUCs. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness: 1) complete the assessment of occupied site buildings to evaluate VI based on the presence of VOCs in groundwater; 2) complete an groundwater evaluation to determine if 1,4-dioxane should be considered a COC for the site and revise the site remedy, LUC boundary, and/or treatment system as warranted, 3) determine the presence/absence of PFCs in site groundwater and compare to toxicological values once established by USEPA 4) evaluate data gaps in groundwater LTM, and modify the LTM network and/or site remedy as warranted.

OU8– Site 22: Action Requiring Follow-Up from Third Five-Year Review Report		
None		
OU8 – Site 22: Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness		
None		
Protectiveness Statement(s)		
Operable Unit: OU8 (Site 22)	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* N/A
Protectiveness Statement: The cover systems at Site 22 are protective by preventing direct contact with soil and sediment. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the covers and enforcement of LUCs.		

OU10– Site 23: Action Requiring Follow-Up from Third Five-Year Review Report		
None		
OU10 – Site 23: Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness		
None		
Protectiveness Statement(s)		
Operable Unit: OU10 (Site 23)	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* N/A
Protectiveness Statement: The cover at Site 23 is protective by preventing direct contact with the soil. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the concrete cover and enforcement of LUCs.		

OU13– SWMU 14: Action Requiring Follow-Up from Third Five-Year Review Report				
None				
OU13 – SWMU 14: Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU6 & 7 (Site 6)	**Issue Category:** No Issue			
	Issue: The signs required by the LUC Remedial Design (RD) are repeatedly blown away due to high winds caused by storms at the site.			
	Recommendation: The Navy is currently working on a strategy to increase the longevity of the signs considering the high winds frequently experienced at the site.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	USEPA/State	NA
OU(s): OU13 (SWMU 14)	**Issue Category:** No Issue			
	Issue: The bioretention swales are in poor condition as observed during multiple site inspections.			
	Recommendation: The Navy is conducting maintenance to restore the functionality and the effectiveness (and aesthetics) of the bioretention swales.			

Protectiveness Statement(s)		
Operable Unit: OU13 (SWMU 14)	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* N/A
Protectiveness Statement: The asphalt cover at SWMU 14 is protective by preventing direct contact with the soil. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the cover and enforcement of LUCs.		

Contents

Appendixes

Tables (Tables are located at the end of each section.)

Figures (Figures are located at the end of each section.)

Acronyms and Abbreviations

°F	degree Fahrenheit
µg/L	microgram per liter
AF/VR	aggressive fluid/vapor recovery
amsl	above mean sea level
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
AS	air sparge
BEQ	Bachelor Enlisted Quarters
bgs	below ground surface
CALF	Camp Allen Landfill
CASE	Corrective Action Site Evaluation
CASY	Camp Allen Salvage Yard
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action—Navy
COC	constituent of concern
COPC	constituent of potential concern
CSM	conceptual site model
CTE	central tendency exposure
DCA	dichloroethane
DCE	dichloroethene
DD	Decision Document
DNAPL	dense non-aqueous phase liquid
DoD	Department of Defense
DPVE	Dual Phase Vapor Extraction
EE/CA	Engineering Evaluation/Cost Analysis
EP	Extraction Procedure
EPIC	Environmental Photographic Interpretation Center
ERA	Ecological Risk Assessment
ERM	Effects Range-Median
ERP	Environmental Restoration Program
ESI	Environmental Site Investigation
FFS	Focused Feasibility Study
FS	Feasibility Study
ft^2	square foot
GMP	Groundwater Management Plan
HHRA	Human Health Risk Assessment
HRS	Hazard Ranking System
IAS	Initial Assessment Study
IC	institutional control
IRACR	Interim Remedial Action Completion Report
IRP	Installation Restoration Program
IRPRI	Installation Restoration Program Remedial Investigation

lb	pound
LTM	long-term monitoring
LUC	land use control
MCL	maximum contaminant level
mg/kg	milligram per kilogram
N/A	not applicable
NACIP	Navy Assessment and Control of Installation Pollutants
NADEP	Naval Aviation Depot
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NM	Naval Magazine
NPL	National Priorities List
NSN	Naval Station Norfolk
NTCRA	non-time-critical removal action
O&M	operation and maintenance
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PA	Preliminary Assessment
PAH	polynuclear aromatic hydrocarbon
PAL	Project Action Limit
PCB	polychlorinated biphenyl
PFOA	perfluorooctanoic acid
PP	Proposed Plan
PRAP	Proposed Remedial Action Plan
PWC	Public Works Center
QADSY	Q-Area Drum Storage Yard
RA	Remedial Action
RAB	Restoration Advisory Board
RACR	Remedial Action Completion Report
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RFA	Resource Conservation and Recovery Act Facility Assessment
RfD	reference dose
RI	Remedial Investigation
RIP	remedy-in-place
RME	reasonable maximum exposure
ROD	Record of Decision
RPM	Remedial Project Manager
RPO	Remedial Process Optimization
RRR	Relative Risk Ranking
RSL	Regional Screening Level
SARA	Superfund Amendments and Reauthorization Act
SI	Site Investigation
SMP	Site Management Plan
SVE	soil vapor extraction

SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TBC	to-be-considered
TBD	to-be-determined
TCA	trichloroethane
TCE	trichloroethene
TM	Technical Memorandum
TPH	total petroleum hydrocarbons
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
UU/UE	unlimited use and unrestricted exposure
VC	vinyl chloride
VDEQ	Virginia Department of Environmental Quality
VDOH	Virginia Department of Health
VDOT	Virginia Department of Transportation
VI	vapor intrusion
VOC	volatile organic compound
VSWMR	Virginia Solid Waste Management Regulations
WWTP	wastewater treatment plant
yd^2	square yard
yd^3	cubic yard

SECTION 1

Introduction

The Department of the Navy (Navy) conducted this Five-year Review for Naval Station Norfolk (NSN) in Norfolk, Virginia, as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in accordance with CERCLA §121(c), as amended, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Part 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR). This report has been prepared in accordance with the United States Environmental Protection Agency (USEPA) *Comprehensive Five-Year Review Guidance* (USEPA, 2001), and summarizes the evaluation of remedies and Remedial Actions (RAs) that resulted in hazardous substances, pollutants, or contaminants remaining at sites above levels that allow for unlimited use and unrestricted exposure (UU/UE), and for which there is a Record of Decision (ROD) or Decision Document (DD) in place. The NSN sites requiring a Five-year Review are:

- Site 1 (Operable Unit [OU] 1)—Camp Allen Landfill (CALF)
- Site 2 (OU 2)— Naval Magazine (NM) Slag Pile
- Site 3 (OU 3) —Q-Area Drum Storage Yard (QADSY)
- Site 6 (OU 6 and 7)—CD Landfill
- Site 18 (OU 14) – Former NM Disposal Area
- Site 20 (OU 4)—Building LP-20
- Site 22 (OU 8) —Camp Allen Salvage Yard (CASY)
- Site 23 (OU 10)—Building LP-20 Plating Shop
- Solid Waste Management Unit (SWMU) 14 (OU 13)– Q-50 Satellite Accumulation Area

The objective of this Five-year Review is to evaluate current remedies at these nine sites and determine whether the remedies are protective of human health and the environment in accordance with the requirements established in the RODs and preceding DDs (where applicable). The principal method used to evaluate the protectiveness of the remedies was a thorough review of reports, analytical data, and documents pertaining to site activities and findings. The methods, findings, and conclusions from the document reviews are presented in this Five-year Review. In addition, this report identifies issues that may prevent a particular remedy from functioning as designed or as appropriate, which could endanger the protection of human health and the environment.

This Five-year Review was prepared pursuant to CERCLA §121 and NCP requirements. A Five-year Review is required 5 years from the initiation of the first RA that leaves hazardous substances, pollutants, or contaminants remaining at sites above levels that allow for UU/UE. If a site contains multiple remedies, all are subject to a Five-year Review when at least one remedy is triggered. NSN has elected to follow Navy recommendations of conducting an installation-wide Five-year Review that includes all sites with remedies in place based on the remedy initiation trigger date for the first site.

This Five-year Review was prepared pursuant to CERCLA 121 and the NCP. CERCLA 121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

USEPA interpreted this requirement further in the NCP; 40 CFR 300.430 (f)(4)(ii), which states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

The triggering action of this statutory review is the initiation of the selected RA for Site 1 (CALF), dated August 1995. The first Five-year Review for NSN was finalized October 2003 (CH2M HILL, 2003) followed by the second Five-year Review finalized in October 2008 (CH2M HILL, 2008). This Third Five-year Review is required because hazardous contaminants remain at sites at NSN above levels that allow for UU/UE.

SECTION 2

Facility Background and History

The background information for NSN presented in this section is necessary to identify the potential threats that were posed to the public and the environment at the time of the ROD or DD for each site. This allows for the remedy performance to be compared with the site conditions that the remedies were intended to address. Information presented in this section includes a discussion of the facility description, physical characteristics of the facility, and the environmental history.

2.1 Facility Description

NSN encompasses 4,631 acres in the northwest portion of the City of Norfolk, Virginia (**Figure 2-1**). The western portion of NSN is a developed waterfront area containing the piers and facilities for loading, unloading, and servicing naval vessels. Land use in the surrounding area is commercial, industrial, and residential. The waterfront area south of the NSN provides shipping facilities and connects to a network of rail lines for several large industries.

Naval operations began at NSN in 1917 when the United States Navy acquired 474 acres of land to develop a naval base to support World War I (WWI) activities. During WWI the Navy concluded that the available land was insufficient. It was decided to fill a large part of the flats on the west and north by dredging the Elizabeth River to a depth sufficient for large ships to dock at the base. During the fall and winter of 1917, approximately eight million cubic yards (yd^3) was dredged, moving the northern shoreline from along Dillingham Boulevard to approximately its current location (CNIC, 2013). Bulkheads were built along the coast to extend available land and after extensive dredge and fill operations, 792 acres were under Navy control (**Figure 2-1**).

An additional 143 acres were acquired in 1918 and officially commissioned for the Naval Air Station (NAS). From 1936 through 1940, improvements to the piers and expansion of supply and material handling facilities were also completed.

During World War II (WWII), major construction projects were completed, including a power plant, numerous runways and hangars, a tank farm, and several barracks/housing complexes. During this time, the area of NSN expanded to more than 2,100 acres. After WW II, NSN continued to acquire land through various types of land transfers and dredge-and-fill operations conducted in areas of Mason Creek, the Bousch Creek Basins, and Willoughby Bay.

NSN has expanded to become the world's largest naval installation. NSN operates in various capacities to provide support to vessels, aircraft, and other activities. Many tenants are housed at NSN, each performing different operations involving the servicing and maintenance of vessels and aircraft.

NSN's mission is to provide fleet support and readiness for the United States Atlantic Fleet.

A number of other military installations are located within a 25-mile radius of NSN—Joint Base Langley-Eustis to the north, Joint Expeditionary Base Little Creek-Fort Story to the east, NAS Oceana to the southeast, Norfolk Naval Shipyard and St. Juliens Creek Annex to the south, and Defense Fuel Support Point Craney Island Fuel Terminal to the southwest.

2.2 Physical Characteristics

The major physiographic features of NSN and surrounding area are described in the following subsections.

2.2.1 Climate

The Hampton Roads Area has a maritime climate characterized by long temperate summers and mild winters. The average annual temperature is 60.7 degrees Fahrenheit (°F). July is the warmest month, with temperatures

averaging 71 to 85°F, while January is the coolest, with temperatures averaging 35 to 48°F (Virginia.org, 2013). Precipitation averages 41 inches annually and is evenly distributed throughout the year (Virginia.org, 2013). A slight increase in precipitation occurs from June to August due to the prevalence of convective thunderstorms. The average annual snowfall is 8.8 inches. Winds are generally in an easterly direction and of moderate speed, ranging from 6 to 8 knots (CH2M HILL, 1997).

2.2.2 Topography

The topography of NSN is nearly level. Surface elevations at the base range from sea level to approximately 15 feet above mean sea level (amsl) in the central portion of the base.

2.2.3 Soils

The soils at NSN are a complicated distribution of naturally occurring material and dredge-and-fill material. The native soils are composed of unconsolidated fine sands and silts of low to moderate permeability and are generally underlain by relatively impermeable sediments consisting of silt, clay, and sandy clay. The fill material is primarily composed of heterogeneous sediments removed during dredging operations. The composition of the dredge-fill sediments varies from site to site, but it is generally composed of sand, silt, and gravel. Some concrete, stone, and miscellaneous debris were also used as fill material (CH2M HILL, 1997).

2.2.4 Surface Water Resources

Four major surface water features surround the greater Norfolk area including the James and Elizabeth Rivers, Willoughby Bay, and Chesapeake Bay, all of which are tidal. Most surface water on the base flows either to Mason Creek or to the remnants of Bousch Creek. The northernmost channel of Mason Creek traverses the base via a subgrade aqueduct. The main channel of Bousch Creek was filled in and replaced by a culvert and a network of drainage ditches during the base's development. These narrow drainage channels are interspersed throughout the central part of the base. Bousch Creek, Mason Creek, and these drainage ditches are tidal throughout the base. Both creeks discharge to Willoughby Bay and ultimately, to the Chesapeake Bay. Some surface water from the base discharges directly into the Elizabeth River (CH2M HILL, 1997).

2.2.5 Geology and Hydrogeology

NSN is located in the outer Atlantic Coastal Plain Physiographic Province, which is characterized by low elevations and gently sloping relief. The base is underlain by more than 2,000 feet of gently dipping sandy sediments.

The uppermost geologic unit is the Columbia Group, which is approximately 60 feet thick. The upper 20 to 40 feet consists of unconsolidated fine sands and silts. These sediments possess low to moderate permeabilities and comprise the unconfined Columbia aquifer. The lower 20 to 40 feet consists of relatively impermeable silt, clay, and sandy clay.

The Chesapeake Group underlies the Columbia Group. The uppermost unit in the Chesapeake Group is the Yorktown Formation. It is capped by the Yorktown confining unit, which separates the Columbia aquifer from the underlying Yorktown aquifer. The Yorktown formation is approximately 90 to 100 feet thick in the vicinity of NSN and composed of marine silt and clay and moderately consolidated coarse sand and gravel with abundant shell fragments. The Chesapeake Group is composed of several additional deeper aquifers and confining units.

Two significant shallow aquifer systems in the area are the Columbia aquifer (located in the upper 20 to 40 feet of the Columbia Group) and the underlying Yorktown aquifer. The Columbia aquifer includes the water-table aquifer and consists of discontinuous heterogeneous sand and shell lenses. The water table depth is usually less than 8 feet. The Yorktown aquifer is semi-confined beneath a clay layer in the upper Yorktown Formation. Water-bearing zones in the Yorktown aquifer consist of fine to coarse sand, gravel, and shells (CH2M HILL, 1997).

2.3 Environmental History

Comprehensive environmental restoration activities at NSN began in 1975 under the Navy Assessment and Control of Installation Pollutants (NACIP) Program, termed the Installation Restoration Program (IRP) in 1986 when changed to reflect the requirements of CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA). The purpose of the NACIP and IRPs was to identify, assess, characterize, and cleanup or control contamination from past waste management activities at Navy and Marine Corps facilities. The IRP is now referred to as the Environmental Restoration Program (ERP).

Given the nature and extent of its operations, the Navy has been involved with toxic and hazardous materials for several decades. The Department of Defense (DoD), as well as general industry, has realized that previously acceptable methods of disposal are no longer sufficient, and actions are being taken, through these programs, to cleanup Navy sites that pose a threat to human health or the environment. Current Navy waste management operations are in compliance with all federal, state, and Navy regulations to ensure safe operation and disposal of hazardous substances.

NSN initiated its environmental investigation efforts by conducting an Initial Assessment Study (IAS) in 1983 (ESE, 1983) followed by an Installation Restoration Program Remedial Investigation (IRPRI)—Interim Report (Malcolm Pirnie, 1988); a Resource Conservation and Recovery Act Facility Assessment (RFA) (A.T. Kearney, 1992); an Aerial Photographic Site Analysis (USEPA, 1994); Phase I Relative Risk Ranking (RRR) System Data Collection Sampling and Analysis Report (RRR—Phase I) (Baker, 1996a); and a RRR System Data Collection Sampling and Analysis Report Phase II (RRR—Phase II) (Baker, 1996f). A total of 170 potential contaminated sites, areas, or SWMUs at NSN were identified for evaluation in the IAS, IRPRI, Aerial Site Analysis, RRRs, and other NSN assessments. A detailed discussion of each of these investigations can be found in the most recent Site Management Plan (SMP) (CH2M HILL, 2013a) and results will be discussed in the following sections as they pertain to each site evaluated during the Five-year Review.

On June 17, 1996, the USEPA proposed that NSN be added to the National Priorities List (NPL). The USEPA evaluates industrial sites using the Hazard Ranking System (HRS), and those facilities with HRS scores exceeding 28.5 are proposed for the NPL. The HRS score of 50 was assigned by the USEPA to NSN. The proposed listing was followed by a minimum 60-day review and comment period prior to NSN's inclusion on the NPL on April 1, 1997. The FFA, negotiated between the Navy, USEPA, and the Virginia Department of Environmental Quality (VDEQ), was finalized in February 1999. In accordance with the FFA, the Five-year Review provides a review and evaluation of the selected remedies for those sites with a CERCLA remedy in place.

The Navy and USEPA provide information regarding the cleanup of NSN to the public through the community relations program, which includes a Restoration Advisory Board (RAB) that was formed in 1994; public meetings; the Administrative Record file; the information repository; and announcements published in the local newspapers. During the course of investigations at these sites, the RAB has been apprised of all environmental cleanup activities related to each site.

A Preliminary Closeout Report (PCOR) summarizing the investigations and remedies at each site was signed September 2010. The PCOR documented that the USEPA has evaluated all RAs for the NSN Superfund Site in accordance with *Closeout Procedures for National Priorities List Sites* (USEPA, 2000) and concluded that all RAs were consistent with specifications in the RODs and Remedial Designs (RDs) for each operable unit (OU). No further response actions were appropriate at the site; the findings indicated the Navy has initiated the activities necessary to achieve performance standards and site completion.

1907 - USGS Map

Chesapeake Bay
James River
Willoughby Spit
Willoughby Bay
Mason Creek
Sewall Point
Tanner Creek
City of Norfolk
Elizabeth River
Tanner Pt.

Site 03 - Q Area Drum Storage
SWMU 14: Q-50 Satellite Accumulation Area
Site 03 - Q Area Drum Storage
Site 03 - Q Area Drum Storage
Site 20 - LP-20 Site
Site 23 - Building LP-20 Plating Shop
Site 06 - CD Landfill
Site 01 - Camp Allen Landfill Area A
Site 01 - Camp Allen Landfill Area B
Site 22 - Camp Allen Salvage Yard
Site 18 - Former NM Hazardous Waste Storage Area
Site 02 - NM Slag Pile

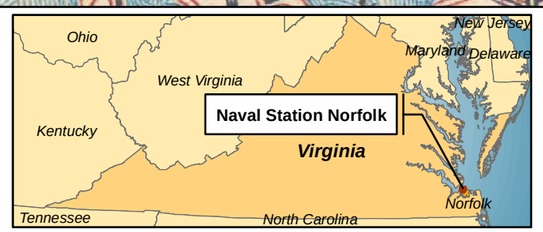
2008 - Aerial Imagery

Chesapeake Bay
James River
Willoughby Bay
Mason Creek
City of Norfolk
Elizabeth River

Site 03 - Q Area Drum Storage
SWMU 14: Q-50 Satellite Accumulation Area
Site 03 - Q Area Drum Storage
Site 03 - Q Area Drum Storage
Site 20 - LP-20 Site
Site 23 - Building LP-20 Plating Shop
Site 06 - CD Landfill
Site 01 - Camp Allen Landfill Area A
Site 01 - Camp Allen Landfill Area B
Site 22 - Camp Allen Salvage Yard
Site 18 - Former NM Hazardous Waste Storage Area
Site 02 - NM Slag Pile

Legend

- Surface Water Features
- Site Boundary
- SWMU Boundary
- Installation Boundary



N
W E
S

0 3,500 7,000
Feet

Reference: 2008 Aerial Photography
1907 Map Source: USGS. Norfolk Virginia Special Map. Edition of June 1907

Figure 2-1
Site Location Map
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 3

Five-Year Review Process

The Five-year Review process for the sites at NSN is described below. This process includes establishing the review team and the review schedule; notifying and presenting the findings to the community; and a review of all relevant documents.

3.1 Administrative Component

The NSN Five-year Review team is led by Mr. Tom Kowalski, Remedial Project Manager (RPM) for the ERP at NSN. In addition to Mr. Kowalski, the Five-year Review team consists of the following members:

- Mr. Eric Salopek /RPM for VDEQ
- Mr. Steven Hirsh/RPM for USEPA

The members of the team were notified of the initiation of this Five-year Review in November 2012 and subsequently, the sites were reviewed by the team between then and June 2013 to prepare this report. The review included evaluation of existing documents, data, inspection checklists, operation and maintenance (O&M) activities, Applicable or Relevant and Appropriate Requirement (ARARs), and risk assessment methodologies. Sections 4 through 12 of this Five-year Review report describe in detail the review process and findings for each site included in this report.

3.2 Community Involvement

Members of the community were notified of the initiation of the Five-year Review on May 8, 2013 via a notification in the *Virginian Pilot* (Attachment 1). The findings of the review will be presented to the community during a future NSN RAB meeting.

3.3 Document Review

This Five-year Review consisted of a review of relevant documents such as Remedial Investigations (RIs), Feasibility Studies (FSs), Engineering Evaluations/Cost Analyses (EE/CAs), DDs, and RODs as applicable for each site included in this review. These documents are located in the Administrative Record which is available to the public at:
https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_ww_pp/navfac_hq_pp/navfac_env_pp/env_restoration_installations/lant/midlant/nsn.

SECTION 4

Site 1—Camp Allen Landfill

4.1 Chronology

The following is the chronology of the major site events for Site 1, CALF.

1940s – 1974	Use of Area A to dispose of municipal, solid, and hazardous wastes
1971	Use of Area B to dispose of wastes (drums and residues) from a fire at CASY
1983	CALF identified as a potential source of contamination in the IAS (Malcolm Pirnie, 1983)
1984	Site Suitability Assessment completed (Malcolm Pirnie, 1984)
1987	Confirmation Study completed (Malcolm Pirnie, 1987)
1988	Interim RI completed
May 1994	Non-time-critical removal action (NTCRA) implemented to address chlorinated volatile organic compound (VOC) source located at Area B
1994	RI/FS completed (Baker, 1994b)
1995	Proposed Remedial Action Plan (PRAP) (Baker, 1995b) completed and DD (Baker, 1995c) signed
April 1997	NSN placed on NPL
1997	Construction of the groundwater extraction and Dual Phase Vapor Extraction (DPVE) system
1998	Operation of the groundwater extraction and DPVE system initiated.
1999	Implementation of long-term monitoring (LTM) and quarterly site inspections
July 2003	NTCRA implemented to address sediment contamination in the Area B pond (removal action completed in conjunction with Site 22)
October 2003	First Five-year Review (CH2M HILL, 2003)
January 2008	Plume delineation in vicinity of Monitoring Wells B-MW3A and B-MW11A
April 2008	NTCRA implemented to address sediment contamination in the Upper Reaches of Bousch Creek (AGVIQ/CH2M HILL, 2008b)
June 2008	DPVE System taken out of service
October 2008	Second Five-year Review
2009	Area B converted to asphalt parking lot as part of Site 22 being converted to recreational fields
July 2010	Proposed Plan (PP) (Navy, 2010a) and Remedial Action Completion Report (RACR) (Navy, 2010b)
August 2010	ROD (Navy, 2010c); reaffirmation of the selected remedy from DD
September 2010	NSN achieves Construction Completion; Preliminary Closeout Report (USEPA, 2010) signed by USEPA
December 2011	Recommendation to cease surface water sampling as part of LTM
June-October 2012	Area B Delineation Investigation south of Camp Allen Elementary School
September 2012	Draft Sites 1 and 20 Vapor Intrusion (VI) Risk Assessment Technical Memorandum (TM) (CH2M HILL, 2012) submitted
April 2013	Demolition of Brig Facility

4.2 Background

4.2.1 Site Description

Site 1 is located approximately 1 mile east of Hampton Boulevard and 1 mile south of Willoughby Bay (**Figure 2-1**). The site is located within a mixed-use, urban land area, bordered by Bousch Creek on the north, south, and west

(Baker, 1995c). The landfill consists of two primary areas, Area A (45-acre landfill) and Area B (2-acre fire disposal area), as shown on **Figure 4-1**. Residential communities lie to the west of Area A and to the south of both areas. The Camp Allen Elementary School is located south of Area B, and the Lincoln military housing complex is located south of the elementary school.

Prior to the use of Site 1 as a landfill, the area was utilized by the base as a source of borrow material. The Area A landfill, which operated from the mid-1940s until approximately 1974, was used for the disposal of various waste materials. These materials included demolition debris, sludges from metal plating processes, parts cleaning and paint stripping wastes, overage chemicals, various chlorinated organic solvents, acids, caustics, paints, paint thinners, pesticides, and asbestos. Fly and bottom ash from the power plant and ash from an incinerator (formerly located just South of the former brig facility), which operated from the mid- 1940s until the mid-1960s and large items too big for the site incinerator were burned in the landfill. Based on industrial waste generation rates, it is estimated that approximately 40,000 pounds (lbs) of metals plating sludge, 60,000 lbs of parts cleaning sludge, and 400,000 lbs of paint stripping residue have been disposed of in the CALF (ESE, 1983). Following landfill operations, a soil cover was placed over the site. The former brig facility was constructed over the Area A landfill by 1976; the heliport pad was built at the Site by 1980.

Wastes from a fire at Site 22 (CASY), including drums containing various chemicals and burn residues, were buried in trenches (estimated to be approximately 150 feet long, 10 feet wide, and 6 to 8 feet deep) at Area B in 1971. The fire occurred in the Northern portion of Site 22 where waste lubricating oil, various solvents, paints, paint thinners, acids, caustics, and pesticides were stored pending disposal.

4.2.2 Physical Characteristics

Area A is covered with soil and vegetation to minimize surface erosion and Area B is covered with asphalt; both areas are located adjacent to tidal drainage ditches that convey stormwater runoff to Willoughby Bay.

The two aquifer systems at the site have been impacted by the CALF; the water table aquifer (Columbia aquifer) and the underlying Yorktown aquifer. The Yorktown aquifer is separated from the water-table aquifer by a confining clay unit. In the vicinity of the CALF, a breach and/or ineffective (poorly developed) portion of the confining clay unit allow downward migration of constituents from the Columbia aquifer to the Yorktown aquifer. Shallow groundwater generally discharges to the site drainage ditches (surface water does not recharge the shallow groundwater).

The site groundwater is currently not used for any purpose other than environmental monitoring and potable water used onsite, and by the nearby community, is supplied by the City of Norfolk (Baker, 1995c).

The conceptual site model (CSM) for Site 1 is provided as **Figures 4-2a and 4-2b**.

4.2.3 Land and Resource Use

Currently, only the heliport is located over a portion of the Area A landfill. The brig facility has been demolished. Area B is used as a parking lot serving the recreational fields located between Areas A and B (Site 22, CASY). It is anticipated that a mix of land uses similar to that described above will continue for the foreseeable future.

4.2.4 History of Contamination

As noted above, the Area A landfill was used for the disposal of various waste materials from the mid-1940s until approximately 1974. Wastes from a fire at Site 22 (CASY), including drums containing various chemicals and burn residues, were buried in trenches at Area B in 1971. The potential for site contamination from disposal practices was initially identified in the 1983 IAS (ESE, 1983).

Initial Response

Field investigations were conducted from 1983 to 1994 to characterize the nature and extent of contamination at the site.

Contamination from prior disposal practices at Site 1 has affected surface and subsurface soil, sediment, surface water, and groundwater. The primary contaminants found in all media at the site are VOCs. The 1994 RI/FS identified two primary source areas of VOCs north (Area A2) and west (Area A1) of the former brig facility (**Figure 4-1**). Groundwater contamination was detected in both the Columbia aquifer and the Yorktown aquifer in Areas A and B; this may be due to the breach of the confining layer between the two aquifers beneath much of the CALF area. The results from the air sampling performed at the former brig facility and the Camp Allen Elementary School indicated no significant site-specific volatile air contaminants were detected. Areas of inorganic contamination of surface water and sediments in the surrounding drainage ditches and in the onsite pond[1] were also detected.

A DD (Baker, 1993) was signed in November 1993 for the NTCRA of the contaminant source (buried debris and impacted soil) from Area B of the CALF. The purpose of the removal action was to remove the primary sources of groundwater contamination within the Area B Landfill so that no further action would be required for the soils and debris. This removal action, implemented in May 1994 and completed in January 1995, removed approximately 11,500 tons of soil and debris for disposal offsite (**Figure 4-1**). The NTCRA consisted of the following:

- Excavation of the soil, debris, and buried drums from the trenches plus over-excavation of visibly-contaminated soil from the side walls and floor of the excavation
- Confirmation soil sampling and analysis, and additional excavation of material contaminated in excess of the removal action cleanup levels
- Disposal of excavated soil, debris, and drums at a Resource Conservation and Recovery Act (RCRA)-permitted hazardous waste disposal facility (landfill or incinerator).

The soil cleanup goals levels were met as established in the Final EE/CA Report; therefore, the primary sources of contamination at Area B were removed.

Site Risks

As part of the RI (Baker, 1994b), a baseline Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA)were conducted (**Table 4-1**). The HHRA identified potential unacceptable risks for both current and future receptors exposed to environmental media at the site (**Table 4-1**). The ecological evaluation concluded habitats seem to be diverse, wildlife was breeding on site, and natural processes like habitat succession indicated that plants were germinating and competing successfully (Baker, 1994b). However, the DD indicated further ecological assessment of constituents detected at the site should be evaluated as the Bousch Creek ERA.

4.2.5 Basis for Taking Action

The primary risks posed by conditions at Site 1 are the contaminated soil in Area A and waste remaining in place at the landfill, which provides a potential source of contamination that threatens the underlying aquifer and surrounding site media (surface water and sediment). Based on the results of previous investigations, remedial action is warranted to protect public health, welfare, and the environment from actual or threatened releases of VOCs in groundwater, debris located in Area A, and polychlorinated biphenyls (PCBs) and/or inorganics in surface soil, subsurface soil, surface water and sediment at Site 1.

4.3 Remedial Actions

4.3.1 Remedy Selection

A PRAP (Baker, 1995b) and a DD (Baker, 1995c) identified the risks to the human health and ecological receptors, established the Remedial Action Objectives (RAOs), and defined the selected remedy for Areas A and B. The selected remedy for the site was reaffirmed in the 2010 via a PP (Navy, 2010a) and ROD (Navy, 2010c). The

[1] The onsite pond was investigated and addressed under Site 22.

purpose of the selected remedy was to control the exposure to contamination present in the soil, groundwater, surface water, and sediment. The selected remedy for Site 1 includes *in situ* treatment of soil and shallow groundwater using DPVE in Area A; extraction and treatment of the water table and Yorktown aquifers groundwater in Areas A and B; and LTM and institutional controls (ICs) to meet the following RAOs:

- Prevent exposure to the contaminated groundwater, subsurface soil, debris, surface water, and sediment[2]
- Prevent further migration of contaminated groundwater
- Remediate the water table and Yorktown aquifers groundwater for future beneficial use
- Minimize the migration of contaminants from soil and debris in Area A to groundwater and surface water

The following LUC objectives were developed for Site 1:

- Prohibit use of the site for residential land use
- Maintain the existing soil cover
- Prohibit use of the groundwater beneath the site other than for environmental monitoring and testing
- Prohibit changes from current building use or construction of new buildings without further evaluation of potential VI risks and/or implementation of mitigation measures

These LUCs restrictions have been implemented with the actions detailed in the RD for LUCs at Site 1. The LUCs will be maintained on all land, surface water, sediment, and groundwater within the boundaries of Site 1 until they are no longer required to protect human health or the environment, as stipulated in the DD (Baker, 1995c).

4.3.2 Remedy Implementation

The established cleanup goals for groundwater are provided in **Table 4-1.** Cleanup goals were established for soil; however, attainment of the soil cleanup goals is qualitative and achievement of these goals is determined through evaluation of groundwater monitoring results (values calculated based on VOC migration from soils into water table aquifer). No cleanup goals were established for surface water or sediments because the removal and/or treatment alternatives were not evaluated for these media. The selected RAs are summarized below:

Area A1

- Treatment of the soil and water table aquifer using a DPVE system in combination with ICs that control access to the site and incorporate land and groundwater use restrictions.
- Treatment of the Yorktown aquifer through deep extraction wells that pump the groundwater to an onsite treatment system.

Area A2

- A pilot study in this area showed that DPVE was an ineffective treatment due to the lack of identifiable contaminants observed in the extracted groundwater or soil vapors and the low hydraulic conductivity of the soil matrix. Therefore, ICs were implemented and the shallow groundwater that could migrate horizontally or vertically into the Yorktown aquifer is extracted for treatment by the onsite system where solids are removed via clarification/filtration to prevent fouling of the treatment system.
- Implementation of ICs with groundwater monitoring for the Yorktown aquifer (at the time the 1995 DD was completed, the contaminant plume was not expected to migrate off Navy property).

Area B

- Extraction and treatment of both aquifers, implementation of ICs, and monitoring.

[2] Risks to surface water and sediment were addressed by the Upper Reaches of Bousch Creek Sediment Removal action (**Figure 4-1**) completed in 2008 and the Site 22 Removal Action completed in 2003.

Surface Water and Sediment

- Implementation of ICs and monitoring.

Construction of the groundwater extraction and treatment system was initiated in 1997 and continuous operation of the Camp Allen Treatment Plant began in November 1998. **Figure 4-1** illustrates the layout of the system with associated shallow and deep extraction and monitoring well locations. Groundwater samples were collected from monitoring wells in March 1997 and June 1998 to provide baseline information on water quality before the extraction system was started. In August 1997, the extraction wells were sampled to provide information on water quality prior to system startup. In May 1998, the DPVE system was completed and began operation.

In accordance with the DD, additional sampling/analysis of surface water/sediment was completed in 2006 to determine the full extent of ecological impacts to the area surrounding the CALF. An ERA through Step 7 for the Upper Reaches of Bousch Creek as related to Site 1 concluded unacceptable risk to benthic invertebrate receptors in the Upper Reaches of the creek from exposure to metals (CH2M HILL, 2006a). The NSN Partnering Team agreed to mitigate the risk in approximately 2,100 linear feet of the creek in the vicinity of Site 1 using a sediment removal strategy. The selected NTCRA concluded in April 2008 and consisted of the excavation of 2 feet of sediment throughout the designated removal areas and backfill of 1 foot of clean fill (**Figure 4-1**); no further action was required. The Area B pond was investigated and remediated as part of the Site 22 RA (see Section 10).

In accordance with the DD and ROD, Site 1 is part of the LTM program at NSN. The LTM plan for the Site 1 groundwater remediation system requires groundwater monitoring until cleanup goals are met.

4.3.3 System Operation/Operation and Maintenance

The standard O&M of the DPVE and groundwater extraction treatment systems is documented in the *Operations and Maintenance Manual for Soil and Groundwater Remedial Action* (OHM, 1997). The operation of the groundwater extraction system was modified to include precipitation of dissolved inorganic constituents in the groundwater to prevent fouling of the system.

The majority of the process optimization measures at Site 1 consist of equipment and process modifications to the treatment plant to reduce maintenance costs and increase the efficiency of operation. Current optimization efforts include accelerated remediation by aggressive fluid/vapor recovery (AF/VR) at hotspot area at B-20W (when free product is measured) and discontinuing the operation of the DPVE system in Area B. Additionally, shallow groundwater delineation activities South of the Camp Allen Elementary School are ongoing to determine if it is feasible to consider localized groundwater treatment alternatives or modification to the existing shallow treatment system.

4.4 Progress Since the Last Review

4.4.1 Follow-up Actions Since Last Five-year Review

The previous Five-year Review Report included the following protectiveness statement for Site 1:

The remedy at Site 1 consisting of the groundwater extraction system is currently protective of human health and the environment and is expected to be protective in the future. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the groundwater extraction system, LUCs (i.e., fencing, signage, etc.), and the implementation of ICs.

Although the Five-year Review concluded that the remedy is functioning as intended and protective of human health and the environment, issues and recommendations for follow-up actions were identified. **Table 4-2** presents the status of these recommendations and follow-up actions.

4.4.2 Actions Summary

This section is intended to provide a summary of O&M and LTM program activities at Site 1 since the last Five-year Review Report completed in October 2008. O&M is currently performed as described in Section 4.3. The LTM

activities have continued at Site 1 in accordance with the *Long Term Monitoring Plan for Four Sites* (CH2M HILL, 2007e); however, the NSN Tier I Partnering Team has completed supplemental LTM in 2011 and 2012 to evaluate the effectiveness of the remedy. An update to the LTM program is in progress via new Basewide LTM Sampling and Analysis Plan for NSN, which is under review by the NSN Tier I Partnering Team concurrent to this Five Year Review. The LTM activities consist of annual groundwater extraction and monitoring well sampling for site constituents of concern (COCs) and the collection of water level measurements semiannually to model groundwater flow and hydraulic capture zones at Site 1. The results of the monitoring are summarized below and documented in greater detail in the *Draft 2012 Annual Long Term Monitoring Report* (CH2M HILL, 2013a) (hereafter referred to as the 2012 LTM Report). Additionally, site inspections are performed quarterly.

Groundwater Treatment

Influent and effluent discharge monitoring for the GWTP is conducted monthly in order to ensure that the effluent does not exceed the allowable discharge requirements to the tributary of Bousch Creek. Influent and effluent samples are analyzed for VOCs and dissolved metals.

Hydraulic Model Review

Groundwater level measurements are collected semiannually to determine groundwater flow at Site 1. The CALF model was first developed in 2001 using the United States Geological Survey (USGS) modular groundwater modeling code known as MODFLOW (McDonald and Harbaugh, 1988) to model forward particle tracking to delineate the extent of capture zones under March 2000 average monthly pumping conditions using the USGS particle tracking program MODPATH (Pollock, 1994). A recalibration of the 2001 groundwater flow model for the CALF was conducted in response to the findings and recommendations regarding future model in 2006.

The hydraulic model created from data collected since the previous Five-year Review generally indicates the pump and treat system is effective in preventing offsite migration of COCs. Only small areas in the shallow and deep aquifers underlying the site are not captured by the existing pump and treat system as modeled by the particle tracking software; although migration of COCs is present beyond the existing site boundary for Site 1, concentrations of COCs are generally low and have decreased in concentration from 2009 to 2012 (**Figures 4-3 and 4-4**).

In 2010, the pumping rate of A2-EW2B declined significantly. This well was previously rehabilitated in 2008; however, the pumping rate continued to decline. The extraction well was replaced in 2011 and is now functioning properly. The concentrations of COCs beyond the site boundary have decreased since the replacement of extraction well A2-EW2B (**Figure 4-4**).

Groundwater Monitoring Data Review

The extraction system began operation in July 1997, and was shut down for adjustments in March 1998. The system was restarted in November 1998 and has been in operation since. The latest round of LTM groundwater sampling at Site 1 was performed in September 2012. These results are presented in the 2012 LTM Report. **Figures 4-5** and **4-6** provide a comparison of the baseline analytical data collected in 1997 and 1998, 2003, 2007, and the most recent LTM analytical data collected in 2012 for select monitoring wells.

Concentrations of constituents identified as COCs for Site 1 groundwater are presented in **Table 4-1**. The concentrations of these COCs in the shallow aquifer of in both Areas A and B have generally decreased or remained the same. However, there are three areas that are being evaluated by the Remedial Process Optimization (RPO) Team for evaluation. These areas are the vicinity of B-20W, and Area B near newly installed monitoring well B-MW39 (adjacent to the Lincoln Housing area):

- In Area A, the total VOC concentrations in samples from monitoring well B-20W demonstrated an overall increase since first sampled in 1992 during the RI, but have been highly variable; the RPO believe this trend may be due to groundwater table fluctuation and waste, or a source in the depth interval consistent with the fluctuating water table. Localized treatment or removal options may be considered.

- In Area B, COC concentrations above cleanup goals were detected during the groundwater delineation activities conducted in 2012. Two new shallow monitoring wells (B-MW38 and B-MW39) were installed just north of the Lincoln Housing Area to monitor groundwater concentrations. Additional monitoring wells are planned to the north and south of B-MW39 to identify the contaminant source and plume boundary. In December 2012, the NSN Tier I Partnering Team agreed VI is not significant due to the presence of a clean water lens (shallow grab groundwater samples did not detect COCs); the groundwater contamination was detected below a deeper organic layer that may have acted as a preferential pathway for COCs to migrate. The current groundwater model indicates groundwater in the vicinity of Area B is extracted and treated at the CATP. Due to the high concentrations of COCs in the vicinity of B-MW39, the RPO is confirming the extent of contamination and will then evaluate alternative groundwater treatment strategies.

Additional data gaps/observations identified by the RPO are the following:

- Groundwater contamination south of the Elementary School may be deeper than existing monitoring wells are screened; the results of a majority of the monitoring wells screened less than 20 feet below ground surface (bgs) have achieved cleanup goals compared to monitoring wells screened greater than 20 feet bgs have not achieved cleanup goals (**Figures 4-3 and 4-5**).
- The Area B deep groundwater plume is not bound along the Eastern portion of the site (**Figures 4-4 and 4-6**).
- Area B shallow groundwater concentrations at a majority of wells indicate a decreasing trend (**Figure 4-5**); however, several Area B deep groundwater monitoring well groundwater concentrations indicate increasing trends of COCs (**Figure 4-6**); COC contamination in the vicinity of Area B may be migrating into the deep aquifer due to the active groundwater extraction in the deep aquifer.
- Five extraction wells (out of 11) remove and treat approximately 90% of COCs in site groundwater; the RPO agrees the pump and treat system requires optimization.

Site Inspections

Site inspections are conducted quarterly at Site 1 to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review. Only minor corrective measures, including monitoring well repairs, bollard replacement, fence repairs, and vegetation maintenance have been necessary. The most recent inspection was conducted in April 2013 and no discrepancies were noted.

Remedy Costs

The average remedy costs for operating/maintaining the groundwater extraction system, conducting LTM, and conducting quarterly site inspections is approximately $593,000[3] per year. The estimated O&M costs for the selected remedy in the DD were approximately $300,000 per year; the actual cost for the selected remedy is approximately 100 percent more than estimated by the DD.

4.5 Technical Assessment

Is the remedy functioning as intended by the Decision Documents?

Based on the review of the documents, monitoring results, ARARs, risk assumptions and results of the inspections, the remedy is functioning as intended by the DD.

A review of the analytical data indicates that the remediation system at Site 1 is preventing offsite migration of VOCs beyond Navy property and removing VOC mass from the deep and shallow aquifers. The effective implementation of ICs has prevented exposure to, or ingestion of, contaminated groundwater, subsurface soil, debris, surface water, and sediment.

[3] Total estimated based on costs associated with operating CATP (approximately $537,500 per year), LTM (approximately $50,500 per year), and LUCs (approximately $5,000 per year).

The groundwater extraction and treatment system and LTM program are currently under evaluation by the RPO to increase the effectiveness and reduce overall costs associated with the remedy.

Are the exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives used at the time of selection still valid?

Changes in Standards and To-Be-Considereds (TBCs). No substantial changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-year Review. No new contaminants, sources, or routes of exposure were identified and there is no indication that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy. The LUCs and ICs are being implemented and eliminate the potential for exposure to site soil or groundwater.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of contaminants initially sampled during the RI/FS phase of investigation at Site 1, these changes would not adversely affect the protectiveness of the selected remedy for the COCs identified in the ROD as it would not substantially change the results of the risk assessment or the classes of constituents identified as COCs. Additionally, the groundwater cleanup goals are based on maximum contaminant levels (MCLs); therefore, changes in toxicity values would not change the cleanup goals for the groundwater. The LUCs and ICs eliminate any exposure to site media; therefore, changes to the toxicity values would not affect the protectiveness of the remedy.

Based on site history, the potential for elevated concentrations of dioxins and furans (site use as a landfill and burning operations) is present. Dioxins and furans were not sampled during the RI/FS phase of investigation nor identified as a potential issue during subsequent Five-Year Review Reports (RSLs were established for a few of these constituents in 2008). Although the presence of these contaminants are unknown, it can be reasonably expected that the LUC portion of the existing remedy is adequate to protect human health and the environment from potential risks (if any) associated with these contaminants in the short term.

During this Five-year Review period (2008 through 2013), risk-based screening levels for evaluating human health risks associated with exposure to 1,4-dioxane were established. 1,4-dioxane is a stabilizer that was commonly used in chlorinated solvents including 1,1,1-trichloroethane (TCA), which was historically disposed of at Site 1. Groundwater samples collected at Site 1 in 2012 were analyzed for 1,4-dioxane confirming the contaminant presence in the vicinity of Area B. 1,4-dioxane was not confirmed to be present in Area A groundwater; however, the reporting limit of detection was 15 micrograms per liter (µg/L), exceeding the November 2012 Regional Screening Level (RSL) of 0.67 µg/L. Although the extent of 1,4-dioxane is unknown at Site 1, it can be reasonably expected that the LUC portion of the existing remedy is adequate to protect human health and the environment from potential risks (if any) associated with this constituent in the short-term.

PFCs have been recently identified by the USEPA as an emerging contaminant; however, no Tier I screening values have been established to evaluate risk associated with these contaminants. Based on the site history and use of the Site as a landfill, the potential for elevated concentrations of PFCs is present. Although the presence of these compounds are unknown, it can be reasonably expected that the LUC portion of the existing remedy is adequate to protect human health and the environment from potential risks (if any) associated with these contaminants in the short-term.

Additional changes to RSL values of other constituents have been made during this Five-year Review period; however, these changes do not impact the protectiveness of the remedy.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how HHRAs are conducted since the HHRA was prepared, none of these changes adversely affect the protectiveness of the selected remedy for Site 1. Based on the results of the HHRA and review of more recent data, the LUCs need to remain in place as the remediation goals have not yet been met. There have been no major procedural changes in how the ERAs are conducted since the last Five-year Review.

The previous Five-year Review recommended that the potential for VI within the Marine Barracks (Bachelor Enlisted Quarters [BEQ]) be assessed prior to the next Five-year Review. Indoor air samples collected from the Brig and the Camp Allen Elementary School in January 1993 were evaluated in the *Baseline Risk Assessment, Camp Allen Landfill* (Baker, 1995a); however, indoor air and VI into the Marine Barracks had not been evaluated.

Indoor and outdoor air samples collected in February 2012, and subslab soil vapor samples collected in October 2011 and February 2012, from the occupied BEQ were evaluated in the *Draft Sites 1 and 20 Risk Assessment Technical Memorandum, Naval Station Norfolk* (CH2M HILL, 2012).

Chloroform, trichloroethene (TCE), and benzene were detected in exceedance of Project Action Limits (PALs) in subslab and/or indoor air samples collected during Phase I or Phase II of the VI investigation. However, the evaluation of multiple lines of evidence suggests the VI pathway is not complete. The indoor air concentrations of chloroform and benzene are likely related to a background source. TCE has low relative subsurface contaminant source strength based on its limited presence in groundwater, and subslab soil is not contributing to indoor air. Therefore, no further action was recommended to address VI from VOCs in shallow groundwater. Based upon feedback received from USEPA on the findings of the VI investigation, the Navy has agreed to collect additional indoor air, subslab vapor, and outdoor air samples to further evaluate the VI pathway. These samples are planned for the fall of 2013. The results of the additional samples will be documented in an addendum to the existing TM.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the remedy.

Technical Assessment Summary

Although groundwater concentrations of VOCs remain above MCLs, a majority of concentrations of VOCs in the shallow and deep aquifers are decreasing (**Figure 4-5 and 4-6**). The ROD identified an anticipated project life of 30 years to calculate net present worth, but initially used risk-based goals for the shallow aquifer. With the revision of risk-based cleanup goals in the shallow aquifer to MCLs, compliance with chemical-specific ARARs (MCLs) for groundwater would not likely occur during the 30-year project life. As indicated by the progress of the remedy since its start in 1998, it is expected that compliance of the chemical-specific ARARs for portions of the aquifers may not occur within 30 years of the remedy implementation as a result of the presence of multiple potential source areas. The potential source areas will continue to be hydraulically contained with groundwater extraction.

Based on the information presented herein, the remedy for Site 1 is functioning as intended by the DD containing COCs to prevent exposure and migration of COCs in site media. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through engineered LUCs (such as site security, fencing, and signage), and ICs.

4.6 Issues, Recommendations, and Follow-up Actions

Table 4-3 outlines the issues identified during this Five-year Review and presents recommendations and follow-up actions for Site 1.

4.7 Protectiveness Statement

The remedy at Site 1, consisting of containment (through groundwater extraction and treatment) with LUCs, is currently protective in the short-term for human health and the environment. Exposure pathways that could result in an unacceptable risk are being controlled through engineered LUCs (such as site security, fencing, and signage) and institutional controls (ICs). However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure continued protectiveness: 1) complete an groundwater evaluation to determine if 1,4-dioxane, dioxins, and furans should be considered a COC for the site and revise the site remedy, LUC boundary, and/or treatment system as warranted, 2) determine the presence/absence of PFCs in site

groundwater and compare to Tier I toxicological values once established by USEPA, 3) complete additional sampling (groundwater and VI) at Building MCA600 and 4) evaluate data gaps in groundwater LTM and modify the LTM network as warranted.

TABLE 4-1

Site 1 Remedy Performance Standards

OU	Site	Area	Risk	Media	Reasonably Anticipated Land Use	COC Requiring Action	Basis for Action	RAO	Remedy Component	Site Closeout Strategy	Performance Metric / Cleanup Level
1	1	A	Human and Ecological Health	Landfill Debris	Industrial / vacant land	Landfill Debris	Waste remaining in place	Prevent exposure to the contaminated groundwater, subsurface soil, debris, surface water, and sediment Minimize the migration of contaminants from soil and debris in Area A to groundwater and surface water	LUCs; maintain existing soil cover	LUCs to prevent intrusive activities and residential development of site. Risks to sediment in the Upper Reaches of Bousch Creek and Site 22 were addressed Removal Actions completed in 2006 and 2008.	No intrusive activites or change in land use
			Human Health	Soil		Arsenic	HI > 1	Prevent exposure to the contaminated groundwater, subsurface soil, debris, surface water, and sediment Minimize the migration of contaminants from soil and debris in Area A to groundwater and surface water			
						Cadmium					
			Human Health	Sediment		Arsenic		Prevent exposure to the contaminated groundwater, subsurface soil, debris, surface water, and sediment			
						Aroclor-1254					
						Aroclor-1260					
			Human Health	Surface Water		Aroclor-1254		Prevent exposure to the contaminated groundwater, subsurface soil, debris, surface water, and sediment	LUCs	The Upper Reaches of Bousch Creek and Site 22 sediment removal actions completed in 2006 and 2008 addressed potential surface water risk.	No further action
			Ecological Health	Sediment		Inorganics	High risks to benthic invertebrates	Further investigation to evaluate ecological risk	LTM	BERA completed for Upper Reaches of Bousch Creek resulted in sediment removal action; no further action required for ecological receptor exposure to sediment	No further action
			Human Health	Groundwater	Potential drinking water resource	1,2-DCA	Concentration > MCL (=5 µg/L)	Prevent exposure to contaminated groundwater, Prevent further migration of contaminated groundwater Remediate the water table and Yorktown aquifers groundwater for future beneficial use	Groundwater extraction and treatment, LTM and LUCs	Conduct LTM and enforce LUCs until each groundwater COC is at or below its respective cleanup level	5 µg/L
						Benzene	Concentration > MCL (=5 µg/L)				5 µg/L
						PCE	Concentration > MCL (=5 µg/L)				5 µg/L
						Toluene	Concentration > MCL (=1,000 µg/L)				1000 µg/L
						1,2-DCE	ILCR > $1x10^{-1}$				70 µg/L
						Vinyl Chloride					2µg/L
						TCE					5 µg/L
		B	Human Health	Soil	Industrial / vacant land	Arsenic	ILCR > $1x10^{1}$	Prevent exposure to the contaminated groundwater, subsurface soil, debris, surface water, and sediment	LUCs	LUCs to prevent residential development of site	No intrusive activities or change in land use
						Cadmium					
						Manganese					
			Human Health	Sediment		Arsenic			LUCs	Ecological risk addressed by Site 22 remedial action; onsite pond excavated 2 ft, backfilled with 1 ft and sediment cover installed; the sediment cover is maintained and inspected during quarterly inspections	No intrusive activities or change in land use
						Cadmium					
			Ecological Health	Sediment		Inorganics	High risks to benthic invertebrates	Further investigation to evaluate ecological risk			
			Human Health	Groundwater	Potential drinking water resource	1,1,1-TCA	Concentration > MCL (=200 µg/L)	Prevent exposure to contaminated groundwater, Prevent further migration of contaminated groundwater Remediate the water table and Yorktown aquifers groundwater for future beneficial use	Groundwater extraction and treatment, LTM and LUCs	Conduct LTM and enforce LUCs until each groundwater COC is at or below its respective cleanup level	200 µg/L
						1,2-DCA	Concentration > MCL (=5 µg/L)				5 µg/L
						PCE	Concentration > MCL (=5 µg/L)				5 µg/L
						1,2-DCE	ILCR > $1x10^{-2}$				70 µg/L
						Benzene					5 µg/L
						Vinyl Chloride					2 µg/L
						TCE					5 µg/L
						Arsenic					Not established

Note: Clean up goals were only assigned to COCs identified in groundwater per the 2010 ROD; all other COCs are addressed through limitied/no exposure pathways enforced by LUCs.

Acronyms:

AS - air sparge
COC - contaminant of concern
DCA - dichloroethane
DCE - dichloroethene
DD - Decision Document
HI - hazard index
ILCR - incremental lifetime cancer risk
LTM - long-term monitoring
LUC - land use control
MCL - maximum contaminant level
µg/L - micrograms per liter
OU - operable unit
PCB - polychlorinated biphenyl
RAO - remedial action objective
ROD - Record of Decision
SVE - soil vapor extraction
TCA - trichloroethane
TCE - trichloroethene

TABLE 4-2

Site 1 Action Item Progress from 2008 Five-Year Review

Issue from Second Five-Year Review Report							
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**		**Status - June 2013**	
				Current	**Future**	**Action Taken and Outcome**	**Date of Action**
Vapor intrusion in the Marine Barracks was not evaluated as part of the RI. Because limited information is available, additional assessment of the Marine Barracks will be required before the next Five-Year Report.	The potential for vapor intrusion within the Marine Barracks will need to be assessed based on the presence of VOCs within groundwater.	Navy, USEPA, and VDEQ	Next Five-Year Review	No	TBD	Vapor Intrusion evaluation conducted of marine barracks in 2011/2012. Report submitted to regulators indicating no current or future risk to receptors; however, USEPA requested additional samples to be collected. As a result, the Navy agreed to collect additional VI samples late calendar year 2013 and submit an addendum summarizing the results of the samples.	Ongoing
In May of 2004, utility trenching activities were observed in Area A, along the outer security fence at the Brig facility. Additionally, in July 2004, excavation for a drainage ditch in Area A was observed. Both of these activities resulted in a breach of the landfill cover, contamination of the cover with landfill materials, and stockpiling of landfill materials. Navy personnel and regulators representatives were notified and corrective action was completed October through December 2004.	The Navy has revised and implemented an internal review process for all construction activities that occur on the base to ensure the land use controls are not violated. Since the implementation of the revised review, no additional violations have occurred.	Navy, USEPA, and VDEQ	Next Five-Year Review	No	No	The Environmental checklist is utilized by the Navy. No unapproved intrusive activities have been observed during quarterly site inspections since the previous Five-Year Review.	Ongoing

Acronyms:
USEPA - United States Environmental Protection Agency
VI - vapor intrusion
VDEQ - Virginia Department of Environmental Quality
VOC - volatile organic chemical

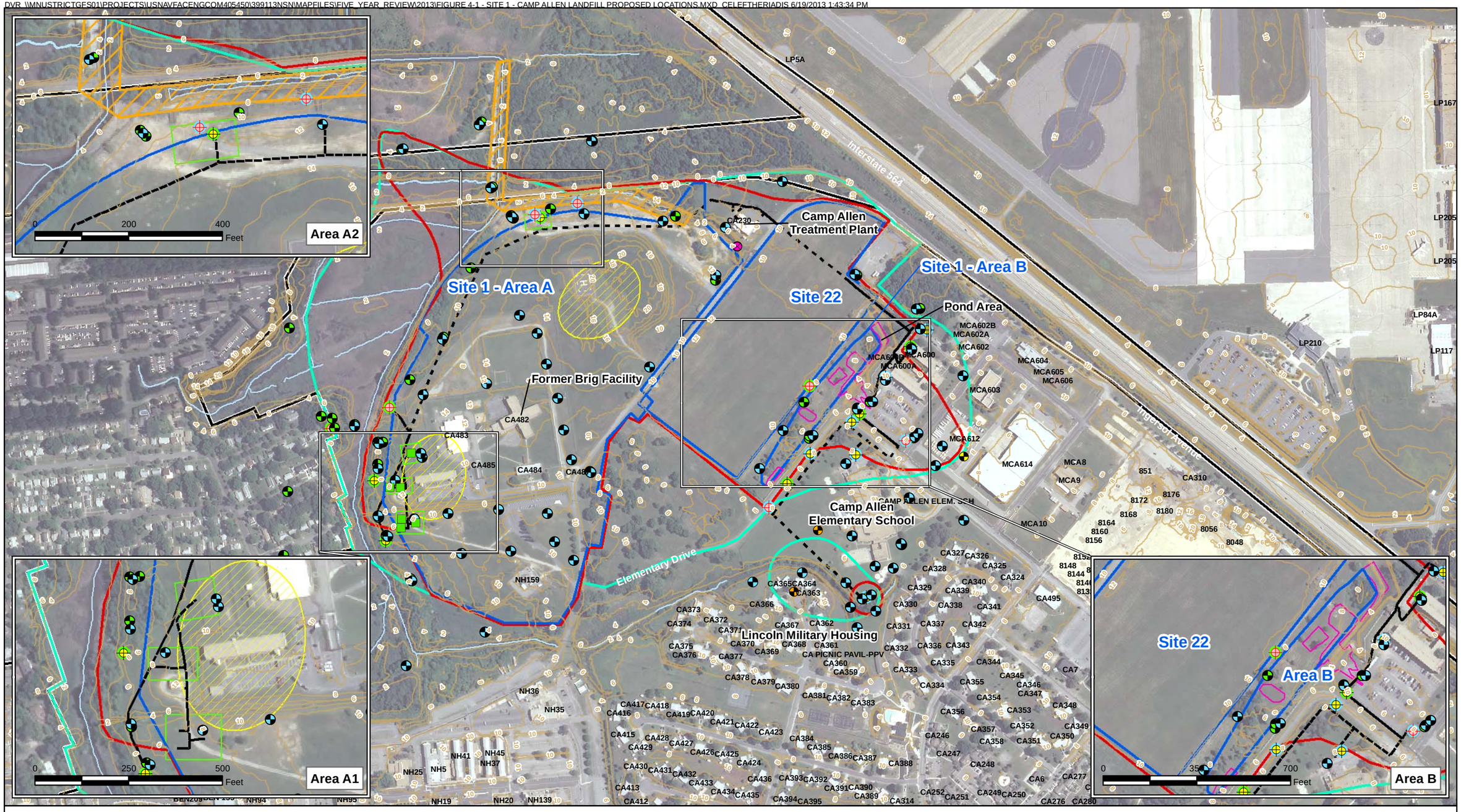
TABLE 4-3

Issues, Recommendations and Follow-up Actions for Site 1

Action Requiring Follow-Up from Third Five-Year Review Report					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
An RSL was established for 1,4-dioxane. The 2012 groundwater data indicates the constituent is present in site groundwater above the established RSL.	Evaluate the extent of 1,4-dioxane in site groundwater and its presence in treated effluent. If the data evaluation indicates 1,4-dioxane should be considered a contaminant of concern (COC) for Site 1, the NSN Tier I Partnering Team will determine if modifications to the existing remedy, LUC boundary, and/or treatment system are warranted.	Navy, USEPA, and VDEQ	Jul-14	TBD	TBD
Toxicity values were established for dioxins and furans. Based on site history, these constituents have the potential to be present in site groundwater.	Determine if dioxins and furans are present in site groundwater above established screening values. If a data evaluation indicates these compounds should be considered a COC for Site 1, the NSN Tier I Partnering Team will determine if modifications to the existing remedy, LUC boundary, and/or treatment system are warranted.	Navy, USEPA, and VDEQ	Oct-16	TBD	TBD
Perfluorinated compounds (PFCs) have been identified by the USEPA as an emerging contaminant. Based on site history, these constituents have the potential to be present in site media (specifically groundwater).	Determine the presence or absence of PFCs in site groundwater. If PFCs are present, concentrations will be compared to Tier I toxicological values when established by USEPA. If a data evaluation indicates these compounds should be considered a COC for Site 1 (based on Tier I toxicological values), modifications to the existing remedy, LUC boundary, and/or treatment system are warranted as required under CERCLA	Navy, USEPA, and VDEQ	Oct-15	TBD	TBD
Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
The VI investigation completed in 2011 indicates there are no significant pathways for Vapor Intrusion within Building MCA600. However, additional investigation was recommended by USEPA. .	Include chloroform and carbon tetrachloride analysis in groundwater LTM scheduled in 2013 and collect and additional round of indoor/outdoor air and subslab vapor samples in Building MCA600. A Supplemental VI Report will be completed to summarize the additional investigation.	Navy, USEPA, and VDEQ	Oct-15	No	TBD
The current remedy is not expected to remediate the Columbia and Yorktown aquifers to beneficial reuse.	Conduct optimization analysis to determine time frame and practicability of reaching maximum contaminant levels (MCLs) in the Columbia and Yorktown Aquifers	Navy, USEPA, and VDEQ	Oct-18	No	No
Data gaps are present in the groundwater long-term monitoring (LTM) network for Area B; contamination south of the Elementary School is likely deeper than the existing shallow monitoring wells are screened and the deep chlorinated VOC plume remains undefined to the southeast.	Evaluate data gaps by installing and sampling new monitoring wells. If COCs are present above clean up goals, then the NSN Tier I Partnering Team will determine if modifications to the existing remedy, LUC boundary, and/or treatment system are warranted.	Navy, USEPA, and VDEQ	Sep-14	No	TBD

Acronyms:

LTM - long-term monitoring
LUC - land use control
NSN - Naval Station Norfolk
MCLs - maximum contaminant level
PFOA - perfluorooctanoic acid
RD - Remedial Design
RSL - risk screening level
TBD - to be determined
TCA - trichloroethane
USEPA - United States Environmental Protection Agency
VDEQ - Virginia Department of Environmental Quality
VI - vapor intrusion
VOC - volatile organic compound



Legend

- Proposed Shallow Monitoring Well
- Proposed Deep Monitoring Well
- Shallow Monitoring Well
- Deep Monitoring Well
- Shallow Active Extraction Well Location
- Shallow Inactive Extraction Well Location
- Deep Active Extraction Well Location
- Deep Inactive Extraction Well Location
- Treatment Plant Discharge Point
- Inactive DPVE Well
- Topographic Contour (2ft Interval)
- Surface Water Features
- Piping for Groundwater Treatment System
- Piping for Groundwater Treatment System (assumed location)
- Area B Removal Action (1993)
- Estimated Soil Contaminated Area (DD, 1995)
- Estimated VOC Source Areas (Baker, 1994)
- Bousch Creek Sediment Removal Action (2008)
- Land Use Control Area (2007)
- Proposed Land Use Control Area (2013)
- Site Boundary

Notes:
DD - Decision Document
DPVE - Dual Phase Vapor Extraction
VOC - Volatile Organic Compound

N
W
E
S

0 500 1,000
Feet

Figure 4-1
Site 1 Camp Allen Landfill Layout
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

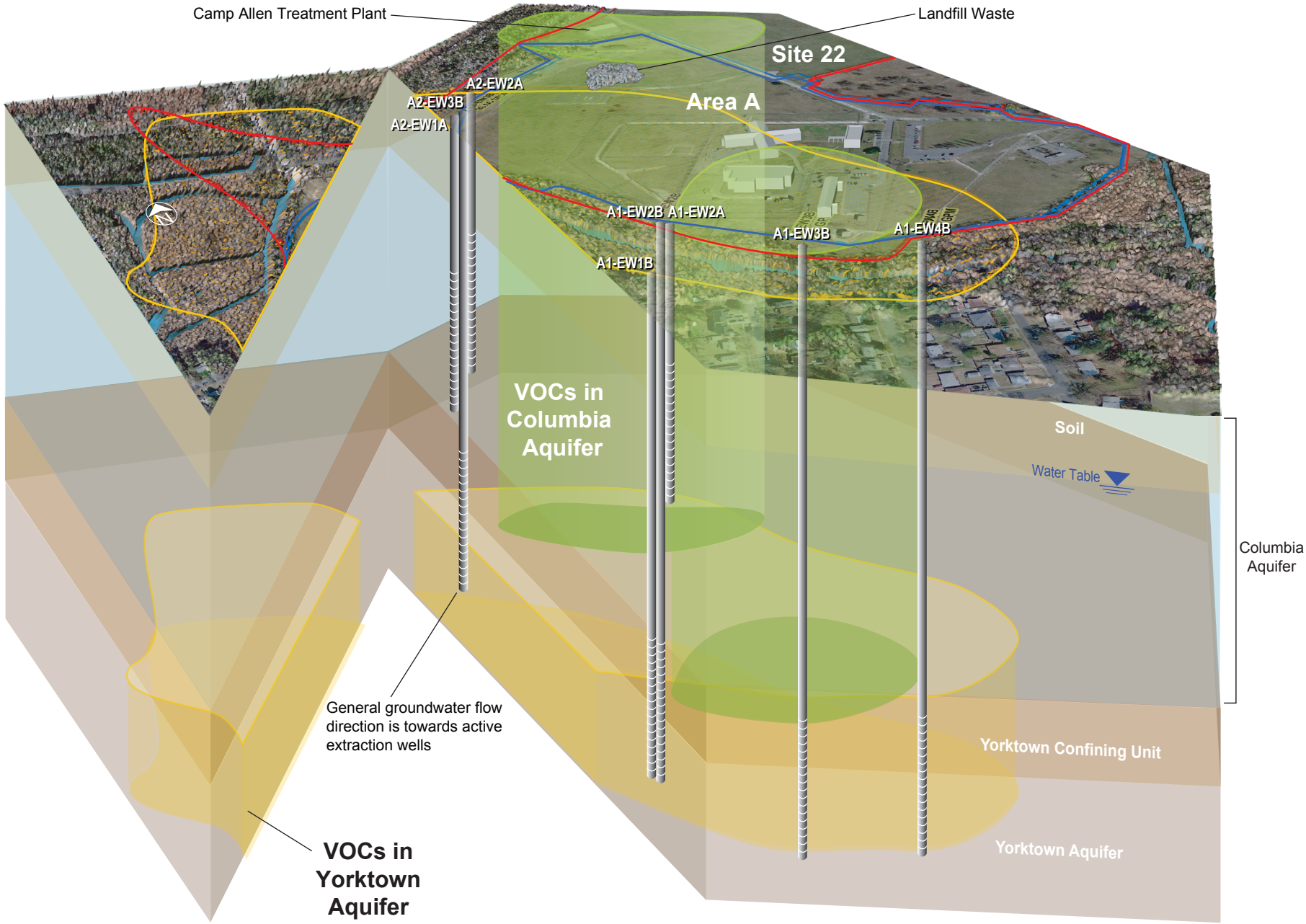


FIGURE 4-2a
Conceptual Site Model, Camp Allen Landfill Area A
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

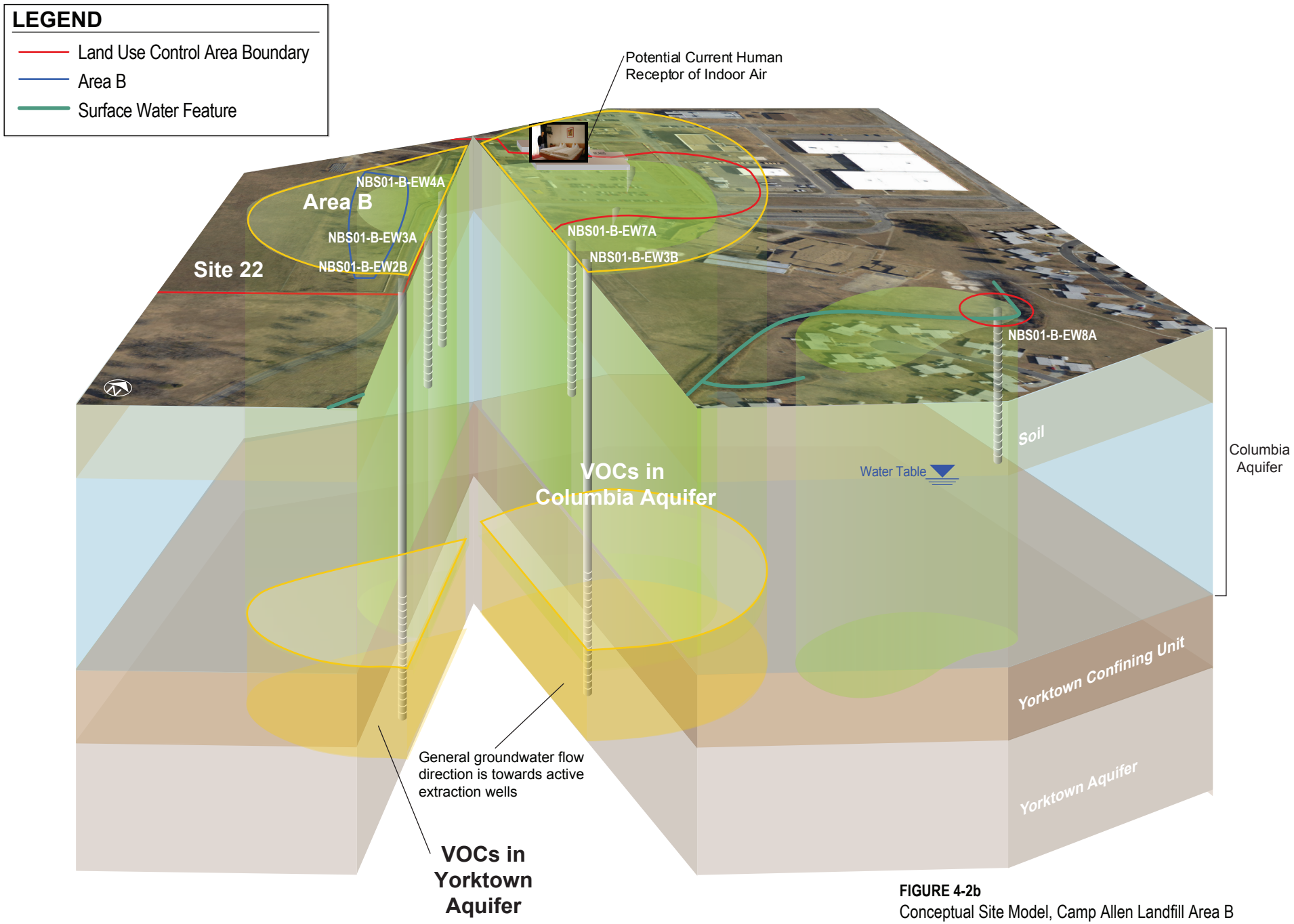
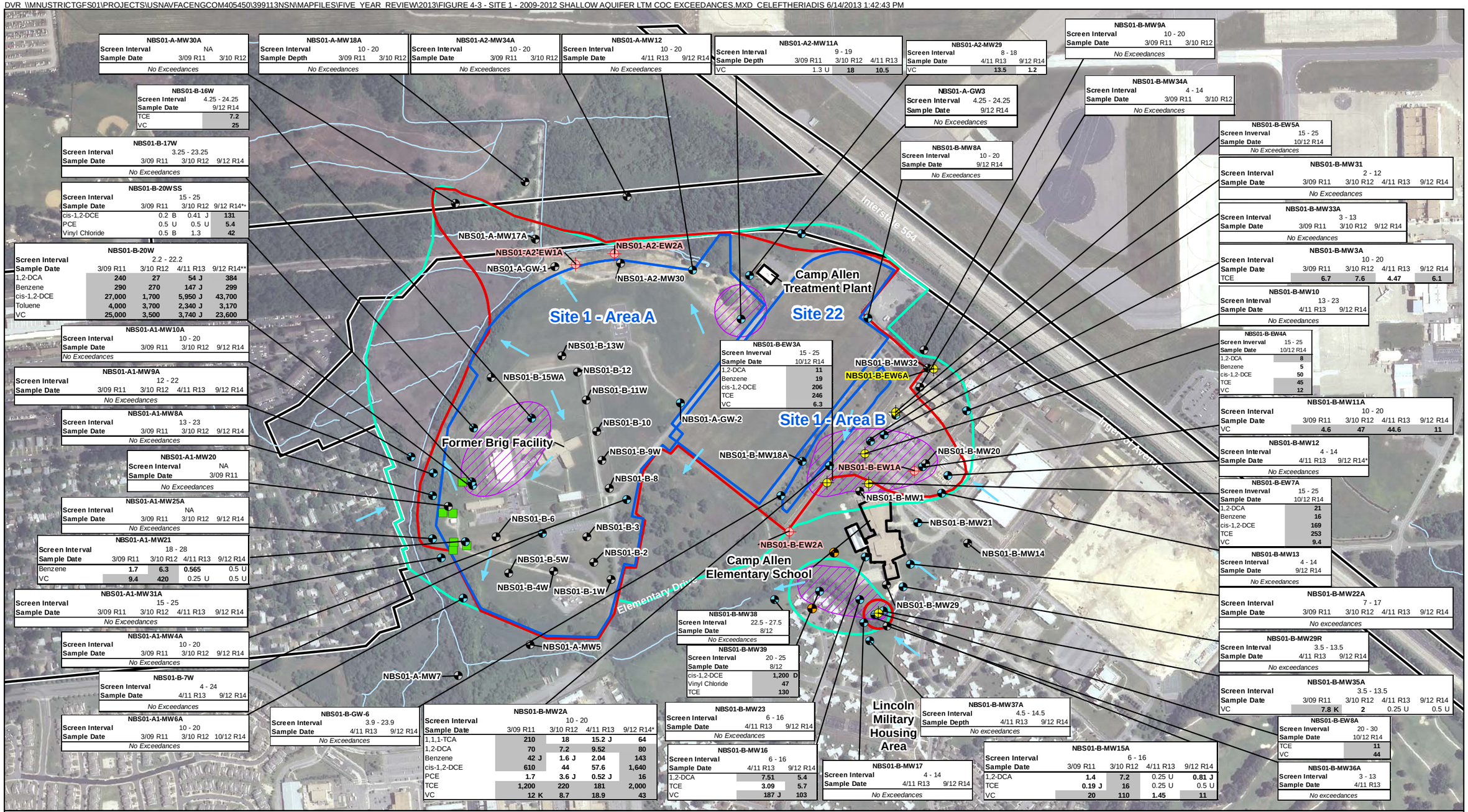


FIGURE 4-2b
Conceptual Site Model, Camp Allen Landfill Area B
Naval Station Norfolk
Norfolk, Virginia

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 4-3 - SITE 1 - 2009-2012 SHALLOW AQUIFER LTM COC EXCEEDANCES.MXD CELEFTHERIADIS 6/14/2013 1:42:43 PM



Legend

- Shallow Monitoring Well
- Shallow Monitoring Well not included in 2012 LTM
- Active Extraction Well Location
- Inactive Extraction Well Location
- Proposed Shallow Monitoring Well
- Inactive DPVE Well
- Approximate Extent of COC Plume (September 2012)
- Simulated Groundwater Flow Direction (August 2012)
- Surface Water Features
- Land Use Control Area (2007)
- Proposed Land Use Control Area (2013)
- Site Boundary
- Installation Boundary

Notes:
The detected concentration values that exceed the clean up goals are highlighted.
The figure only shows the past 4 rounds of LTM sampling
4/11 R13 indicates the month/year the sample was collected and the LTM sampling round number
All concentrations are in micrograms per liter
J - Analyte Present, value may or may not be accurate or precise
U - The material was analyzed for, but not detected
LTM - Long-Term Monitoring
* - Duplicate sample collected, most conservative value shown

Chemical of Concern (COC)	Cleanup Goals (Maximum Contaminant Level)
1,1,1-Trichloroethane (1,1,1-TCA)	200
1,2-Dichloroethane (1,2-DCA)	5
Benzene	5
cis-1,2-Dichloroethene (cis-1,2-DCE)	70
Toluene	1000
Tetrachloroethene (PCE)	5
Trichloroethene (TCE)	5
Vinyl chloride (VC)	2

Figure 4-3
2009 - 2012 Shallow Aquifer LTM COC Exceedances
Naval Station Norfolk
Norfolk, Virginia

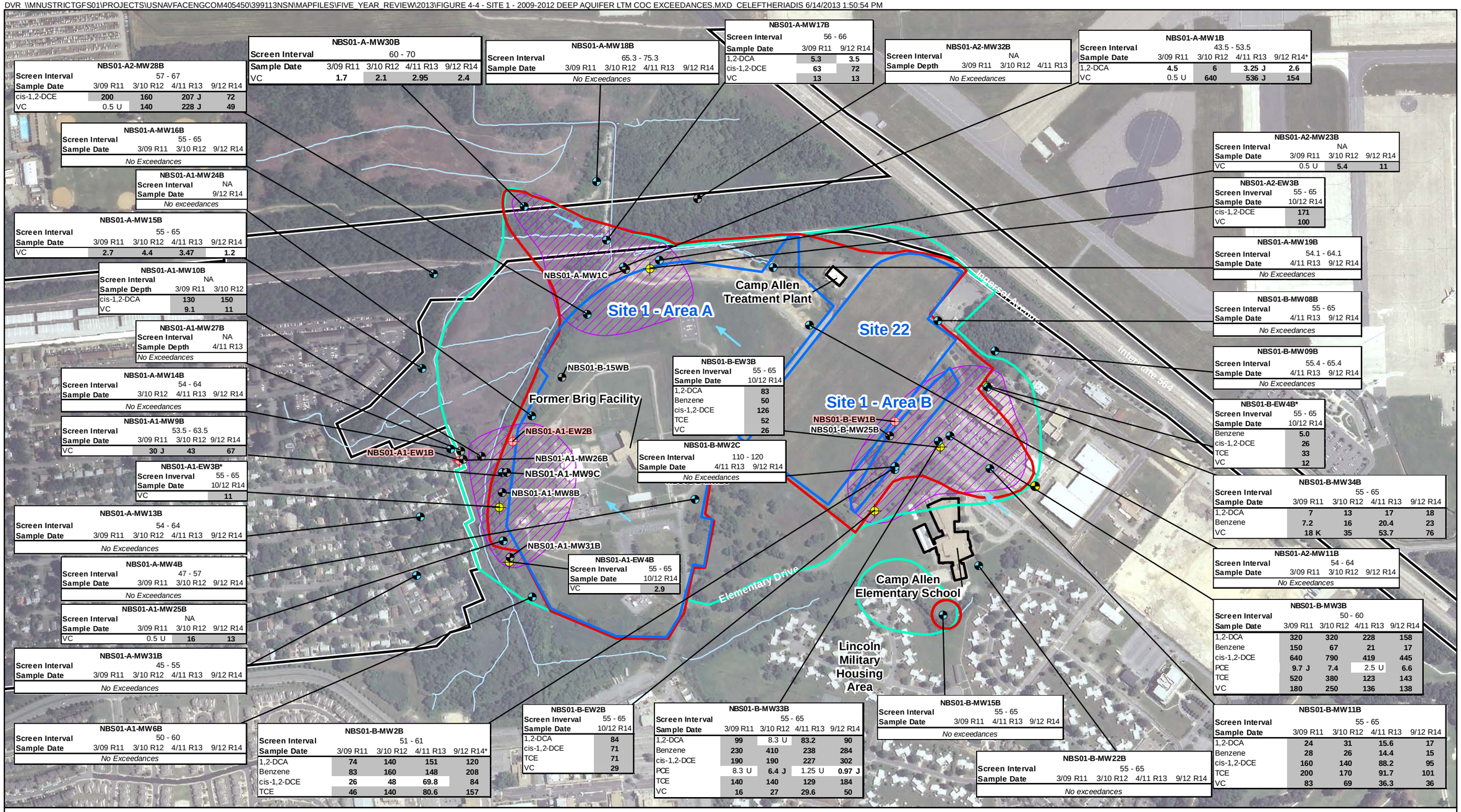
N W E S

0 550 1,100 Feet

Reference: 2008 Aerial Photography

CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 4-4 - SITE 1 - 2009-2012 DEEP AQUIFER LTM COC EXCEEDANCES.MXD CELEFTHERIADIS 6/14/2013 1:50:54 PM



NBS01-A-MW30B

Screen Interval	60 - 70			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
VC	1.7	2.1	2.95	2.4

NBS01-A-MW18B

Screen Interval	65.3 - 75.3			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
No Exceedances				

NBS01-A-MW17B

Screen Interval	56 - 66	
Sample Date	3/09 R11	9/12 R14
1,2-DCA	5.3	3.5
cis-1,2-DCE	63	72
VC	13	13

NBS01-A2-MW32B

Screen Interval	NA		
Sample Depth	3/09 R11	3/10 R12	4/11 R13
No Exceedances			

NBS01-A-MW1B

Screen Interval	43.5 - 53.5			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14*
1,2-DCA	4.5	6	3.25 J	2.6
VC	0.5 U	640	536 J	154

NBS01-A2-MW28B

Screen Interval	57 - 67			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
cis-1,2-DCE	200	160	207 J	72
VC	0.5 U	140	228 J	49

NBS01-A-MW16B

Screen Interval	55 - 65		
Sample Date	3/09 R11	3/10 R12	9/12 R14
No Exceedances			

NBS01-A1-MW24B

Screen Interval	NA
Sample Date	9/12 R14
No exceedances	

NBS01-A-MW15B

Screen Interval	55 - 65			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
VC	2.7	4.4	3.47	1.2

NBS01-A1-MW10B

Screen Interval	NA	
Sample Depth	3/09 R11	3/10 R12
cis-1,2-DCA	130	150
VC	9.1	11

NBS01-A1-MW27B

Screen Interval	NA
Sample Depth	4/11 R13
No Exceedances	

NBS01-A-MW14B

Screen Interval	54 - 64		
Sample Date	3/10 R12	4/11 R13	9/12 R14
No Exceedances			

NBS01-A1-MW9B

Screen Interval	53.5 - 63.5		
Sample Date	3/09 R11	3/10 R12	9/12 R14
VC	30 J	43	67

NBS01-A1-EW3B*

Screen Inverval	55 - 65
Sample Date	10/12 R14
VC	11

NBS01-A-MW13B

Screen Interval	54 - 64			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
No Exceedances				

NBS01-A-MW4B

Screen Interval	47 - 57		
Sample Date	3/09 R11	3/10 R12	9/12 R14
No Exceedances			

NBS01-A1-MW25B

Screen Interval	NA		
Sample Date	3/09 R11	3/10 R12	9/12 R14
VC	0.5 U	16	13

NBS01-A-MW31B

Screen Interval	45 - 55			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
No Exceedances				

NBS01-A1-MW6B

Screen Interval	50 - 60			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
No Exceedances				

NBS01-B-MW2B

Screen Interval	51 - 61			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14*
1,2-DCA	74	140	151	120
Benzene	83	160	148	208
cis-1,2-DCE	26	48	69.8	84
TCE	46	140	80.6	157

NBS01-B-EW3B

Screen Inverval	55 - 65
Sample Date	10/12 R14
1,2-DCA	83
Benzene	50
cis-1,2-DCE	126
TCE	52
VC	26

NBS01-B-MW2C

Screen Interval	110 - 120
Sample Date	4/11 R13 9/12 R14
No Exceedances	

NBS01-A1-EW4B

Screen Inverval	55 - 65
Sample Date	10/12 R14
VC	2.9

NBS01-B-EW2B

Screen Inverval	55 - 65
Sample Date	10/12 R14
1,2-DCA	84
cis-1,2-DCE	71
TCE	71
VC	29

NBS01-B-MW33B

Screen Interval	55 - 65			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
1,2-DCA	99	8.3 U	83.2	90
Benzene	230	410	238	284
cis-1,2-DCE	190	190	227	302
PCE	8.3 U	6.4 J	1.25 U	0.97 J
TCE	140	140	129	184
VC	16	27	29.6	50

NBS01-B-MW15B

Screen Interval	55 - 65		
Sample Date	3/09 R11	4/11 R13	9/12 R14
No exceedances			

NBS01-B-MW22B

Screen Interval	55 - 65			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
No exceedances				

NBS01-A2-MW23B

Screen Interval	NA		
Sample Date	3/09 R11	3/10 R12	9/12 R14
VC	0.5 U	5.4	11

NBS01-A2-EW3B

Screen Inverval	55 - 65
Sample Date	10/12 R14
cis-1,2-DCE	171
VC	100

NBS01-A-MW19B

Screen Interval	54.1 - 64.1	
Sample Date	4/11 R13	9/12 R14
No Exceedances		

NBS01-B-MW08B

Screen Interval	55 - 65	
Sample Date	4/11 R13	9/12 R14
No Exceedances		

NBS01-B-MW09B

Screen Interval	55.4 - 65.4	
Sample Date	4/11 R13	9/12 R14
No Exceedances		

NBS01-B-EW4B*

Screen Inverval	55 - 65
Sample Date	10/12 R14
Benzene	5.0
cis-1,2-DCE	26
TCE	33
VC	12

NBS01-B-MW34B

Screen Interval	55 - 65			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
1,2-DCA	7	13	17	18
Benzene	7.2	16	20.4	23
VC	18 K	35	53.7	76

NBS01-A2-MW11B

Screen Interval	54 - 64		
Sample Date	3/09 R11	3/10 R12	9/12 R14
No Exceedances			

NBS01-B-MW3B

Screen Interval	50 - 60			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
1,2-DCA	320	320	228	158
Benzene	150	67	21	17
cis-1,2-DCE	640	790	419	445
PCE	9.7 J	7.4	2.5 U	6.6
TCE	520	380	123	143
VC	180	250	136	138

NBS01-B-MW11B

Screen Interval	55 - 65			
Sample Date	3/09 R11	3/10 R12	4/11 R13	9/12 R14
1,2-DCA	24	31	15.6	17
Benzene	28	26	14.4	15
cis-1,2-DCE	160	140	88.2	95
TCE	200	170	91.7	101
VC	83	69	36.3	36

Legend

- Deep Monitoring Well
- Deep Monitoring Well not included in 2012 LTM
- Active Extraction Well Location
- Inactive Extraction Well Location
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- Simulated Groundwater Flow Direction (August 2012)
- Approximate Extent of COC Plume (September 2012)
- Surface Water Features
- Land Use Control Area (2007)
- Proposed Land Use Control Area (2013)
- Site Boundary
- Installation Boundary

Notes:
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The figure only shows the past 4 rounds of LTM sampling
4/11 R13 indicates the month/year the sample was collected and the LTM sampling round number
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* - Duplicate sample collected, most conservative value shown

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1,2-Dichloroethane (1,2-DCA)	5
Benzene	5
cis-1,2-Dichloroethene (cis-1,2-DCE)	70
Toluene	1000
Tetrachloroethene (PCE)	5
Trichloroethene (TCE)	5
Vinyl chloride (VC)	2

Figure 4-4
2009 - 2012 Deep Aquifer LTM COC Exceedances
Naval Station Norfolk
Norfolk, Virginia

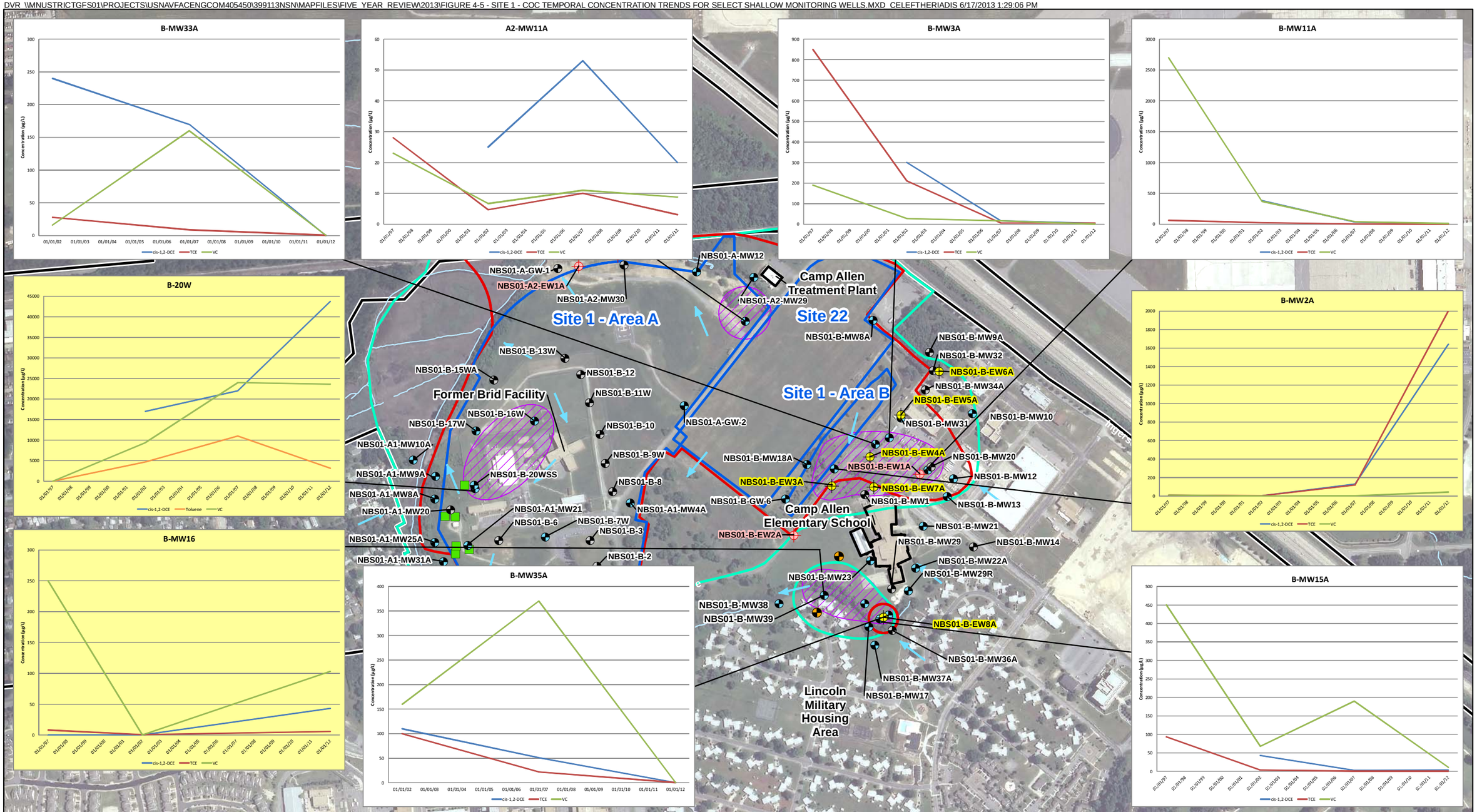
N W E S

0 550 1,100 Feet

Reference: 2008 Aerial Photography

CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 4-5 - SITE 1 - COC TEMPORAL CONCENTRATION TRENDS FOR SELECT SHALLOW MONITORING WELLS.MXD CELEFTHERIADIS 6/17/2013 1:29:06 PM



Legend

- Shallow Monitoring Well
- Shallow Monitoring Well not included in 2012 LTM
- Active Extraction Well Location
- Inactive Extraction Well Location
- Proposed Shallow Monitoring Well
- Inactive DPVE Well
- Approximate Extent of COC Plume (September 2012)
- Simulated Groundwater Flow Direction (August 2012)
- Surface Water Features
- Land Use Control Area (2007)
- Proposed Land Use Control Area (2013)
- Site Boundary
- Installation Boundary

Notes:
-Highlighted graph indicates an increasing trend in COC concentrations.
-Graphs not highlighted indicate little to no change in COC concentrations or a decreasing trend in COC concentrations.
-Vertical scales on graphs are not consistent
COC - Contaminant of Concern
DPVE - Dual Phase Vapor Extraction

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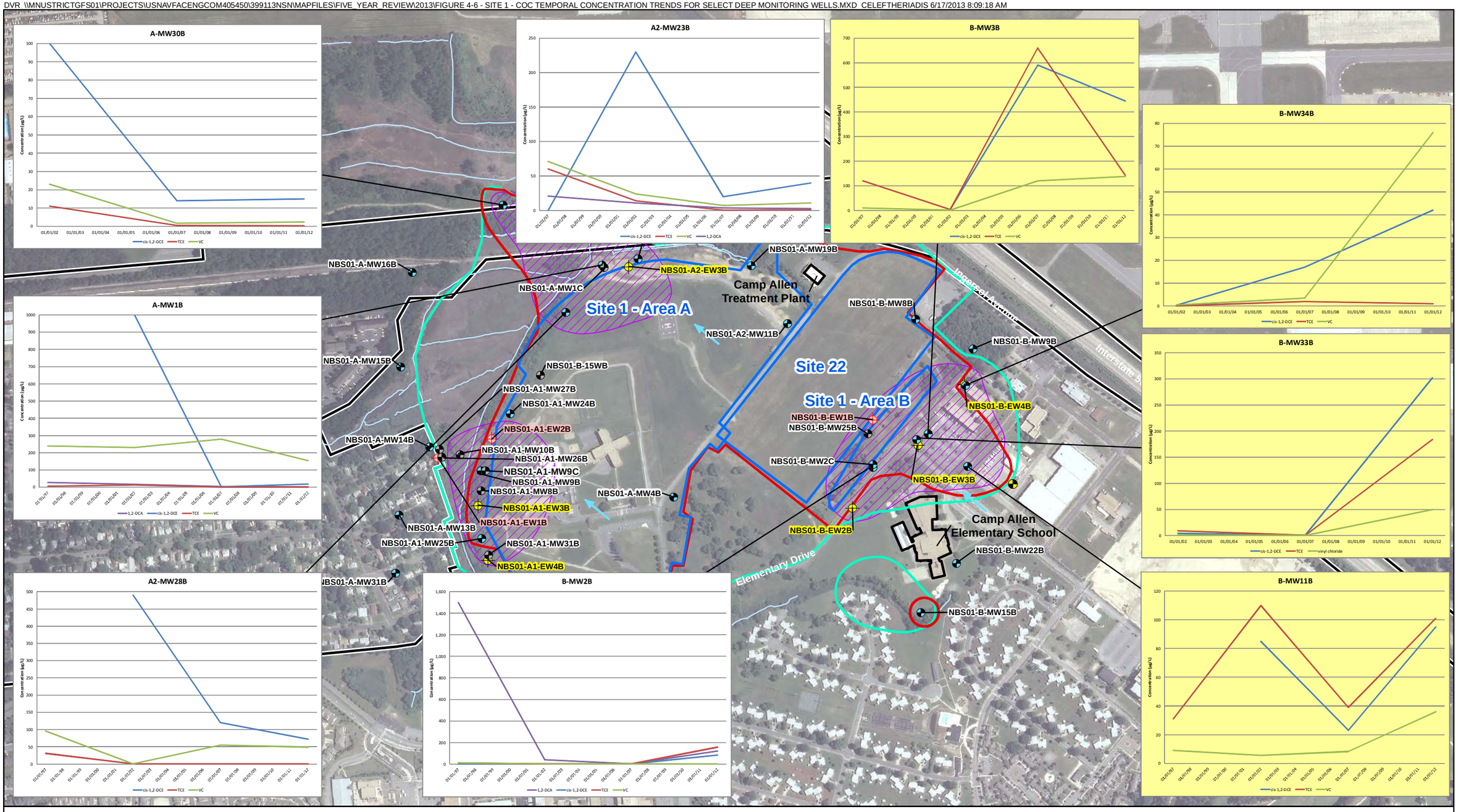
0 550 1,100
Feet

Reference: 2008 Aerial Photography

Figure 4-5
COC Temporal Concentration Trends for Select Shallow Monitoring Wells
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 4-6 - SITE 1 - COC TEMPORAL CONCENTRATION TRENDS FOR SELECT DEEP MONITORING WELLS.MXD CELEFTHERIADIS 6/17/2013 8:09:18 AM



Legend

- Deep Monitoring Well
- Deep Monitoring Well not included in 2012 LTM
- Active Extraction Well Location
- Inactive Extraction Well Location
- Proposed Deep Monitoring Well
- Simulated Groundwater Flow Direction (August 2012)
- Approximate Extent of COC Plume (September 2012)
- Surface Water Features
- Land Use Control Area (2007)
- Proposed Land Use Control Area (2013)
- Site Boundary
- Installation Boundary

Notes:
Highlighted graph indicates an increasing trend in COC concentrations.
Graphs not highlighted indicate little to no change in COC concentrations or a decreasing trend in COC concentrations.
Scales on graphs are not consistent.
COC - Contaminant of Concern
LTM - Long-Term Monitoring

N
W E
S

0 550 1,100
Feet

Reference: 2008 Aerial Photography

Figure 4-6
COC Temporal Concentration Trends for Select Deep Monitoring Wells
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 5

Site 2—Naval Magazine Slag Pile

5.1 Chronology

The following is the chronology of the major site events for Site 2, NM Slag Pile.

1950s-1960s	Disposal of slag, fly ash, and/or bottom ash at the site
1983	Slag Pile identified as a potential source of contamination in the IAS
April 1997	NSN placed on the NPL
August 1998	RI completed
September 1998	FS completed
January 1999	PRAP completed
September 1999	RA Design completed
November 1999	Sediment removal action completed
February 2000	Placement of the soil and asphalt cover completed
October 2000	Initiation of annual LTM
December 2000	ROD signed
October 2003	Implementation of Five-year Review process
September 2004	Transition to LTM every 5 years
January 2005	Final RD for LUCs at Site 2
June 2007	RACR
October 2008	Second Five-year Review
September 2010	Signature of Site 18 ROD adding upgradient Site 18 monitoring wells to the LTM program at Site 2

5.2 Background

5.2.1 Site Description

Site 2, the NM Slag Pile, is located in the southeast portion of NSN, near the intersection of Interstate-64 and Interstate-564 (**Figure 2-1**). The site is bordered by Patrol Road to the southwest, the fenced NM Van Facility to the southeast, and a fenced weapons storage area to the northeast (**Figure 5-1**).

5.2.2 Physical Characteristics

Site 2 is located within a broad open area adjacent to a remnant pine forest and is intended to remain an open space to serve as a buffer zone around the weapons area (EDAW, 1995). The drainage channel adjacent to the site conveys water from the upstream watershed, the site stormwater runoff, and the shallow water table aquifer underlying the site. Prior to remediation activities, the site's surface consisted of a gravel parking lot and open grassy field. As part of remediation activities, the site's surface has been regraded and vegetation planted. The ground surface currently consists of a paved parking lot and a vegetated field which remains unused, but is periodically mowed.

Only one aquifer system has been impacted by Site 2 activities; the water table aquifer (Columbia aquifer). The Yorktown aquifer is separated from the water-table aquifer by a confining clay unit. Shallow groundwater generally discharges to the site drainage ditches (surface water does not recharge the shallow groundwater).

The CSM for Site 2 is provided as **Figure 5-2**.

5.2.3 Land and Resource Use

The site's surface currently consists of a paved parking lot and a vegetated field which remains unused, but is periodically mowed. The land use is not anticipated to change in the near future.

5.2.4 History of Contamination

The NM Slag Pile was a 1-acre area used for the disposal of slag generated by an aluminum smelting operation during the 1950s and 1960s. The slag was a residual cinder material formed from the fusion of a mineral such as limestone with impurities from the aluminum ore and ash from the blast-furnace fuel. To create a level surface upon which the slag could be deposited, fly ash and/or bottom ash (derived from coal burning operations elsewhere at NSN) was also used as fill material at the site. During the smelting operation, the slag pile area was defined by a lack of vegetation around the site near the slag pile.

Initial Response

The potential for site contamination from metals—including chromium, cadmium, and zinc—was identified in the IAS (ESE, 1983). Trace amounts of inorganic constituents were detected in surface soil, surface water, and sediment samples collected during the Interim RI (Malcolm Pirnie, 1988). However, the samples were collected after site regrading and placement of gravel surfacing. Since these activities disturbed the surface soil, the analytical results may not have been representative of activities at the site.

The 1998 RI (CH2M HILL, 1998a) conducted at Site 2 concluded that the disposal activities had impacted the groundwater and soil as well as sediment and surface water in the adjacent drainage channel. In correlation with the type of material disposed of at the site, the primary contaminants consist of metals—arsenic, antimony, cadmium, chromium, copper, iron, lead, nickel, silver, and zinc. Sediment and surface soil sampling was conducted in February 1998 to delineate the contamination limits for a sediment removal action.

Site Risks

A risk assessment report was based on data presented in the RI report. The HHRA was conducted on the constituents that were detected at Site 2 and had available toxicological values. The baseline risk assessment assessed the potential human health impacts from the site under current and hypothetical future conditions. All of the cumulative carcinogenic and noncarcinogenic hazards are below or within the USEPA's recommended levels except for construction worker exposure. If construction were to occur at Site 2, there may be a hazard to construction workers exposed to the surface soil (**Table 5-1**).

An ERA was conducted by using hazard quotient values generated for receptor species from maximum and mean concentrations of constituents of potential concern (COPCs) in soil, sediment, and surface water. USEPA ecological risk guidance suggests that values equal to or greater than 1.0 represent a "potential ecological risk." Based on the results of the Screening ERA, "potential ecological risk" existed at Site 2 from the following metals: aluminum, antimony, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc (**Table 5-1**).

5.2.5 Basis for Taking Action

The primary risks to human health and the environment posed by conditions at Site 2 is the contaminated fill at Site 2, which provides a potential source of contamination that threatens the underlying aquifer and surrounding site media (surface water and sediment). Based on the results of previous investigations, remedial action was warranted to protect public health, welfare, and the environment from actual or threatened releases of inorganics in soil and sediment at Site 2.

5.3 Remedial Actions

5.3.1 Remedy Selection

The FS was submitted in 1998 (CH2M HILL, 1998c) and the PRAP was issued in 1999 (CH2M HILL, 1999a). The RA Design was completed in 1999 (CH2M HILL, 1999b) and the ROD was signed in December 2000 (CH2M HILL, 2000b). The ROD identified the risks to human health and the environment, established the RAOs, and defined the selected remedy. The purpose of the selected remedy was to minimize exposure to contamination present in the soil, groundwater, surface water, and sediment. The selected remedy for Site 2 includes sediment excavation and side-slope stabilization, asphalt and soil cover, LTM, and LUCs to meet the following RAOs:

- Prevent or minimize human health exposure to inorganic contaminants in the subsurface soil above health-based criteria.
- Prevent degradation of groundwater quality by limiting downward percolation of precipitation into the water table aquifer beneath Site 2.
- Minimize the risk to ecological receptors posed by lead-contaminated sediment and surface water.
- Prevent further migration of contaminated sediment from the site.

The ROD selected the following LUC objectives for Site 2:

- Prohibit excavating or disturbing the asphalt and soil covers, provided the sewage main traversing the site may be maintained from time to time, as necessary or appropriate.
- Prohibit the use of groundwater underlying the site for drinking water.
- Prohibit any other activity that would disturb the integrity of the asphalt and soil covers or impair the function of groundwater monitoring systems.

These LUC restrictions have been implemented with the actions detailed in the RD for LUCs at Site 2 (CH2M HILL, 2005a). The LUCs will be maintained on the soil and asphalt cover and groundwater within the boundaries of Site 2 until ICs are no longer required to protect human health or the environment, as stipulated in the ROD.

Lead was considered the indicator parameter for the sediment COCs, and since it was co-located with the other COCs, the removal of lead to the established cleanup level was expected to remove the other elevated contaminants posing a risk. The lead cleanup goal for sediment was 218 milligrams per kilogram (mg/kg) and was based on the Effects Range-Median (ERM) concentration.

5.3.2 Remedy Implementation

RA construction was completed from August 1999 through February 2000. The extent of the sediment removal, asphalt cover, and soil cover are shown on **Figure 5-1.** Approximately 1,600 tons of sediment were removed to achieve the lead cleanup goal of 218 mg/kg. A rip rap lining was placed at channel junctions, a rip rap apron was placed around the culvert of the channel segment, and a 100-foot section of the west bank of the drainage channel was regraded, seeded, and covered with matting and a 24-inch soil cover to prevent erosion of site materials. The asphalt cover consisted of a minimum of 8 inches of stone and 2 inches of asphalt placed over the original gravel parking lot. The soil cover consisted of a minimum of 18 inches of common fill and 4 to 6 inches of topsoil.

In accordance with the ROD, Site 2 is part of the LTM program at NSN. The LTM plan for Site 2 required sampling and analysis of inorganic constituents subsequent to the implementation of the RA. Samples were collected in sediment, surface water, and groundwater once a year for 5 years and in groundwater once every 5 years thereafter. Sediment and surface water sample locations were selected such that they could be sampled over time to allow for the completion of a trend analysis to evaluate changes in concentrations over time. As detailed in the 2007 LTM Plan (CH2M HILL, 2007e), one additional sediment sampling event was completed to provide

further data for constituent trend analysis. Statistical methods to evaluate the effectiveness of the remedy are detailed in the 2007 LTM Plan (CH2M HILL, 2007e).

5.3.3 System Operation and Maintenance

Current site maintenance consists of periodically mowing the cover of the grass field. Site inspections are conducted quarterly.

5.4 Progress Since Last Review

5.4.1 Follow up Actions Since the Last Five-year Review

The previous Five-year Review Report included the following protectiveness statement for Site 2:

The cover remedy soil and sediment at Site 2, NM Area Slag Pile, prevents direct contact with soil and sediment. Supporting inspection information and monitoring data indicate the landfill cover is in good condition. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in unacceptable risks are being controlled through a combination of existence of the cover, LUCs, and the implementation of ICs.

Although the Five-year Review concluded that the remedy is functioning as intended and protective of human health and the environment, issues and recommendations for follow-up actions were identified. **Table 5-2** presents the status of these recommendations and follow-up actions.

5.4.2 Actions Summary

This section is intended to provide a summary of O&M and LTM program activities at Site 2 since the last Five-year Review Report completed in October 2008. The LTM activities have continued at Site 2 in accordance with the *Long Term Monitoring Plan for Four Sites* (CH2M HILL, 2007e); however, the NSN Tier I Partnering Team agreed to include the upgradient Site 18 monitoring wells within the Site 2 LTM network. An update to the LTM program is in progress via new Basewide LTM Sampling and Analysis Plan for NSN, which is under review by the NSN Tier I Partnering Team concurrent to this Five Year Review. The LTM activities consist of monitoring well sampling for inorganics; surface water and sediment sampling was removed from the LTM program for Site 2 in 2005 via NSN Tier I Partnering Team Agreement. Sediment sample results indicated lead concentrations remained beneath the cleanup goal of 218 mg/kg. The results of the groundwater monitoring are summarized below and documented in greater detail in the 2012 LTM Report. Additionally, site inspections are performed quarterly.

Groundwater Monitoring

Total and dissolved metals detected in the baseline, 2004, and the 2009/2012 rounds of groundwater sampling are shown on **Figure 5-3**. Following the initial 5 years of LTM (2000 through 2004), a statistical analysis concluded that concentrations of metals in groundwater showed a decreasing trend since the completion of the RA (CH2M HILL, 2007e). Therefore, the LTM groundwater sampling has been reduced to a frequency of once every 5 years.

The groundwater monitoring results from 2012 (including the upgradient Site 18 monitoring wells) indicate arsenic is the only inorganic detected in exceedance of its respective MCL. The highest concentration of arsenic detected at the site is located at the upgradient well location for the site (**Figure 5-3**); this may indicate arsenic concentrations are not site related. The next round of groundwater samples are scheduled to be collected in June 2015 and the continuing effectiveness of the RA at Site 2 will be evaluated as part of future Five-year Reviews conducted at the facility.

Site Inspections

Site inspections are conducted at Site 2 quarterly to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review.

In 2012, quarterly site inspections observed miscellaneous debris (refrigerator, tires, and so forth) was present at the site. All debris was subsequently removed by the Navy prior to the February 2013 Site Inspection.

During the February 2013 and April 2013 inspections, a hole was observed in the southeastern corner of the asphalt parking lot outside of the LUC boundary. During the April 2013 inspection, the hole is present but located. No deficiencies affecting the remedy were observed.

Remedy Costs

The average remedy costs for maintaining the asphalt/soil cover, conducting LTM, and conducting quarterly site inspections is approximately $10,000 per year. The estimated O&M costs for the selected remedy in the ROD were approximately $33,800 per year; the actual cost for the selected remedy is approximately 70 percent less than estimated by the ROD.

5.5 Technical Assessment

Is the remedy functioning as intended by the Decision Documents?

Based on the review of the documents, monitoring results, ARARs, risk assumptions and results of the inspections, the remedy is functioning as intended by the ROD. The capping of contaminated soil and sediment has achieved the RAOs as demonstrated by the monitoring results. Concentrations of metals in groundwater, surface water, and sediment have decreased since the implementation of the remedy. In accordance with the ROD requirements for Site 2, sampling of surface water and sediment has been discontinued and groundwater monitoring has been reduced to once every 5 years. There is re-growth of vegetation on the soil cover and the asphalt cover remains in fair condition. Implementation and maintenance of ICs has prevented exposure to contaminated media.

Are the exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-year Review. There is no indication that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of some contaminants at Site 2, these changes would not adversely affect the protectiveness of the selected remedy as it would not change the classes of constituents identified as COCs. The remediation goals for the subsurface soil were based on a construction worker exposure scenario and were used to help determine the extent of the asphalt and soil cover. Although some of the toxicity numbers used to calculate the remediation goals have changed slightly (such as chromium oral reference dose [RfD] is now lower, iron oral RfD is now higher, copper oral RfD is now lower), these changes do not affect the effectiveness of the remedy since the remedy is ICs and the subsurface soil is covered with asphalt and soil cover, and therefore, there is no exposure to subsurface soil. The ER-M value (218 mg/kg) that was used as the sediment lead removal level has not changed.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how HHRAs are conducted, none of these changes adversely affect the protectiveness of the selected remedy for Site 2. There have been no major procedural changes in how the ERAs are conducted since the last Five-year Review.

Residential use of groundwater was not evaluated in the HHRA, as it was considered an incomplete pathway. It is current practice to evaluate future residential use of groundwater, even though it may not be a likely future scenario, as an evaluation of unrestricted site use. However, evaluation of this scenario would not change the effectiveness of the remedy, as ICs are in place and prevent use of and exposure to the groundwater at Site 2. Additionally, since the placement of the cover, the concentrations of the inorganic constituents in groundwater

samples collected as part of the LTM program showed a decreasing concentration trend. Furthermore, the cover and ICs prevent any exposure to surface or subsurface soil. Therefore, the remedy is still considered to be protective.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the remedy.

5.6 Issues, Recommendations, and Follow-up Actions Identified

Table 5-3 outlines the issues identified during this Five-year Review and presents recommendations and follow-up actions for Site 2.

5.7 Protectiveness Statement

The remedy at Site 2, NM Area Slag Pile, is protective by preventing direct contact with soil. Supporting inspection information and monitoring data indicate the asphalt and soil covers are in good condition. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in unacceptable risks are being controlled through a combination of covers, LUCs, and the implementation of ICs.

TABLE 5-1

Site 2 Remedy Performance Standards

OU	Site	Risk	Media	Reasonably Anticipated Land Use	COC Requiring Action	Basis for Action	RAO	Remedy Component	Site Closeout Strategy	Performance Metric / Cleanup Level*
2	2	Human Health	Subsurface Soil	Vacant Land and Parking Lot	Aluminum	HI > 1	Prevent or minimize human health exposure to inorganic contaminants in the subsuface soil above health-based critieria. Prevent degradation of groundwater quality by limiting downward percolation of precipitation into the water table aquifer beneath Site 2	Soil and asphalt cover & LUCs	LUCs to prevent intrusive activities.	No intrusive activites or change in land use
					Antimony	HI > 1				
					Arsenic	ILCR > $1x10^{-6}$				
					Cadmium	HI > 1				
					Chromium	HI > 1				
					Copper	HI > 1				
					Iron	HI > 1				
					Lead	Concentration > 609 ppm				
					Nickel	HI > 1				
			Groundwater	Potential drinking water resource	Lead	Concentration > 15 µg/L	Prevent degradation of groundwater quality by limiting downward percolation of precipitation (and thereby reducing the porential for the leachong of dissolved lead) into the water table aquifer at Site 2.	Soil and asphalt cover, LTM, & LUCs	Confirm whether contaminant levels are within protective levels and ensure further degradation of groundwater does not occur	15 µg/L
		Ecological	Soil	Vacant Land and Parking Lot	Aluminum	Potential Ecological Risk	None defined	Soil and asphalt cover & LUCs	LUCs to prevent intrusive activities.	No intrusive activites or change in land use
					Antimony					
					Barium					
					Beryllium					
					Cadmium					
					Chromium					
					Cobalt					
					Copper					
					Iron					
					Lead					
					Manganese					
					Mercury					
					Nickel					
					Selenium					
					Silver					
					Thallium					
					Vanadium					
					Zinc					
			Surface Water	Man-made drainage ditch	Aluminum		Minimize the risk to ecological receptors posed by lead-contaminated sediment and surface water Prevent further migration of contaminated sediment from the site	Sediment excavation, bank stabilization, and LTM	Conduct LTM to monitor effectiveness of remedy	Sediment lead concentration < 218 mg/kg
					Cadmium					
					Copper					
					Iron					
					Lead					
					Silver					
					Zinc					
			Sediment	Man-made drainage ditch	Aluminum			Sediment excavation, bank stabilization, and LTM		
					Barium					
					Beryllium					
					Cadmium					
					Chromium					
					Cobalt					
					Copper					
					Iron					
					Lead					
					Nickel					
					Selenium					
					Silver					
					Thallium					
					Vanadium					
					Zinc					

Acronyms:

AS - air sparge
COC - contaminant of concern
DD - Decision Document
HI - hazard index
ILCR - incremental lifetime cancer risk
LTM - long-term monitoring
LUC - land use control
µg/L - micrograms per liter
mg/kg - milligrams per kilogram
OU - operable unit
RAO - remedial action objective

TABLE 5-2

Site 2 Action Item Progress from 2008 Five-Year Review

Issue from Second Five-Year Review Report							
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**		**Status - June 2013**	
				Current	**Future**	**Action Taken and Outcome**	**Date of Action**
During the May 2005 inspection a hole was observed in the northwestern corner of the asphalt parking lot. To maintain the integrity of the asphalt cover the hole was repaired as documented during the February 2006 inspection.	Repair holes promptly and conduct inspections to ensure integrity of the cover. The hole was repaired as documented in the February 2006 inspection	Navy, USEPA, and VDEQ	Summer 2005	No	yes	The hole was repaired as documented in the February 2006 inspection.	Winter 2006

Acronyms:
USEPA - United States Environmental Protection Agency
VDEQ - Virginia Department of Environmental Quality

TABLE 5-3

Issues, Recommendations and Follow-up Actions for Site 2

Action Requiring Follow-Up from Third Five-Year Review Report					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
None					
Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
An erosional feature located along the asphalt parking lot is present; the hole continues to be observed to ensure the asphalt cover is not affected.	Continue to observe the erosional feature during quarterly site inspections and complete repairs if warranted	Navy, USEPA, and VDEQ	NA	No	No
Debris (tires, concrete, refrigerator, etc) has been observed at the site during two site visits; the Navy quickly removed all debris from the site prior to the subsequent site inspection.	Continue to observe and report debris at found at the site during quarterly site inspections and complete removals when warranted.	Navy, USEPA, and VDEQ	NA	No	No
Exit strategy for exiting groundwater LTM is not defined; the ROD estimates groundwater monitoring will be conducted every 5 years over a 30 year period	Discuss groundwater monitoring data with the NSN Tier I Partnering Team to establish an exit strategy for groundwater LTM.	Navy, USEPA, and VDEQ	NA	No	No

Acronyms:

LTM - long-term monitoring

NA - Not applicable

NSN - Naval Station Norfolk

ROD - Record of Decision

USEPA - United States Environmental Protection Agency

VDEQ - Virginia Department of Environmental Quality

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 5-1 - SITE 2 - NM SLAG PILE LAYOUT.MXD CELEFTHERIADIS 6/17/2013 8:33:07 AM

Legend

- Monitoring Well
- Upgradient Site 18 Monitoring Well
- Topographic Contour (2ft Interval)
- Estimated Groundwater Flow Direction
- Surface Water
- Area of Sediment Removal
- Area of Soil Cover
- Approximate Location of Slag Pile
- Area of Asphalt Cover
- Land Use Control Area (2007)

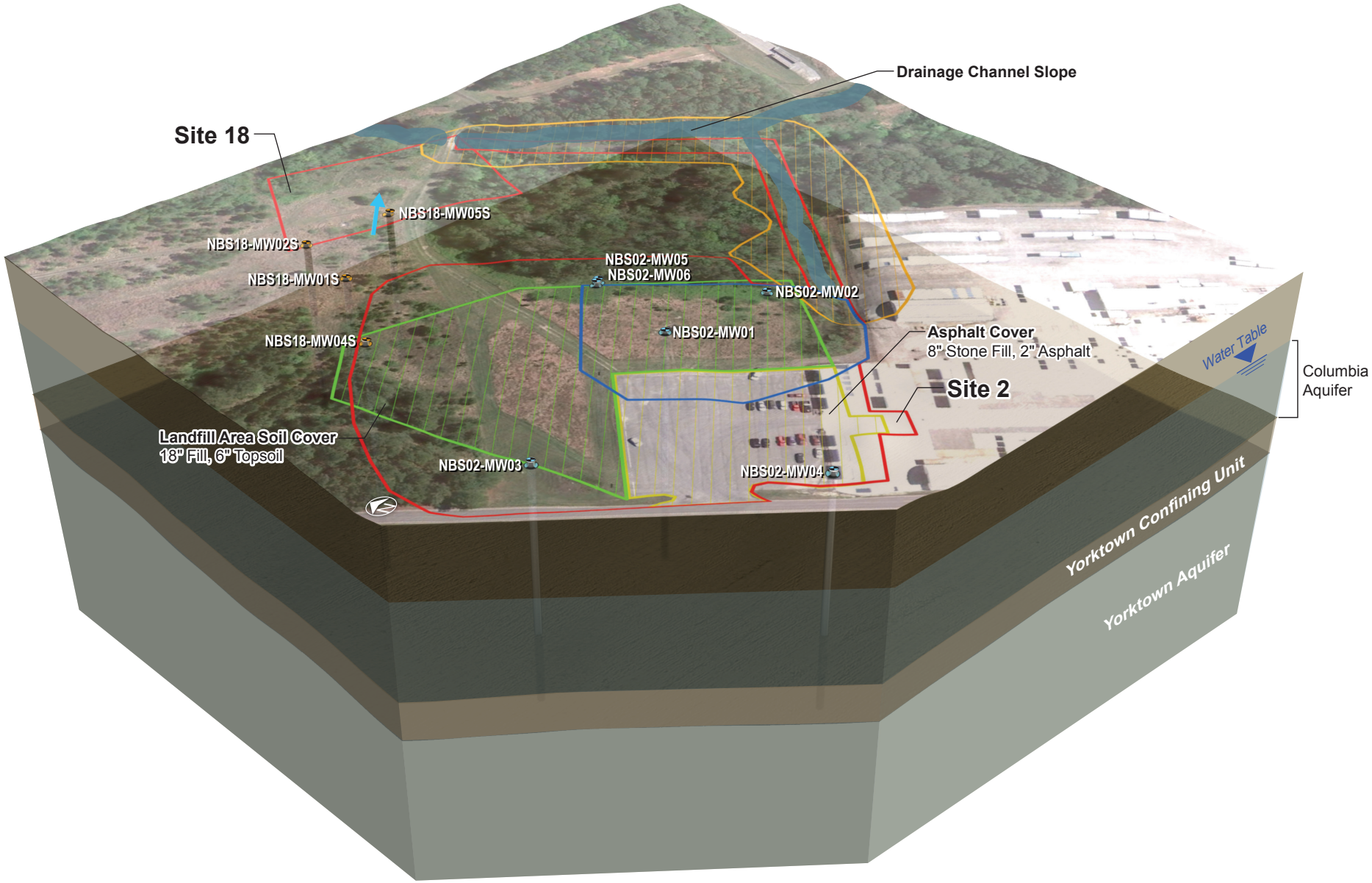
N
W E
S

0 125 250
Feet

Reference: 2008 Aerial Photography

Figure 5-1
Site 2 - NM Slag Pile Layout
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL



LEGEND

- Land Use Control Area Boundary
- Area of Sediment Removal
- Area of Soil Cover
- Approximate Location of Slag Pile
- Area of Asphalt Cover
- Monitoring Well
- Upgradient Site 18 Monitoring Well
- Estimated Groundwater Flow Direction
- Surface Water Feature

FIGURE 5-2
Conceptual Site Model, Site 2
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 5-3 - SITE 2 - TOTAL DISSOLVED METALS IN GW.MXD CELEFTHERIADIS 6/17/2013 8:24:02 AM

NBS18-MW01S				
Screen Interval	3.5' - 13.5' bgs			
Sample Date	06/01	02/02	12/02	11/12
Total Metals				
Arsenic	54	36	54	12
Thallium	5.5 U	9.6 J	5.1 U	2 U
Dissolved Metals				
Arsenic	28	17	19	13

NBS18-MW02S				
Screen Interval	3' - 13' bgs			
Sample Date	06/01	02/02	12/02	11/12
Total Metals				
Arsenic	27	17	24	12
Thallium	5.5 U	10.9	5.1 U	2 U
Dissolved Metals				
Arsenic	28	17	19	11

NBS18-MW05S				
Screen Interval	4' - 14' bgs			
Sample Date	06/03	06/04	08/09	11/12
Total Metals				
No exceedances				
Dissolved Metals				
Thallium	NA	9.9 J	2.4 UL	2 U

NBS02-MW05				
Screen Interval	70' - 80' bgs			
Sample Date	06/03	06/04	08/09	11/12
Total Metals				
No exceedances				
Dissolved Metals				
No exceedances				

NBS18-MW04S				
Screen Interval	3.5' - 13.5' bgs			
Sample Date	06/01	02/02	12/02	11/12
Total Metals				
No exceedances				
Dissolved Metals				
Arsenic	NA	24	3 U	3 J
Thallium	NA	9.3 J	4.9 B	2 U

NBS02-MW06				
Screen Interval	4' - 14' bgs			
Sample Date	06/03	06/04	08/09	11/12
Total Metals				
No exceedances				
Dissolved Metals				
No exceedances				

NBS02-MW03				
Screen Interval	4' - 14' bgs			
Sample Date	06/03	06/04	08/09	11/12
Total Metals				
No exceedances				
Dissolved Metals				
No exceedances				

NBS02-MW02				
Screen Interval	5' - 15' bgs			
Sample Date	06/03	06/04	08/09	11/12
Total Metals				
No exceedances				
Dissolved Metals				
No exceedances				

NBS02-MW04				
Screen Interval	4' - 14' bgs			
Sample Date	06/03	06/04	08/09	11/12
Total Metals				
Arsenic	22	21	21	16
Dissolved Metals				
Arsenic	18	20	NA	15
Thallium	7 U	4.5 J	NA	2 U

NBS02-MW01				
Screen Interval	5' - 15' bgs			
Sample Date	06/03	06/04	08/09	11/12
Total Metals				
No exceedances				
Dissolved Metals				
No exceedances				

Site 18

Site 2

Interstate 564

NM95

NM110

NM111

NM110

NM110

NM92

Legend

- Monitoring Well
- Upgradient Site 18 Monitoring Well
- Estimated Groundwater Flow Direction
- Surface Water
- Area of Sediment Removal
- Area of Soil Cover
- Approximate Location of Slag Pile
- Area of Asphalt Cover
- Land Use Control Area (2007)
- Installation Boundary

Notes:
All concentrations are in micrograms per liter.
bgs - below ground surface
MCL - Maximum Contaminant Level

N
W E
S

0 125 250
Feet

Reference: 2008 Aerial Photography

Chemical	Screening Criteria (MCLs)
Arsenic	10 µg/L
Thallium	4 µg/L

Figure 5-3
Total and Dissolved Metals in Groundwater
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 6

Site 3—Q-Area Drum Storage Yard

6.1 Chronology

The following is the chronology of the major site events for Site 3, QADSY.

1950s-1980s	Area was used to store drums
1983	Area identified as a potential source of contamination in the IAS
1987	Soil removal action completed
1988	Interim RI completed
1996	RI/FS completed
1996	PRAP completed and DD signed
April 1997	NSN placed on the NPL
1997	Construction of the air sparge (AS)/soil vapor extraction (SVE) system
August 1998	Remediation system began operation
February 1999	Implementation of the biannual LTM
September 1999	System operation was modified to a 2-week cycle of pulsing
April 2003	Closeout Strategy was implemented for Area of Concern (AOC) 1
October 2003	Implementation of Five-year Review process
June 2006	Closeout Strategy was implemented for AOC 2
April 2007	Final RD for LUCs at Site 3 (CH2M HILL, 2007d
October 2008	Second Five-year Review
June 2010	RACR signature
July 2010	AOC 1 system operation resumed
August 2010	Signature of ROD[4] (Reaffirmation of 1996 DD selected remedy)
September 2010	NSN achieves construction completion; PCOR signature
2012	Transition from semi-annual to annual LTM
June 2013	AOC 1 and AOC 2 systems shutdown in accordance with NSN Tier I Partnering Team agreement

6.2 Background

6.2.1 Site Description

The Site 3, QADSY, occupied approximately 5 acres in the northwest corner of NSN near the aircraft carrier piers (**Figures 2-1 and 6-1**). This area was created by dredging operations in the early 1950s. Two large water bodies are located adjacent to Site 3. The Elizabeth River borders the western boundary of the site and Willoughby Bay borders the northern and eastern boundary of the site.

6.2.2 Physical Characteristics

The topography of the area is relatively uniform, characterized by very gently sloping areas. The average elevation of the site is approximately 10 feet amsl. The water table is approximately 8 feet bgs, and water table elevations range from 2 to 5 feet amsl. Groundwater flow is west toward the Elizabeth River across much of the site, with a small component of flow to the north and east toward Willoughby Bay. The underlying Yorktown aquifer is hydraulically connected to the Columbia aquifer at this site. The Yorktown aquifer discharges into the Elizabeth

[4] The cleanup goals for groundwater COCs were revised to MCLs where the clean up goal is greater than the MCL. If the existing clean up goal was less than the MCL, the risk-based clean up goal remained the existing clean up goal (the risk-based clean up goal is applicable to carbon tetrachloride, 1,1-DCE and vinyl chloride; all other COC clean up goals were reduced to MCLs) as documented in the ROD.

River and Willoughby Bay; however, these bodies of water are not used for domestic public, commercial, or industrial supply because the water is brackish.

The CSM for Site 3 is provided as **Figure 6-2**.

6.2.3 Land and Resource Use

The site is currently utilized as a parking lot for operations along the piers. Groundwater is not utilized as a resource in the vicinity of the site. Land use is not expected to change in the near future.

6.2.4 History of Contamination

Site 3 was an open earthen yard used from the 1950s until the late 1980s to store tens of thousands of drums, most of which contained new petroleum products, various chlorinated organic solvents, paint thinners, and pesticides. The site currently serves as a fleet parking area.

Initial Response

The potential for site contamination from drum storage activities was initially identified in the 1983 IAS (ESE, 1983). The initial site visit noted dark stains on the soil and oil-saturated soil throughout the storage yard, indicative of past spills. The yard's northern portion, which was used to store leaking or damaged drums and hazardous materials, was particularly stained. Field investigations were conducted from 1983 to 1986 to characterize the nature and extent of contamination at the site. The analytical results indicated that soil and groundwater were contaminated with metals and VOCs (Malcolm Pirnie, 1988).

In 1986, Navy fire inspectors expressed concern with the oil-saturated soils at the northern end of the storage area (previously used to store damaged or leaking drums). On the basis of a potential fire hazard, the top 6 inches of soil were excavated in the northern section from an area of 4,240 square yards (yd^2) (totaling approximately 750 yd^3 of soil removed) and disposed offsite in 1987 (Malcolm Pirnie, 1988). Following the removal action, this area of the storage yard was paved.

The RI/FS (ESE, 1996a) for this site revealed that the soil was contaminated with total petroleum hydrocarbons (TPH), VOCs, and pesticides. In addition, VOC contamination was found in the groundwater beneath the site and outside the site boundary. The shallow groundwater beneath the hazardous materials area and the northern portion of the petroleum products area was most significantly impacted. Several VOCs were detected in one deep well (DW-1) at very low concentrations and found at higher concentrations in the shallower nested well. This may be due to the lack of a confining layer between the two aquifers in this area. None of the VOCs for which VDEQ nonpublic water supply standards had been established were exceeded in the deep well. The general extent of the groundwater plume, which affects approximately 29 acres beneath the fleet parking area west of the site, has been defined with monitoring-well and direct-push groundwater sampling. As a result of the delineation, the Q-Area was subdivided into AOC 1 and AOC 2 (**Figure 6-1**) to reflect two areas of high concentrations of VOCs.

Site Risks

A human health and ecological evaluation was conducted at Site 3 (**Table 6-1**). The human health evaluation identified VOCs in groundwater as presenting an unacceptable risk. The ecological screening evaluation did not identify any receptors under current and foreseeable future scenarios as a result of the site being a paved parking lot.

6.2.5 Basis for Taking Action

The primary risk posed by conditions at Site 3 is the contaminated groundwater, which threatens the underlying aquifer. Based on the results of previous investigations, remedial action is warranted to protect public health and welfare from actual or threatened releases of VOCs in groundwater.

6.3 Remedial Actions

6.3.1 Remedy Selection

The PRAP was issued in 1996 and the DD was signed in November 1996 to treat groundwater at the site (ESE, 1996b). The DD identified the risks to human health and the environment, established the RAO, and defined the selected remedy. The selected remedy for Site 3 includes remediation of the groundwater using AS/SVE, LTM, and LUCs to meet the following RAO:

- Minimize the threat of exposure to the contaminated groundwater through inhalation of VOCs by a potential human receptor (site worker and resident) in future buildings.

There was no additional action taken to treat the soil at Site 3 because the inorganic compounds appear to be inherited from the dredged material; Site 3 is not conducive to an ecological environment because it is a highly industrial area and is mostly a paved parking lot; and the present plans are for the unpaved area to be paved, which will subsequently eliminate the ecological risk pathway (ESE, 1996b).

The following LUCs were defined for Site 3:

- Prohibit residential development on the site.
- Prohibit use of the shallow aquifer groundwater beneath the site for use as a potable water source.
- Prohibit changes from current building use or construction of new buildings without further evaluation of potential VI risks and/or implementation of mitigation measures

The LUC restrictions have been implemented as detailed in the RD for LUCs at Site 3. The LUCs will be maintained on all land within the boundaries of QADSY (**Figures 6-1**) until the concentrations of hazardous substances in the groundwater have been reduced to levels to allow for UU/UE.

6.3.2 Remedy Implementation

The AS/SVE remediation system began operation in August 1998. Separate systems were installed to treat the two site areas (AOC 1 and AOC 2) that exceeded cleanup goals (**Table 6-1**). The AS/SVE system for AOC 1 consists of 30 AS wells and 14 SVE wells and the system for AOC 2 consists of 20 AS wells and 10 SVE wells. The AS/SVE systems for AOC 1 and AOC 2 are shown on **Figure 6-1**.

Before the AS/SVE remediation system started, monitoring wells were sampled in February 1998 and in May 1998 to provide baseline VOC and water-quality data. Subsequent to system operation, groundwater samples were collected at monitoring wells biannually. Monitoring well CMW-103 was paved over during parking lot repair activities and monitoring well SW-2 was buried in a dirt parking lot. Both monitoring wells were replaced in 2002 as CMW-103R and SW-2R, respectively. Sampling continues at Site 3 annually at monitoring wells that have been retained in the LTM program.

Based on a substantial decrease of VOC concentrations during the first years of operation, the systems at AOC 1 and AOC 2 were modified in September 1999. The SVE system was shut off and the operation of the AS system was altered to a two-week cycle of pulse pumping. Prior to construction completion in September 2010, the NSN Tier I Partnering Team agreed to operate both AOC 1 and AOC 2 systems since groundwater contamination was detected within the footprints of the systems. Following the collection and assessment of groundwater samples in 2012, the NSN Tier I Partnering Team agreed to turn off both systems in June 2013 and monitor groundwater in November 2013. This determination was supported by both the concentration and distribution of detected contaminants in groundwater that are not likely to be affected by continued operation of the systems and the potential for increased rates of biodegradation under oxygen depleted conditions, which are not facilitated during air sparging.

6.3.3 System Operation and Maintenance

The standard O&M of the AS/SVE system is documented in the *Environmental Facility User Manual for Groundwater Remediation* (OHM, 1998b). The maintenance associated with the operation of the AS/SVE system consists of weekly site visits for system monitoring, and replacement of components when necessary.

The RPO Team continually evaluates the O&M of the AS/SVE system, including operating costs, and makes adjustments as appropriate to increase system efficiency. Historically, the findings have lead to the former closeout strategies developed and implemented for each AOC; however, recent groundwater monitoring results indicate the groundwater plume is present above established cleanup goals at a greater extent than is likely to be affected by the operation of the AS/SVE systems. The NSN Tier I Partnering Team is currently reviewing historical and recent groundwater data to create a revised close-out strategy for the site.

6.4 Progress Since Last Review

6.4.1 Follow up Actions Since the Last Five-year Review

The previous Five-year Review Report included the following protectiveness statement for Site 3:

The remedy at Site 3 consisting of the AS/SVE system is currently protective of human health and the environment and is expected to be protective in the future. The site groundwater concentrations are approaching the MCLs, which has resulted in implementation of a closeout strategy. The exposure pathways that could result in unacceptable risks are being controlled through a combination of the groundwater treatment system, LUCs, and the implementation of ICs. Long-term protectiveness of the remedial action will be verified by continuing the LTM program until the cleanup levels have been achieved.

No additional recommendations or follow-up actions were identified for Site 3 during the previous Five-year Review.

6.4.2 Actions Summary

This section is intended to provide a summary of O&M and LTM program activities at Site 3 since the last Five-year Review Report completed in October 2008. The LTM activities have continued at Site 3 in accordance with the *Long Term Monitoring Plan for Four Sites* (CH2M HILL, 2007e); however, alternate LTM strategies (sampling of all site wells) were completed in 2011 and 2012. An update to the LTM program is in progress via new Basewide LTM Sampling and Analysis Plan for NSN, which is under review by the NSN Tier I Partnering Team concurrent to this Five Year Review. The results of the groundwater monitoring are summarized below and documented in greater detail in the 2012 LTM Report. Additionally, site inspections are performed quarterly.

The shallow aquifer cleanup goals detailed in the DD were risk-based values for non-potable use. The 2010 ROD documented the revision of cleanup goals for COCs whose MCLs were more stringent than the initial risk-based goals documented by the DD. The groundwater clean-up goals for carbon tetrachloride, 1,1-dichloroethene (DCE), and vinyl chloride (VC) remain below their respective MCLs.

Groundwater Monitoring Data Review

The LTM program was implemented as a requirement in the DD (ESE, 1996b) for Site 3 to evaluate the effectiveness of the RA. Baseline groundwater samples were collected in February and May 1998 and the LTM program at Site 3 began in 1999. LTM groundwater samples have historically been collected semi-annually and analyzed for groundwater COCs. Additionally, select natural attenuation parameters are collected periodically at the site to evaluate aquifer conditions at Site 3.

Groundwater monitoring at Site 3 proceeded under the existing close-out strategies for AOC 1 and AOC 2 until 2010; since the groundwater cleanup goals for all COCs were not established as their respective MCL in the 2010 ROD, all site groundwater monitoring wells were sampled to define the extent of groundwater contamination above established cleanup goals. **Figure 6-3** provides the results of the last five rounds of available sampling for all site monitoring wells. A majority of site monitoring wells indicate a decreasing trend or concentrations remain the same

over the past five monitoring rounds. Based on the results of the recent groundwater monitoring, the NSN Tier I Partnering Team agreed to turn off the systems at AOC 1 and AOC 2 in June 2013 and sample groundwater in November 2013 to determine a path forward for the site.

Site Inspections

Site inspections have been conducted at Site 3 quarterly to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review.

No discrepancies have been observed at Site 3 during any of the quarterly inspections.

Remedy Costs

The estimated O&M cost for Site 3 is approximately $34,000 per year. The estimated O&M cost documented by the DD was approximately $160,000 per year (over 30 years). The current estimated O&M costs are significantly less than the cost documented by the DD.

6.5 Technical Assessment

Is the remedy functioning as intended by the Decision Documents?

The review of documents, ARARs, risk assumptions, and the results of the site inspection indicates the remedy is functioning as intended by the DD. The ICs that are in place include prohibitions on residential development and the use of groundwater at the site.

Based on the significant reduction of VOC concentrations during the first year of operation, the system operation was modified in September 1999. The SVE system was shut off and the operation of the AS system was altered to a 2-week cycle of pulsing. For several years prior to June 2013, only the AS portion of each system was in operation. Operation of the AS system has resulted in decreasing concentrations of VOCs. A revised closeout strategy for the site is being developed by the NSN Tier I Partnering Team based upon the current distribution and concentration of groundwater COCs.

Are the exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-year Review. There is no indication that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of contaminants initially sampled during the RI/FS phase of investigation at Site 3, these changes would not adversely affect the protectiveness of the selected remedy for the COCs identified in the ROD as it would not substantially change the results of the risk assessment or the classes of constituents identified as COCs.

Additionally, the groundwater cleanup goals are based on MCLs, unless the original, risk-based goals were more stringent. Changes in toxicity values would not affect the cleanup goals for the groundwater. The LUCs and ICs eliminate any exposure to site media; therefore, changes to the toxicity values would not affect the protectiveness of the remedy.

During this Five-year Review period, risk-based screening levels for evaluating human health risks associated with exposure to 1,4-dioxane were established. 1,4-dioxane is a stabilizer that was commonly used in chlorinated solvents including 1,1,1-TCA, which was historically released and detected at Site 3. 1,4-dioxane was not detected in groundwater samples collected at Site 3 in 2012; however, the reporting limits ranged from 10 µg/L to 100

µg/L, exceeding the November 2012 RSL of 0.67 µg/L. Although the presence of 1,4-dioxane is unknown at Site 3, it can be reasonably expected that the enforcement of LUCs would be adequate to protect human health and the environment from potential risks (if any) associated with this constituent under current land use scenarios.

Additional changes to RSL values of other constituents have been made during this Five-year Review period; however, these changes do not impact the protectiveness of the remedy.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how HHRAs are conducted, none of these changes adversely affect the protectiveness of the selected remedy for Site 3. There have been no major procedural changes in how the ERAs are conducted since the last Five-year Review.

Cleanup goals were established for the site based on risk scenarios; however, the 2010 ROD documented the change to the site cleanup goals to the MCLs (where risk-based goals were less stringent than respective MCLs), which are protective of potable use of groundwater. As ICs are also in place, there is no current exposure to groundwater that is still present at the site at concentrations above MCLs. Any changes in methodology to conduct risk assessments would not affect the use of MCLs as the cleanup goals, and therefore would not affect the remedy. The use of risk-based cleanup goals for carbon tetrachloride, 1,1-DCE, and VC are more protective than MCLs (where established) for these constituents.

Residential use of groundwater was not evaluated in the HHRA as it was considered an incomplete pathway. It is current practice to evaluate future residential use of groundwater, even though it may not be a likely future scenario, as an evaluation of unrestricted site use. However, evaluation of this scenario would not change the effectiveness of the remedy, as ICs are in place and they prevent use of and exposure to the groundwater at Site 3.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the remedy.

6.6 Issues, Recommendations, and Follow-up Actions Identified

Table 6-2 outlines the issues identified during this Five-year Review and presents recommendations and follow-up actions for Site 3.

6.7 Protectiveness Statement

The remedy at Site 3, consisting of air sparge (AS)/soil vapor extraction (SVE), LTM, and LUCs, is currently protective in the short-term for human health and the environment. Exposure pathways that could result in an unacceptable risk are being controlled by LUCs and ICs. However, in order ensure the remedy's protectiveness for the long-term, a groundwater evaluation to determine if 1,4-dioxane should be considered a COC for the site and revision the site remedy and/or LUC boundary is warranted.

TABLE 6-1

Site 3 Remedy Performance Standards

OU	Site	Risk	Media	Reasonably Anticipated Land Use	COC Requiring Action	Basis for Action	RAO	Remedy Component	Site Closeout Strategy	Performance Metric / Cleanup Level*
3	3	Human Health	Indoor Air	Parking Lot	Carbon Tetrachloride	HI > 4.1	Minimize the threat of exposure to the contaminated groundwater through inhalation of VOCs by a potential human receptor (site worker and resident) in future buildings	AS/SVE and LUCs	Conduct LTM and enforce LUCs until each groundwater COC is at or below its respective cleanup level	2.7 µg/L
					Chloroform	ILCR > $1x10^{-6}$				11.1 µg/L
					1,1-DCE	ILCR > $1x10^{-4}$				0.38 µg/L
					PCE	ILCR > $1x10^{-6}$				5 µg/L
					TCE	ILCR > $1x10^{-5}$				5 µg/L
					Vinyl Chloride	ILCR > $1x10^{-4}$				0.08 µg/L

*Risk-based clean up goals were intially calculated based on exposure to indoor air contaminated by volatization of VOCs in groundwater; in 2010, the COCs with more stringent MCLs were revised to the MCL.

Acronyms:
AS - air sparge
COC - contaminant of concern
DCE - dichloroethene
DD - Decision Document
HI - hazard index
ILCR - incremental lifetime cancer risk
LTM - long-term monitoring
LUC - land use control
MCL - maximum contaminant level
µg/L - micrograms per liter
OU - operable unit
PCE - tetrachloroethene
RAO - remedial action objective
SVE - soil vapor extraction
TCE - trichloroethene
VOC - volatile organic chemical

TABLE 6-2

Issues, Recommendations and Follow-up Actions for Site 3

Action Requiring Follow-Up from Third Five-Year Review Report					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
An RSL was established for 1,4-dioxane. Historical detection of 1,1,1-TCA in site groundwater data indicate the constituent may be present in site groundwater above the established RSL.	Evaluate the presence of 1,4-dioxane in site groundwater. If a data evaluation indicates 1,4-dioxane should be considered a contaminant of concern (COC) for Site 3, the NSN Tier I Partnering Team will determine if modifications to the existing remedy and/or LUC boundary are necessary.	Navy, USEPA, and VDEQ	Jul-14	No	TBD
Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
The current remedy is not expected to remediate the groundwater to cleanup goals within the next 30 years since the remaining groundwater contamination is detected outside of the radius of influence of the existing systems. All elevated concentrations of COC are within the existing LUC boundary.	Conduct optimization analysis to determine timeframe and practicability of reaching cleanup goals in a more efficient manner.	Navy, USEPA, and VDEQ	NA	No	No
Existing exit strategy to cease groundwater monitoring requires revision.	Discuss groundwater monitoring data with the NSN Tier I Partnering Team to establish an exit strategy for groundwater LTM.	Navy, USEPA, and VDEQ	NA	No	No
Current cleanup goals for carbon tetrachloride, 1,1-dichloroethene, and vinyl chloride are less than the MCL; the conservative cleanup goals are calculated based on potential future risk to indoor air.	NSN Tier I Partnering Team will establish appropriate cleanup goals for groundwater at Site 3 and complete the appropriate documentation.	Navy, USEPA, and VDEQ	NA	No	No

Acronyms:

LTM - long-term monitoring

LUC - land use control

MCLs - maximum contaminant level

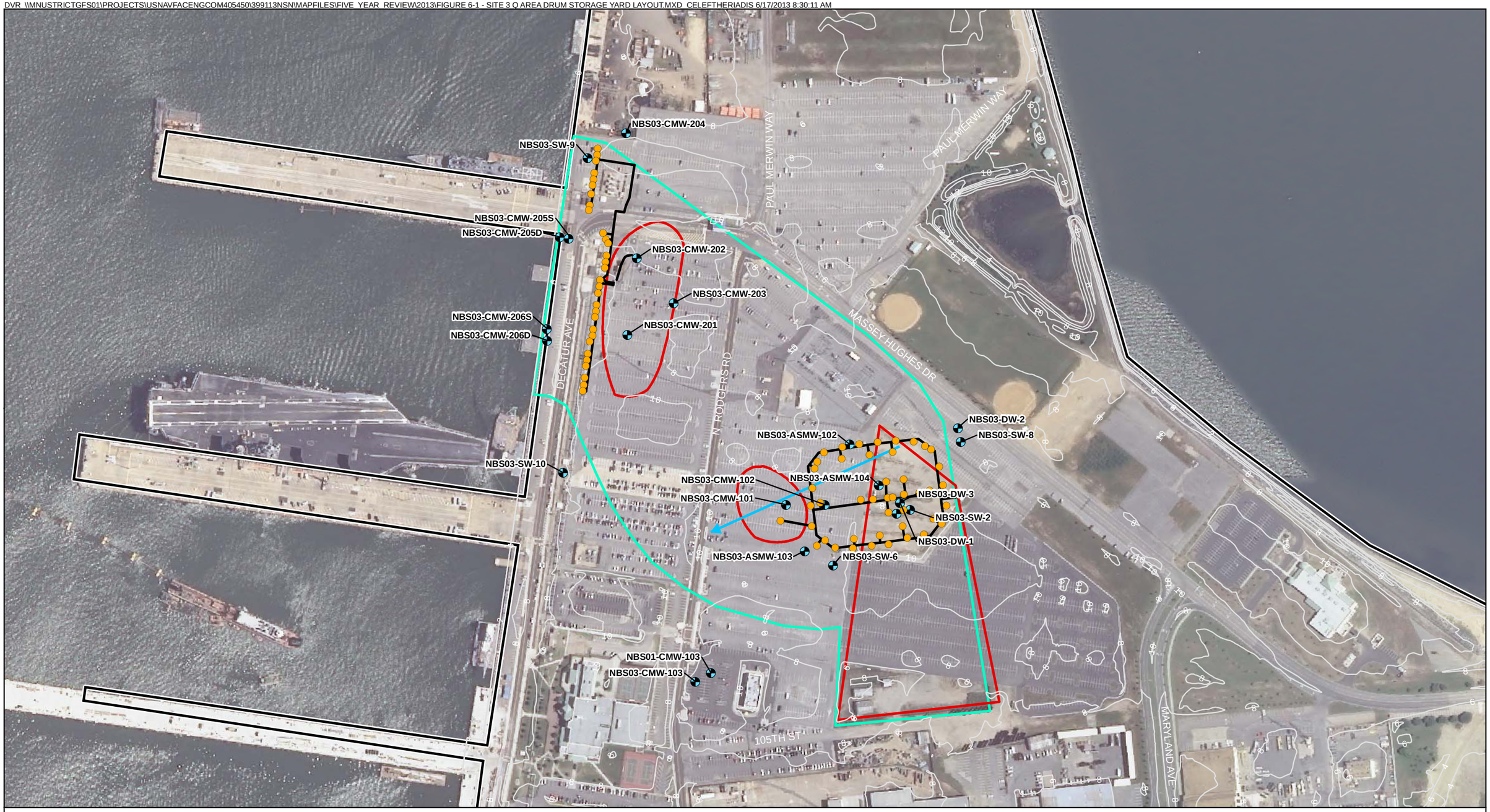
RSL - risk screening level

TBD - to be determined

USEPA - United States Environmental Protection Agency

VDEQ - Virginia Department of Environmental Quality

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 6-1 - SITE 3 Q AREA DRUM STORAGE YARD LAYOUT.MXD CELEFTHERIADIS 6/17/2013 8:30:11 AM



Legend

- Monitoring Well
- Air Sparge Well (AS)
- Piping for AS System
- Topographic Contour (2ft Interval)
- Generalized Groundwater Flow Direction at Mean Tide (2011)
- Land Use Control Area (2007)
- Proposed Land Use Control Area (2013)
- Installation Boundary

N
W E
S

0 300 600
Feet

Reference: 2008 Aerial Photography

Figure 6-1
Site 3 - Q Area Drum Storage Yard Layout
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

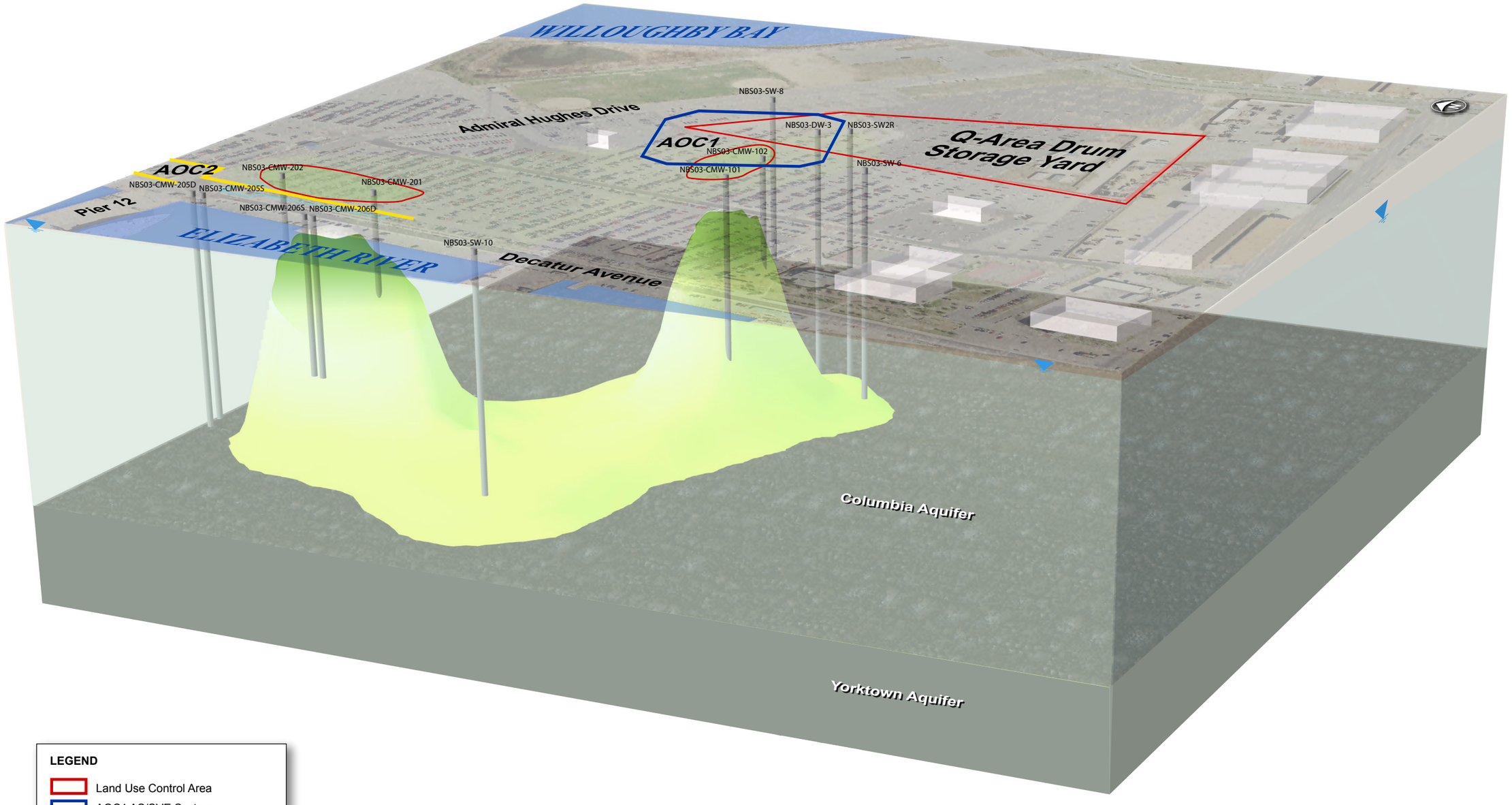
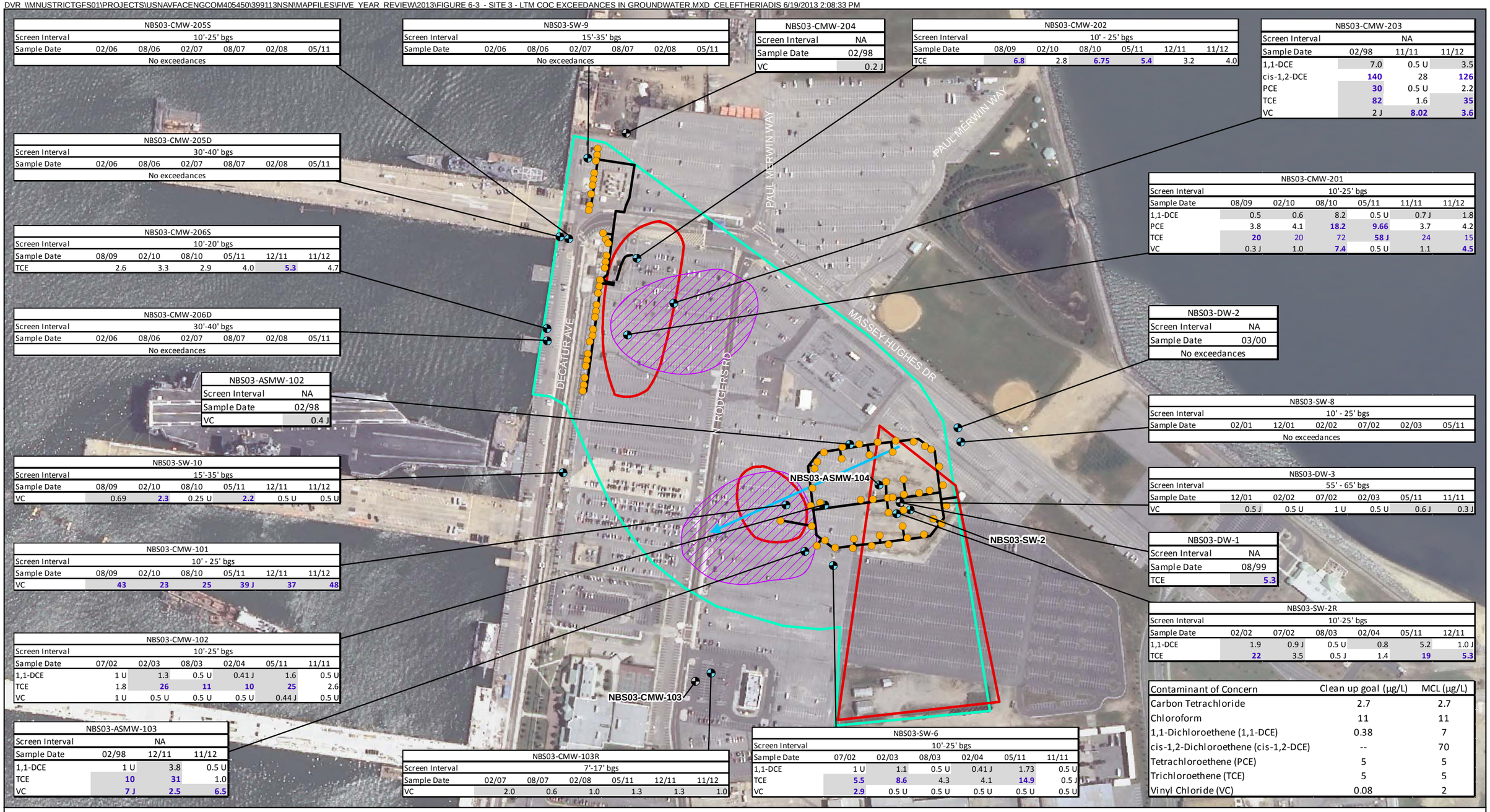


FIGURE 6-2
Conceptual Site Model, Site 3
Naval Station Norfolk
Norfolk, Virginia

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 6-3 - SITE 3 - LTM COC EXCEEDANCES IN GROUNDWATER.MXD CELEFTHERIADIS 6/19/2013 2:08:33 PM



NBS03-CMW-205S						
Screen Interval	10'-25' bgs					
Sample Date	02/06	08/06	02/07	08/07	02/08	05/11
No exceedances						

NBS03-SW-9						
Screen Interval	15'-35' bgs					
Sample Date	02/06	08/06	02/07	08/07	02/08	05/11
No exceedances						

NBS03-CMW-204	
Screen Interval	NA
Sample Date	02/98
VC	0.2 J

NBS03-CMW-202						
Screen Interval	10' - 25' bgs					
Sample Date	08/09	02/10	08/10	05/11	12/11	11/12
TCE	**6.8**	2.8	**6.75**	**5.4**	3.2	4.0

NBS03-CMW-203			
Screen Interval	NA		
Sample Date	02/98	11/11	11/12
1,1-DCE	7.0	0.5 U	3.5
cis-1,2-DCE	**140**	28	**126**
PCE	**30**	0.5 U	2.2
TCE	**82**	1.6	**35**
VC	2 J	**8.02**	**3.6**

NBS03-CMW-205D						
Screen Interval	30'-40' bgs					
Sample Date	02/06	08/06	02/07	08/07	02/08	05/11
No exceedances						

NBS03-CMW-201						
Screen Interval	10'-25' bgs					
Sample Date	08/09	02/10	08/10	05/11	11/11	11/12
1,1-DCE	0.5	0.6	8.2	0.5 U	0.7 J	1.8
PCE	3.8	4.1	**18.2**	**9.66**	3.7	4.2
TCE	**20**	20	72	**58 J**	24	15
VC	0.3 J	1.0	**7.4**	0.5 U	1.1	**4.5**

NBS03-CMW-206S						
Screen Interval	10'-20' bgs					
Sample Date	08/09	02/10	08/10	05/11	12/11	11/12
TCE	2.6	3.3	2.9	4.0	**5.3**	4.7

NBS03-DW-2	
Screen Interval	NA
Sample Date	03/00
No exceedances	

NBS03-CMW-206D						
Screen Interval	30'-40' bgs					
Sample Date	02/06	08/06	02/07	08/07	02/08	05/11
No exceedances						

NBS03-ASMW-102	
Screen Interval	NA
Sample Date	02/98
VC	0.4 J

NBS03-SW-8						
Screen Interval	10' - 25' bgs					
Sample Date	02/01	12/01	02/02	07/02	02/03	05/11
No exceedances						

NBS03-SW-10						
Screen Interval	15'-35' bgs					
Sample Date	08/09	02/10	08/10	05/11	12/11	11/12
VC	0.69	**2.3**	0.25 U	**2.2**	0.5 U	0.5 U

NBS03-DW-3						
Screen Interval	55' - 65' bgs					
Sample Date	12/01	02/02	07/02	02/03	05/11	11/11
VC	0.5 J	0.5 U	1 U	0.5 U	0.6 J	0.3 J

NBS03-DW-1	
Screen Interval	NA
Sample Date	08/99
TCE	**5.3**

NBS03-CMW-101						
Screen Interval	10' - 25' bgs					
Sample Date	08/09	02/10	08/10	05/11	12/11	11/12
VC	**43**	**23**	**25**	**39 J**	**37**	**48**

NBS03-SW-2R						
Screen Interval	10'-25' bgs					
Sample Date	02/02	07/02	08/03	02/04	05/11	12/11
1,1-DCE	1.9	0.9 J	0.5 U	0.8	5.2	1.0 J
TCE	**22**	3.5	0.5 J	1.4	**19**	**5.3**

NBS03-CMW-102						
Screen Interval	10'-25' bgs					
Sample Date	07/02	02/03	08/03	02/04	05/11	11/11
1,1-DCE	1 U	1.3	0.5 U	0.41 J	1.6	0.5 U
TCE	1.8	**26**	**11**	**10**	**25**	2.6
VC	1 U	0.5 U	0.5 U	0.5 U	0.44 J	0.5 U

NBS03-ASMW-103			
Screen Interval	NA		
Sample Date	02/98	12/11	11/12
1,1-DCE	1 U	3.8	0.5 U
TCE	**10**	**31**	1.0
VC	**7 J**	**2.5**	**6.5**

NBS03-CMW-103R						
Screen Interval	7'-17' bgs					
Sample Date	02/07	08/07	02/08	05/11	12/11	11/12
VC	2.0	0.6	1.0	1.3	1.3	1.0

NBS03-SW-6						
Screen Interval	10'-25' bgs					
Sample Date	07/02	02/03	08/03	02/04	05/11	11/11
1,1-DCE	1 U	1.1	0.5 U	0.41 J	1.73	0.5 U
TCE	**5.5**	**8.6**	4.3	4.1	**14.9**	0.5 J
VC	**2.9**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Contaminant of Concern	Clean up goal (µg/L)	MCL (µg/L)
Carbon Tetrachloride	2.7	2.7
Chloroform	11	11
1,1-Dichloroethene (1,1-DCE)	0.38	7
cis-1,2-Dichloroethene (cis-1,2-DCE)	--	70
Tetrachloroethene (PCE)	5	5
Trichloroethene (TCE)	5	5
Vinyl Chloride (VC)	0.08	2

Legend

- Monitoring Well
- Air Sparge (AS) Well
- Generalized Groundwater Flow Direction at Mean Tide (2011)
- Piping for AS Systems
- Estimated extent of COCs greater than respective MCLs (November 2012)
- Land Use Control Area (2007)
- Proposed Land Use Control Area (2013)

Notes:

Highlight indicates exceedances of clean up goals

Bold blue text indicates exceedance of MCL

Results for the most recent 6 rounds of sampling (if available) for each monitoring well.

SW-6 was not able to be sampled 11/12 (car was parked over the well for the month of November)

All concentrations shown are in micrograms per liter

bgs - below ground surface

LTM - long term monitoring

MCL - maximum contaminant level

J - Analyte present, value may or may not be accurate or precise

U - the material was analyzed for, but not detected

COC - contaminant of concern

N W E S

0 300 600 Feet

Reference: 2008 Aerial Photography

Figure 6-3

LTM COC Exceedances in Groundwater

Naval Station Norfolk

Norfolk, Virginia

CH2MHILL

SECTION 7

Site 6—CD Landfill

7.1 Chronology

The following is the chronology of the major site events for Site 6, CD Landfill.

1974	Purchase of property from Western Railway Company
1974-1979	Disposal of material in the unpermitted (eastern) section of the landfill
October 1979	Virginia Department of Health (VDOH) issued a permit for disposal of demolition debris and non-putrescible wastes at the site
1979-1987	Disposal of material in the permitted (western) section of the landfill
1983	CD Landfill identified as a potential source of contamination in the IAS
1991	Site Investigation (SI) completed
1993	Seabee Road was constructed over the site
1995	RI completed
July 1996	FS completed
October 1996	PRAP completed and DD signed for site sediment OU1
April 1997	NSN placed on the NPL
1997	Partial removal of contaminated sediments
1998	PRAP completed and ROD signed for site soil and groundwater (OU2)
December 1999	Construction of the landfill cap was completed
December 1999	Post-closure Plan was completed
2000-2001	Quarterly groundwater and surface water monitoring conducted
March 2001	Annual Post-closure Monitoring Report completed
February 2002	Annual Post-closure Monitoring Report completed
February 2003	Annual Post-closure Monitoring Report completed
October 2003	Implementation of Five-year Review process
February 2004	Annual Post-closure Monitoring Report completed
March 2004	First Determination Report completed. LTM Phase II monitoring discontinued and LTM Phase I monitoring reinstated in accordance with recommendations from the First Determination Report
February 2005	Annual Post-closure Monitoring Report completed
March 2007	Virginia Solid Waste Management Regulations (VSWMR) Groundwater Monitoring Plan completed
January 2007	LUC RD finalized
February 2008	LTM Site 6 TM completed to document 2007 sampling
October 2008	Second Five-year Review Report
February 2009	LTM Site 6 TM completed to document 2008 sampling
February 2010	LTM Site 6 TM completed to document 2009 sampling
2010	Corrective Action Site Evaluation (CASE) Reported completed
February 2011	LTM Site 6 TM completed to document 2010 sampling
April 2013	Groundwater and HHRA Evaluation TM completed
May 2013	VDEQ Landfill Permit revoked

7.2 Background

7.2.1 Description

Site 6, the CD Landfill, occupies approximately 22 acres located in the central portion of NSN just east of Hampton Boulevard and south of the Naval Exchange, as illustrated on **Figure 2-1**. The site incorporates two areas of landfilling operations; the easternmost (unpermitted) section and the western (permitted) section (**Figure 7-1**).

Disposal of material in the unpermitted (eastern) section of the landfill occurred from 1974 to 1979. In October 1979, the Naval Facilities Engineering Command (NAVFAC) received a permit from VDOH to use the landfill (western portion) for disposal of demolition debris and other non-putrescible wastes, excluding fly ash, incinerator residues, chemicals, and asbestos. Blasting grit used for sandblasting cadmium-plated aircraft parts was deposited at the landfill until 1981 when the blasting grit was tested and found to exceed the USEPA Extraction Procedure (EP) toxicity limit for cadmium. The grit was classified as a hazardous waste and onsite disposal of the material ceased. Landfilling operations continued in the site's western portion of the site. At the time the landfill permit was granted, a portion of the site's southeastern corner was removed and regraded to allow for runway expansion at the NAS. The runway expansion design specified that excess material was to be spread over the landfill and not removed from the site.

In 1993, Seabee Road was constructed over the site and opened to the public. Construction plans required only the addition of fill material; no cutting or grading into the existing landfill occurred. Most of the existing debris mounds situated in the north-central portion of the landfill were leveled and spread around the site to reduce the amount of standing water that accumulated after rain events.

7.2.2 Physical Characteristics

The two drainage ditches were constructed to facilitate runoff of surface water (eventually flowing into Bousch Creek) from the landfill area (Baker, 1998b). Presently, Site 6 is not utilized for any land or resource uses, nor anticipated to change in the near future. Fences encompass both the eastern and western portions of the landfill and along Seabee Road.

The CERCLA investigated surficial geology at Site 6 consists of the Columbia aquifer, Yorktown confining unit, and the Yorktown aquifer. The Columbia and Yorktown aquifers are not used for beneficial use within the vicinity or downgradient of Site 6. The water table is encountered approximately 4 to 6 feet bgs in the unconfined Columbia aquifer (Baker, 1998b). The groundwater flow in the surficial aquifer within the vicinity of Site 6 is varies across the site and is shown on **Figure 7-1**.

A CSM for the site is provided as **Figure 7-2**.

7.2.3 Land and Resource Use

This site is an open vacant field with engineered controls (site fencing, gate, and engineered cap system). Groundwater is not use as a resource in the vicinity of the site. No change in land use is anticipated in the foreseeable future.

7.2.4 History of Contamination

The unpermitted eastern portion operated from 1974 to 1979 and was used for demolition debris, inert solid waste, fly ash, and incinerator residue (CH2M HILL, 2002). The permitted western portion of the landfill was in use until 1987.

Initial Response

Site 6 was first identified as an area of potential contamination in the IAS. A Confirmation Study, Environmental Site Investigation (ESI), and Limited Soils Study guided the scope of the RI completed in 1994. The RI was conducted in three separate rounds of sampling. During each round of sampling, soil, sediment, groundwater, and surface water samples were collected. As a result of the RI Report, an FS was prepared in July 1996 to address

contaminated media at the CD Landfill site. Potential risks to ecological and human health risk associated with contaminants in the soil, sediments, groundwater, and surface water were identified and guided the development and evaluation of the media-specific RA alternatives. In addition to the FS, a separate geostatistical analysis was performed to evaluate and better define the areas of sediment contamination.

The RI (Baker, 1995d) analysis concluded the landfill activities had impacted the surface soil, subsurface soil, sediment, surface water, and shallow groundwater.

In June 1997, the NSN Tier I Partnering Team agreed to an additional sampling event to characterize the landfill material and determine closure requirements. A statistical sampling approach was developed to determine within a specified confidence interval whether the fill material would be classified as hazardous. All of the samples collected and analyzed during the June event were below the regulatory standards. Based on the statistical findings, the fill material at the CD Landfill was not considered a hazardous waste and it was agreed that the site would be closed under the VSWMR for a construction demolition debris landfill.

Site Risk

Potential unacceptable human health and ecological risks were identified due to exposure to site media. The COCs per media are summarized in **Table 7-1**.

7.2.5 Basis for Taking Action

The primary risks to human health and the environment posed by conditions at Site 6 is the landfill debris, which threatens the surround media. Based on the results of previous investigations, RA is warranted to protect public health and welfare from actual or threatened releases of contaminants from the waste.

7.3 Remedial Actions

7.3.1 Remedy Selection

A DD was issued for contaminated sediments (OU1) at the CD Landfill in October 1996 (Baker, 1996d) to reduce the risk to human and ecological receptors. A NTCRA was implemented in the fall of 1997 for the removal and offsite disposal of contaminated sediments that exceeded the ERM levels. As shown on **Figure 7-1**, a partial removal of the contaminated sediments was initiated but not completed. The remaining sediments were addressed during the construction of cap for Site 6.

A PRAP (Baker, 1998a) and ROD (Baker, 1998b) for Site 6 were issued to address the soil and groundwater (OU2) and to extend the cover over the remaining sediment area that was not completed for OU1 (**Figure 7-1**). The purpose of the RA was to reduce hazards to human health and the environment by eliminating exposure to contaminated media. The selected remedy includes an engineered landfill cap, groundwater monitoring program, restricted access to the site, and ICs prohibiting future land and resource uses.

The selected remedies for OU1 and OU2 were implemented to meet the following RAOs:

- Prevent exposure to contaminated sediment by human and ecological receptors.
- Prevent exposure to contamination within the subsurface soil and debris.
- Minimize potential movement of contaminants from soil and debris to groundwater and surface water.
- Minimize direct ecological exposure to the surface soils.
- Prevent potable and non-potable exposure to the shallow groundwater by human receptors.
- Prevent Yorktown aquifer groundwater use for potable purposes.
- Monitor migration of shallow groundwater towards site boundaries and for discharge to surface water.

The DD for OU1 and the ROD for OU2 selected the following LUC objectives at Site 6:

OU1

- Prohibiting residential use of the area.
- Prohibit invasive construction activities in the drainage ditch.

OU2

- Prohibit residential development of the site.
- Prohibit use of the shallow aquifer groundwater beneath the site other than for environmental monitoring and testing.
- Prohibit public access to the site.
- Prohibit any action that would disturb the integrity of the existing landfill cover or function of the monitoring systems.

The LUCs have been implemented and maintained on all land and groundwater within the boundaries of Site 6. The LUCs will be maintained on all media by the Navy until the concentrations of hazardous substances have been reduced to levels that allow for UU/UE.

7.3.2 Remedy Implementation

The RAs completed at Site 6 are summarized below:

- Partial removal and offsite disposal of sediments in the former drainage ditch occurred in the fall of 1997.
- An engineered, geomembrane landfill cap was designed and constructed to VSWMR.
- LUCs are maintained as defined in the RD to maintain the cap and prevent migration of contaminants and potential exposure to receptors.

A NTCRA was implemented in the fall of 1997 for the removal and off-site disposal of contaminated sediments that exceeded the Effect-Range Median (ERM) levels. As shown in **Figure 7-1**, a partial removal of the contaminated sediments was conducted. The remaining sediments were covered during the construction of CD Landfill cap for Site 6. A PRAP (Baker, June 1998a) and ROD (Baker, 1998b) for Site 6 were issued to address the soil and groundwater (OU2) and to extend the cover over the remaining sediment area that was not completed for OU1 (**Figure 7-1**). The purpose of the remedial action was to reduce hazards to human health and the environment by eliminating exposure to contaminated media. The selected remedy includes a landfill cap, monitoring program, restricted access to the site, and ICs prohibiting future land and resource uses

As outlined in the Landfill Closure Certification Report (CH2M HILL, 2000a), construction of the CD Landfill cap was initiated in May 1999 and completed in June 2000. The cap's extent is illustrated on Figure 7-1. Construction began with a final grading of the waste and installation of a 6-inch bedding layer to support the cover material. Following placement of the bedding layer, an impermeable barrier membrane was installed to prevent infiltration of water into the landfill material. A geocomposite drainage layer was also placed to provide adequate drainage of the cover and prevent water pressure from causing slope stability problems. The drainage layer is covered with a minimum of 24 inches of soil. This soil layer consists of 18 inches of material overlain by 6 inches of topsoil to provide adequate nutrients to support the vegetation necessary to prevent erosion of the landfill cover. No venting systems for landfill gas were necessary according to the investigation performed in the Basis of Design for the Landfill Cap CD Landfill (CH2M HILL/Baker/CDM, 1998).

7.3.3 System Operation and Maintenance

O&M at the site consists of periodic mowing of the vegetative cover as well as inspections of the landfill cover and ICs. The inspections are conducted quarterly to ensure the landfill cover, fences, and gates are maintained as defined in the RD.

In accordance with the ROD, Site 6 is part of the LTM program at NSN. The LTM plan for Site 6 required sampling and analysis of groundwater in accordance with VSWMR, Part D of 9 VAC 20-80-270. Baseline groundwater

samples and surface water samples were collected in 2000. Surface water monitoring was ceased after analysis of the initial 2 years of sampling when COC levels dropped below screening criteria. In 2006, the VDEQ, USEPA, and the NAVY addressed concerns of the current groundwater monitoring program to meet the substantive requirements of the VSWMR based upon the groundwater results that had been collected and reported through 2005. As a result of this meeting, a *Groundwater Management Plan for Site 6, CD Landfill* (CH2M HILL, 2007a) was completed and implemented in March 2007. The Groundwater Management Plan (GMP) outlined groundwater monitoring that would be needed in order to complete a CASE report in 2010. The new monitoring program required monitoring of eight wells (MW01B, MW02B, MW03A, MW04A, MW05B, MW06B, MW11AR, and MW12A) on a quarterly basis for the first 2 years of monitoring, then semiannual monitoring for the third year. Ten rounds of data were collected from 2007 to 2009 to produce a CASE report.

The CASE report was submitted in 2010; during this review period groundwater monitoring continued at the site in accordance with the GMP until August 2011. In accordance with team agreement, no additional groundwater monitoring has occurred at the site while the Navy and VDEQ coordinated to close the existing landfill permit to move the site wholly to the CERCLA program (completed May 2013).

7.4 Progress since Last Review

7.4.1 Follow-up Actions since the last Five-year Review

The previous Five-year Review concluded the following:

The landfill cap remedy at Site 6 prevents direct contact with the soil. Supporting inspection information and monitoring data indicate the landfill cap is in good condition. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the cap, LUCs, and the implementation of ICs.

Although the Five-year Review concluded that the remedy is functioning as intended and protective of human health and the environment, issues and recommendations for a follow-up action was identified. **Table 7-2** presents the status of this recommendation and follow-up action.

7.4.2 Action Summary

Long-term Monitoring Data Review

The LTM program included sampling surface water and groundwater for 10 years following the implementation of the ROD. As a requirement of the VSWMR, Part D of 9 VAC 20-80-270, the CD Landfill is currently part of the LTM program at NSN, as described in the system maintenance and operation section (Site 6) of this report. Surface water monitoring was ceased after the first 2 years of sampling when COC levels dropped below screening criteria. The initial 6 years of groundwater monitoring have been completed and are documented in Annual Post-closure Monitoring Reports for each year.

Groundwater monitoring was conducted in accordance with the *Groundwater Management Plan for Site 6, CD Landfill* (CH2M HILL, 2007a) from 2007 to 2011; this plan was finalized to outline the establish a groundwater monitoring program that meets the substantive requirements of the corrective action groundwater monitoring program in accordance with VSWMR. Groundwater monitoring was ceased at the site in accordance with Team agreement while the Navy and VDEQ were coordinating the closure of the landfill permit.

In April 2013, the *Site 6, CD Landfill Human Health Risk Assessment and Piezometer Installation Summary, Naval Station Norfolk, Norfolk, Virginia Technical Memorandum* (CH2M HILL, 2013c) was submitted for regulatory review and approval. The TM included a revised risk assessment completed using the groundwater data collected from 2007 through 2011 at the site and groundwater flow evaluation. The TM concluded the following:

- Potential contact with groundwater by future adult and child residents may result in reasonable maximum exposure (RME) and central tendency exposure (CTE) noncarcinogenic hazards and carcinogenic risks above USEPA's acceptable risk range and hazard level. The noncarcinogenic hazard is primarily associated with

arsenic, cobalt, iron, and manganese. The carcinogenic risk is primarily associated with arsenic, with smaller contributions from chromium and dieldrin.

- The installation of downgradient measuring points MW14 and MW15 indicates a low point in site groundwater elevations at the very eastern end of the site (MW15). The groundwater elevation at MW14 is also lower in elevation than the other two wells (MW05B and MW12A) located on the eastern side of the drainage feature. MW12A has served as a downgradient monitoring well in previous monitoring events. The addition of these measuring points indicates that groundwater flow appears to be to the east and into the direction of the drainage feature, and not toward MW12A. Based upon the revised potentiometric map with water level measurements from MW14 and MW15, MW05B and MW12 are not down gradient monitoring wells for Site 6.

The NSN Team is currently discussing the future groundwater monitoring program for the site. LTM will be documented in a Basewide LTM SAP for outline the groundwater monitoring objectives and strategies for the site.

Site Inspections

Site inspections have been conducted at Site 6 quarterly to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review. The most recent inspection was conducted in April 2013 and no discrepancies were noted.

Remedy Costs

The average remedy costs for maintaining the asphalt/soil cover, conducting LTM, and conducting quarterly site inspections is approximately $15,000 per year. The estimated O&M costs for the selected remedy in the DD and ROD were approximately $14,500 per year; the actual cost for the selected remedy is similar to the cost estimated by the DD and ROD.

7.5 Technical Assessment

Is the remedy functioning as intended by the Decision Documents?

Upon review of historical documents, risk assessments, ARARs, site inspections, and LTM monitoring results, the remedy-in-place (RIP) is functioning as intended by the ROD(s). The stabilization and capping of the landfill and contaminated soil and sediments has achieved the RAOs to minimize migration of contaminants to surface water and groundwater. The ICs implemented have prevented exposure to groundwater by potential receptors.

The LTM conducted at the site will be addressed within the CERCLA program because the solid waste landfill permit has been terminated. An update to the LTM program is in progress via new Basewide LTM Sampling and Analysis Plan for NSN, which is under review by the NSN Tier I Partnering Team concurrent to this Five Year Review. This document will develop the strategy to evaluate the effectiveness of the selected remedy for the site during future Five-year Reviews.

The ICs will continue to be implemented at the site to prohibit the use of groundwater and disturbance to the landfill cap until UU/UE is achieved.

Are the exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affects the protectiveness of the remedy were identified during this Five-year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-year Review. There is no indication that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. A baseline HHRA was performed for Site 6 groundwater in 2012 (documented in the April 1, 2013, TM) using current site data and toxicity values. The HHRA demonstrated that potable use of groundwater by future adult and child residents may still result in RME and CTE noncarcinogenic hazards and carcinogenic risks above USEPA's acceptable risk range and hazard level. The noncarcinogenic hazard is primarily associated with arsenic, cobalt, iron, and manganese. The carcinogenic risk is primarily associated with arsenic, with smaller contributions from chromium and dieldrin. Although there may have been changes in toxicity values, regulatory levels, and risk characteristics for COCs in media other than groundwater at Site 6, these changes would not adversely affect the protectiveness of the selected remedy and were considered during the 2013 TM. Land use restrictions prevent exposure to site media by human receptors.

Sediment cleanup goals were based on ecological criteria, which are lower than the human health risk-based levels. All sediments for which unacceptable ecological risks were identified at Site 6 have been removed or capped, resulting in acceptable risks to ecological receptors from the sediment exposure pathway. The integrity of the cap is maintained by LUCs and quarterly inspections..

Changes in Risk Assessment Methodologies. Although few procedural changes to how a HHRA is conducted have been made since the HHRA was prepared in the RI, none of these changes adversely affect the protectiveness of the selected remedy for Site 6. Additionally, the groundwater HHRA prepared in 2012 to support the TM used current risk assessment methodologies. There have been no major procedural changes in how the ERAs are conducted since the last Five-year Review.

The remedies for Site 6, removal of contaminated sediment, capping the landfill, and land use restrictions remain protective of human health.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the selected remedy.

Technical Assessment Summary

Based on the information presented herein, the remedy for Site 6 is functioning as intended by the ROD containing COCs to prevent exposure and migration of COCs in site media. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the landfill cap and LUCs.

7.6 Issues, Recommendations, and Follow-up Actions Identified

Table 7-3 presents the issues, recommendations, and follow-up actions that have been identified for Site 6 based on this Five-year Review.

7.7 Protectiveness Statement

The landfill cap remedy at Site 6 is protective by preventing direct contact with the soil. Supporting inspection information and monitoring data indicate the landfill cap is in good condition. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the cap and enforcement of LUCs.

TABLE 7-1

Site 6 Remedy Performance Standards

OU	Site	Risk	Media	Reasonably Anticipated Land Use	COC Requiring Action	Basis for Action	RAO	Remedy Component	Site Closeout Strategy	Performance Metric / Cleanup Level*
6 & 7	6	Human and Ecological Health	Landfill debris	Vacant Land	Debris	Waste remains at the site	Prevent exposure to contamination within the subsurface soil and debris Minimize potential movement of contaminants from soil and debris to groundwater and surface water.	Landfill cap and LUCs	Prohibit Intrusive activities in landfill cap	No intrusive activities
		Human Health	Sediment	Vacant Land	Benzo(a)anthracene	HI > 1 ILCR > 1 x 10^{-4}	Prevent exposure to contaminated sediment by human and ecological receptors	Sediment excavation or landfill cap and LUCs	Remove sediment exceeding ER,Ms and prevent intrusive activities into the landfill cap	1.6 mg/kg
					Benzo(b)fluoranthene					11 mg/kg
					Benzo(a)pyrene					1.6 mg/kg
					Chrysene					2.8 mg/kg
					Dibenzo(a,h)anthracene					0.26 mg/kg
					Ideno(1,2,3-cd)anthracene					11 mg/kg
					Dieldrin					0.008 mg/kg
					Arsenic					70 mg/kg
			Groundwater	Potential potable resource	Aroclor-1260	HI > 1 ILCR > 1 x 10^{-4}	Prevent potable and non-potable exposure to the shallow groundwater by human receptors. Prevent Yorktown aquifer groundwater use for potable purposes.	Landfill Cap, LTM, and LUCs	VSWMR closure monitoring for 10 years	[1]0.5 µg/L
					Chlorobenzene					100 µg/L
					Arsenic					10 µg/L
					Antimony					5 µg/L
					Beryllium					4 µg/L
			Soil	Vacant Land	arsenic	HI > 1 ILCR > 1 x 10^{-4}	Prevent exposure to contamination within the subsurface soil and debris. Minimize potential movement of contaminants from soil and debris to groundwater and surface water.	Landfill cap and LUCs	Prohibit Intrusive activities into landfill cap	No intrusive activities; decrease concentration of COCs in groundwater
					beryllium					
					lead					
					manganese					
					antimony					
					cadmium					
					chromium					
					copper					
					Nickel					
					vanadium					
					Zinc					
			Soil	Vacant Land	None defined	None defined	Minimize direct ecological exposure to the surface soils.	Landfill cap and LUCs	Prohibit Intrusive activities in landfill cap	No intrusive activities
			Surface Water	Man-made drainage ditch	dieldrin		Monitor migration of shallow groundwater towards site boundaries and for discharge to surface water.	Landfill cap and LUCs	Prevent intrusive activities into landfill cap	No intrusive activities
					4,4' DDD					
					Cobalt					
					Copper					
					Iron					
					Manganese					
					Nickel					
		Ecological Risk	Sediment	Man-made drainage ditch	Acenaphthylene	Potential ecological risk	Prevent exposure to contaminated sediment by human and ecological receptors	Sediment excavation and LUCs	Remove sediment exceeding ER,Ms and prevent intrusive activities.	0.64 mg/kg
					Acenaphthene					0.5 mg/kg
					Anthracene					1.1 mg/kg
					Benzo(a)anthracene					1.6 mg/kg
					Benzo(a)pyrene					1.6 mg/kg
					Chrysene					2.8 mg/kg
					Dibenz(a,h)anthracene					0.26 mg/kg
					Fluorene					0.54 mg/kg
					Fluoranthene					5.1 mg/kg
					2-Methylnapthalene					0.67 mg/kg
					Napthalene					2.1 mg/kg
					Phenanthrene					1.5 mg/kg
					Pyrene					2.6 mg/kg
					4,4-DDD					0.02 mg/kg
					4,4-DDE					0.027 mg/kg
					4,4-DDT					0.007 mg/kg
					Alpha-chlordane					0.006 mg/kg
					Gamma-chlordane					0.006 mg/kg
					Dieldrin					0.008 mg/kg
					Total PCBs					0.18 mg/kg
					Arsenic					70 mg/kg
					Cadmium					9.6 mg/kg
					Chromium					370 mg/kg
					Copper					270 mg/kg
					Lead					218 mg/kg
					Mercury					0.71 mg/kg
					Nickel					51.6 mg/kg
					Silver					3.7 mg/kg
					Zinc					410 mg/kg

Notes:

[1]Clean up level based on total PCBs

Acronyms:

COC - contaminant of concern

DDD - dichloroethene

DDE -

DDT -

HI - hazard index

ILCR - incremental lifetime cancer risk

LTM - long-term monitoring

LUC - land use control

mg/kg - milligram per kilogram

OU - operable unit

PCB - polychlorinated biphenyl

RAO - remedial action objective

VSWMR - Virginia Solid Waste Management Regulations

TABLE 7-2

Site 6 Action Item Progress from 2008 Five-Year Review

Issue from Second Five-Year Review Report							
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**		**Status - June 2013**	
				Current	**Future**	**Action Taken and Outcome**	**Date of Action**
Trees within the landfill along SeaBee Road and had impacted the integrity of the landfill cap.	The landfill cap was repaired and documented in October, 2006. Continued improvement of the facility's site approval process prior to site disturbance is recommended.	Navy, USEPA, VDEQ	October 2006	Current	Future	The holes were repaired as documented in October 2006. Navy use of the Environmental Checklist is standard procedure to prevent future occurrence.	Oct-06

Acronyms:

USEPA - United States Environmental Protection Agency

VDEQ - Virginia Department of Environmental Quality

TABLE 7-3

Issues, Recommendations and Follow-up Actions for Site 6

Action Requiring Follow-Up from Third Five-Year Review Report					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
None					
Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
The existing fencing and gates are in poor condition and require maintenance.	Repair fencing and gates and continue to inspect the site during quarterly site inspections. Report any discrepancies to the NSN Tier I Partnering Team.	Navy, USEPA, and VDEQ	NA	No	No
Debris (tires) has been observed at the site during several site visits. The Navy currently working on removing all surficial debris from the site.	Remove miscellaneous debris and continue to inspect the site during quarterly site inspections. Report any discrepancies to the NSN Tier I Partnering Team.	Navy, USEPA, and VDEQ	NA	No	No
Groundwater monitoring program is transitioning to wholly CERCLA (ROD defined groundwater monitoring as following the VSWMR). Additionally, no exit strategy to cease groundwater monitoring is defined.	Discuss cleanup goals with the NSN Tier I Partnering Team to establish appropriate cleanup goals for groundwater and an exit strategy to cease LTM (as appropriate and based upon waste remaining in place) at Site 6.	Navy, USEPA, and VDEQ	NA	No	No

Acronyms:

CERCLA - Comprehensive Enviromental Reclamation, Compensation, and Liability Act

NA - not applicable

NSN - Naval Station Norfolk

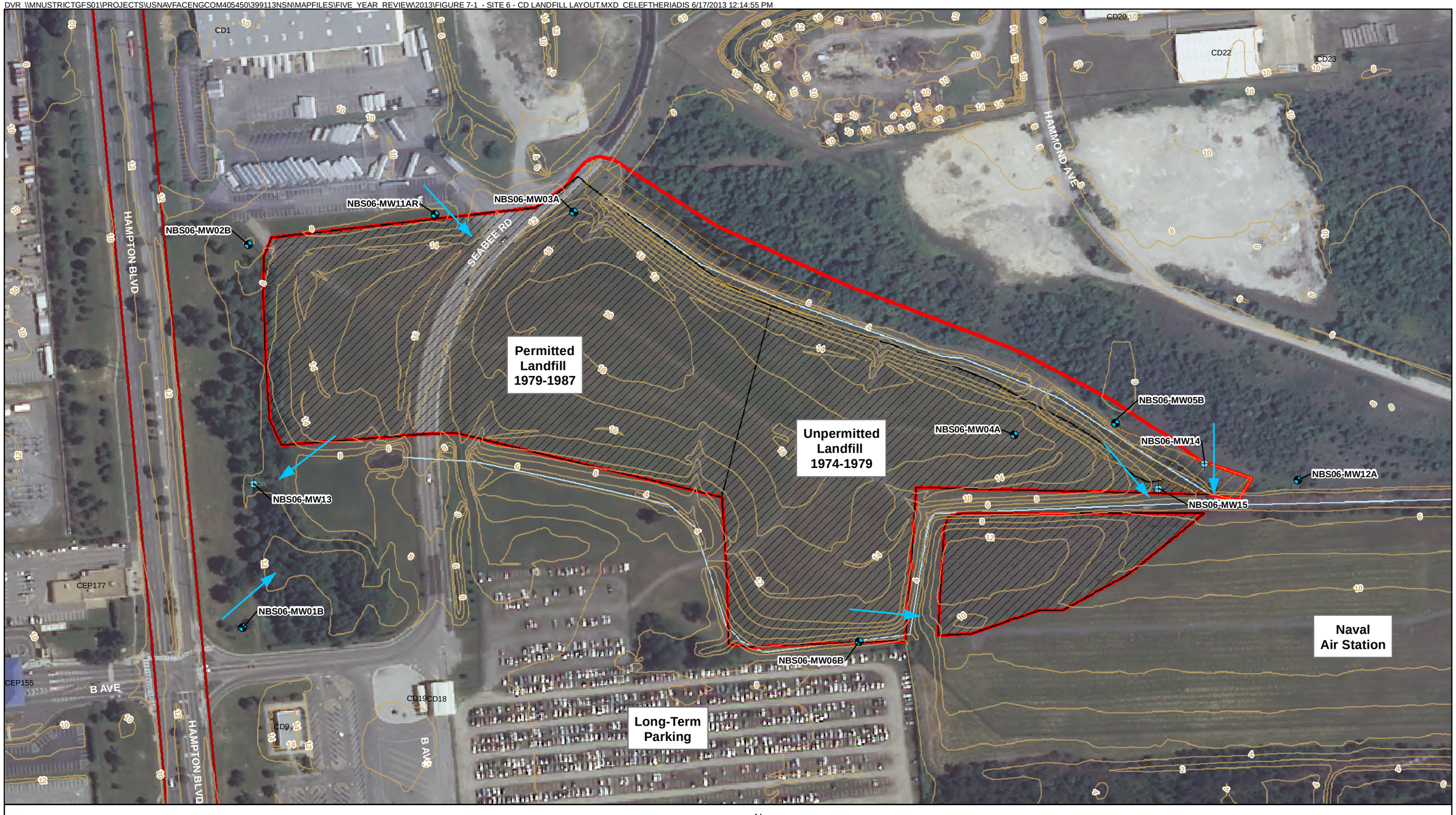
ROD - Record of Decision

USEPA - United States Environmental Protection Agency

VDEQ - Virginia Department of Environmental Quality

VSWMR - Virginia Solid Waste Management Regulations

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 7-1 - SITE 6 - CD LANDFILL LAYOUT.MXD CELEFTHERIADIS 6/17/2013 12:14:55 PM



Legend

- Existing Monitoring Well
- New Piezoemeter/Monitoring Well
- Topographic Contour (2ft Interval)
- Groundwater Flow Direction (2013)
- Areas of Sediment Removal
- Engineered Landfill Cover
- Installation Boundary
- Land Use Control Area (2007)
- Drainage Ditch

N
W E
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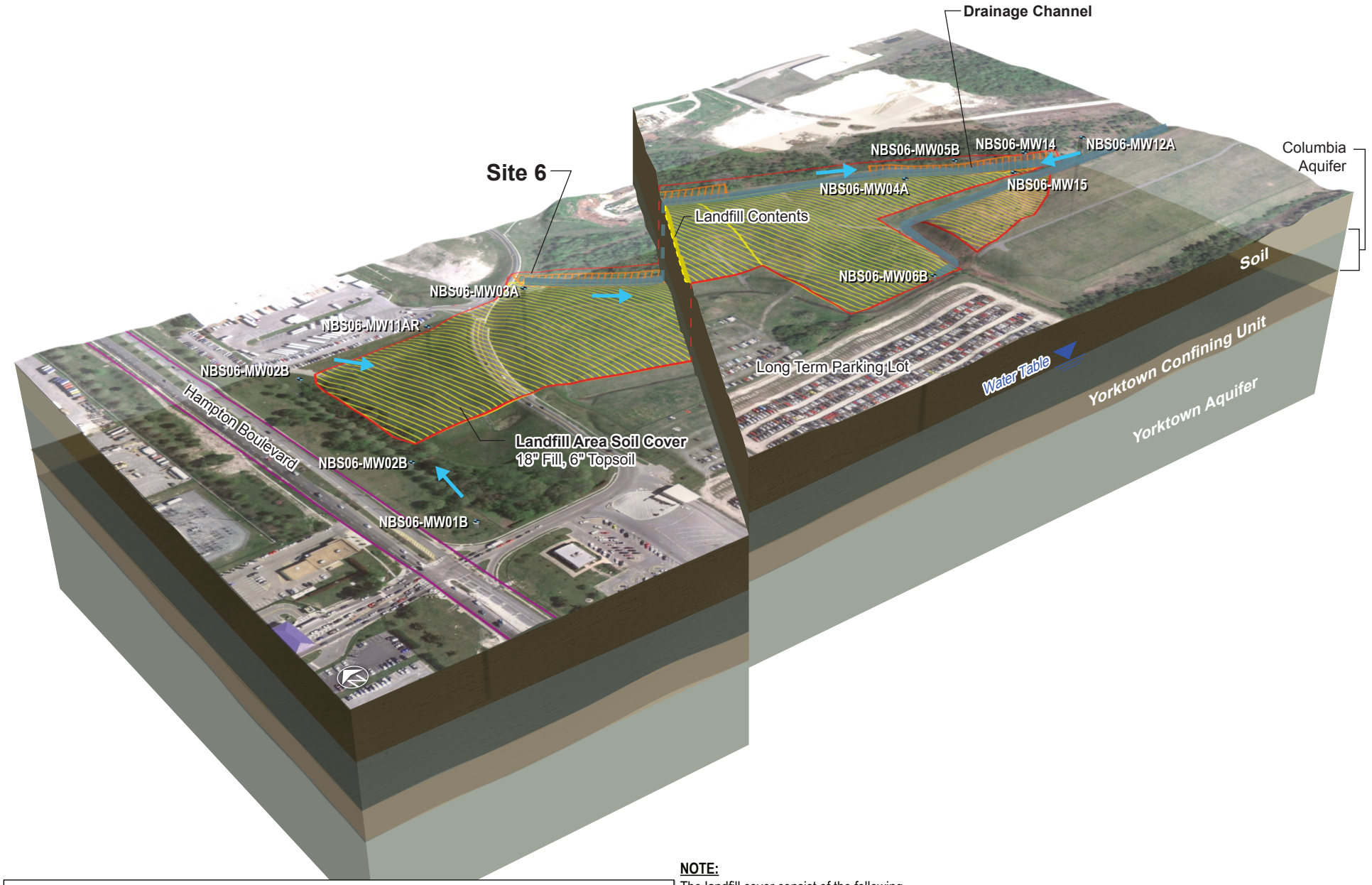
0 200 400 Feet

Reference: 2008 Aerial Photography

Figure 7-1
Site 6 - CD Landfill Layout
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL



LEGEND

- Land Use Control Area Boundary
- Area of Sediment Removal
- Landfill Cover
- Installation Boundary
- Monitoring Well
- Estimated Groundwater Flow Direction
- Surface Water Feature

NOTE:

The landfill cover consist of the following (from the bottom of the cover to the ground surface):

1. 6-inch bedding layer
2. Impermeable barrier
3. Geocomposite drainage layer
4. 18 inches of fill material
5. 6 inches of topsoil

FIGURE 7-2

Conceptual Site Model, Site 6

Naval Station Norfolk

Norfolk, Virginia

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 7-3 - SITE 6 - DISTRIBUTION OF GROUNDWATER CONTAMINANTS.MXD CELEFTHERIADIS 8/9/2013 12:45:41 PM

Station ID	NBS06-MW11AR	
Sample ID	NBS06-MW11AR-07A	NBS06-MW11AR-11B
Sample Date	03/06/07	06/29/11
Volatile Organic Compounds (UG/L)		
Chlorobenzene	0.4 U	0.2 U
Pesticide/Polychlorinated Biphenyls (UG/L)		
Aroclor-1260	0.526 U	NA
Dieldrin	**0.0228 J**	**0.0075 J**
Total Metals (UG/L)		
Antimony	0.3 U	30 U
Arsenic	**2**	5 U
Beryllium	0.5 U	1 U
Chromium	**3.4**	3 U
Cobalt	**0.7 J**	2 U
Iron	NA	40 U
Manganese	NA	**370**

Station ID	NBS06-MW03A	
Sample ID	NBS06-MW03A-07A	NBS06-MW03A-11B
Sample Date	03/06/07	06/30/11
Volatile Organic Compounds (UG/L)		
Chlorobenzene	0.4 U	0.2 U
Pesticide/Polychlorinated Biphenyls (UG/L)		
Aroclor-1260	0.538 U	NA
Dieldrin	0.0538 U	**0.0062 J**
Total Metals (UG/L)		
Antimony	0.3 U	30 U
Arsenic	**2.1**	5 U
Beryllium	0.5 U	1 U
Chromium	**2.9**	3 U
Cobalt	**0.9 J**	2 U
Iron	NA	**344**
Manganese	NA	**886**

Station ID	NBS06-MW05B	
Sample ID	NBS06-MW05B-07A	NBS06-MW05-11B
Sample Date	03/05/07	06/29/11
Volatile Organic Compounds (UG/L)		
Chlorobenzene	0.4 U	0.2 U
Pesticide/Polychlorinated Biphenyls (UG/L)		
Aroclor-1260	0.562 U	NA
Dieldrin	0.0562 U	0.01 U
Total Metals (UG/L)		
Antimony	**0.5 J**	30 U
Arsenic	**2.6**	5 U
Beryllium	0.5 U	1 U
Chromium	**3.3**	3 U
Cobalt	**0.5 J**	2 U
Iron	NA	**2,320**
Manganese	NA	**656**

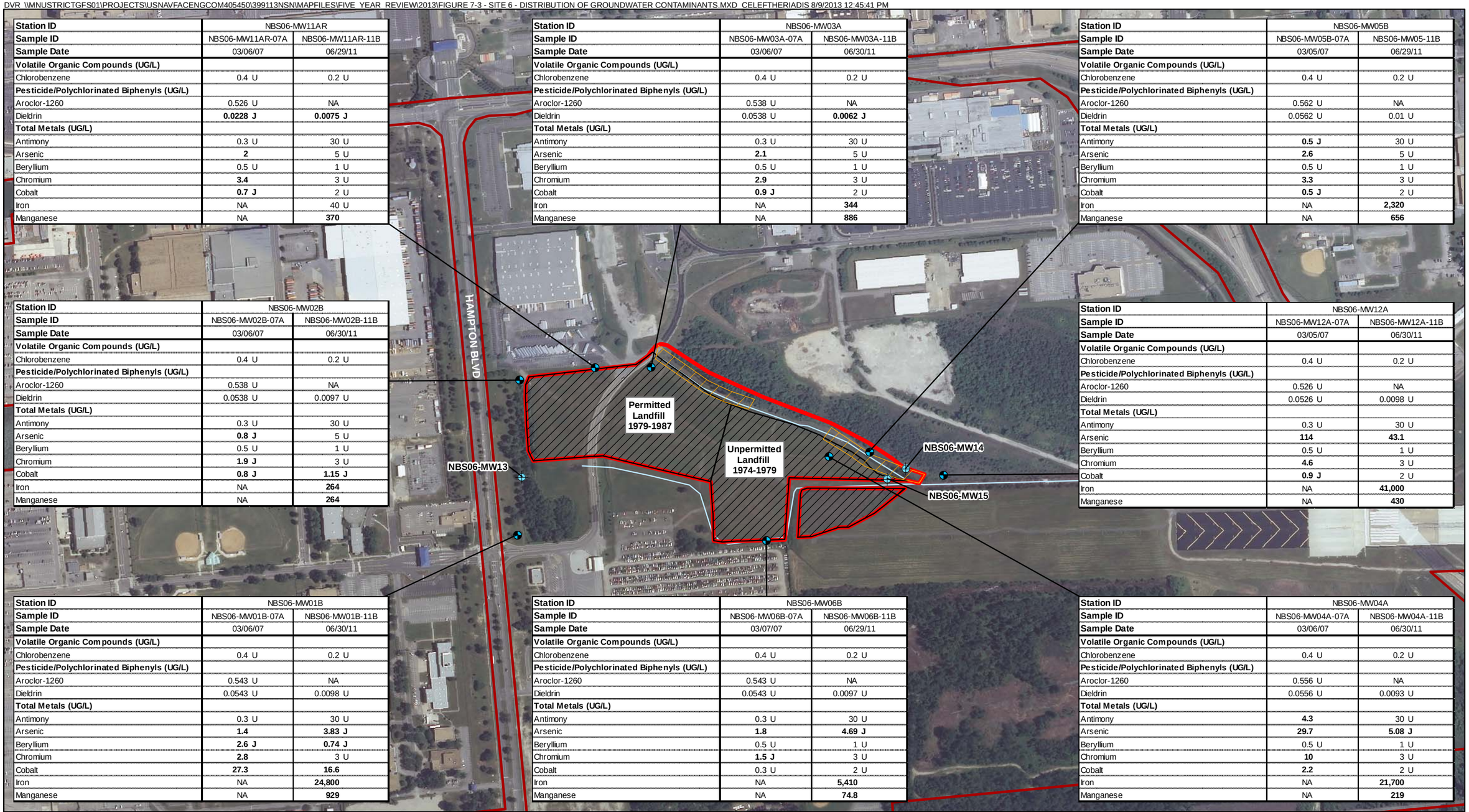
Station ID	NBS06-MW02B	
Sample ID	NBS06-MW02B-07A	NBS06-MW02B-11B
Sample Date	03/06/07	06/30/11
Volatile Organic Compounds (UG/L)		
Chlorobenzene	0.4 U	0.2 U
Pesticide/Polychlorinated Biphenyls (UG/L)		
Aroclor-1260	0.538 U	NA
Dieldrin	0.0538 U	0.0097 U
Total Metals (UG/L)		
Antimony	0.3 U	30 U
Arsenic	**0.8 J**	5 U
Beryllium	0.5 U	1 U
Chromium	**1.9 J**	3 U
Cobalt	**0.8 J**	**1.15 J**
Iron	NA	**264**
Manganese	NA	**264**

Station ID	NBS06-MW12A	
Sample ID	NBS06-MW12A-07A	NBS06-MW12A-11B
Sample Date	03/05/07	06/30/11
Volatile Organic Compounds (UG/L)		
Chlorobenzene	0.4 U	0.2 U
Pesticide/Polychlorinated Biphenyls (UG/L)		
Aroclor-1260	0.526 U	NA
Dieldrin	0.0526 U	0.0098 U
Total Metals (UG/L)		
Antimony	0.3 U	30 U
Arsenic	**114**	**43.1**
Beryllium	0.5 U	1 U
Chromium	**4.6**	3 U
Cobalt	**0.9 J**	2 U
Iron	NA	**41,000**
Manganese	NA	**430**

Station ID	NBS06-MW01B	
Sample ID	NBS06-MW01B-07A	NBS06-MW01B-11B
Sample Date	03/06/07	06/30/11
Volatile Organic Compounds (UG/L)		
Chlorobenzene	0.4 U	0.2 U
Pesticide/Polychlorinated Biphenyls (UG/L)		
Aroclor-1260	0.543 U	NA
Dieldrin	0.0543 U	0.0098 U
Total Metals (UG/L)		
Antimony	0.3 U	30 U
Arsenic	**1.4**	**3.83 J**
Beryllium	**2.6 J**	**0.74 J**
Chromium	**2.8**	3 U
Cobalt	**27.3**	**16.6**
Iron	NA	**24,800**
Manganese	NA	**929**

Station ID	NBS06-MW06B	
Sample ID	NBS06-MW06B-07A	NBS06-MW06B-11B
Sample Date	03/07/07	06/29/11
Volatile Organic Compounds (UG/L)		
Chlorobenzene	0.4 U	0.2 U
Pesticide/Polychlorinated Biphenyls (UG/L)		
Aroclor-1260	0.543 U	NA
Dieldrin	0.0543 U	0.0097 U
Total Metals (UG/L)		
Antimony	0.3 U	30 U
Arsenic	**1.8**	**4.69 J**
Beryllium	0.5 U	1 U
Chromium	**1.5 J**	3 U
Cobalt	0.3 U	2 U
Iron	NA	**5,410**
Manganese	NA	**74.8**

Station ID	NBS06-MW04A	
Sample ID	NBS06-MW04A-07A	NBS06-MW04A-11B
Sample Date	03/06/07	06/30/11
Volatile Organic Compounds (UG/L)		
Chlorobenzene	0.4 U	0.2 U
Pesticide/Polychlorinated Biphenyls (UG/L)		
Aroclor-1260	0.556 U	NA
Dieldrin	0.0556 U	0.0093 U
Total Metals (UG/L)		
Antimony	**4.3**	30 U
Arsenic	**29.7**	**5.08 J**
Beryllium	0.5 U	1 U
Chromium	**10**	3 U
Cobalt	**2.2**	2 U
Iron	NA	**21,700**
Manganese	NA	**219**



Legend

- New Piezoemeter/Monitoring Well
- Existing Monitoring Well
- Groundwater Flow Direction (2013)
- Areas of Sediment Removal
- Soil Cap - Remedial System Caps/Covers
- Installation Boundary
- Land Use Control Area (2007)
- Drainage Ditch

Bold text indicates detections
B - Analyte not detected above the level reported in blanks
J - Analyte present, value may or may not be accurate or precise
K - Analyte present, value may be biased high, actual value may be lower
L - Analyte present, value may be biased low, actual value may be higher
NA - Not analyzed
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
UL - Analyte not detected, quantitation limit is probably higher
UG/L - Micrograms per liter

N W E S

0 500 1,000 Feet

Reference: 2008 Aerial Photography

Figure 7-3
Distribution of Groundwater Contaminants
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 8

Site 18 – Former Naval Magazine Storage Area

8.1 Chronology

The following is the chronology of the major site events for Site 18, Former NM Storage Area:

1975-1979	Site used to store drums hazardous waste
July 1979	Intentional spill of hazardous waste
October 1980	Landfill permit obtained from the Virginia Department of Solid Waste
1980-1985	Landfill Permit Monitoring
October 1985	Landfill Permit Monitoring Discontinued
1995	RCRA Inspection and Phase I RRR Study completed
April 1997	NSN placed on the NPL
June 2001	Supplemental Investigation completed for groundwater under CERCLA
December 2002	Expanded Site Inspection
November 2007	SI Summary Report Completed (CH2M HILL, 2007g)
July 2008	NTCRA for groundwater Completed
May 2010	Supplemental NTCRA for groundwater Completed
June 2010	PP
August 2010	ROD and Interim Remedial Action Completion Report (IRACR) Signature; LUC RD Finalized
April 2013	Performance Monitoring Completed

8.2 Site Background

8.2.1 Site Description

Site 18—Former NM Storage Area, is located in the southeastern corner of NSN (**Figure 2-1**). The Site was used from 1975 to 1979 to store drums of hazardous waste consisting of waste oil, metal-plating solutions and sludges, chlorinated organic acids (including TCE and 1,1,1-TCA), and paint-stripping solutions. The storage area was an open, unpaved yard east of the metal storage buildings in the NM area (Taussig Can Area).

8.2.2 Physical Characteristics

The Columbia aquifer at Site 18 consists of fine to coarse-grained sands with minor amounts of silt, gravel layers, and shell hash. Depth to water is typically 3.5 to 7 feet bgs. The Yorktown confining unit is at 22 to 35 feet bgs throughout the site. The Yorktown aquifer below the confining unit consists of fine to coarse-grained sands with some interbedded shell hash and thin clay layers. Groundwater in the Columbia aquifer flows north-northeast through the site toward the drainage channel located immediately north of the site boundary (**Figure 8-1**). The hydraulic gradient is low across the site (estimated to be less than 0.005 foot per foot). A drainage channel, located just north of the site, is the discharge point for the shallow groundwater flowing to the northeast from the site. A site conceptual model is provided as **Figure 8-2**.

8.2.3 Land and Resource Use

This site is an open vacant field with engineered controls (posted sign). Groundwater is not use as a resource in the vicinity of the site. No change in land use is anticipated in the foreseeable future.

8.2.4 History of Contamination

Waste oil and hazardous wastes were spilled in this area, including an intentional spill in July 1979. As a result of this spill, a pit was excavated and an existing drainage ditch was widened and lengthened to channel the waste oil and contaminated runoff into an unlined pit. Oil and contaminated water were periodically pumped from the pit

and transported to a wastewater treatment plant (WWTP). Soil in the area of the spill was sampled and found to be contaminated primarily with chromium and cadmium. However, the soil was classified nonhazardous based on USEPA EP toxicity testing.

A landfill permit was obtained in October 1980 from the Virginia Department of Solid Waste to address the contaminated soil at the site by grading and seeding it to establish a vegetative cover. The permit required continuous monitoring of the shallow groundwater and surface water to determine if contaminant migration was occurring (ESE, 1983). The monitoring program was conducted over 55 months. In October 1985, the Virginia State Water Control Board agreed to discontinue the monitoring on the basis that no significant contamination was observed.

Initial Response

In 2000, the Navy, USEPA, and VDEQ agreed to reevaluate Site 18 soil by comparing the Phase I RRR soil data to risk-based screening criteria. On the basis of this review, the Navy, USEPA, and VDEQ that no addition investigation of was soil was warranted and agreed to undertake a groundwater investigation at the site. Additional investigation indicated the shallow groundwater was contaminated with VOCs and metals. The results of groundwater investigation at Site 18 were compiled in the *Final Site 18 Site Investigation Summary Report* (CH2M HILL, 2007g). This report recommended that an EE/CA be completed to evaluate NTCRA alternatives for the treatment of VOCs in groundwater.

In April 2008, an Action Memorandum (CH2M HILL, 2008b) was completed to authorize the implementation of the NTCRA to address the potential human health risk from groundwater, which was completed in July 2008. The NTCRA provided for the injection of a substrate into the groundwater to promote enhanced reductive dechlorination (ERD) of the VOCs in groundwater. Performance monitoring was completed for 1 year following the substrate injection. The last round of performance monitoring indicated contamination levels that still exceeded cleanup goals in the shallow groundwater; therefore, the NSN Partnering Team agreed to re-inject substrate into the shallow aquifer to encourage further ERD. This action was documented in a Removal Action Memorandum Addendum in April 2010 (CH2M HILL, 2010), and the supplemental injections were completed in May 2010.

Site Risks

Potential unacceptable risks to human health were identified to groundwater at the site (**Table 8-1**).

The conclusions of the ecological risk evaluation were based upon a qualitative assessment using conservative screening values. No unacceptable risk was identified for ecological receptors due to site-related contaminants above background levels.

8.2.5 Basis for Taking Action

In 2010, a ROD for Site 18 was completed, which required the shallow groundwater aquifer at the site be treated to reduce the threat to human health. The Selected Remedy documented in the ROD for Site 18 is necessary to protect public health, welfare, and the environment from exposure to hazardous substances in the groundwater.

8.3 Remedial Actions

8.3.1 Remedy Selection

The ROD identified the risks to the human health, established the RAO, and defined the selected remedy. The selected remedy for Site 18 includes continued enhances bioremediation, LTM, and LUCs to meet the following RAO:

- Eliminate potential unacceptable human health risk associated with exposure to chlorinated VOCs in groundwater.

The LUC RD identifies the following LUC objectives:

- Prohibit digging into or disturbance of the site
- Prohibit the withdrawal of groundwater for purposes other than environmental monitoring
- Prohibit construction of new buildings without further evaluation of potential VI risks and/or implementation of mitigation measures

The LUC restrictions have been implemented as detailed in the RD for LUCs at Site 18. The LUCs will be maintained on all land and groundwater within the boundaries of Site 18 (**Figure 8-1**). The LUCs will be maintained until the concentrations of hazardous substances in the groundwater has been reduced to levels that allow for UU/UE.

8.3.2 Remedy Implementation

In April 2008, a NTCRA provided for the injection of a substrate into the groundwater to promote enhanced reductive dechlorination (ERD) of the VOCs in groundwater subsequently followed by performance monitoring conducted for 1 year following the substrate injection. The last round of performance monitoring indicated contamination levels remained in exceedance of the cleanup goals in the shallow groundwater; therefore, the NSN Partnering Team agreed to re-inject substrate into the shallow aquifer to encourage further ERD; supplemental injections were completed in May 2010 followed by performance monitoring conducted from June 2010 to April 2013.

In accordance with the ROD, Site 18 will be included in the LTM program for NSN. The NSN Team is currently discussing a path forward for the site following the conclusion of the second injection performance monitoring period for data collected in 2012 and 2013.

8.3.3 System Operation and Maintenance

Minimal site maintenance is required for Site 18; quarterly site inspections are completed to monitor the condition of site monitoring wells, signs, and evidence of intrusive activities.

8.4 Progress since Last Review

8.4.1 Follow-up Action Since the last Five-year Review

This is the first Five-year Review for Site 18.

8.4.2 Action Summary

Performance Monitoring Groundwater Review

Since the signature of the ROD in August 2010, performance monitoring has been conducted at the site for site COCs and natural attenuation indicator parameters as defined in the Site 18 Sampling and Analysis Plan (JVII, 2008). The performance monitoring period recently concluded in April 2013. The detected COPC concentrations of performance monitoring rounds conducted from 2010 – 2013 with clean-up goal exceedances are shown on **Figure 8-3.** Only VC is detected in exceedance of the established cleanup goal at three site monitoring wells as of April 2013. No other COPCs were detected above respective cleanup goals.

The NSN Team is currently discussing the future groundwater monitoring program for the site. LTM will be documented in a Basewide LTM SAP for outline the groundwater monitoring objectives and strategies for the site.

Site Inspections

Site inspections have been conducted at Site 18 quarterly to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review. The most recent inspection was conducted in April 2013. No discrepancies were noted.

Remedy Costs

The average remedy costs for conducting performance monitoring and conducting quarterly site inspections is approximately $20,000 per year. The estimated O&M costs for the selected remedy in the ROD were approximately $8,900 per year; however, the site has yet to transition into the LTM program for NSN. It is anticipate the actual remedy cost will be approximately the same as the estimated amount documented by the ROD in the near future.

8.5 Technical Assessment

Is the remedy functioning as intended by the Decision Documents?

Upon review of historical documents, SIs, ESIs, ARARs, and site inspections, the selected remedy and LUCs are functioning as intended by the ROD. Continued enhanced bioremediation, groundwater monitoring, and LUCs has achieved the RAOs to prevent exposure by potential receptors. The LUCs implemented have prohibited digging into or disturbance of the site and the withdrawal of groundwater for purposes other than environmental monitoring.

LUCs will continue to be implemented until site conditions allow for UU/UE.

Groundwater monitoring results from 2011 and 2012 indicate VC is still present above the established cleanup goals in a limited number of monitoring wells.

Are the exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affects the protectiveness of the remedy were identified during this Five-year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-year Review. Continued implementation of the LUCs prevent any exposure to groundwater.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been several changes in toxicity values, regulatory levels, and risk characteristics of some constituents detected and some of the COPCs at Site 18 since completion of the screening HHRA included in the Final Expanded SI, these changes would not adversely affect the protectiveness of the selected remedy as it would not substantially change the results of the risk assessment, the cleanup goals (MCLs), or the effectiveness of the remedy (bioremediation, groundwater monitoring and LUCs). The cleanup goals for the COCs are MCLs, and these values have not changed since presented in the Expanded SI or the ROD.

Since the signature of the ROD, risk-based screening levels for evaluating human health risks associated with exposure to 1,4-dioxane were established. 1,4-dioxane is a stabilizer that was commonly used in chlorinated solvents including 1,1,1-TCA[5], reportedly stored at the site. Groundwater samples collected at Site 18 in 2012 were analyzed for 1,4-dioxane; however, the reporting limits ranged from 10 µg/L to 100 µg/L, exceeding the November 2012 RSL of 0.67 µg/L. It should also be noted 1,1,1-TCA has never been detected within any media at the site during ERP investigations. Although the presence of 1,4-dioxane is unknown at Site 18, it can be reasonably expected that the existing remedy would be adequate to protect human health and the environment from potential risks associated with this constituent under future land use conditions, and the lack of 1,1,1-TCA detected in any media at Site 18 makes the presence of this contaminant unlikely. Additional changes to RSL values of other constituents have been made during this Five-year Review period; however, these changes do not impact the protectiveness of the remedy.

[5] Although the site history indicates 1,1,1-TCA was stored at the site, 1,1,1-TCA has never been detected in any media at Site 18 during investigations conducted under the ERP.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how HHRAs and ERAs are conducted, none of these changes adversely affect the protectiveness of the selected remedy for Site 18.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the selected remedy.

Technical Assessment Summary

Based on the information presented herein, the remedy for Site 18 is functioning as intended by the ROD containing COCs to prevent exposure and migration of COCs in site media. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the landfill cap and LUCs.

8.6 Issues, Recommendations, and Follow-up Actions Identified

There are no issues, recommendations, and follow-up actions related to the protectiveness of the remedy that have been identified for Site 18 based on this Five-year Review (the first Five-year Review for Site 18).

8.7 Protectiveness Statement

The remedy at Site 18 is protective by preventing direct contact with the groundwater. Supporting inspection information and monitoring data indicate bioremediation of the groundwater has reduced COC concentrations for all COCs with the exception of VC at two site monitoring wells. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through the enforcement of LUCs.

TABLE 8-1

Site 18 Remedy Performance Standards

OU	Site	Risk	Media	Reasonably Anticipated Land Use	COPC Requiring Action	Basis for Action	RAO	Remedy Component	Site Closeout Strategy	Performance Metric / Cleanup Level*
14	18	Human Health	Groundwater	Vacant Field	cis-1,2-DCE	Concentration > MCL	Eliminate potential unacceptable human health risk associated with exposure to chlorinated VOCs in groundwater.	Continued Enhanced Bioremediation, LTM, and LUCs	Conduct LTM and enforce LUCs until each groundwater COC is at or below its respective cleanup level	70 µg/L
					1,1-DCE	Concentration > MCL				7 µg/L
					TCE	Concentration > MCL				5 µg/L
					Vinyl Chloride	Concentration > MCL				2 µg/L

Acronyms:
COC - contaminant of concern
DCE - dichloroethene
ILCR - incremental lifetime cancer risk
LTM - long-term monitoring
LUC - land use control
µg/L - micrograms per liter
OU - operable unit
RAO - remedial action objective
TCE - trichloroethene

TABLE 8-2

Issues, Recommendations and Follow-up Actions for Site 18

Action Requiring Follow-Up from Third Five-Year Review Report					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
None					
Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
No exit strategy to cease groundwater monitoring is defined.	Discuss groundwater monitoring data with the NSN Tier I Partnering Team to establish an exit strategy for groundwater LTM.	Navy, USEPA, and VDEQ	NA	No	No

Acronyms:

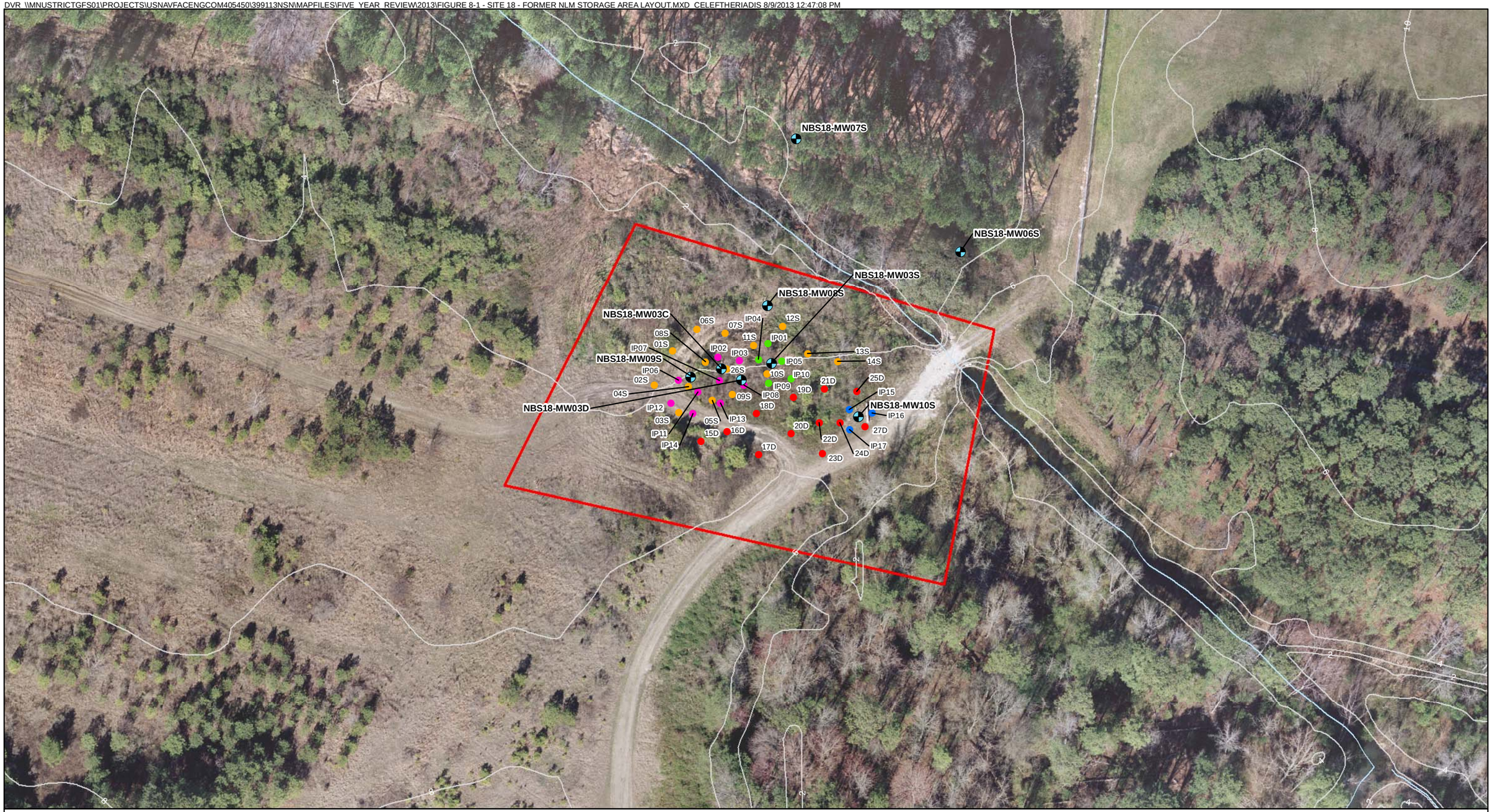
LTM - long-term monitoring

NA - not applicable

USEPA - United States Environmental Protection Agency

VDEQ - Virginia Department of Environmental Quality

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 8-1 - SITE 18 - FORMER NLM STORAGE AREA LAYOUT.MXD CELEFTHERIADIS 8/9/2013 12:47:08 PM



Legend

- Monitoring Well
- 2010 Supplemental DPT Injection Location (16 to 22 feet below ground surface)
- 2010 Supplemental DPT Injection Location (3 to 13 feet below ground surface)
- 2010 Supplemental DPT Injection Location (7 to 14 feet below ground surface)
- 2008 DPT Injection Location (6 to 16 feet below ground surface)
- 2008 DPT Injection Location (12 to 22 feet below ground surface)
- Topographic Contour (2ft Interval)
- Drainage Channel
- Land Use Control Area

N
W E
S

0 60 120
Feet

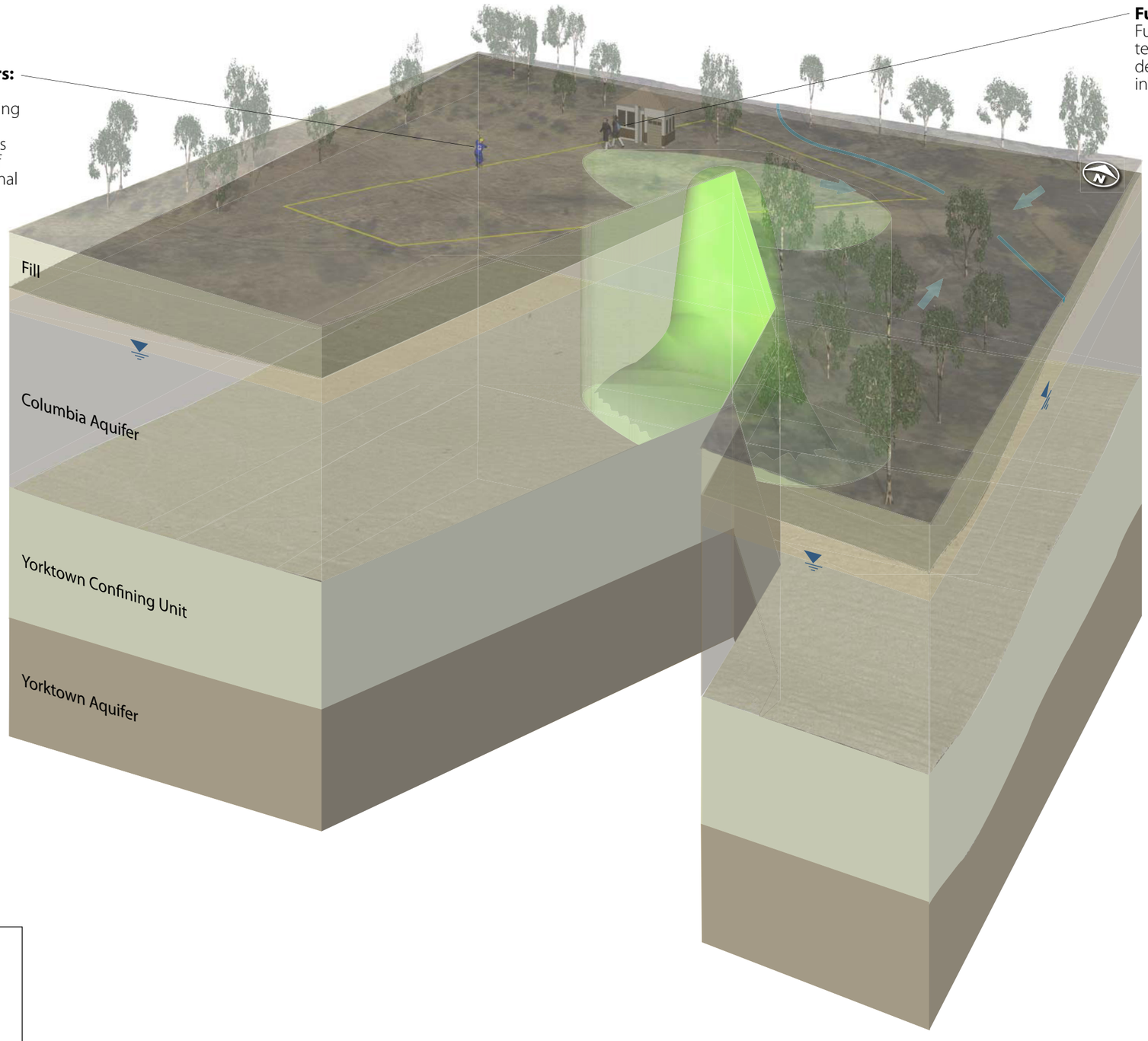
Reference: 2008 Aerial Photography

Figure 8-1
Site 18 - Former NMStorage Area Layout
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

Future Construction Workers:
Future construction workers in contact with groundwater during construction or excavation activities. Construction workers could be exposed as a result of inhalation of volatiles and dermal contact with groundwater.

Future Residents:
Future residents exposed to groundwater through ingestion of potable water, dermal contact while bathing, and inhalation of VOCs while showering



LEGEND

- Groundwater Flow
- Water Table
- Site Boundary

FIGURE 8-2
Site 18 Conceptual Site Model
Naval Station Norfolk
Norfolk, Virginia

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 8-3 - SITE 18 - PERFORMANCE MONITORING CLEANUP GOAL EXCEEDANCES 2010-2013.MXD CELEFTHERIADIS 8/9/2013 12:50:55 PM

Monitoring Well	MW09S								
Sample Date	03/04/10	06/28/10	11/11/10	02/01/11	05/17/11	02/13/12	08/07/12	11/28/12	04/04/13
1,1-DCE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	2.5 U
cis-1,2-DCE	1.9	1.62	3.48	2.46 J	2.44	3.91	9.3	2.95 J	2.5 U
TCE	0.66	0.408 J	0.395 J	0.563 J	0.267 J	0.45 J	2.5 U	2.5 U	2.5 U
vinyl chloride	35	5.64	3.71	3.02 J	6.25	6.95	66.1	41.6	40.8

Monitoring Well	MW03S								
Sample Date	03/04/10	06/28/10	11/11/10	02/01/11	05/17/11	02/13/12	08/07/12	11/28/12	04/04/13
1,1-DCE	0.5 U	0.37 J	0.775 J	0.5 U	0.933 J	0.5 U	2.5 U	2.5 U	2.5 U
cis-1,2-DCE	3.9	14.3	73.1	1.58	206 J	0.46 J	75	3.5 J	4.3 J
TCE	1	1.1	4.66	0.479 J	11.2	0.5 U	3.75 J	2.5 U	2.5 U
vinyl chloride	4.9	49.3	128	6.45	87.7 J	0.75 J	60.6	4.8 J	5.15

Monitoring Well	MW10S								
Sample Date	03/04/10	06/28/10	11/11/10	02/01/11	05/17/11	02/13/12	08/07/12	11/28/12	04/04/13
1,1-DCE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,2-DCE	10	10.4	4.97	6.8	14.5 J	6.2	9.52	6.32	7.13
TCE	0.48 J	2.66	2.09	3.44	5.41 J	2.35	2.16	2.37	2.53
vinyl chloride	2.4	3.78	0.362 J	0.5 U	0.5 U	0.48 J	1.31	0.49 J	5.11

NBS18-MW06S
NBS18-MW08S
NBS18-MW03D
NBS18-MW03C
NBS18-MW02S
NBS18-MW05S
NBS18-MW01S
NBS18-MW04S

Chemical Name	MCL (UG/L)
1,2-dichloroethene (1,1-DCE)	70
cis-1,2-dichloroethene (cis-1,2-DCE)	7
trichloroethene (TCE)	5
vinyl chloride (VC)	2

Legend

- Monitoring Well
- Drainage Channel
- Drainage Channel Flow
- LUC Boundary

Notes:
Shading indicates exceedance of MCLs
Bold indicates detections
J - Analyte present, value may or may not be accurate or precise
U - The material was analyzed for, but not detected
All results are reported in UG/L - Micrograms per liter

N
W E
S

0 60 120
Feet

Figure 8-3
Site 18 -Performance Monitoring Cleanup Goal Exceedances, 2010-2013
Naval Station Norfolk
Norfolk, Virginia

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SECTION 9

Site 20—Building LP-20

9.1 Chronology

The following is the chronology of the major site events for Site 20, Building LP-20.

1940s-1990s	Numerous spills and releases documented in the area
Circa 1986	Product Recovery System #1 installed
Circa 1988-1990	Product Recovery System #2 installed
1991	Preliminary Assessment (PA)/SI completed
December 1994	Product Recovery Systems shut down and dismantled
1995	RI/FS completed
1996	PRAP completed and DD signed
April 1997	NSN placed on the NPL
1997	Construction of the AS/SVE remediation system
April 1998	Remediation system began operation
November 1998	Implementation of annual LTM
October 2003	Implementation of Five-year Review process
April 2007	Final RD for LUCs at Site 20 (CH2M HILL, 2007c)
2009	AS/SVE system shut down in accordance with recommendations of a Tiger (Optimization) Team; additional monitoring wells installed at the site for inclusion in the LTM program
August 2010	AS/SVE and remedy enhancement (groundwater extraction and treatment) operational
September 2010	Reaffirmation of remedy in accordance with ROD (Navy, 2010c)
February 2011	Remedy enhancement (groundwater extraction and treatment) shut down due to unexpected site conditions
September 2012	Draft VI TM submitted
June 2013	Groundwater Delineation Field Work

9.2 Background

9.2.1 Site Description

The Site 20, Building LP-20, is located within the former Naval Aviation Depot (NADEP) area of NSN (**Figures 2-1 and 9-1**). In general, this area is highly developed and industrialized. Building LP-20 is one of many large buildings northwest of the NAS main runway (**Figure 9-1**). Currently, the building primarily houses the Navy Public Works Center's (PWC's) Transportation Department. In the past, a portion of the building was used for aircraft engine overhaul and maintenance.

9.2.2 Physical Characteristics

The entire surface of Site 20 is relatively flat and covered by buildings or paved with either asphalt or concrete. The only vegetation present in the area is in the landscaped zones located along roadways or parking areas. Groundwater flow varies across Site 20 and is shown on **Figure 9-1**. The water table is typically 5 to 7 feet bgs. The Columbia aquifer is separated from the upper Yorktown aquifer by a confining clay layer that extends from approximately 27 to 37 feet bgs. The Yorktown aquifer is reported to be approximately 100 feet thick in the vicinity of Site 20.

A CSM of Site 20 is provided as **Figure 9-2**.

9.2.3 Land and Resource Use

The site is currently utilized as an industrial area and parking lot to support Naval Fleet Operations. Recently, several new buildings have been constructed along the border of the LUC boundary in which the impermeable ground surface was reduced through the inclusion of green space. Groundwater is not utilized as a resource in the vicinity of the site. Current land use is not expected to change in the foreseeable future.

9.2.4 History of Contamination

Previous activities at Building LP-20 included painting, X-ray facilities, cleaning and blasting, and a metal-plating operation. Waste products generated from these activities were transferred to the industrial WWTP via underground piping. In addition, a large fuel storage area, known as LP fuel farm, is also located south of the building. An underground pipeline extends from the Fuel Farm to buildings LP-78 and LP-176 located east of the site. Over the years (1940s to 1990s), numerous spills or releases of wastewater and petroleum have been documented. Significant releases were associated with damage to underground wastewater lines during construction activities, and leakage of the underground petroleum pipeline (Baker, 1996b).

Initial Response

Investigations at the site began in 1986 following a release of JP-5 fuel from the underground pipeline. Since 1986, numerous investigations have been conducted to evaluate the extent of releases from underground fuel pipelines, the industrial wastewater line, and various underground storage tanks (USTs) at the site. These investigations determined that significant amounts of free product as well as chlorinated solvents are present. An RI and baseline risk assessment (Baker, 1996b) and an FS (Baker, 1996c) summarizing the previous investigation data were completed in 1995.

The data generated during the RI (Baker, 1996b) indicate that VOCs are the primary contaminants detected in the area. Specifically, chlorinated solvents were detected in the vicinity of LP-20 and LP-26. In addition, petroleum products occur east of Building LP-22 and south of Building LP-179 and are being handled as part of the UST Program. VC, 1,1-DCE, 1,2-DCE, 1,2-dichloroethane (DCA), TCE, and benzene were observed in the shallow aquifer (Columbia) and VC, 1,2-DCE, and TCE were also detected in the deep aquifer (Yorktown).

Site Risks

The human health evaluation identified VOCs in groundwater as presenting an unacceptable risk to construction and utility workers who may be exposed to shallow groundwater (**Table 9-1**).

A detailed ecological evaluation was not performed during the RI because the site is industrialized in nature and very limited habitat is present within the site. The entire area is covered by buildings or paved with asphalt or concrete. The only vegetation present is landscaped zones along roadways or parking areas (Baker, 1996b). The site remains industrial with very little to no habitat.

9.2.5 Basis for Taking Action

The primary risk posed by conditions at Site 20 is the contaminated groundwater, which threatens the underlying aquifers. Based on the results of previous investigations, RA is warranted to protect public health and welfare from actual or threatened releases of VOCs in groundwater.

9.3 Remedial Actions

9.3.1 Remedy Selection

In 1996, a DD for the Building LP-20 Site was completed which required the shallow groundwater aquifer at the site be treated to reduce the threat to human health and the environment. The DD report identified the risks to the human health and ecological receptors, established the RAO, and defined the selected remedy. The selected remedy for Site 20 includes treatment of the groundwater using AS/SVE, LTM, and LUCs to meet the following RAOs:

- Prevent current and future exposure to human and ecological receptors to the contaminated shallow and Yorktown aquifer groundwater.
- Prevent further migration of contaminated shallow groundwater.
- Reduce contaminant concentrations in the shallow and Yorktown aquifer to risk-based levels defined in the DD.

The DD was limited to groundwater remediation as there was not a major discrete soil source area that would lend itself to remediation. Additionally, the entire site is covered by buildings or pavement and any contaminated soils in the vadose zone are, in effect capped, by low-permeability materials that minimize rainwater infiltration and subsequent leaching of contaminants.

The LUC RD identifies the following LUCs for Site 20:

- Prohibit use of the shallow and Yorktown aquifer groundwater.
- Ensure concrete and asphalt pavement are maintained to minimize exposure to site soils.
- Prohibit changes from current building use or construction of new buildings without further evaluation of potential VI risks and/or implementation of mitigation measures

The LUC restrictions have been implemented as detailed in the RD for LUCs at Site 20. The LUCs will be maintained on all land and groundwater within the boundaries of Site 20 (**Figure 9-1**). The LUCs will be maintained until the concentrations of hazardous substances in the groundwater has been reduced to levels that allow for UU/UE.

Reaffirmation of the DD remedy was document by a ROD in 2010. In addition to reducing cleanup goals for COCs to their respective MCL, a remedy enhancement via groundwater extraction and treatment was implemented at the Site.

9.3.2 Remedy Implementation

Construction of the AS/SVE system for the shallow aquifer began in 1997. The system is comprised of 53 AS wells and 27 SVE wells which are placed throughout the center and the downgradient extent of the contaminant plume in an effort to reduce the VOC concentrations that exceed cleanup goals (**Table 9-1**) in the contaminant source area and to prevent further migration of the plume offsite (**Figure 9-1**).The system began operating on April 14, 1998. Optimization efforts have resulted in varying the system operation prior to temporary shutdown of the system in 2009 in accordance with Tiger Team recommendations while additional investigation was conducted. The system was returned to operation in August 2010. Currently, the AS/SVE system is operational.

Via the 2010 ROD, a groundwater extraction and treatment system was constructed at the site to accelerate the remediation of groundwater at the site. The groundwater extraction system was operational for approximately 6 months before unfavorable site conditions were encountered; the high iron content in the shallow aquifer caused extensive system maintenance and petroleum began to be captured by the extraction well. As a result, the extraction and treatment system was taken out of service while the Navy is evaluating alternatives to return the system to operational.

Sampling was completed in February 1998 at 15 monitoring wells to provide baseline analytical data before the AS/SVE system was started. Annual LTM was initiated at the same monitoring wells in February 1999. Annual LTM has been conducted at the site from 1999 to present, with the exception of 2010. In accordance with NSN Team agreement, no sampling was conducted in 2010 in order to plan additional investigation activities to delineate the shallow COC plume at the site. Eight new monitoring wells were installed for inclusion in the LTM program if warranted by the NSN Team. Additional investigation is planned for the summer of 2013.

9.3.3 System Operation and Maintenance

The standard O&M of the AS/SVE system are documented in the *Environmental Facility User Manual for Groundwater Remediation* (OHM, 1998a). Maintenance associated with the operation of the AS/SVE system

consists of weekly (at a minimum) site visits, system monitoring, and component replacements when necessary. There have not been any unexpected difficulties with the operation of the AS/SVE system at Site 20.

The shallow groundwater extraction and treatment system has been inoperable since 2011; currently, the Navy is evaluating alternatives to return the system to operational. The additional data being collected as part of the planned investigation activities for 2013 will be used to support this evaluation.

The RPO Team continually evaluates the O&M of the AS/SVE and groundwater extraction and treatment systems, including operating costs, and makes adjustments as appropriate to increase system efficiency.

9.4 Progress since Last Review

9.4.1 Follow-up Action Since the last Five-year Review

The previous Five-year Review Report included the following protectiveness statement for Site 3:

The remedy at Site 20 consisting of the existing AS/SVE system is currently protective of human health and the environment and is expected to continue to be protective in the future. However, as limited air monitoring results are available for Site 20, an additional air assessment will be conducted before the next Five Year review. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the groundwater treatment system, LUCs, and the implementation of ICs.

Although the remedy for Site 20 was deemed protective, issues, recommendations, and follow-up actions were identified. The status of these items is discussed in **Table 9-2**.

9.4.2 Action Summary

Long-term Monitoring Data Review

The LTM program was implemented as a requirement in the Site 20 DD (Baker, 1996d) to evaluate the effectiveness of the RA. Baseline samples were collected in February 1998 at 15 monitoring wells and annual LTM was initiated at the same monitoring wells in February 1999. LTM continued at the site until 2009; the Tiger Team was created in 2008 in accordance with recommendations of the 2008 Five-year Review and additional investigation activities were completed to supplement the LTM data. The team agreed to install an additional eight shallow monitoring wells (NBS20-MW100 – NBS20-MW107, **Figure 9-1**) at the site and install a groundwater extraction and treatment system to accelerate remediation of groundwater. Existing site monitoring and new site monitoring wells were sampled in 2011 and 2012 (**Figures 9-3 and 9-4**). Based on the 2012 data, three site monitoring wells (NBS20-MW101, NBS20-MW103, and NBS20-MW02) contain concentrations of COCs indicative of dense non-aqueous phase liquid (DNAPL). Additionally, data gaps were identified by the NSN Team as follows:

Columbia aquifer:

- The boundary of the source area concentrations (DNAPL) northwest of NBS20-MW02 and NBS20-MW103
- The boundary of the dissolved phase plume northeast of NBS20-MW13 and southwest of NBS20-MW12
- The eastern boundary of the dissolved phase plume in the vicinity of NBS20-MW97-2D
- The southeastern boundary of the dissolved phase plume at the base of the Columbia aquifer in the vicinity of NBS20-MW97-1D. Wells with no detections in this area are screened at a shallower interval than NBS20-MW97-1D.
- Specific source area characterization in the central portion of the site along the east side of Building LP-20
- Reevaluation of the current concentrations in the former location of NBS20-MW-20 (located along the NW plume boundary), where high concentrations of total chlorinated ethenes were detected historically

Yorktown aquifer:

- Determination of Yorktown aquifer concentrations in the source area associated with Columbia aquifer monitoring wells NBS20-MW101 and NBS20-MW02 along the western side of Building LP-20
- Southern boundary of the Yorktown aquifer plume in the vicinity of NBS20-MW08 and east of NBS20-MW07
- Extent of contamination downgradient of Building LP-26

A SAP was submitted to the team in April 2013 to outline the groundwater investigation to address the data gaps above. The data gathered from the investigation will be used to optimize the current groundwater LTM network and provide supplemental information to the Navy to adequately construct a groundwater extraction and treatment system to fulfill the requirements of the ROD. Field work for the additional groundwater investigation is scheduled for summer 2013.

A comparison of the groundwater data collected in 1998, 2003, 2007, and 2012 indicates an overall decrease or asymptotic trend in the VOC concentrations detected at Site 20 (**Figures 9-5 and 9-6**); however, concentrations remain elevated in samples collected from both the shallow and deep monitoring wells and there has been a substantial increase in COC concentrations detected in monitoring wells MW-2, SW-1, and MW-5; particularly of degradation products of TCE. Under anaerobic conditions, TCE degrades to cis/trans-1,2-DCE, 1,1-DCE, and VC. Although the AS/SVE system is expected to create an aerobic environment at Site 20, areas not targeted by the system may be anaerobic. Therefore, the increase of TCE degradation product concentrations observed in some of the monitoring wells may be attributed to reductive dechlorination of parent compounds in anaerobic areas of the site.

Site Inspections

Site inspections have been conducted quarterly at Site 20 to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review. No discrepancies have been observed at Site 20 during the quarterly inspections. The most recent inspection was conducted in April 2013.

Remedy Costs

The average remedy costs for operating the AS/SVE system, LTM and conducting quarterly site inspections is approximately $40,000[6] per year. The estimated O&M costs for the selected remedy in the ROD were approximately $123,600 per year; the actual cost for the existing remedy are significantly less than the estimated cost documented by the DD.

9.5 Technical Assessment

Is the remedy functioning as intended by the Decision Documents?

The review of documents, ARARs, risk assumptions, and the results of the site inspection indicates the remedy is functioning as intended by the DD/ROD. As the site is highly industrialized, it is effectively capped by asphalt and concrete, eliminating direct exposure pathways. Additionally, aquifer use restrictions (for both the shallow and deep aquifer) prevent the use of the groundwater.

The goal of the RA was to treat the contaminant plume in the shallow aquifer using an AS/SVE system to prevent migration of the plume offsite and into the deep aquifer, and reduce the contaminant concentrations to the established cleanup goals. Subsequently, a groundwater extraction system (intended to operate at approximately 10 gallons per minute) was installed as an enhancement to the remedy in accordance with the Site 20 ROD (Navy, 2010).

[6] The costs associated with the groundwater extraction and treatment system are not included in this total since the system was only operational for a short period of time from 2010 – 2011.

Additionally, while concentrations of VOCs in soil and groundwater have been investigated as part of previous studies, additional sampling and evaluation was determined necessary to address uncertainties identified at the site based upon the existing monitoring well network. The additional groundwater investigation to address the uncertainties (discussed in Section 9.4.2) is anticipated to occur in summer 2013.

Concentrations detected at the site are indicative of DNAPL source strength contamination. Since the remedy was designed and implemented, technical knowledge of cleanup of source-strength contamination has improved considerably and AS/SVE is no longer considered an optimal technology for contamination of this kind. Consequently, the Team is currently evaluating potential enhancements to the existing remedy to expedite the cleanup at the site.

LUCs prevent exposure to groundwater by onsite receptors in accordance with the DD and ROD. The entire area is covered by buildings or pavement, and any contaminated soils in the unsaturated zone are, in effect, “capped”, by low-permeability materials that minimize rainwater infiltration and subsequent leaching of contaminants.

Are the exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-year Review. There is no indication hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

However, additional groundwater sampling, and installation of additional monitoring wells is planned to eliminate uncertainties associated with the existing monitoring well network.

A vapor intrusion investigation of buildings within 100 feet of the groundwater contaminant plume is planned at the site once the additional groundwater investigation activities are completed in 2013. The results of the 2013 investigation activities will be used to identify potential building of concern to evaluated for potential vapor intrusion.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of contaminants initially sampled during the RI/FS phase of investigation at Site 20, these changes would not adversely affect the protectiveness of the selected remedy for the COCs identified in the ROD as it would not substantially change the results of the risk assessment or the classes of constituents identified as COCs. Additionally, the groundwater cleanup goals are based on maximum contaminant levels (MCLs); therefore, changes in toxicity values would not change the cleanup goals for the groundwater. The LUCs and ICs eliminate any exposure to site media; therefore, changes to the toxicity values would not affect the protectiveness of the remedy.

During this Five-year Review period, risk-based screening levels for evaluating human health risks associated with exposure to 1,4-dioxane were established. 1,4-dioxane is a stabilizer that was commonly used in chlorinated solvents including 1,1,1-TCA, historically detected in groundwater at Site 20. Groundwater samples collected at Site 20 in 2012 were analyzed for 1,4-dioxane; however, the reporting limits ranged from 10 µg/L to 100 µg/L, exceeding the November 2012 RSL of 0.67 µg/L. Although the presence of 1,4-dioxane is unknown at Site 20, it can be reasonably expected that the existing remedy would be adequate to protect human health and the environment from potential risks associated with this constituent under current land use conditions.

PFCs have been recently identified by the USEPA as an emerging contaminant; however no Tier I screening values have been established to evaluate risk associated with these contaminants. Based on the site history, the potential for elevated concentrations of PFCs is present. Although the presence of these contaminants are unknown, it can be reasonably expected that the LUC portion of the existing remedy is adequate to protect

human health and the environment from potential risks (if any) associated with these contaminants in the short-term.

Additional changes to RSL values of other constituents have been made during this Five-year Review period; however, these changes do not impact the protectiveness of the remedy.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how HHRAs are conducted, none of these changes adversely affect the protectiveness of the selected remedy for LP-20. There have been no major procedural changes in how the ERAs are conducted since the last Five-year Review.

A VI indoor air evaluation was completed for Building LP-20 in September 2012. The results of the risk evaluation indicated that the indoor air risks to current industrial workers in Building LP-20 are less than USEPA target levels. Although hypothetical future risks based on subslab concentrations and conservative assumptions exceeded target levels, future VI impacts are not expected based on the age of the release, the age of the building, the observation at other Navy and legacy sites.

VI sites, and concerns about increased VI with time has not been documented, particularly at industrial buildings similar to Building LP-20. It was recommended that the current LUCs at Site 20 be modified throughout the RA to maintain current building uses, prevent activities that would compromise the integrity of the building foundation and/or subslab, and prevent construction of additional structures at the site without further evaluation and/or implementation of mitigation measures until the groundwater RA is completed. As a conservative measure, the Navy anticipates VI investigations of occupied buildings within 100 feet of the COC plume will be conducted prior to the next Five-year Review.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the remedy.

Technical Assessment Summary

Based on the information presented herein, the remedy for Site 20 is functioning as intended by the ROD. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through the enforcement of LUCs or will be evaluated in the near future. As noted above, additional investigation is planned and assessment of alternative remedial strategies for Site 20 will be completed prior to the next Five-year Review.

9.6 Issues, Recommendations, and Follow-up Actions Identified

Table 9-2 presents the issues, recommendations, and follow-up actions that have been identified for Site 20 based on this Five-year Review.

9.7 Protectiveness Statement

The remedy at Site 20, consisting of treatment of shallow groundwater (through AS/SVE and enhanced by groundwater extraction and treatment) with LUCs, is currently protective of human health and the environment. Exposure pathways that could result in an unacceptable risk are being controlled through the enforcement of LUCs. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness: 1) complete the assessment of occupied site buildings within 100 feet of the COC plume to evaluate VI based on the presence of COCs in groundwater; 2) complete an groundwater evaluation to determine if 1,4-dioxane should be considered a COC for the site and revise the site remedy, LUC boundary, and/or treatment system as warranted; 3) determine the presence/absence of PFCs in site groundwater and compare to Tier I toxicological values once established by USEPA; and 4) evaluate data gaps in groundwater LTM, modify the LTM network and/or remedy as warranted.

TABLE 9-1

Site 20 Remedy Performance Standards

OU	Site	Risk	Media	Reasonably Anticipated Land Use	COC Requiring Action	Basis for Action	RAO	Remedy Component	Site Closeout Strategy	Performance Metric / Cleanup Level*
4	20	Human Health	Surface Soil	Parking Lot	Arsenic	HI > 1	None Defined	LUCs	Ensure concrete and asphalt pavement are maintained to minimize exposure to site soils	No intrusive activities
					Beryllium	HI > 1				
					Benzo(a)pyrene	HI > 1				
					1,2-DCA	Concentration > MCL	Prevent current and future exposure to human and ecological receptors to the contaminated shallow and Yorktown aquifer groundwater. Prevent further migration of contaminated shallow groundwater. Reduce contaminant concentrations in the shallow and Yorktown aquifer to risk-based levels defined in the DD.	AS/SVE, groundwater extraction and treatment, LTM, and LUCs	Conduct LTM and enforce LUCs until each groundwater COC is at or below its respective cleanup level	5 µg/L
			Groundwater (shallow and deep)		1,1-DCE	ILCR > $1x10^{-4}$				7 µg/L
					cis-1,2-DCE[1]	HI > 1				70 µg/L
					trans-1,2-DCE[1]	HI > 1				100 µg/L
					benzene	ILCR > $1x10^{-4}$				5 µg/L
					TCE	ILCR > $1x10^{-4}$				5 µg/L
					Vinyl Chloride	ILCR > $1x10^{-4}$				2 µg/L

Notes:

[1]Cis-1,2-DCE and trans-1,2-DCE is representative of total 1,2-DCE.

Acronyms:

AS - air sparge
COC - contaminant of concern
DCE - dichloroethene
DD - Decision Document
HI - hazard index
ILCR - incremental lifetime cancer risk
LTM - long-term monitoring
LUC - land use control
µg/L - micrograms per liter
OU - operable unit
PCB - polychlorinated biphenyl
RAO - remedial action objective
SVE - soil vapor extraction
TCE - trichloroethene

TABLE 9-2

Site 20 Action Item Progress from 2008 Five-Year Review

Issue from Second Five-Year Review Report							
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**		**Status - June 2013**	
				Current	**Future**	**Action Taken and Outcome**	**Date of Action**
Vapor intrusion was not evaluated as a potential pathway as part of the RI/FS process for the site. Since there are buildings overlying the VOC groundwater plume, further evaluation of the vapor intrusion pathway at Site 20 may be warranted to assess whether this pathway generates potentially unacceptable risk. Since air monitoring was conducted as part of the AS/SVE system pilot study, additional air monitoring will be assessed before the next Five Year Review.	An assessment of the potential for vapor intrusion will be performed based on the presence of VOCs within the groundwater. This assessment will include an evaluation of the air monitoring results, obtained during the AS/SVE pilot study.	Navy, USEPA, and VDEQ	Next Five-Year Review	No	Yes	Vapor Intrusion evaluation conducted of Building LP-20 in 2011/2012. Report submitted to regulators indicating no current risk to receptors in Building LP-20 however future risk is present. The Navy anticipates the remaining buildings within 100 feet of the current VOC plume will be conducted by the next Five-Year Review.	Ongoing
There is an overall decrease in the VOC concentrations detected at Site 20; however, concentrations remain elevated in samples collected at some of the monitoring wells. Therefore, the RPO team will need to evaluate supplements or enhancements to the current system in order to expedite the reduction of VOC concentrations.	The NSN Partnering team will need to evaluate potential supplements or enhancements to the current system in order to ensure the remedial system achieves its objectives in a shorter timeframe.	Navy, USEPA, and VDEQ	Next Five-Year Review	No	No	Remedy enhancement (groundwater extraction and treatment) operational at the site in September 2010.	September 2010

Acronyms:
AS - air sparge
FS - Feasibility Study
NSN - Naval Station Norfolk
RI - Remedial Investigation
RPO - remedial process optimization
SVE - soil vapor extraction
USEPA - United States Environmental Protection Agency
VI - vapor intrusion
VDEQ - Virginia Department of Environmental Quality
VOC - volatile organic chemical

TABLE 9-3

Issues, Recommendations and Follow-up Actions for Site 20

Action Requiring Follow-Up from Third Five-Year Review Report					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
An evaluation of VI at Building LP-20 (considered the worst case scenario by the NSN Tier I Partnering Team based on the existing conceptual site model [CSM] and detected concentrations of COCs in groundwater) indicated no current risk to receptors is present; however a potential future risk is present. Therefore, an evaluation of the VI pathway for buildings within 100 feet of the COC plume is recommended.	Complete the assessment of occupied site building to evaluate VI based on the presence of COCs in groundwater.	Navy, USEPA, and VDEQ	Oct-16	No	TBD
An RSL was established for 1,4-dioxane. The historical detection of 1,1,1-TCA indicates 1,4-dioxane may be present at Site 20.	Evaluate the presence of 1,4-dioxane in site groundwater and treated effluent. If a data evaluation indicates 1,4-dioxane should be considered a COC for Site 20, the NSN Tier I Partnering Team will determine if modifications to the existing remedy and/or LUC boundary are necessary in accordance with CERCLA.	Navy, USEPA, and VDEQ	Jul-14	No	TBD
Perfluorinated compounds (PFCs) have been identified by the USEPA as an emerging contaminant. Based on site history, these constituents have the potential to be present in site groundwater.	Determine the presence or absence of PFCs in site groundwater. If PFCs are present, concentrations will be compared to Tier I toxicological values when established by USEPA. If a data evaluation indicates these compounds should be considered a COC for Site 20 (based on Tier I toxicological values), the NSN Tier I Partnering Team will determine if modifications to the existing remedy, LUC boundary, and/or treatment system(s) are warranted.	Navy, USEPA, and VDEQ	Oct-15	No	TBD
The remedy enhancement (groundwater extraction and treatment) is not functioning at the site (the system has been down for approximately 18 months); the Navy is currently working on plans to operate the system in a more efficient manner	Complete additional investigation (resolve data gaps in regards to the extent of COC contamination in the shallow and deep aquifers) to evaluate the most effective location(s) for extraction well(s) and treatment components to operate the extraction system.	Navy, USEPA, and VDEQ	Oct-15	No	No

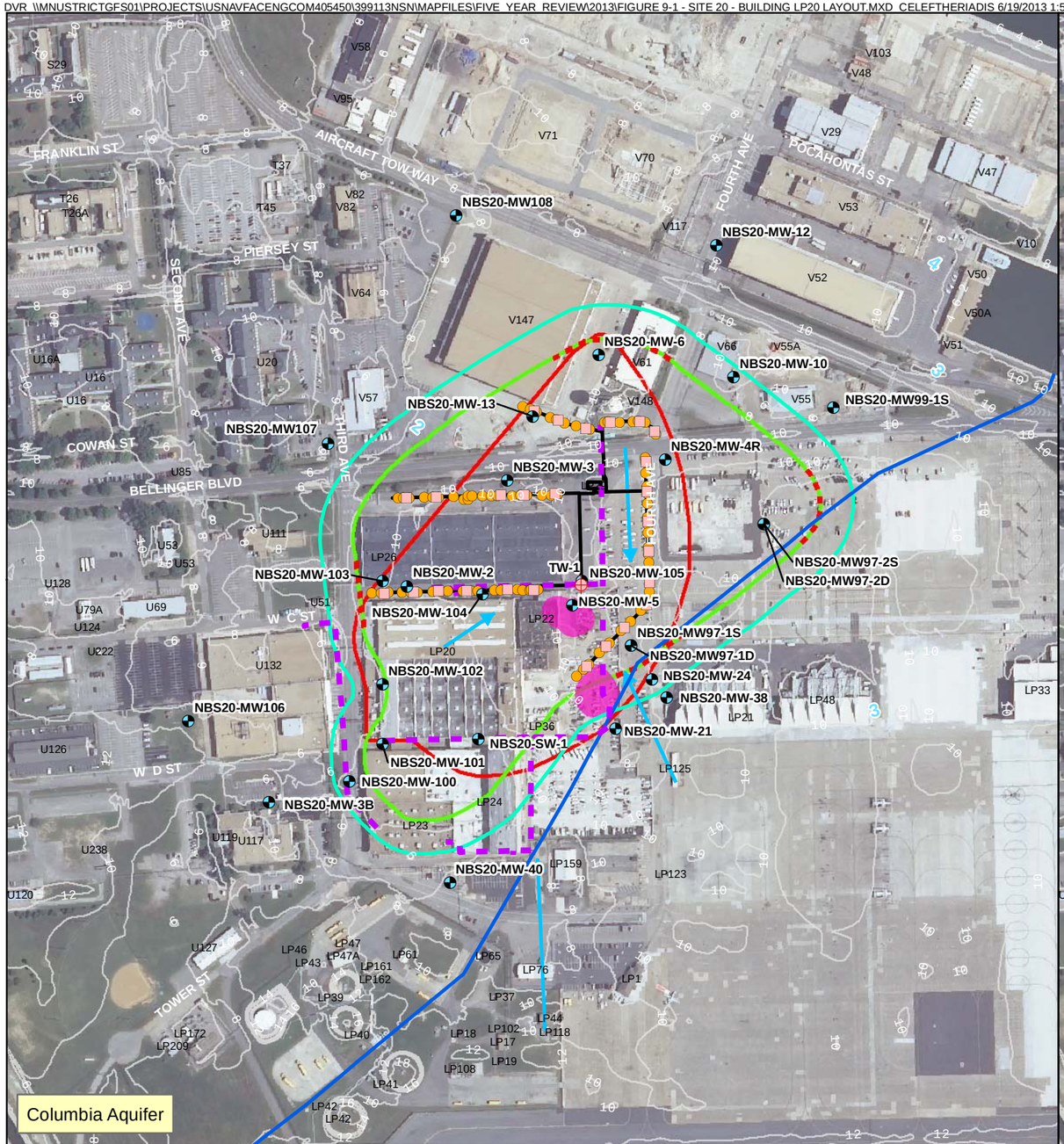
TABLE 9-3

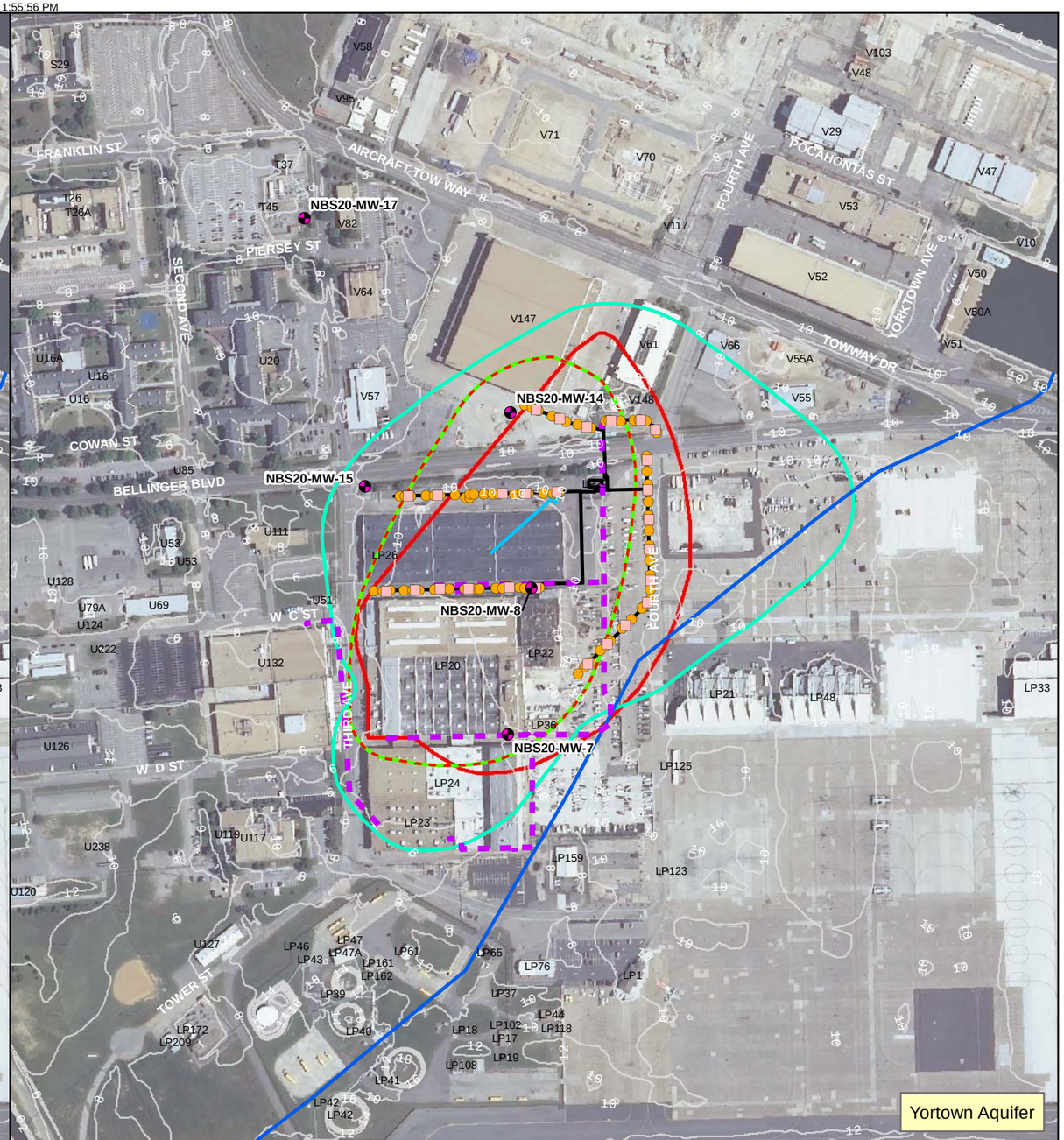
Issues, Recommendations and Follow-up Actions for Site 20

Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
The current remedy is not expected to remediate the Columbia and Yorktown aquifers to beneficial reuse within the next 30 years.	The Decision Document (Baker, 1996e) acknowledges the AS/SVE system is not anticipated to remediate site groundwater within 30 years.	Navy, USEPA, and VDEQ	NA	No	No
Data gaps are present in groundwater LTM network; the lateral extent of shallow groundwater COC contamination is not completely defined (4 locations) and the lateral/vertical extent of COC contamination is not defined in the deep aquifer.	Evaluate data gaps by installing and sampling new monitoring wells. If COCs are present above clean up goals, then the NSN Tier I Partnering Team will determine if modifications to the existing remedy, LUC boundary, and/or treatment system are warranted.	Navy, USEPA, and VDEQ	NA	No	TBD

Acronyms:
LTM - long-term monitoring
LUC - land use control
MCLs - maximum contaminant level
NA - not applicable
PFOA - perfluorooctanoic acid
RD - Remedial Design
RSL - risk screening level
TBD - to be determined
TCA - trichloroethane
USEPA - United States Environmental Protection Agency
VDEQ - Virginia Department of Environmental Quality
VI - vapor intrusion
VOC - volatile organic compound

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 9-1 - SITE 20 - BUILDING LP20 LAYOUT.MXD CELEFTHERIADIS 6/19/2013 1:55:56 PM





Legend

- Columbia Aquifer Monitoring Well
- Yorktown Aquifer Monitoring Well
- Extraction Well
- Air Sparge (AS) Well
- Soil Vapor Extraction (SVE) Well
- Groundwater Flow Direction (2012)
- Piping for AS/SVE Systems
- Bousch Creek Culvert
- Topographic Contour (2ft Interval)
- Industrial Waste Sewer Line
- Estimated Extent of POL Plume (August 2012)
- Area of Uncertainty
- Estimated Extent of COC
- Groundwater Contaminant Plume (2012)
- Land Use Control Area (2007)
- Proposed Land Use Control Area (2013)

Notes:
TW-1 is the current extraction well for the remedy enhancement for Site 20
AS - Air Sparge
COC - Contaminant of Concern
POL - Petroleum, Oil, and Lubricant
SVE - Soil Vapor Extraction

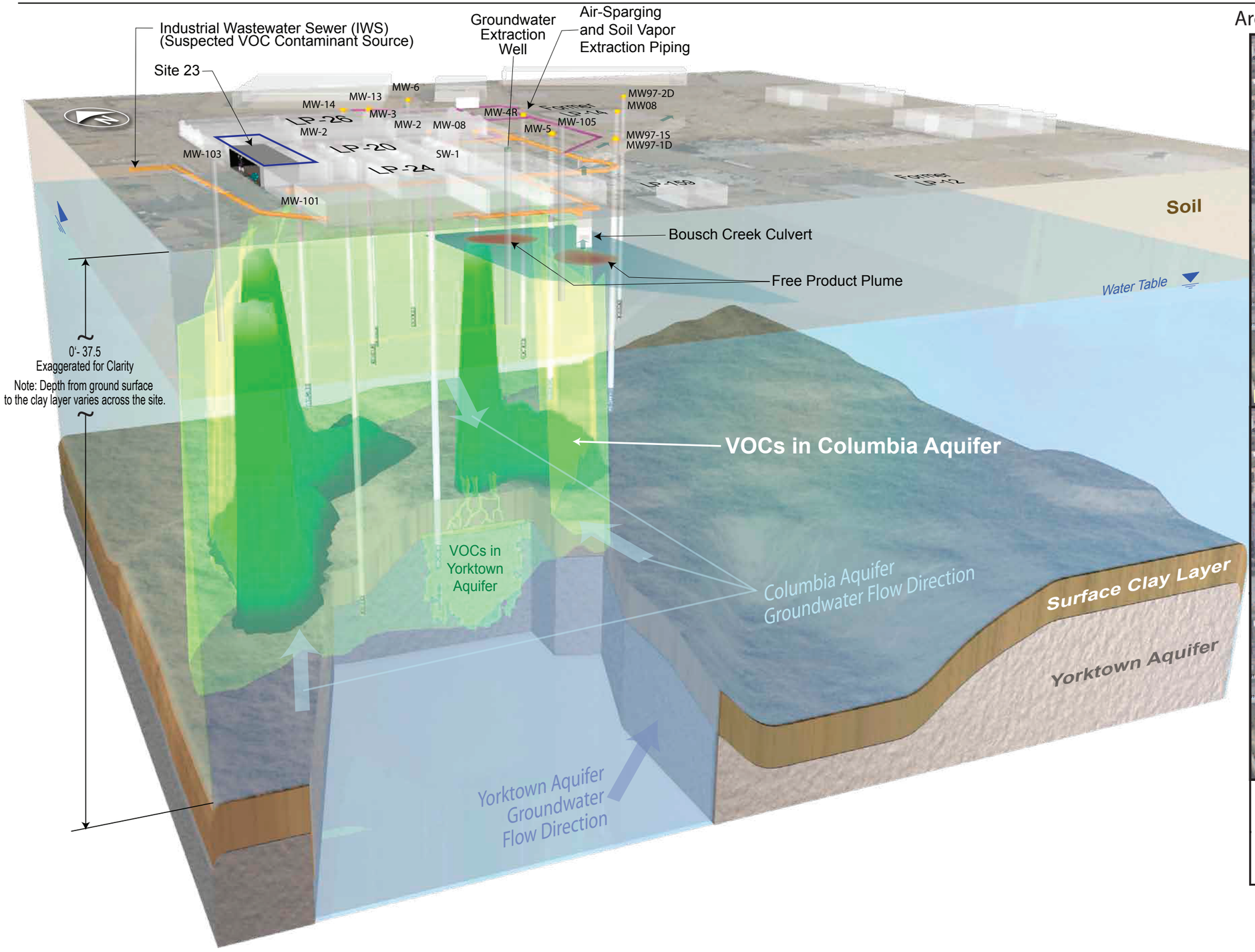
N
W E
S

0 400 800
Feet

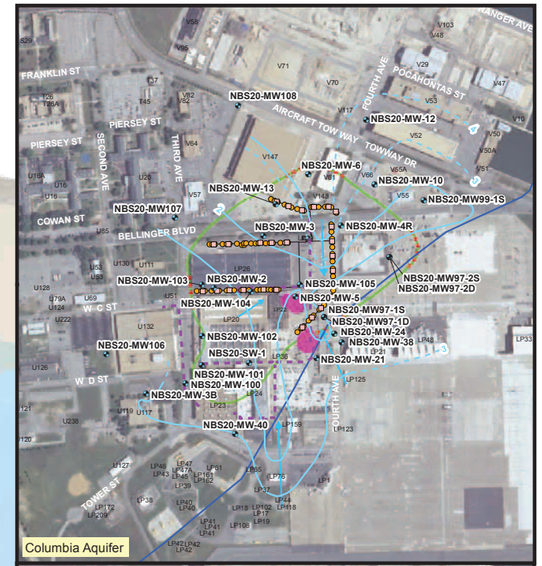
Reference: 2008 Aerial Photography

Figure 9-1
Site 20 - Building LP-20 Layout
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL



Areas of Uncertainty Shown on Figure 9-1:

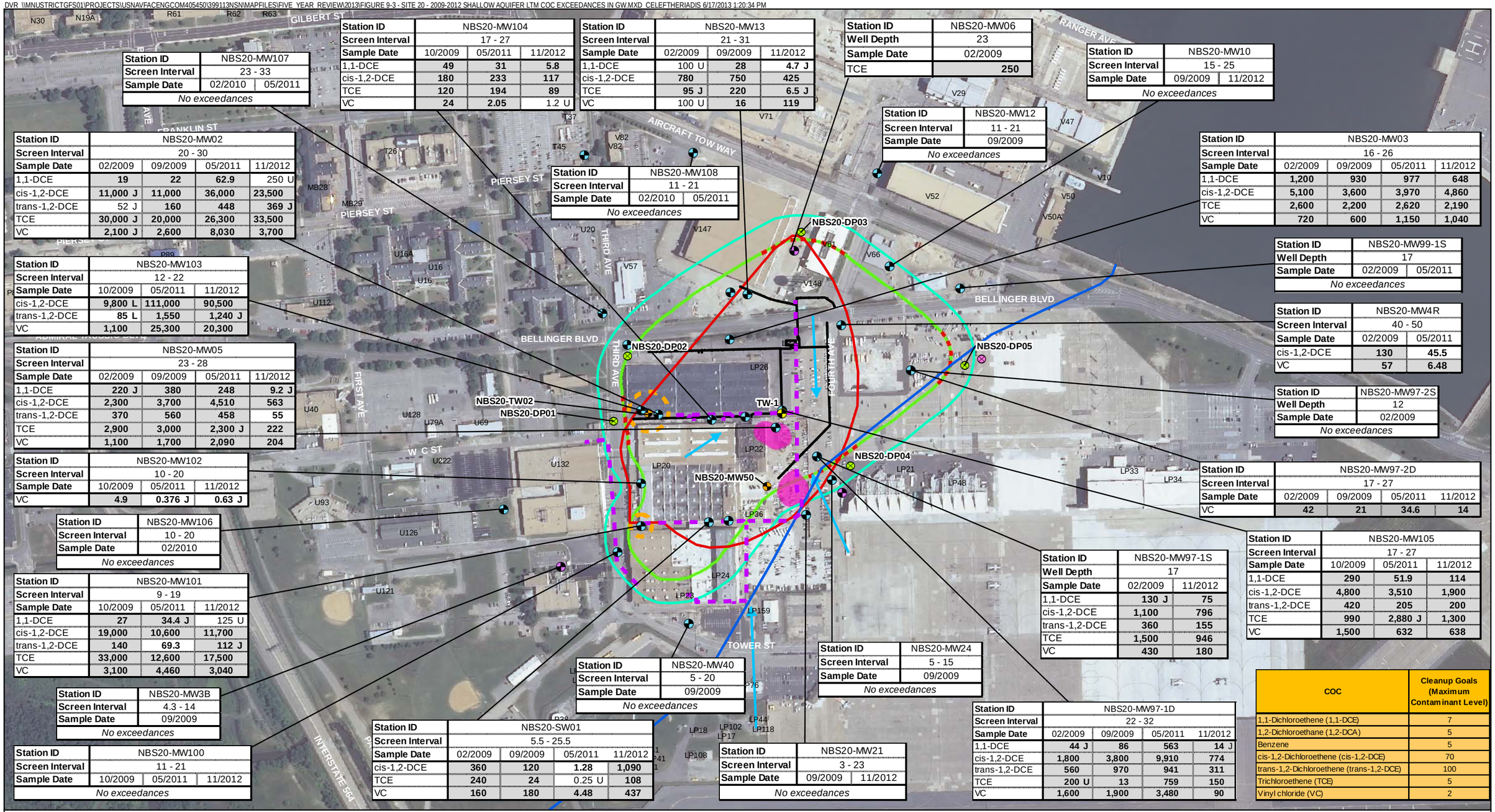


Legend

- Columbia Aquifer Monitoring Wells
- Yorktown Aquifer Monitoring Wells
- Air Sparge Wells
- Soil Vapor Extraction Well
- Groundwater Flow Direction (2012)
- Groundwater Contour Line (Dashed Where Inferred)
- Piping for AS/SVE Systems
- Bousch Creek Culvert
- Industrial Waste Sewer Line
- Estimated Extent of POL Plume (August 2012)
- Area of Uncertainty
- Estimated Extent of CERCLA Groundwater Contaminant Plume (2012)

FIGURE 9-2
Conceptual Site Model
Site 20- Building LP-20
Naval Station Norfolk
Norfolk, Virginia

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 9-3 - SITE 20 - 2009-2012 SHALLOW AQUIFER LTM COC EXCEEDANCES IN GW.MXD CELEFTHERIADIS 6/17/2013 1:20:34 PM



Station ID	NBS20-MW107	
Screen Interval	23 - 33	
Sample Date	02/2010	05/2011
No exceedances		

Station ID	NBS20-MW104		
Screen Interval	17 - 27		
Sample Date	10/2009	05/2011	11/2012
1,1-DCE	**49**	**31**	**5.8**
cis-1,2-DCE	**180**	**233**	**117**
TCE	**120**	**194**	**89**
VC	**24**	**2.05**	1.2 U

Station ID	NBS20-MW13		
Screen Interval	21 - 31		
Sample Date	02/2009	09/2009	11/2012
1,1-DCE	100 U	**28**	**4.7 J**
cis-1,2-DCE	**780**	**750**	**425**
TCE	**95 J**	**220**	**6.5 J**
VC	100 U	**16**	**119**

Station ID	NBS20-MW06	
Well Depth	23	
Sample Date	02/2009	
TCE	**250**	

Station ID	NBS20-MW10	
Screen Interval	15 - 25	
Sample Date	09/2009	11/2012
No exceedances		

Station ID	NBS20-MW12	
Screen Interval	11 - 21	
Sample Date	09/2009	
No exceedances		

Station ID	NBS20-MW02			
Screen Interval	20 - 30			
Sample Date	02/2009	09/2009	05/2011	11/2012
1,1-DCE	**19**	**22**	**62.9**	250 U
cis-1,2-DCE	**11,000 J**	**11,000**	**36,000**	**23,500**
trans-1,2-DCE	52 J	**160**	**448**	**369 J**
TCE	**30,000 J**	**20,000**	**26,300**	**33,500**
VC	**2,100 J**	**2,600**	**8,030**	**3,700**

Station ID	NBS20-MW108	
Screen Interval	11 - 21	
Sample Date	02/2010	05/2011
No exceedances		

Station ID	NBS20-MW03			
Screen Interval	16 - 26			
Sample Date	02/2009	09/2009	05/2011	11/2012
1,1-DCE	**1,200**	**930**	**977**	**648**
cis-1,2-DCE	**5,100**	**3,600**	**3,970**	**4,860**
TCE	**2,600**	**2,200**	**2,620**	**2,190**
VC	**720**	**600**	**1,150**	**1,040**

Station ID	NBS20-MW99-1S	
Well Depth	17	
Sample Date	02/2009	05/2011
No exceedances		

Station ID	NBS20-MW103		
Screen Interval	12 - 22		
Sample Date	10/2009	05/2011	11/2012
cis-1,2-DCE	**9,800 L**	**111,000**	**90,500**
trans-1,2-DCE	**85 L**	**1,550**	**1,240 J**
VC	**1,100**	**25,300**	**20,300**

Station ID	NBS20-MW4R	
Screen Interval	40 - 50	
Sample Date	02/2009	05/2011
cis-1,2-DCE	**130**	**45.5**
VC	**57**	**6.48**

Station ID	NBS20-MW05			
Screen Interval	23 - 28			
Sample Date	02/2009	09/2009	05/2011	11/2012
1,1-DCE	**220 J**	**380**	**248**	**9.2 J**
cis-1,2-DCE	**2,300**	**3,700**	**4,510**	**563**
trans-1,2-DCE	**370**	**560**	**458**	**55**
TCE	**2,900**	**3,000**	**2,300 J**	**222**
VC	**1,100**	**1,700**	**2,090**	**204**

Station ID	NBS20-MW97-2S	
Well Depth	12	
Sample Date	02/2009	
No exceedances		

Station ID	NBS20-MW102		
Screen Interval	10 - 20		
Sample Date	10/2009	05/2011	11/2012
VC	**4.9**	**0.376 J**	**0.63 J**

Station ID	NBS20-MW97-2D			
Screen Interval	17 - 27			
Sample Date	02/2009	09/2009	05/2011	11/2012
VC	**42**	**21**	**34.6**	**14**

Station ID	NBS20-MW106	
Screen Interval	10 - 20	
Sample Date	02/2010	
No exceedances		

Station ID	NBS20-MW105		
Screen Interval	17 - 27		
Sample Date	10/2009	05/2011	11/2012
1,1-DCE	**290**	**51.9**	**114**
cis-1,2-DCE	**4,800**	**3,510**	**1,900**
trans-1,2-DCE	**420**	**205**	**200**
TCE	**990**	**2,880 J**	**1,300**
VC	**1,500**	**632**	**638**

Station ID	NBS20-MW101		
Screen Interval	9 - 19		
Sample Date	10/2009	05/2011	11/2012
1,1-DCE	**27**	**34.4 J**	125 U
cis-1,2-DCE	**19,000**	**10,600**	**11,700**
trans-1,2-DCE	**140**	**69.3**	**112 J**
TCE	**33,000**	**12,600**	**17,500**
VC	**3,100**	**4,460**	**3,040**

Station ID	NBS20-MW97-1S	
Well Depth	17	
Sample Date	02/2009	11/2012
1,1-DCE	**130 J**	**75**
cis-1,2-DCE	**1,100**	**796**
trans-1,2-DCE	**360**	**155**
TCE	**1,500**	**946**
VC	**430**	**180**

Station ID	NBS20-MW40	
Screen Interval	5 - 20	
Sample Date	09/2009	
No exceedances		

Station ID	NBS20-MW24	
Screen Interval	5 - 15	
Sample Date	09/2009	
No exceedances		

Station ID	NBS20-MW3B	
Screen Interval	4.3 - 14	
Sample Date	09/2009	
No exceedances		

Station ID	NBS20-MW97-1D			
Screen Interval	22 - 32			
Sample Date	02/2009	09/2009	05/2011	11/2012
1,1-DCE	**44 J**	**86**	**563**	**14** J
cis-1,2-DCE	**1,800**	**3,800**	**9,910**	**774**
trans-1,2-DCE	**560**	**970**	**941**	**311**
TCE	**200 U**	**13**	**759**	**150**
VC	**1,600**	**1,900**	**3,480**	**90**

Station ID	NBS20-SW01			
Screen Interval	5.5 - 25.5			
Sample Date	02/2009	09/2009	05/2011	11/2012
cis-1,2-DCE	**360**	**120**	**1.28**	**1,090**
TCE	**240**	**24**	0.25 U	**108**
VC	**160**	**180**	**4.48**	**437**

Station ID	NBS20-MW21	
Screen Interval	3 - 23	
Sample Date	09/2009	11/2012
No exceedances		

Station ID	NBS20-MW100		
Screen Interval	11 - 21		
Sample Date	10/2009	05/2011	11/2012
No exceedances			

COC	Cleanup Goals (Maximum Contaminant Level)
1,1-Dichloroethene (1,1-DCE)	7
1,2-Dichloroethane (1,2-DCA)	5
Benzene	5
cis-1,2-Dichloroethene (cis-1,2-DCE)	70
trans-1,2-Dichloroethene (trans-1,2-DCE)	100
Trichloroethene (TCE)	5
Vinyl chloride (VC)	2

Legend

- Proposed Columbia Aquifer Monitoring Well
- Proposed Primary Hydropunch Sample
- Proposed Secondary Hydropunch Sample
- Temporary Well Location
- Columbia Aquifer Monitoring Well
- Former Monitoring Well
- Groundwater Flow Direction (2012)
- Piping for Air Sparge/Soil Vapor Extraction System
- Bousch Creek Culvert
- Industrial Waste Sewer Line
- Area of Uncertainty
- Estimated Extent of POL Plume (November 2012)
- Approximate Extent of DNAPL Source Area
- Estimated Extent of COC Groundwater Contaminant Plume (2012)
- Land Use Control Area (2007)
- Proposed Land Use Control Area (2013)

Notes:
-**Bold text indicates detections**
-Highlighted text indicates exceedance of clean up goal or MCL
-Results for the most recent 4 rounds of sampling are shown for each sample location when available
-All screen intervals shown are in feet below ground surface
-All concentrations are in micrograms per liter
-TW-1 is the groundwater extraction well for the Site 20 remedy enhancement
-NBS20-MW4R was not sampled in 2012 due to the well screen filled with sediment.
J - Analyte present, value may or may not be accurate or precise
L - Analyte present, value may be biased low. Value may be higher
U - The material was analyzed for, but not detected
DNAPL - Dense Nonaqueous Phase Liquid
LTM - Long Term Monitoring

N W E S

0 400 800 Feet

Reference: 2008 Aerial Photography

Figure 9-3
2009-2012 Columbia Aquifer LTM COC Exceedances in Groundwater
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 9-4 - SITE 20 - 2009-2012 DEEP AQUIFER LTM COC EXCEEDANCES IN GW.MXD CELEFTHERIADIS 6/17/2013 12:23:09 PM

Station ID	NBS20-MW17	
Screen Interval	67 - 77	
Sample Date	09/2009	05/2011
No exceedances		

Station ID	NBS20-MW14			
Screen Interval	60 - 70			
Sample Date	02/2009	09/2009	05/2011	11/2012
TCE	**13**	**15**	**3.94**	**9.9**
VC	**5 J**	**10**	0.5 U	**1.8**

Station ID	NBS20-MW15	
Screen Interval	58 - 68	
Sample Date	09/2009	05/2011
No exceedances		

Station ID	NBS20-MW08			
Screen Interval	51 - 61			
Sample Date	02/2009	09/2009	05/2011	11/2012
cis-1,2-DCE	**1,100**	**1,200**	**723 J**	**888**
TCE	100 U	**3.1**	**1.94**	**9.4 J**
VC	**53 J**	**92**	**99.8**	**128**

Station ID	NBS20-MW07	
Screen Interval	65 - 75	
Sample Date	02/2009	05/2011
VC	**43**	**30.7**

Volatile Organic Compund (VOC)	Cleanup Goals (Maximum Contaminant Level)
1,1-Dichloroethene (1,1-DCE)	7
1,2-Dichloroethane (1,2-DCA)	5
1,2-Dichloroethene (1,2-DCE)	70
Benzene	5
Trichloroethene (TCE)	5
Vinyl chloride (VC)	2

Legend

- Yorktown Aquifer Monitoring Well
- Proposed Well Location
- Proposed Contingency Well Location
- Proposed Primary Hydropunch Location
- Proposed Secondary Hydropunch Sample
- Groundwater Flow Direction (March 2009)
- Area of Uncertainty
- Estimated Extent of COC Groundwater Contaminant Plume (November 2012)
- *Approximate Extent of Columbia Aquifer DNAPL Source Area*
- Land Use Control Area (2007)
- Proposed Revised Land Use Control Area (2013)

Notes:
-**Bold text indicates detections**
-Highlighted text indicates exceedance of clean up goal or MCL
-Results for the most recent 4 rounds of sampling are shown for each sample location when available
-All screen intervals shown are in feet below ground surface 2012 LTM data is unvalidated
-NBS20-MW07 was not sampled in 2012 due to the well screen filled with sediment.
bgs - below ground surface
NA - not analyzed
J - Analyte Present, value may or may not be accurate or precise
U - The material was analyzed for, but not detected
COC - Contaminant of Concern
DNAPL - Dense Non-Aqueous Phase Liquid
LTM - Long-Term Monitoring

N W E S

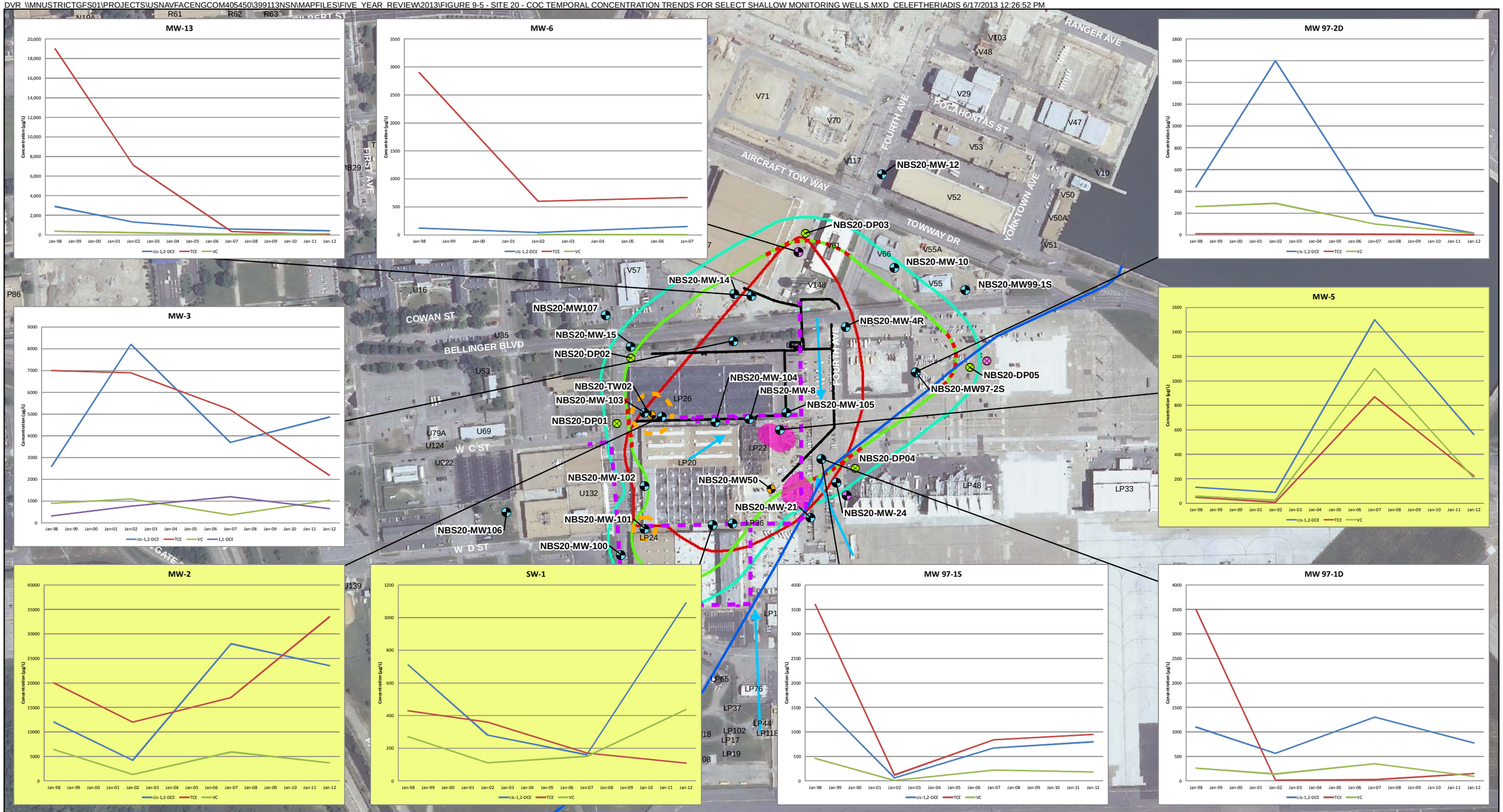
0 400 800 Feet

Reference: 2008 Aerial Photography

Figure 9-4
2009-2012 Yorktown Aquifer LTM COC Exceedances in Groundwater
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 9-5 - SITE 20 - COC TEMPORAL CONCENTRATION TRENDS FOR SELECT SHALLOW MONITORING WELLS.MXD CELEFTHERIADIS 6/17/2013 12:26:52 PM



Legend

- Proposed Columbia Aquifer Monitoring Well
- Proposed Primary Hydropunch Sample
- Proposed Secondary Hydropunch Sample
- Columbia Aquifer Monitoring Well
- Former Monitoring Well
- Groundwater Flow Direction (2012)
- Piping for AS/SVE Systems
- Bousch Creek Culvert
- Industrial Waste Sewer Line
- Area of Uncertainty
- Estimated Extent of POL Plume (November 2012)
- Approximate Extent of DNAPL Source Area
- Estimated Extent of COC Groundwater Contaminant Plume (2012)
- Land Use Control Area (2007)
- Proposed Revised Land Use Control Area (2013)

Notes:
Highlighted graph indicates an increasing trend in COC concentrations.
Graphs not highlighted indicate little to no change in COC concentrations or a decreasing trend in COC concentrations.
Vertical scales on all graphs are not consistent.
AS- Air Sparge
COC - Contaminant of Concern
DNAPL - Dense Non-Aqueous Phase Liquid
POL - Petroleum, Oil, and Lubricant

N W E S

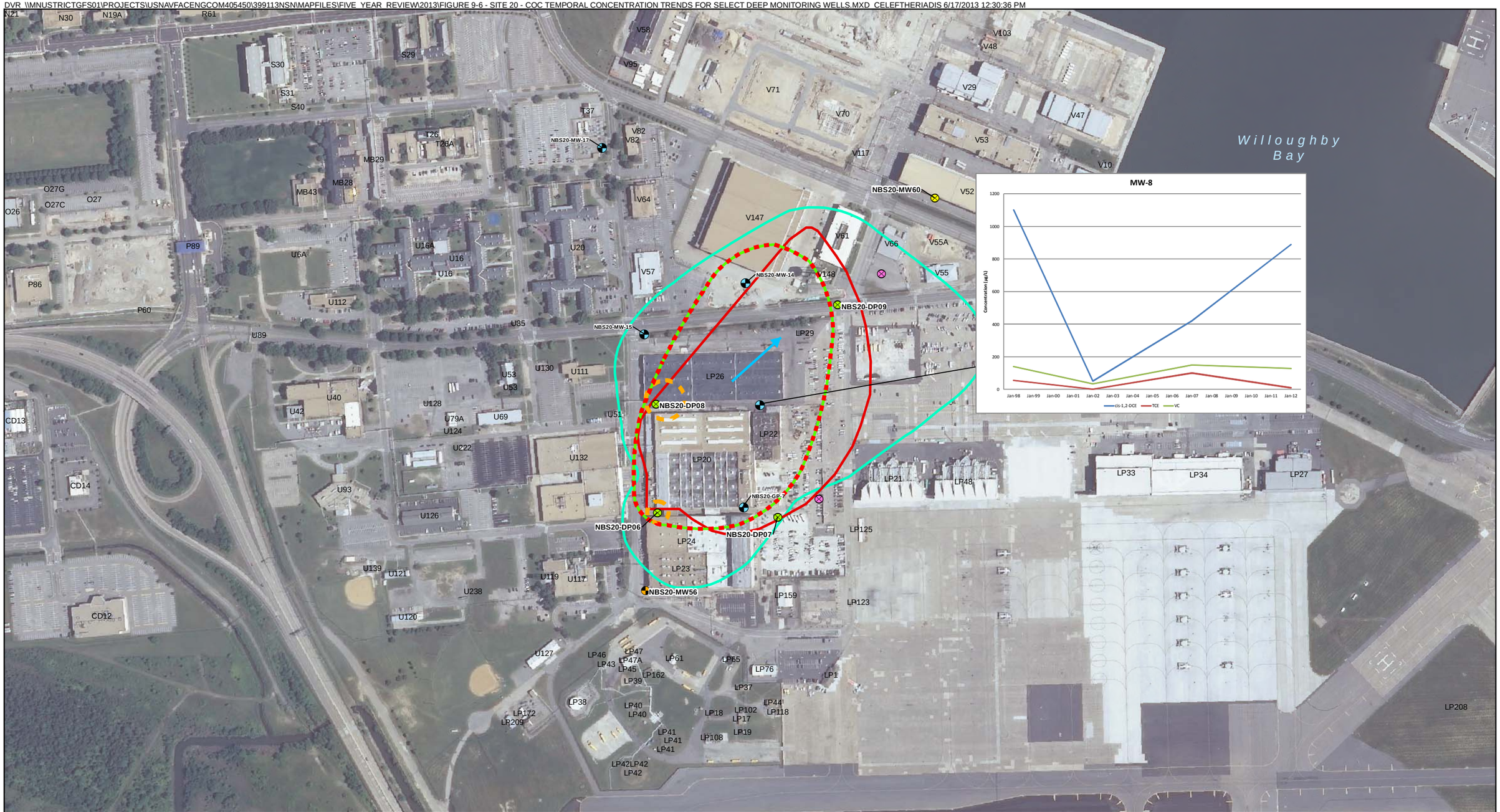
0 400 800 Feet

Reference: 2008 Aerial Photography

Figure 9-5
COC Temporal Concentration Trends for Select Shallow Monitoring Wells
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 9-6 - SITE 20 - COC TEMPORAL CONCENTRATION TRENDS FOR SELECT DEEP MONITORING WELLS.MXD CELEFTHERIADIS 6/17/2013 12:30:36 PM



Legend

- Yorktown Aquifer Monitoring Well
- Proposed Well Location
- Proposed Contingency Well Location
- Proposed Primary Hydropunch Location
- Proposed Secondary Hydropunch Sample
- Groundwater Flow Direction (March 2009)
- Area of Uncertainty
- Estimated Extent of COC Groundwater Contaminant Plume (November 2012)
- Approximate Extent of Columbia Aquifer DNAPL Source Area
- Land Use Control Area (2007)
- Proposed Revised Land Use Control Area (2013)

Notes:
Highlighted graph indicates an increasing trend in COC concentrations.
Graphs not highlighted indicate little to no change in COC concentrations or a decreasing trend in COC concentrations.
COC - Contaminant of Concern
DNAPL - Dense Non-Aqueous Phase Liquid

N
W E
S

0 400 800
Feet

Reference: 2008 Aerial Photography

Figure 9-6
COC Temporal Concentration Trends for Select Deep Monitoring Wells
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 10

Site 22—Camp Allen Salvage Yard

10.1 Chronology

The following is the chronology of the major site events for Site 22, CASY.

1940s – 1995	Use of site to salvage and process scrap materials generated at NSN
April 1982	Site 22 identified as a potential AOC in the IAS
January 1993	PA/SI Report completed
July 1996	RI Phase I conducted
August 1996	RI Phase II conducted
April 1997	NSN was placed on NPL
August 1998	NTCRA initiated at Site 22 to excavate PCB-contaminated Soil
November 1999	RI Report completed
2001	Interim removal initiated at Site 22 to excavate PCB- and metal-contaminated Soil
May 2002	FS completed at Site 22
November 2002	NTCRA initiated at Site 22 to construct a soil cover over metals-contaminated Soil – Placement of Soil Cover
July 2003	NTCRA initiated at Site 22 to cap contaminated sediments in the Pond Area
October 2003	Implementation of Five-year Review process
February 2004	PP for Site 22 made available to the public
September 2004	ROD for Site 22 completed
2008-2009	Construction of Recreational Fields on top of existing soil cover
January 2009	RACR signed; LUC RD completed

10.2 Background

10.2.1 Site Description

Site 22, the CASY, is located in the Camp Allen area south of Naval Station airfield and Interstate 564 (**Figure 10-1**). The site consists of approximately 22 acres of level ground, which is located between Areas A and B of Site 1, the CALF. The facilities that surround Site 22 include the heliport, CALF, the United States Marine Corps Camp Elmore, military housing, the Camp Allen Elementary School, and a civilian community (Glenwood Park).

10.2.2 Physical Characteristics

Site 22 is covered with soil and vegetation to minimize surface erosion and a stormwater drainage basin (pond) is located on the eastern side of the site, north of Area B at Site 1. This pond collects stormwater that drains into a storm sewer that crosses the site. The storm sewer discharges into a ditch on the north side of the site and ultimately into Bousch Creek. In May 1999, the pond area was verified to be upland property and is therefore not a jurisdictional wetland. The site groundwater is currently not used for any purpose; potable water used onsite, and by the nearby community, is supplied by the City of Norfolk (Baker, 1995c).

Groundwater associated with the site is addressed by the Site 1 RA. The two aquifer systems addressed by the Site 1 RA are the water table aquifer (Columbia aquifer) and the underlying Yorktown aquifer. The Yorktown aquifer is separated from the water-table aquifer by a confining clay unit. In the vicinity of Site 22, a breach and/or ineffective (poorly developed) portion of the confining clay unit allows downward migration of constituents from the Columbia aquifer to the Yorktown aquifer. Shallow groundwater generally discharges to the site drainage ditches (surface water does not recharge the shallow groundwater).

The CSMs for Site 1 and Site 22 is provided as **Figures 4-2a and 4-2b**.

10.2.3 Land and Resource Use

Currently, Site 22 serves as recreational fields for the Navy. Groundwater is not used for any use and potable water is supplied by the City of Norfolk. It is not anticipated land use will change in the foreseeable future.

10.2.4 History of Contamination

Site 22 operated from the 1940s until 1995 salvaging and processing scrap materials generated at NSN. Salvage yard activities have included storage and management of waste oils, used chemicals, and scrap industrial and commercial equipment, in addition to metal smelting, various recycling activities, and miscellaneous burning. Acids, paint thinners, solvents, pesticides, and transformers were also stored at the salvage yard. A PCB spill occurred at Site 22 in 1989 when a transformer was damaged by a forklift. PWC responded to the spill and conducted a preliminary cleanup at that time. When operations ceased in 1995, the buildings, incinerators, and rail lines were demolished.

Initial Response

A PA/SI was completed for CASY (Baker, 1994a) and the investigation results indicated that the surface and subsurface soil were contaminated with PCBs, pesticides, and metals. Additional data were generated during the RI/risk assessment (Baker, 1999) and showed that semivolatile organic compounds (SVOCs), pesticides, PCBs, and metals had impacted surface and subsurface soil; surface water samples collected in storm drains contained arsenic; sediment samples indicated the presence of arsenic, pesticides, and PCBs; and, antimony, arsenic, and iron were present in groundwater.

Several NTCRAs (**Figure 10-1**) have occurred at Site 22:

- In September 1997, the Navy performed an EE/CA addressing PCBs at Site 22. The intent of this action was to remove PCB-contaminated soil from the site. In August 1998, the Navy initiated a NTCRA in which more than 4,100 tons of PCB-contaminated soil exceeding cleanup goals were removed from the southern portion of the site (Baker, 1997).
- In 2001, based on the results of the initial PCB removal, a metals “hot spot” investigation was conducted to further delineate and characterize the nature and extent of antimony, arsenic, iron, and lead contamination in soil at Site 22. Six hot spot areas, totaling approximately 4,800 yd^3 of metals- and PCB-contaminated soil, were identified. In 2001, more than 16,000 yd^3 of metals- and PCB-contaminated soil were removed and sent offsite for disposal (Baker, 2001).
- As part of the confirmation sampling associated with the 2001 PCB and hot spot removal actions, more extensive and widespread metals contamination was identified at Site 22. In early 2002, the Navy completed an EE/CA addressing the metals contamination and issued a public notice of a proposed NTCRA. The public comment period of the EE/CA ended on March 4, 2002, and no comments were received. In November 2002, the Navy completed the NTCRA by placement of a 1-foot vegetated soil cover over the entire 22-acre site to reduce potential human and ecological exposure to metals contamination (Baker, 2002).
- In July 2003, the Navy completed an EE/CA addressing contaminated sediment in the pond area adjacent to the CASY and issued a public notice of a proposed NTCRA. The removal action included the removal of approximately 1,825 yd^3 of contaminated sediment, the installation of a compacted 1-foot cover of soil, and installation of a cellular concrete block system over a geotextile which covered the remaining contaminated pond sediment. The 1-foot soil cover was installed to reduce potential exposure to ecological receptors (Baker, 2003).

Site Risks

The HHRA identified no unacceptable risk from exposure to groundwater for the exposure scenarios evaluated. However, unacceptable risk to soil was identified as shown in **Table 10-1**.

At present, the Virginia Department of Transportation (VDOT) has implemented a plan to extend the I-564 intermodal connector to the Norfolk International Terminals. The highway expansion will require that local

utilities, Navy-owned ballfields, and a rail line be relocated, which will impact the northernmost section of Site 22. As a result, Site 22 was covered with approximately 3 feet of additional fill material and recreational ballfields have been constructed at the site to replace those demolished during the future highway expansion. The Navy has no plans to construct housing units on this site, as it is intended to be used as a recreational area.

Ecological risks were not assessed during the RI; however, potential ecological risk to receptors was addressed during the NTCRAs (**Figure 10-1**) conducted and the Bousch Creek Sediment Removal action (**Figure 4-1**). Potential unacceptable risks to ecological receptors were present within the pond at Site 22 (**Table 10-1**).

10.2.5 Basis for Taking Action

The primary risk posed by conditions at Site 22 is the contaminated soil underlying the soil cover, which poses a potential risk to human and ecological receptors. Based on the results of previous investigations, RA is warranted to protect public health and welfare from actual or threatened releases of inorganics in soil and sediment. Site 22 groundwater (and potential VI pathways) are addressed as component of the remedy for Site 1.

10.3 Remedial Actions

10.3.1 Remedy Selection

RI and FS reports were completed at Site 22 in 1999 (Baker, 1999) and 2002 (Baker, 2002), respectively. A ROD, addressing the soil and sediment at the site, was signed in September of 2004. The ROD identified the risks to human and ecological receptors exposed to soil and sediment, established the RAOs, and defined the selected remedy. The selected remedy for Site 22 includes LUCs for soil and sediment to meet the following RAOs:

- Reduce the threat of the covered soil from becoming a potential source of contamination to human and ecological receptors.
- Reduce the threat of the covered sediment from becoming a potential source of contamination to ecological receptors in the pond area.

The LUC RD specifies the following LUC objectives for Site 22:

- Prohibit the development and use of the property for residential housing, elementary and secondary schools, child-care facilities, and other activities that would pose an unacceptable risk to human and environmental receptors.
- Ensure no construction and maintenance activities, including activities that involve digging into the existing soil cover, are undertaken until the Navy implements adequate base procedures to ensure the integrity of the soil cover.
- Ensure no work on the storm drainage system or around the pond occurs without the use of appropriate worker precautions.

These LUC restrictions have been implemented as detailed in the *Revised Draft Final RD for LUCs for Soil and Sediment at Site 22*. The LUCs will be maintained on all land within the boundaries of Site 22 and the pond area adjacent to Site 22 until contaminant levels diminish so as to allow UU/UE, as stipulated in the ROD (Baker, 2004). Because the shallow and deep aquifers at Sites 1 and 22 are considered one hydrogeologic unit, the cleanup of groundwater at Site 22 is included in the Site 1 groundwater extraction and treatment system.

10.3.2 Remedy Implementation

The initial RA at Site 22 consisted of the NTCRA and offsite disposal of metals and PCB contaminated soils in August 1998. Additional delineation of site contaminants in 2001 identified six metals hot spots throughout the site. As an interim measure, the Navy began removal of the hot spot soils in conjunction with the on-going PCB removal action. The hot spot and PCB contaminated soil removal continued through 2001 with the ultimate excavation of more than 16,000 yd^3 of material. The removal action achieved the soil PCB cleanup goals; however,

the additional soil analytical data indicated that the extent of metals contamination was more widespread than previously estimated. It was estimated that approximately 29,000 yd^3 of soil remained at the site above the metals cleanup goals. Based upon the more comprehensive confirmation sampling and anticipated future land use of the site, the remedial measures for the site were re-evaluated. In March 2002, the NSN Tier I Partnering Team agreed that the placement of a soil cover was more cost effective than removal of the metals contaminated soils.

In 2003, the Navy completed an EE/CA addressing the contaminated sediment in the pond area. The removal action included the removal of approximately 1,825 yd^3 of contaminated sediment, the installation of a soil cover, and a cellular concrete block system over a geotextile covering for the remaining contaminated pond sediment. The engineered soil cover and the cover for the sediments in the pond were completed in June 2004.

In November 1998, the Site 1 groundwater remediation system was placed in continuous operation. This system collects and treats VOCs in the groundwater underlying Areas A and B of Site 1 in addition to Site 22.

10.3.3 System Operation and Maintenance

In accordance with the ROD, quarterly inspections of the soil and sediment covers are conducted to verify their integrity. Posted signs on the perimeter of the site are maintained to indicate the environmental monitoring at the site and prohibit intrusive activities.

10.4 Progress since the Last Review

10.4.1 Follow-up Actions since the Last Five-year Review:

The previous Five-year Review Report included the following protectiveness statement for Site 3:

The cover systems at Site 22 prevent direct contact with soil and sediment. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the covers, LUCs, and implementation of ICs.

No additional recommendations or follow-up actions were identified for Site 22 during the previous Five-year Review.

10.4.2 Actions Summary

Long-term Monitoring Data Review

Because the shallow and deep aquifer at Sites 1 and 22 are considered one hydrogeologic unit, the groundwater at Site 22 has been characterized and will be addressed concurrent to the groundwater at Site 1.

Site Inspections

Site inspections are conducted quarterly at Site 22 to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review. No discrepancies affecting the remedy have been observed at Site 22 during the quarterly inspections. The most recent inspection was conducted in April 2013.

Remedy Costs

The average remedy costs for maintaining the soil and sediment cover and conducting quarterly site inspections is approximately $9,000 per year. The estimated O&M costs for the selected remedy in the ROD were approximately $9,200 per year; the actual cost for the selected remedy is similar to the costs estimated by the ROD.

10.5 Technical Assessment

Is the remedy functioning as intended by the Decision Documents?

The covering of soils and sediments at Site 22 has achieved the RAOs to reduce the threat of contamination to human and ecological receptors.

Are the exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-year Review. There is no indication that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of some contaminants at Site 22, these changes would not adversely affect the protectiveness of the selected remedy as it would not substantially change the results of the risk assessment. Additionally, the remedy is LUCs and cover of the soil and sediment, preventing an exposure to the site contamination.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how HHRAs and ERAs are conducted, none of these changes adversely affect the protectiveness of the selected remedy for Site 22.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information that calls into question the protectiveness of the remedy.

Technical Assessment Summary

Based on the information presented herein, the remedy for Site 22 is functioning as intended by the ROD containing COCs to prevent exposure and migration of COCs in site media. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the soil cover, sediment cover, and LUCs.

10.6 Issues, Recommendations, and Follow-up Actions Identified

There were no issues, recommendations, or follow-up actions identified at Site 22 during this Five-year Review.

10.7 Protectiveness Statement

The cover systems at Site 22 are protective by preventing direct contact with soil and sediment. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the covers and enforcement of LUCs.

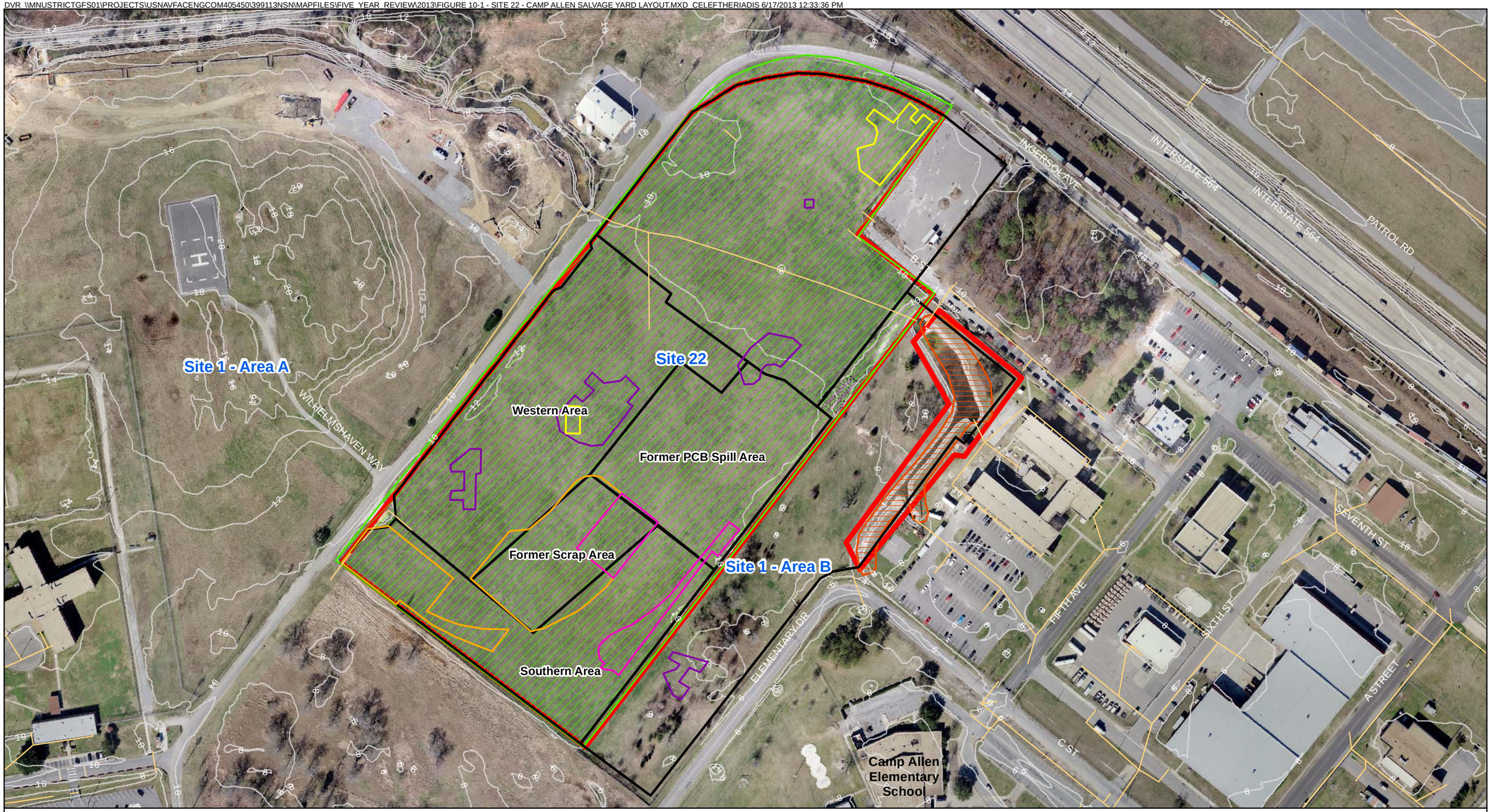
TABLE 10-1

Site 22 Remedy Performance Standards

OU	Site	Risk	Media	Reasonably Anticipated Land Use	COC Requiring Action	Basis for Action	RAO	Remedy Component	Site Closeout Strategy	Performance Metric / Cleanup Level*
8	22	Human Health	Soil	Recreational Use	Arsenic	HI > 1 ICLR > 1 x 10^{-6}	Prevent unlimited use and unrestricted exposure UUUE to soil beneath the former process pits that poses a potential unacceptable risk to human health Reduce the threat of the covered soil from becoming a potential source of contamination to human and ecological receptors	LUCs	Enforce LUCs to prevent exposure to receptors.	No intrusive activities
					Antimony	HI > 1				
					Iron	HI > 1				
					Lead	HI > 1				
		Ecological	Sediment	Stormwater Retention Pond	Pesticides	Potential unacceptable risk	Reduce the threat of the covered soil from becoming a potential source of contamination to human and ecological receptors	LUCs	Enforce LUCs to prevent exposure to receptors.	No intrusive activities
					PCBs					
					Inorganics					

Acronyms:
COC - contaminant of concern
HI - hazard index
ILCR - incremental lifetime cancer risk
LUC - land use control
OU - operable unit
PCB - polychlorinated biphenyl
RAO - remedial action objective

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 10-1 - SITE 22 - CAMP ALLEN SALVAGE YARD LAYOUT.MXD CELEFTHERIADIS 6/17/2013 12:33:36 PM



Legend

- Storm Sewer Line
- Topographic Contour (2ft Interval)
- PCB Contaminated Soil Removed in 1998
- PCB/Metals Contaminated Soil Removed in 2001
- Metals 'Hot Spot' Soil Removed (0-4 Foot) in 2001
- Metals 'Hot Spot' Soil Removed (0-1.5 Foot) in 2001
- Sediment Cover Installed in 2003
- Soil Cover Installed in 2002
- Former Area
- Land Use Control Area (2008)

N
W E
S

0 200 400 Feet

Reference: 2008 Aerial Photography

Figure 10-1
Site 22 - Camp Allen Salvage Yard Layout
Naval Station Norfolk
Norfolk, Virginia

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SECTION 11

Site 23—Building LP-20 Plating Shop

11.1 Chronology

The following is the chronology of the major site events for Site 23, Building LP-20 Plating Shop.

1986 – 1994	Eleven separate pre-RIs in the LP area.
December 1990	Enforcement order based upon observed violation of the Virginia Hazardous Waste Management Regulations (VHWMRs)
1994	Removal of the process tanks and equipment located in the pits and removal of the piping for decontamination or disposal
September 1996	Site 20 RI completed
February 1996	RCRA Phase I Investigation
October 1996	RCRA Phase II Investigation
April 1997	NSN placed on the NPL
December 1997	RCRA Phase III Investigation
December 1997	Risk-Based Closure Plan
September 2000	Revised Clean Closure Plan was submitted to VDEQ
July 2003	Site was transferred from the RCRA to the CERCLA program
July 2005	SI completed
2007	NTCRA implemented at Site 23 to remove debris and brick tiling located within the process pits and brick tiles covering the floor and install concrete cover over metals-contaminated soil
March 2008	Focused Feasibility Study (FFS) completed
August 2008	PP completed
September 2008	ROD signature
October 2008	Implementation of Five-year Review process
July 2009	LUC RD completed

11.2 Background

11.2.1 Site Description

Site 23, Building LP-20 Plating Shop, is located inside Building LP-20 (Site 20), which is one of many large buildings located northwest of the NAS main runway (**Figures 2-1 and 11-1**).

The Plating Shop occupies approximately 9,500 square feet (ft^2) of Building LP-20, which a little less than a quarter of the total area of the building. In the past, a portion of the building was used for aircraft engine overhaul and maintenance. Currently, the building is used as a motor pool and office space; however, the former Plating Shop area within the building, designated Site 23 is currently only used for warehouse storage.

11.2.2 Physical Description

Site 23 lies completely within the boundary of Site 20; accordingly, the geology and hydrogeology at Site 23 are the same as Site 20. The former plating shop contained several pits that protruded into the concrete slab which are now filled. A solid concrete surface is currently present at the site as a result of the completed NTCRA.

The CSM for Site 20 (including Site 23) is provided as **Figure 9-2**.

11.2.3 Land and Resource Use

It is anticipated that use of the site will continue to be industrial. No residential development is planned or expected for Building LP-20 or the immediate surrounding area. Groundwater is not used as a potable water supply; potable water is supplied to the base and surrounding areas by the City of Norfolk.

11.2.4 History of Contamination

Previous activities in the plating shop included disassembling, stripping, and replating metal parts. The shop contained seven process pits that extended beneath the concrete slab floor that were used for cleaning, stripping, and plating engine parts. The process tanks and equipment were also located in pits. The floor and pits were lined with corrosion resistant brick tiles. The shop also contained a drainage system for the collection of wastewater from the pits and delivery to the industrial WWTP.

During a 1989 site visit, VDEQ observed violations of the VHWMRs. An enforcement order was effective in December 1990. Under RCRA, the Clean Closure Plan and Contingency Plan were completed in 1993 and approved by VDEQ in September 1994. The Navy requested a modification of the plans to conduct a risk-based closure. Multiple phases of investigation were conducted for partial implementation of the Risk-based Closure Plan (Versar, 1997). The risk assessment indicated unacceptable industrial risk in soils, but no unacceptable risks with exposure to the Plating Shop concrete floors. Groundwater was recommended to be addressed under a post closure monitoring program. Final closure was not achieved; however, under the RCRA program, a partial closure of the site was performed that included the removal of the process tanks and equipment located in the pits and removal of the piping for decontamination or disposal (Versar, 1997). In September 2000, a revised Clean Closure Plan was submitted to VDEQ. However, in July 2003, the Navy decided to move the site from the RCRA to the CERCLA program. As such, the clean closure was never implemented.

Initial Response

A PA/SI is the first step in evaluating a site under CERCLA; however, in November 2003 the NSN Tier I Partnering Team agreed that the existing documents completed under the RCRA program could be used in lieu of a formal PA/SI. In addition, the NSN Tier I Partnering Team joint-scoped additional soil investigation activities. The additional investigation was conducted in December of 2004. The results of the investigation showed that there were concentrations of one VOC, SVOCs (primarily polynuclear aromatic hydrocarbons [PAHs]), and metals above respective residential and industrial risk-based concentrations.

In May 2005, the NSN Tier I Partnering Team agreed to conduct an interim removal action to address the site soils. Accordingly, an EE/CA was completed in December 2006 (CH2M HILL, 2006b) and construction activities were initiated in June 2006. All debris and brick tiling located within the process pits and brick tiles covering the floor were removed and appropriately disposed. The Plating Shop pits and interconnected conduits were filled with flowable concrete fill, and a 6-inch concrete cover with an industrial floor sealant was constructed to prevent potential exposure to underlying impacted soil. The construction activities are documented in the *Final Completion Report, Site 23, LP-20 Plating Shop, Naval Station Norfolk, Norfolk, Virginia* Construction (Shaw, 2008).

Site Risks

Unacceptable risk to soil was identified as shown in **Table 11-1**. Groundwater beneath the site is addressed as the RA for Site 20.

There is no ecological habitat at the site; therefore, no unacceptable ecological risks were identified at Site 23.

11.2.5 Basis for Taking Action

The primary risk posed by conditions at Site 23 is the contaminated soil underlying the concrete cover, which poses a potential risk to human receptors. Based on the results of previous investigations, RA is warranted to protect public health and welfare from actual or threatened releases of inorganics and polynuclear aromatic hydrocarbons (PAHs) in soil. Site 23 groundwater (and potential VI pathways) are addressed as component of the remedy for Site 20.

11.3 Remedial Actions

11.3.1 Remedy Selection

The completion of the interim removal action to place the concrete cover at Site 23 provided the protective barrier to prevent exposure to contaminated soils beneath the former plating shop. A FFS was developed to evaluate the implementation of LUCs to prevent future exposure.

The FFS was submitted in March of 2008 (CH2M HILL, 2008a), the PP was issued in September of 2008 (CH2M HILL, 2008d), and the ROD was signed in September 2008 (CH2M HILL, 2008e). The ROD identified the risks to human health and the environment, established the RAO, and defined LUCs as the selected remedy. The purpose of the LUCs was to minimize exposure to contamination present in the soil. Based on future use of Site 23 as an industrial site, the existing concrete cover prevents an exposure to soil. Construction workers, however, could be exposed to impacted soil during excavations or other intrusive activities. The selected remedy for Site 23 is LUCs to meet the following RAO:

- Prevent UU/UE to soil beneath the former process pits that poses a potential unacceptable risk to human health.
- Reduce the threat of the covered soil from becoming a potential source of contamination to human and ecological receptors.

The LUC RD established the following LUC objectives for Site 23:

- Prohibit residential use of the area surrounding the Site 23 workshop.
- Two, prohibit activities that interfere with or compromise the integrity of the concrete cover at Site 23.

The LUC restrictions have been implemented as detailed in the RD for LUCs at Site 23.The LUC is to be maintained by the Navy within the boundaries of Site 23 until concentrations of contaminant have reduced to levels to allow UU/UE, as stipulated in the ROD.

As documented in the ROD, since Site 23 is within the boundaries of Site 20; therefore, the groundwater at Site 23 is being addressed with the RA implemented for Site 20 (see Section 8).

11.3.2 Remedy Implementation

RA was implemented at Site 23 on June 4, 2008. Since completion of the ROD, engineering controls that have been implemented include quarterly inspections and signage.

11.3.3 System Operation and Maintenance

In accordance with the ROD, quarterly inspections of the cover are conducted to verify its integrity. Posted signs on the perimeter of the site are maintained to maintain access/use restrictions.

11.4 Progress Since Last Review

11.4.1 Follow-up Actions since the last Five-year Review

The previous Five-year Review Report included the following protectiveness statement for Site 23:

The cover at Site 23 prevents direct contact with the soil. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the cover, LUCs, and implementation of ICs.

No additional recommendations or follow-up actions were identified for Site 23 during the previous Five-year Review.

11.4.2 Action Summary

Long-term Monitoring Data Review

The groundwater at Site 23 is being monitored as part of the LTM program at NSN for Site 20. Details of the groundwater evaluation for Site 20 are provided in Section 9.5.

Site Inspections

Site inspections are completed quarterly at Site 23 to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review. No discrepancies have been observed over the past 5 years; the last inspection was completed April 2013.

Remedy Costs

The average remedy costs for maintaining the concrete cover and conducting quarterly site inspections is approximately $1,500 per year. The estimated O&M costs for the selected remedy in the ROD were approximately $1,526 per year; the actual cost for the selected remedy is similar to the costs estimated by the ROD.

11.5 Technical Assessment

Is the remedy functioning as intended by the Decision Documents?

Based on the review of the documents, ARARs, risk assumptions, and inspections, the remedy is functioning as intended by the ROD. Implementation and maintenance of ICs has prevented exposure to contaminated media.

Are the exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affect the protectiveness of the remedy were identified during this Five-year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-year Review. There is no indication that hydrologic or hydrogeologic conditions have changed in a way to adversely affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been some changes in toxicity values, regulatory levels, and risk characteristics of some contaminants at Site 23, these changes would not adversely affect the protectiveness of the selected remedy as it would not substantially change the results of the risk assessment.

Changes in Risk Assessment Methodologies. Although there have been some procedural changes to how HHRAs and ERAs are conducted, none of these changes adversely affect the protectiveness of the selected remedy for Site 23.

There have been no changes that would affect the effectiveness of remedy (LUCs) there is no exposure or risk, and remedy is effective.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the remedy.

Technical Assessment Summary

Based on the information presented herein, the remedy for Site 23 is functioning as intended by the ROD containing COCs to prevent exposure and migration of COCs in site media. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the concrete cover and LUCs.

11.6 Issues, Recommendations, and Follow-up Actions Identified

There were no issues identified at Site 23 during this Five-year Review.

11.7 Protectiveness Statement

The cover at Site 23 is protective by preventing direct contact with the soil. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the concrete cover and enforcement of LUCs.

TABLE 11-1

Site 23 Remedy Performance Standards

OU	Site	Risk	Media	Reasonably Anticipated Land Use	COC Requiring Action	Basis for Action	RAO	Remedy Component	Site Closeout Strategy	Performance Metric / Cleanup Level*
10	22	Human Health	Soil	Industrial Facility	benzo(a)anthracene	ICLR > 1 x 10^{-6}	Prevent unlimited use and unrestricted exposure to soil beneath the former process pits that poses a potential unacceptable risk to human health. Reduce the threat of the covered soil from becoming a potential source of contamination to human and ecological receptors.	LUCs	Enforce LUCs to prevent exposure to receptors.	No intrusive activities and no change in land use
					benzo(a)pyrene	ICLR > 1 x 10^{-6}				
					benzo(b)fluoranthene	ICLR > 1 x 10^{-6}				
					benzo(k)fluoranthene	ICLR > 1 x 10^{-6}				
					dibenz(a,h)anthracene	ICLR > 1 x 10^{-6}				
					indeno(1,2,3-cd)pyrene	ICLR > 1 x 10^{-6}				
					Arsenic	HI > 1 ICLR > 1 x 10^{-6}				
					Cadmium	HI > 1 ICLR > 1 x 10^{-6}				
					Chromium	HI > 1 ICLR > 1 x 10^{-6}				
					Lead	HI > 1				
					Nickel	HI > 1				

Acronyms:
COC - contaminant of concern
HI - hazard index
ILCR - incremental lifetime cancer risk
LUC - land use control
OU - operable unit
RAO - remedial action objective

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 11-1 - SITE 23 - BUILDING LP20 PLATING SHOP LAYOUT.MXD CELEFTHERIADIS 6/17/2013 12:40:42 PM

Legend

- Topographic Contour (2ft Interval)
- Land Use Control Area (2008)

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Reference: 2008 Aerial Photography

Figure 11-1
Site 23 - Building LP-20 Plating Shop Layout
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL

SECTION 12

SWMU 14 — Q-50 Satellite Accumulation Area

12.1 SWMU 14 Chronology

The following is the chronology of the major site events for SWMU 14, Satellite Accumulation Area.

1974 – 1978	Eastern portion of Sewells Point was formed from the disposal of construction debris
1992	RFA identified SWMU
1995	Phase I RRR Completed
1996	Phase II RRR Completed
April 1997	NSN placed on the NPL
1998	Supplemental Investigation Report
August 2004	RI/HHRA/ERA Completed
2006	Ecological Sampling Investigation Summary of Groundwater/Pore Water
2008	NTCRA implemented to construct protective barrier over the site
July 2009	Revised Final FFS Completed
August 2009	PP Completed
July 2010	ROD Signature
August 2010	RACR Signature and LUC RD

12.2 Background

12.2.1 Description

SWMU 14 (**Figure 12-1**) is located on the northwest corner of NSN adjacent to both Willoughby Bay and the Chesapeake Bay in an area referred to as Sewell's point. SWMU 14 is composed of a former a satellite accumulation area and is co-located with Site 9 (Q-Area Landfill). The satellite accumulation area and the Q-Area landfill were initially identified in the ERP as SWMU 14 and Site 9, respectively. Site 9 was recommended for No Further Action in 1997, and future investigation activities for both the landfill and the accumulation area were completed as a single site as SWMU 14. The boundary for SWMU 14 encompassed what had been previously defined as Site 9 for the investigations.

12.2.2 Physical Characteristics

The peninsula at Sewell's Point is a manmade landmass formed from two distinct periods of fill activities. The first began in the 1950s, when the channels were dredged to allow for construction of the northernmost series of piers at the site. The resulting dredge material was used to create much of the land at Sewell's Point. The second was between 1974 and 1978, when the peninsula's eastern portion was formed from the disposal of construction debris.

There are two significant groundwater aquifer systems located beneath NSN—the water-table (Columbia) aquifer and the underlying Yorktown aquifer. The water-table aquifer at NSN is generally thin and consists of discontinuous heterogeneous sand and shell lenses in the upper 20 to 40 feet bgs of the Columbia group. The depth to the water-table is usually less than 8 feet. The Yorktown aquifer is semiconfined beneath a clay layer in the upper Yorktown Formation. Water-bearing zones in the Yorktown aquifer consist of fine to coarse sand, gravel, and shells. The shallow groundwater at SWMU 14 is located within dredge fill and construction debris fill materials.

The CSM for SWMU 14 is provided as **Figure 12-2**.

12.2.3 Land and Resource Use

Currently the site serves as a parking lot to support the aircraft carrier piers located to the Southwest of the site. Groundwater is not utilized as a resource at NSN and all potable water is provided by the City of Norfolk.

12.2.4 History of Contamination

The satellite accumulation area initially consisted of a concrete storage pad surrounded by a grass-covered field that was periodically used as a temporary parking lot when adjacent lots were full. The original concrete pad served as a less-than-90-day hazardous waste accumulation area, where wastes from various waste streams were sampled, identified, labeled, and packaged before being shipped for disposal. The pad was later removed and replaced by a second pad, which was used for temporary storage of environmental investigation-derived waste (IDW) materials. Currently, the site is completely covered by a protective barrier which also serves as an asphalt parking lot (**Figure 12-1**).

Initial Response

The SWMU was initially identified from a 1982 Environmental Photographic Interpretation Center (EPIC) aerial photograph and the site was cited during the 1992 RFA site inspection, when areas of stained soil were observed. Site 9 (included in the evaluation of SWMU 14) was identified in the IAS (ESE, 1983) where it was reportedly used for the disposal of nonhazardous construction debris. NSN initiated environmental investigation efforts at SMWU 14 and other sites by conducting two RRRs in 1995 and 1996 and a Supplemental SI report completed in 1999.

A four-phase RI with an HHRA and ERA was conducted to further define the nature and extent of soil, groundwater, sediment, and surface water contamination and assess potential risks to human health and the environment. As a result of the RI, a NTCRA was completed to completely cover the site with a protective barrier which also serves as an asphalt parking lot. The protective barrier construction was implemented in 2008 by a NTCRA that was supported by and based upon an EE/CA (CH2M HILL, 2008). Following the 2008 NTCRA, the satellite accumulation area and a portion of the Q-Area landfill were converted to an asphalt parking lot

Site Risks

Unacceptable human health risk to soil and subsurface soil was identified as shown in **Table 11-1**.

Minimal/limited ecological risk to receptors due to exposure to soil and sediment at SWMU 14. No unacceptable ecological risks associated with groundwater discharging from beneath SWMU 14 to surrounding water bodies were identified by the ERA. A trident probe study was completed in 2006 that evaluated the potential for groundwater to discharge to surface water (CH2M HILL, 2007h). The results of the study indicated there was no discernable evidence of groundwater discharge to surface water.

12.2.5 Basis for Action

The Selected Remedy documented in the ROD for SWMU 14 was necessary to protect public health, welfare, and the environment from exposure to hazardous substances in the surface and subsurface soil remaining in place at SWMU 14. Based on the results of the 2004 HHRA and ERA, the 2006 Trident Probe study, the completion of the NTCRA, and the additional assessment of groundwater, potential risks associated with sediment and groundwater are acceptable.

12.3 Remedial Actions

12.3.1 Remedy Selection

The NTCRA constructed a parking lot at SWMU 14, which provided the protective barrier to prevent exposure to contaminated soils. A FFS was developed to evaluate the implementation of LUCs to prevent future exposure.

The FFS was submitted in 2008, the PP was issued in August 2009, and the ROD was signed in July 2010. The ROD identified the risks to human health and the environment, established the RAO, and defined LUCs as the selected

remedy. The purpose of the LUCs was to minimize exposure to contamination present in the soil. Based on future use of SWMU 14 as parking lot, the existing asphalt cover prevents an exposure to soil. Construction workers, however, could be exposed to impacted soil during excavations or other intrusive activities. The selected remedy for SWMU 14 is LUCs to meet the following RAO:

- Implement measures to reduce or eliminate exposure routes that pose a potential unacceptable risk to human health.

The ROD selected the following LUC objectives for SWMU 14:

- Prohibit digging into or disturbance of the existing asphalt cover
- Prohibit the withdrawal of groundwater

These LUC restrictions are implemented with the actions detailed in the LUC RD. The LUCs will be maintained within the boundaries of SWMU 14 until concentrations of contaminant have reduced to levels to allow UU/UE, as stipulated in the ROD.

12.3.2 Remedy Implementation

RA was implemented at SWMU 14 in August 2010. Engineering controls implemented at SWMU 14 include and signage. Site inspections for LUCs are conducted quarterly.

12.3.3 System Operation and Maintenance

In accordance with the ROD, quarterly inspections of the cover are conducted to verify its integrity. Posted signs on the perimeter of the site are maintained to maintain access restrictions.

12.4 Progress Since Last Review

12.4.1 Follow-up Actions since the last Five-year Review

This is the first Five-year Review for SWMU 14.

12.4.2 Action Summary

Site Inspections

Site inspections are completed quarterly at SWMU 14 to ensure LUCs are maintained. The inspection findings and resolutions are summarized in an annual report that is provided to the USEPA and VDEQ for review. No discrepancies have been observed since the signature of the ROD in 2010; the last inspection was completed April 2013.

Beginning in 2011, several of the bioretention areas associated with SWMU 14 have been noted to be in poor condition due to off-road vehicle traffic. The Navy expects to conduct maintenance on the western bioretention areas in July 2013. Additionally, several of the LUC signs have been knocked down by high winds at the site; the Navy plans to replace and reinstall the signs in June 2013.

Remedy Costs

The average remedy costs for maintaining the asphalt cover and conducting quarterly site inspections is approximately $1,500 per year. The estimated O&M costs for the selected remedy in the ROD were approximately $7,886 per year; the actual cost for the selected remedy is less than the costs estimated by the ROD.

12.5 Technical Assessment

Is the remedy functioning as intended by the Decision Documents?

Upon review of historical documents, risk assessments, ARARs, and site inspections, the remedy is functioning as intended by the ROD. The capping of the landfill and contaminated soil has achieved the RAO to prevent exposure

by potential receptors. The LUCs implemented have prevented activities at SWMU 14 that would result in impact to the protective barrier (asphalt parking lot) and exposure to by potential receptors.

The ICs will continue to be implemented at the site to prohibit the activities at the site that would disturb the protective barrier.

Although the RI indicated potential unacceptable risks associated with potable use of groundwater, a further evaluation of the groundwater by USEPA suggested that groundwater does not pose an unacceptable risk. Arsenic was the only contaminant found in an aerial extent large enough to be considered a plume. The arsenic data, which were collected prior to completion of the NTCRA, exceeds the current MCL; however, is within an acceptable risk range based upon USEPA's Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-30. Based upon maximum concentrations of arsenic in groundwater and site-specific conditions, the groundwater MCL exceedances were considered acceptable at SWMU 14.

Are the exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives used at the time of selection still valid?

Changes in Standards and TBCs. No changes in standards or TBCs that adversely affects the protectiveness of the remedy were identified during this Five-year Review.

Changes in Exposure Pathways. No changes in the site conditions that would affect exposure pathways were identified during the Five-year Review. No new contaminants, sources, or routes of exposure were identified as part of this Five-year Review.

Changes in Toxicity and Other Contaminant Characteristics. Although there have been several changes in toxicity values, regulatory levels, and risk characteristics of some constituents detected and some of the COCs at SWMU 14, these changes would not adversely affect the protectiveness of the selected remedy as it would not substantially change the results of the risk assessment or the effectiveness of the remedy (protective barrier and LUCs).

Changes in Risk Assessment Methodologies. Although few procedural changes to how a HHRA is conducted have been made, none of these changes adversely affect the protectiveness of the selected remedy for SWMU 14. There have been no major procedural changes in how the ERAs are conducted since the signature of the ROD.

The remedy for SWMU 14, a protective barrier for contaminated soil and land use restrictions, remains protective of human health.

Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that could call into question the protectiveness of the selected remedy.

Technical Assessment Summary

Based on the information presented herein, the remedy for SWMU 14 is functioning as intended by the ROD containing COCs to prevent exposure and migration of COCs in soil. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the protective cover and LUCs.

12.6 Issues, Recommendations, and Follow-up Actions Identified

Issues, recommendations, and follow-up actions identified for SWMU 14 during this Five-year Review are provided in **Table 12-2**.

12.7 Protectiveness Statement

The asphalt cover at SWMU 14 is protective by preventing direct contact with the soil. Exposure pathways that could result in an unacceptable risk are being controlled through a combination of the cover and enforcement of LUCs.

TABLE 12-1

SWMU 14 Remedy Performance Standards

OU	Site	Risk	Media	Reasonably Anticipated Land Use	COC Requiring Action	Basis for Action	RAO	Remedy Component	Site Closeout Strategy	Performance Metric / Cleanup Level*
13	SWMU 14	Human Health	Surface Soil	Parking Lot	Iron	HI > 1	Implement measures to reduce or eliminate exposure routes that pose a potential unacceptable risk to human health	LUCs	No intrusive activities	No intrusive activities or change in land use
					Thallium	HI > 1				
					Vanadium	HI > 1				
			Subsurface Soil		Benzo(a)pyrene	ILCR > $1x10^{-4}$				
					Antimony	HI > 1				
					Iron	HI > 1				
					Thallium	HI > 1				
					Vanadium	HI > 1				

Acronyms:
COC - contaminant of concern
HI - hazard index
ILCR - incremental lifetime cancer risk
LUC - land use control
OU - operable unit
RAO - remedial action objective
SWMU - solid waste management unit

TABLE 12-2

Issues, Recommendations and Follow-up Actions for SWMU 14

Action Requiring Follow-Up from Third Five-Year Review Report					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
None					
Ongoing Site Supplemental Investigation and Optimization Activities to ensure Continued Protectiveness					
Issue	**Recommendations and Follow up actions**	**Party Responsible**	**Milestone Date**	**Affects Protectiveness**	
				Current	**Future**
The signs required by the LUC RD are repeatedly blown away due to high winds caused by storms at the site.	The Navy is currently working on a strategy to increase the longevity of the signs considering the high winds frequently experienced at the site.	Navy, USEPA, and VDEQ	NA	No	No
The bioretention swales are in poor condition as observed during multiple site inspections.	The Navy is conducting maintenance to restore the functionality and the effectiveness (and aesthetics) of the bioretention swales.	Navy, USEPA, and VDEQ	NA	No	No

Acronyms:
LUC - land use control
NA - not applicable
RD - Remedial Design
USEPA - United States Environmental Protection Agency
VDEQ - Virginia Department of Environmental Quality

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\399113NSN\MAPFILES\FIVE_YEAR_REVIEW\2013\FIGURE 12-1 - SWMU 14 - SATELLITE ACCUMULATION AREA LAYOUT.MXD CELEFTHERIADIS 6/17/2013 12:41:24 PM

Legend

- Topographic Contour (2ft Interval)
- Asphalt Cover
- Bioretention Areas
- Land Use Control Area (2010)

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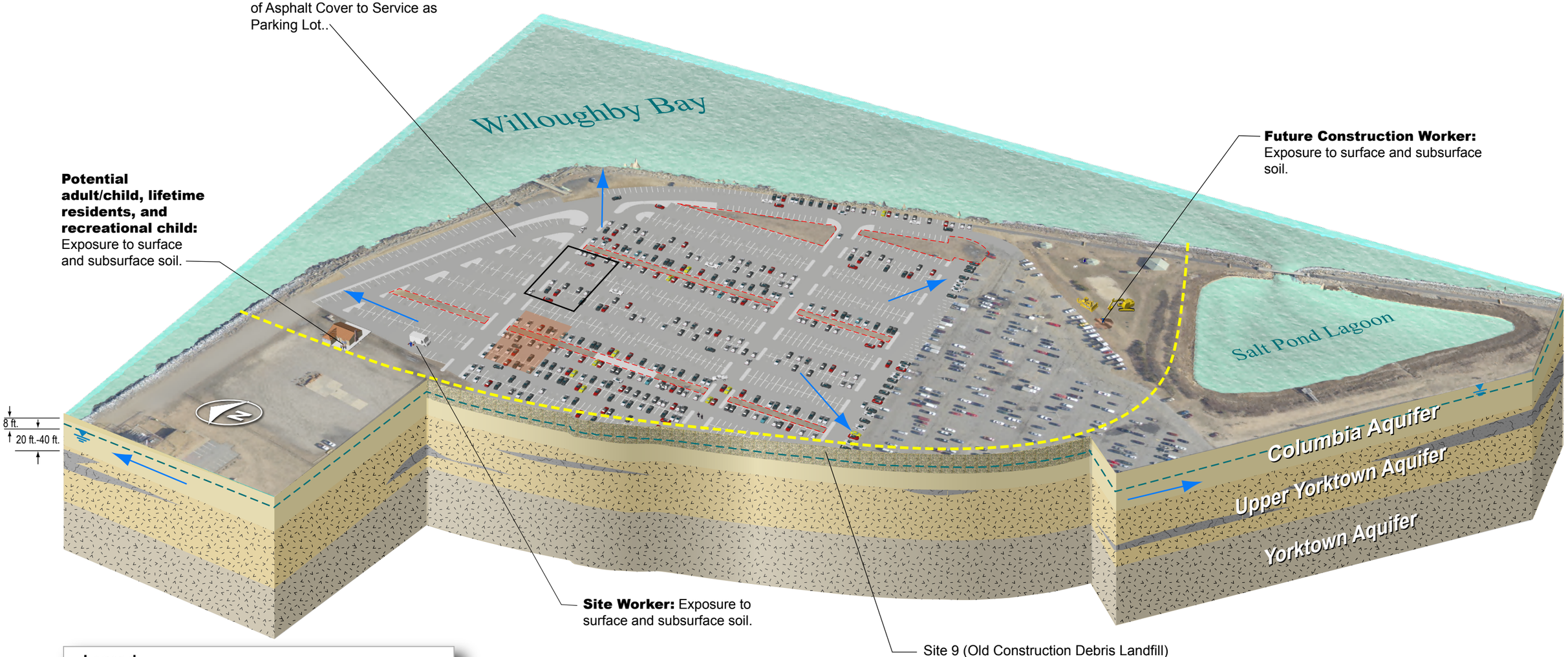
Reference: 2008 Aerial Photography

Figure 12-1
SWMU 14 - Satellite Accumulation Area Layout
Naval Station Norfolk
Norfolk, Virginia

CH2MHILL



Legend

- Site 9 Boundary
- Former Temporary Storage of IDW Materials
- Former SWMU 14 Q-50 Satellite Accumulation Area
- Bioretention Areas
- Assumed Groundwater Flow Direction
- Water Table
- Fill (Old Construction Debris Landfill)
- Columbia Aquifer (Discontinuous Heterogeneous Sand and Shell Lenses)
- Upper Yorktown Aquifer (Clay)
- Yorktown Aquifer (Fine to Course Sand, Gravel, and Shells
- Shell Lenses
- IDW Investigative Derived Waste
- NTCRA Non-Time-Critical Removal Action

Notes: The material at SWMU 14 is characterized by two distinct classifications: dredge fill and construction-debris fill. The dredge fill consists mainly of fine- to medium-grained sand and shell hash in the western half of the Sewell's Point peninsula. Similar material is found below the construction debris fill at 6 to 14 feet deep in the site's eastern portion. The eastern section of the peninsula (Site 9 fill area) consists of construction debris fill composed of black to brown silts and sands with some gravel pockets. Large amounts of metal debris were observed during test pit and drilling activities. Additionally, coal and glass fragments were noted as well as what appeared to be buried wood pilings.

Ecological Risk: Minimal risk to lower-trophic-level and upper-trophic-level receptors associated with metals and PAHs in surface soil as documented by the ROD. Upon the completion of the NTCRA, no potential unacceptable risk are present.

Human Health Risk: Potential unacceptable risks to site workers, construction workers, adult/child residents, lifetime residents, and recreational child for exposure to surface and subsurface soil. Potential unacceptable risk to future adult/child resident to groundwater as documented in the ROD. The USEPA has determined no action is required to address groundwater at SWMU 14.

FIGURE 12-2
NSN SWMU 14 Conceptual Site Model
Naval Station Norfolk
Norfolk, *Virginia*

SECTION 13

Five-Year Review Summary

The completion of the next Five-year Review for NSN is required by February 2019, 5 years from the completion of this review.

SECTION 14

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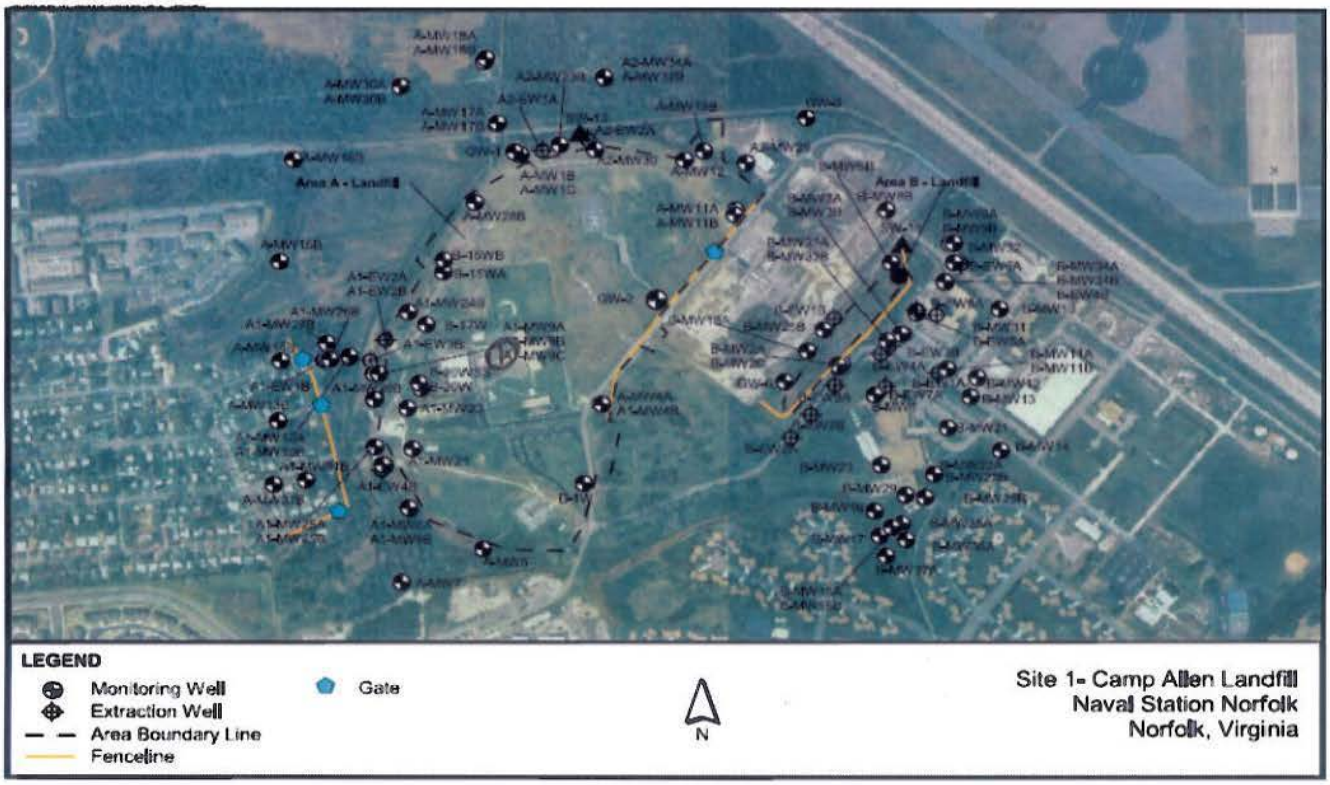
Appendix A
NSN Team Site Inspection Checklists

Site 1 - Camp Allen Landfill
Naval Station Norfolk, Norfolk, Virginia

Description: Site 1 - Camp Allen Landfill is located adjacent southwest of I-564 and consists of two distinct areas (Area A, the 45 acre landfill, and Area B, the 2 acre fire disposal landfill). The Area A landfill operated from the 1940s to 1974 and was used for the disposal of metal plating solution, paint strippers, solvents, chemicals, pesticides, asbestos, ash, and debris. The Area B landfill was used to dispose of drums of waste from a fire at Site 22 - Camp Allen Salvage Yard.



Comments: (Provide related question number for each comment)

1. Demolition of Bldg facility approved by VDEQ and USEPA

Inspection performed by: (Print and sign)	NAVFAC MIDLANT	5/7/2013
Inspection performed by: (Print and sign)	Organization USEPA	Date 5/7/2013
Inspection performed by: (Print and sign)	Organization VDEQ	Date 5/7/2013
	Organization	Date

Site 1 - Camp Allen Landfill
Naval Station Norfolk, Norfolk, Virginia

General

		Yes	No
1	Is the area free of any indication of recent and/or current intrusive activities within the site boundary, as depicted on the figure, or in the immediate vicinity of the site? If no, mark location of intrusive activities on figure, note extent and purpose.	✓	
2	Is the area free of storage of any investigative derived waste (IDW) on site? If no, mark location of IDW on figure, note its condition in the comment section below, and notify activity coordinator. Indicate if IDW is properly labeled, per example below.		✓

Investigative Derived Waste
Purge water from Site 2
January 28, 2003
Do not handle, analysis pending
Contact Winoma Johnson, P.E., IR Coordinator, 444-3418

3	Is the area free of miscellaneous debris? If no, mark location of miscellaneous debris on figure, note its condition in the comment section below, and notify activity coordinator.	✓	
4	Is the area free of stressed vegetation or free of other identifiable concerns with regards to this site? If no, annotate these concerns in the comments section below, mark location of concern on map, and notify activity coordinator.	✓	

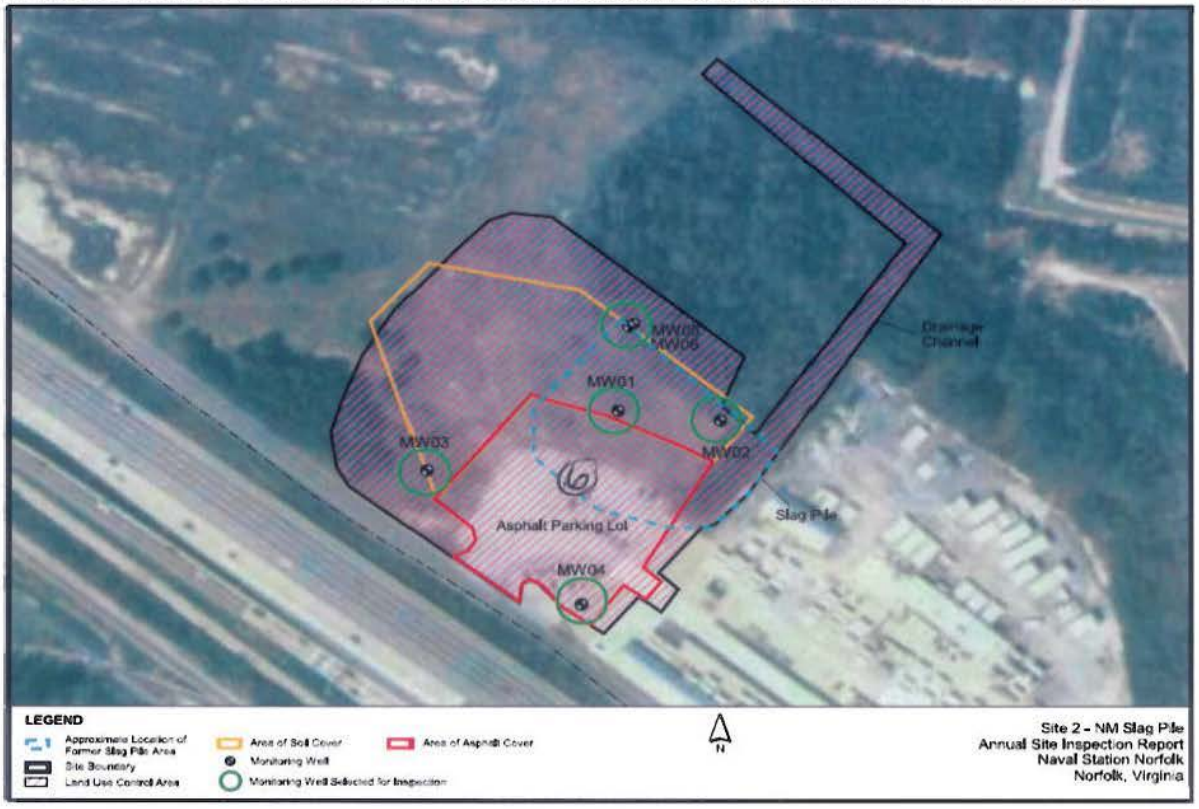
Site Specific

5	Is the site fencing, as depicted on the figure, in good condition and are gates locked? If no, describe condition of fence and/or uncontrolled access points, mark deficient location(s) on map, and notify activity coordinator.	✓	
6	Is the site signage, as depicted on the figure, in good condition? If no, describe condition of signage, mark deficient location(s) on map, and notify activity coordinator.	✓	
7	Are control measures for discharge and/or outfalls, as depicted on the figure and described below, in place and in good condition? (Indicate specific control measures that exist at this site under this question) If no, describe condition of control measures, mark deficient location(s) on map, and notify activity coordinator.	✓	
8	Are site monitoring wells, as depicted on the figure, in good condition and appear to be locked? (i.e. damaged protective posts and/or well head/casing) If no, describe condition of the deficient monitoring well(s), mark location of deficient monitoring well(s) on map, and notify activity coordinator.	✓	
9	Is the area free of any signs of disturbance (i.e. digging, settlement, cracking, holes, erosion) to the site cover/cap, as depicted on the figure? If no, describe condition of the deficient cover/cap, mark location of deficient cover/cap on map, and notify activity coordinator.	✓	

approved demo of brig facility

Site 2 - NM Slag Pile
Naval Station Norfolk, Norfolk, Virginia

Description: Site 2 - NM Slag Pile is located adjacent to the Naval Magazine. The site covers an area of approximately 2 acres and was used in the 1950s and 1960s for the disposal of slag generated by an aluminum smelting process.



Comments: (Provide related question number for each comment)

6. several cracks/seams in asphalt where grass is growing

THOMAS KOWALSKI	NAVFAC MIDLANT	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
[signature]	VDEQ	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
[signature]	USCPA	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date

Site 2 - NM Slag Pile
Naval Station Norfolk, Norfolk, Virginia

		Yes	No
	General		
1	Is the area free of any indication of recent and/or current intrusive activities within the site boundary, as	✓	
2	Is the area free of storage of any investigative derived waste (IDW) on site? If no, mark location of IDW on Investigative Derived Waste	✓	
3	Is the area free of miscellaneous debris? If no, mark location of miscellaneous debris on figure, note its	✓	
4	Is the area free of stressed vegetation or free of other identifiable concerns with regards to this site? If no,	✓	
	Site Specific		
5	Is the area free of any signs of disturbance (i. e. settlement, cracking, holes, erosion) to the site soil cover as depicted on the figure? If no, describe condition of the deficient cover, mark deficient location(s) on map, and notify activity coordinator.	✓	
6	Is the area free of any signs of disturbance (i. e. settlement, cracking, holes, erosion) to the site asphalt cover seams in asphalt where grass is growing		✓
7	Are site monitoring wells, as depicted on the figure, in good condition and appear to be locked? (i.e. damaged protective posts and/or well head/casing) If no, describe condition of the deficient monitoring well(s), mark location of deficient monitoring well(s) on map, and notify activity coordinator.	✓	
8	Is the area free of any signs of disturbance (i. e. settlement, cracking, erosion) to the bank of the drainage channel as highlighted on the figure? If yes, describe condition of the bank, mark locations of deficiencies, and notify activity coordinator.	✓	

Site 3 - Q Drum Storage Area
Naval Station Norfolk, Norfolk, Virginia

Description: Site 3 - Q Area Drum Storage Yard is located adjacent to Piers 10 and 11. The site was used to store tens of thousands of drums containing petroleum products, chlorinated organic solvents, and paint thinners.

Comments: (Provide related question number for each comment)

4. Stressed vegetation in parking lot - caused by cars driving over grass repeatedly

Inspection performed by: (Print and sign)	Organization: NAVFAC MIDLANT	Date: 5/7/2013
Inspection performed by: (Print and sign)	Organization: VDEQ	Date: 5/7/2013
Inspection performed by: (Print and sign)	Organization: USEPA	Date: 5/7/2013

Site 3 - Q Drum Storage Area
Naval Station Norfolk, Norfolk, Virginia

General

	Yes	No
1 Is the area free of any indication of recent and/or current intrusive activities within the site boundary, as depicted on the figure, or in the immediate vicinity of the site? If no, mark location of intrusive activities on figure, note extent and purpose.	Y	
2 Is the area free of storage of any investigative derived waste (IDW) on site? If no, mark location of IDW on figure, note its condition in the comment section below, and notify activity coordinator. Indicate if IDW is properly labeled, per example below.	Y	
3 Is the area free of miscellaneous debris? If no, mark location of miscellaneous debris on figure, note its condition in the comment section below, and notify activity coordinator.	Y	
4 Is the area free of stressed vegetation or free of other identifiable concerns with regards to this site? If no, annotate these concerns in the comments section below, mark location of concern on map, and notify activity coordinator. Stressed vegetation within parking lot		Y

Investigative Derived Waste
Purge water from Site 2
January 28, 2003
Do not handle, analysis pending
Contact Winoma Johnson, P.E., IR Coordinator, 444-3418

Site Specific

5 Are site monitoring wells, as depicted on the figure, in good condition and appear to be locked? (i.e. damaged protective posts and/or well head/casing) If no, describe condition of the deficient monitoring well(s), mark location of deficient monitoring well(s) on map, and notify activity coordinator.	Y	

Site 6 - CD Landfill
Naval Station Norfolk, Norfolk, Virginia

Description: Site 6 - CD Landfill is located adjacent to the Naval Station Norfolk Pass Office along Seebee Rd (see attached figure). The site covers approximately 22 acres and from 1974 to 1979 eastern half of the landfill was used for the disposal of demolition debris, inert waste, fly ash, and incinerator residue. From 1979 to 1987 the western half of the landfill site was used for the disposal of demolition debris and other inert solid wastes.

Comments: (Provide related question number for each comment)

5. Fence requires maintenance

THOMAS KOWALSKI (Inspection performed by: (Print and sign))	NAVFAC MIDLANT (Organization)	5/7/2013 (Date)
(Inspection performed by: (Print and sign))	VDEQ (Organization)	5/7/2013 (Date)
(Inspection performed by: (Print and sign))	USEPA (Organization)	5/7/2013 (Date)

Site 6 - CD Landfill
Naval Station Norfolk, Norfolk, Virginia

General

		Yes	No
1	Is the area free of any indication of recent and/or current intrusive activities within the site boundary, as depicted on the figure, or in the immediate vicinity of the site? If no, mark location of intrusive activities on figure, note extent and purpose.	✓	
2	Is the area free of storage of any investigative derived waste (IDW) on site? If no, mark location of IDW on figure, note its condition in the comment section below, and notify activity coordinator. Indicate if IDW is properly labeled, per example below.	✓	

Investigative Derived Waste
Purge water from Site 2
January 28, 2003
Do not handle, analysis pending
Contact Winoma Johnson, P.E., IR Coordinator, 444-3418

3	Is the area free of miscellaneous debris? If no, mark location of miscellaneous debris on figure, note its condition in the comment section below, and notify activity coordinator.	✓	
4	Is the area free of stressed vegetation or free of other identifiable concerns with regards to this site? If no, annotate these concerns in the comments section below, mark location of concern on map, and notify activity coordinator.	✓	

Site Specific

5	Is the site fencing, as depicted on the figure, in good condition and are gates locked? If no, describe condition of fence and/or uncontrolled access points, mark deficient location(s) on map, and notify activity coordinator. Fence requires maintenance		✓
6	Is the site signage in good condition? If no, describe condition of signage, mark deficient location(s) on map, and notify activity coordinator.	✓	
7	Are control measures for discharge and/or outfalls, as depicted on the figure, in place and in good condition? If no, describe condition of control measures, mark deficient location(s) on map, and notify activity coordinator.	✓	
8	Are site monitoring wells, as depicted on the figure, in good condition and appear to be locked? (i.e. damaged protective posts and/or well head/casing) If no, describe condition of the deficient monitoring well(s), mark location of deficient monitoring well(s) on map, and notify activity coordinator.	✓	
9	Is the area free of any signs of disturbance (i. e. settlement, cracking, holes, erosion) to the site soil cover as depicted on the figure? If no, describe condition of the deficient cover, mark deficient location(s) on map, and notify activity coordinator.	✓	
10	Are the drainage ditches, as depicted on the figure, in place and in good condition? If no, describe condition of the drainage ditch, mark deficient location(s) on map, and notify activity coordinator.	✓	

Site 18 - Former NM Hazardous Waste Storage Area
Naval Station Norfolk, Norfolk, Virginia

Description: Site 18 - Former NM Hazardous Waste Storage Area is located adjacent to the Naval Magazine. The site was used from 1975 to 1979 to store drums of hazardous waste including - waste oil, metal plating solutions, organic acids, and paint stripping solutions. Spillage of hazardous wastes is documented in this area.

Comments: (Provide related question number for each comment)

NO COMMENTS

THOMAS LOWRY SLC	NAVFAC MIDLANT	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
[signature]	VDEQ	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
[signature]	USEPA	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date

Site 18 - Former NM Hazardous Waste Storage Area
Naval Station Norfolk, Norfolk, Virginia

General

		Yes	No
1	Is the area free of any indication of recent and/or current intrusive activities within the land use control boundary, as depicted on the figure, or in the immediate vicinity of the site? If no, mark location of intrusive activities on figure, note extent and purpose.	X	
2	Is the area free of storage of any investigative derived waste (IDW) on site? If no, mark location of IDW on figure, note its condition in the comment section below, and notify activity coordinator. Indicate if IDW is properly labeled, per example below.	X	

Investigative Derived Waste
Purge water from Site 2
January 28, 2003
Do not handle, analysis pending
Contact Winoma Johnson, P.E., IR Coordinator, 444-3418

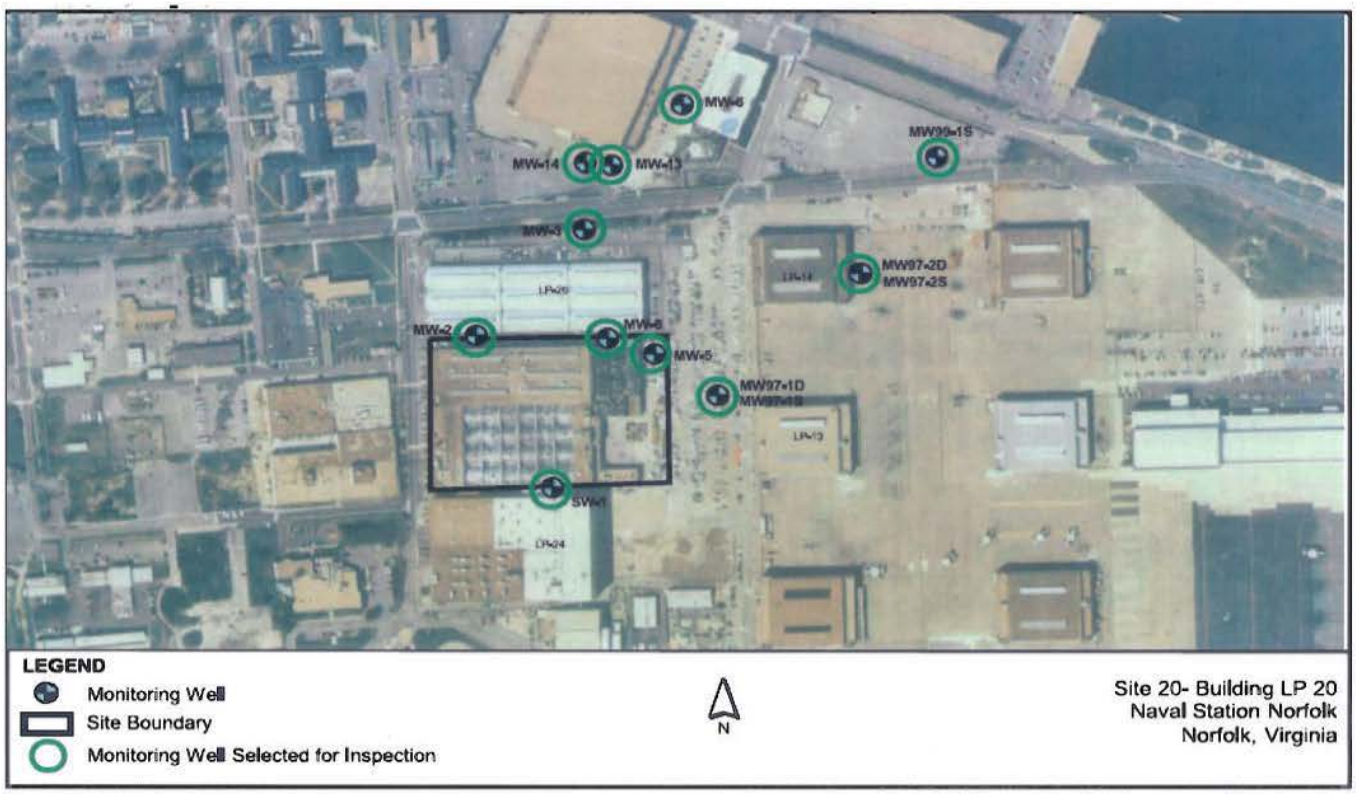
3	Is the area free of miscellaneous debris? If no, mark location of miscellaneous debris on figure, note its condition in the comment section below, and notify activity coordinator.	X	
4	Is the area free of stressed vegetation or free of other identifiable concerns with regards to this site? If no, annotate these concerns in the comments section below, mark location of concern on map, and notify activity coordinator.	X	

Site Specific

5	Are site monitoring wells, as depicted on the figure, in good condition and appear to be locked? (i.e. damaged protective posts and/or well head/casing) If no, describe condition of the deficient monitoring well(s), mark location of deficient monitoring well(s) on map, and notify activity coordinator.	X	

Site 20 - Building LP-20 Site
Naval Station Norfolk, Norfolk, Virginia

Description: Site 20 - Building LP-20 is located northwest of the main runway at Naval Station Norfolk. Building LP-20 was previously used for engine overhaul and maintenance. Wastewater from these processes as well as a large fuel storage area located south of the building are likely sources of contamination in this area.



Comments: (Provide related question number for each comment)

During site walk, 2 air sparge wells were not sealed correctly and air was bubbling out of the well casings.

T Hawks/Lowrscu	NAVFAC Midlant	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
	VDEQ	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
	USCPA	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date

Site 20 - Building LP-20 Site
Naval Station Norfolk, Norfolk, Virginia

General

		Yes	No
1	Is the area free of any indication of recent and/or current intrusive activities within the site boundary, as depicted on the figure, or in the immediate vicinity of the site? If no, mark location of intrusive activities on figure, note extent and purpose.	X	
2	Is the area free of storage of any investigative derived waste (IDW) on site? If no, mark location of IDW on figure, note its condition in the comment section below, and notify activity coordinator. Indicate if IDW is properly labeled, per example below.	X	

Investigative Derived Waste
Purge water from Site 2
January 28, 2003
Do not handle, analysis pending
Contact Winoma Johnson, P.E., IR Coordinator, 444-3418

3	Is the area free of miscellaneous debris? If no, mark location of miscellaneous debris on figure, note its condition in the comment section below, and notify activity coordinator.	X	
4	Is the area free of stressed vegetation or free of other identifiable concerns with regards to this site? If no, annotate these concerns in the comments section below, mark location of concern on map, and notify activity coordinator.	X	

Site Specific

5	Are site monitoring wells, as depicted on the figure, in good condition and appear to be locked? (i.e. damaged protective posts and/or well head/casing) If no, describe condition of the deficient monitoring well(s), mark location of deficient monitoring well(s) on map, and notify activity coordinator.	X	

Site 22 - Camp Allen Salvage Yard
Naval Station Norfolk, Norfolk, Virginia

Description: Site 22 - Camp Allen Salvage Yard is located between Area A and Area B of the Camp Allen Landfill. The site was used from the 1940s to 1995 to salvage and process scrap materials. Site activities included storage and management of waste oils, used chemical, acids, paint thinners, solvents, pesticides, transformers, and scrap industrial/commercial equipment. Site activities also included metal smelting, recycling, and incineration.

Comments: (Provide related question number for each comment)

5/e Fence and signs have been removed ~~because~~ since conversion of the site to recreational fields

Thomas Kowalski, II	NAVFAC MIDLANT	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
	VDEQ	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
	USCG	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date

Site 22 - Camp Allen Salvage Yard
Naval Station Norfolk, Norfolk, Virginia

General

		Yes	No
1	Is the area free of any indication of recent and/or current intrusive activities within the site boundary, as depicted on the figure, or in the immediate vicinity of the site? If no, mark location of intrusive activities on figure, note extent and purpose.	✓	
2	Is the area free of storage of any investigative derived waste (IDW) on site? If no, mark location of IDW on figure, note its condition in the comment section below, and notify activity coordinator. Indicate if IDW is properly labeled, per example below.	✓	

Investigative Derived Waste
Purge water from Site 2
January 28, 2003
Do not handle, analysis pending
Contact Winoma Johnson, P.E., IR Coordinator, 444-3418

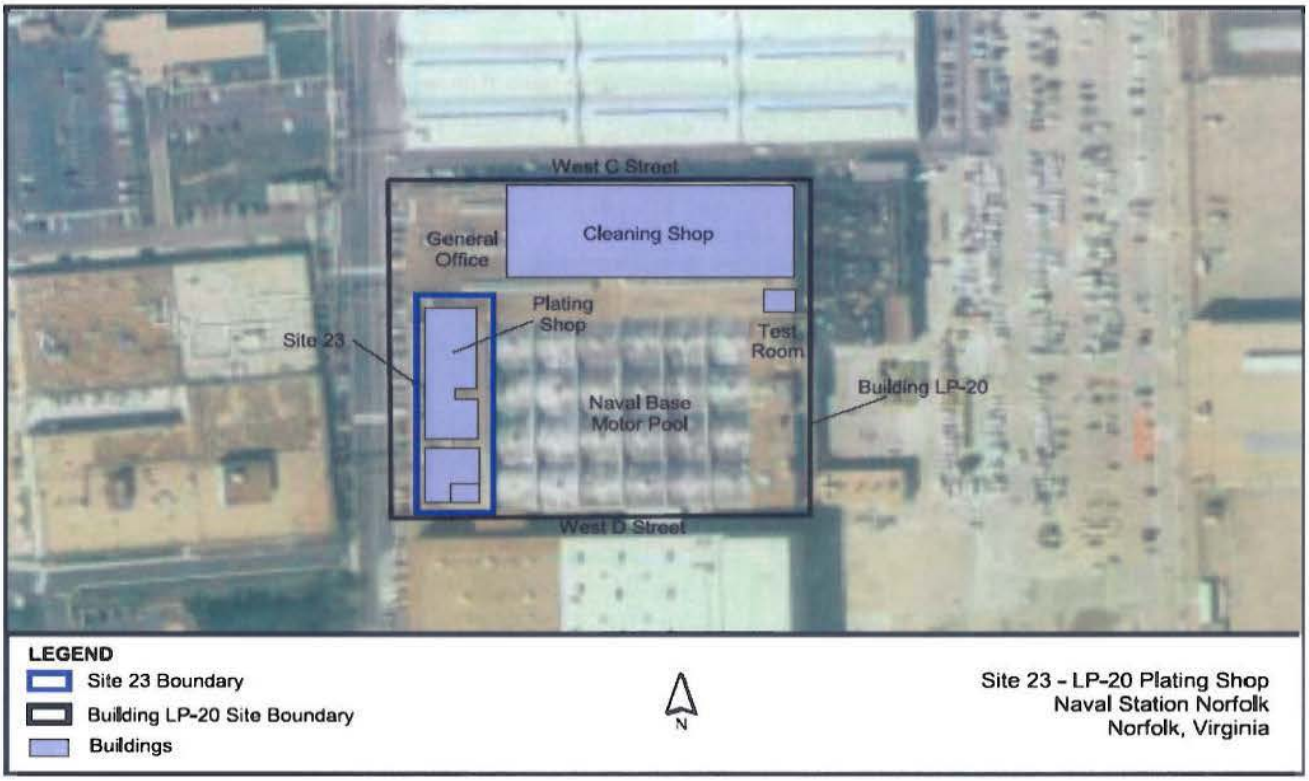
3	Is the area free of miscellaneous debris? If no, mark location of miscellaneous debris on figure, note its condition in the comment section below, and notify activity coordinator.	✓	
4	Is the area free of stressed vegetation or free of other identifiable concerns with regards to this site? If no, annotate these concerns in the comments section below, mark location of concern on map, and notify activity coordinator.	✓	

Site Specific

5	Is the site fencing, as depicted on the figure, in good condition and are gates locked? If no, describe condition of fence and/or uncontrolled access points, mark deficient location(s) on map, and notify activity coordinator. site converted to recreational fields		✓
6	Is the site signage in good condition? If no, describe condition of signage, mark deficient location(s) on map, and notify activity coordinator. site converted to recreational fields & fence/signs removed		✓
7	Are site monitoring wells, as depicted on the figure, in good condition and appear to be locked? (i.e. damaged protective posts and/or well head/casing) If no, describe condition of the deficient monitoring well(s), mark location of deficient monitoring well(s) on map, and notify activity coordinator.	✓	
8	Is the area free of any signs of disturbance (i. e. settlement, cracking, holes, erosion) to the site soil cover as depicted on the figure? If no, describe condition of the deficient cover, mark deficient location(s) on map, and notify activity coordinator.	✓	
9	Is the sedimentation pond free of excessive sedimentation and any signs of disturbance (i.e. digging, settlement, cracking, holes, erosion)? If no, describe condition of the deficient sedimentation pond, mark location of deficient sedimentation pond on map, and notify activity coordinator.	✓	

Site 23 - LP-20 Plating Shop
Naval Station Norfolk, Norfolk, Virginia

Description: Site 23 - LP-20 Plating shop is located northwest of the main runway at Naval Station Norfolk. The building LP-20 Plating Shop was previously used as an engine overhaul facility where metal parts were stripped and re-plated. The shop contains 7 process pits for cleaning, stripping, and plating parts as well as a drainage system for collection of wastewater from the pits.



Comments: (Provide related question number for each comment)

NO comments

THOMAS LOWNSBURY	NAVFAC MIDLANT	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
[signature]	VDEQ	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
[signature]	USEPA	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date

Site 23 - LP-20 Plating Shop
Naval Station Norfolk, Norfolk, Virginia

General

		Yes	No
1	Is the area free of any indication of recent and/or current intrusive activities within the site boundary, as depicted on the figure, or in the immediate vicinity of the site? If no, mark location of intrusive activities on figure, note extent and purpose.	X	
2	Is the area free of storage of any investigative derived waste (IDW) on site? If no, mark location of IDW on figure, note its condition in the comment section below, and notify activity coordinator. Indicate if IDW is properly labeled, per example below.	X	

Investigative Derived Waste
Purge water from Site 2
January 28, 2003
Do not handle, analysis pending
Contact Winoma Johnson, P.E., IR Coordinator, 444-3418

3	Is the area free of miscellaneous debris? If no, mark location of miscellaneous debris on figure, note its condition in the comment section below, and notify activity coordinator.	X	
4	Is the area free of stressed vegetation or free of other identifiable concerns with regards to this site? If no, annotate these concerns in the comments section below, mark location of concern on map, and notify activity coordinator.	X	

SWMU 14 - Q-50 Satellite Accumulation Area
Naval Station Norfolk, Norfolk, Virginia

Description: SWMU 14 - Q-50 Satellite Accumulation Area is located in the northeast corner of Naval Station Norfolk and consisted of a concrete pad that served as a 90-day hazardous waste accumulation pad. This pad has since been demolished and replaced with a new pad located west of the original location. Site 9 - Q Area Landfill forms approximately half of the peninsula located at Sewell's Point and was utilized for the disposal of construction debris from 1974 to 1978. These sites also encompass the drainage lagoon located to the southeast.

Comments: (Provide related question number for each comment)

Western bioretention areas in poor condition. The Navy will conduct maintenance activities to improve the LIDS (anticipate maintenance activities to occur in June).

TOM KOWALSKI	NAVFAC MIDLANT	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
STEVE HIVSH	USEPA	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date
ERIC SCHOPER	VDEQ	5/7/2013
Inspection performed by: (Print and sign)	Organization	Date

SWMU 14 - Q-50 Satellite Accumulation Area
Naval Station Norfolk, Norfolk, Virginia

General

		Yes	No
1	Is the area free of any indication of recent and/or current intrusive activities within the land use control boundary, as depicted on the figure, or in the immediate vicinity of the site? If no, mark location of intrusive activities on figure, note extent and purpose.	✓	
2	Is the area free of storage of any investigative derived waste (IDW) on site? If no, mark location of IDW on figure, note its condition in the comment section below, and notify activity coordinator. Indicate if IDW is properly labeled, per example below.	✓	
3	Is the area free of miscellaneous debris? If no, mark location of miscellaneous debris on figure, note its condition in the comment section below, and notify activity coordinator.	✓	
4	Is the area free of stressed vegetation or free of other identifiable concerns with regards to this site? If no, annotate these concerns in the comments section below, mark location of concern on map, and notify activity coordinator.	✓	

Investigative Derived Waste
Purge water from Site 2
January 28, 2010 (DATE)
Do not handle, analysis pending
Contact Christopher Murray, IR Coordinator, 341-0485

Site Specific

5	Are bioretention areas in good condition and appear to be functioning as intended (i.e. are overflow appartus clogged, trash removed, erosion indicators present?). If no, describe condition and mark location on map, and notify activity coordinator.		

poor condition

Maintenance scheduled w/in next 2 months to repair (first week of June).